UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAINE YANKEE ATOMIC POWER COMPANY
DOCKET NO. 50-309
INTEGRATED ASSESSMENT OF THE MAINE YANKEE
AUXILIARY FEEDWATER SYSTEM

I. An Evaluation Against The Deterministic Criteria Of Standard Review Plan Section 10.4.9, "Auxiliary Feedwater System"

The auxiliary feedwater system was reviewed in accordance with Section 10.4.9 of NUREG-0800 (SRP). An audit review of each of the areas listed in the "Areas of Review" portion of the SRP section was performed according to the guidelines provided in the "Review Procedures" portion of the SRP section. Conformance with the acceptance criteria formed the basis for our evaluation of this system with respect to the applicable regulations of 10 CFR 50. We reviewed the auxiliary feedwater system (AFWS) against the specific acceptance criteria of SRP Section 10.4.9 as follows:

(1) General Design Criterion 2 as related to structures housing the system and the system itself being capable of withstanding the effects of earthquakes. Acceptability is based on meeting Position C.1 of Regulatory Guide 1.29 for safety-related portions and Position C.2 for nonsafety-related portions.

(2) General Design Criterion 4 with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks. The basis for acceptance for this criterion is set forth in SRP Sections 3.5 and 3.6.

(3) General Design Criterion 5 as related to the capability of shared systems and components important to safety to perform required safety functions.

(4) General Design Criterion 19 as related to the design capability of system instrumentation and controls for prompt hot shutdown of the reactor and potential capability for subsequent cold shutdown. Acceptance is based on meeting BTP RSB 5-1, with regard to cold shutdown from the control room using only safety related equipment. (It should be noted that while BTP RSB 5-1 does not apply to operating plants licensed prior to issuance of the SRP, we have included an evaluation against BTP RSB 5-1 in this SER).

(5) General Design Criteria 34 and 44 to ensure the capability to transfer heat loads from the reactor system to a heat sink under both normal operating and accident conditions; redundancy of components so that under accident conditions the safety function can be performed assuming a single active component failure (this may be coincident with the loss of offsite power for certain events); and the capability to isolate components, subsystems, or piping if required so that the system safety function will be maintained.

(6) General Design Criterion 45 as related to design provisions made to permit periodic inservice inspection of system components and equipment.

(7) General Design Criterion 46 as related to design provisions made to permit appropriate functional testing of the system and components to ensure structural integrity and leaktightness, operability and performance of active components, and capability of the integrated system to function as intended during normal, shutdown, and accident conditions.

The following evaluation discusses the implementation of these acceptance criteria and follows the order of SRP 10.4.9 (NUREG-0800). This evaluation also incorporates the staff review of the licensee's response to NUREG-0737 Item II.E.1.1. This includes:

(I) An evaluation against the deterministic criteria of the Standard Review Plan.

(II) An evaluation against the generic recommendations of NUREG-0635.

(III) The evaluation of system reliability based on the NUREG-0635 reliablity study.

(IV) An evaluation of the design basis for the flow capability for the system.

Additionally the staff has included as a fifth section (V) to this SER the staff's evaluation of Multiplant Action Item C-14, "Seismic Qualification of Auxiliary Feedwater System" and a sixth section (VI) which summarizes the open items and items for verification throughout the assessment.

(I) An Evaluation Against the Deterministic Criteria of the Standard Review Plan

The auxiliary feedwater (AFW) system is designed to supply high pressure feedwater to the secondary side of the steam generators when the normal feedwater system is not available, thereby maintaining the heat sink capabilities of the steam generator. It is relied upon to aid in preventing core damage in the event of transients such as loss of normal feedwater or a secondary system pipe rupture.

The original Maine Yankee AFW system consisted of one turbine driven pump and one motor driven pump each with 100% capacity providing redundant emergency feedwater flow. The design was subsequently revised by the installation of a second 100% capacity motor driven pump to replace the turbine driven pump for "emergency feed service."

The licensee subsequently redefined the AFW system as consisting of a turbine driven pump and the emergency feedwater system (EFWS) which contains the two motor driven pumps. By the licensee's redefinition, the EFWS is designed to assure that the health and safety of the public will be protected in the event of certain postulated accidents, such as a loss of a main feedwater event. The EFWS pumps start automatically and receive their power from separate, independent, diesel generator backed safeguards power supplies. The AFW flow control valves and one valve in the steam supply to the turbine are solenoid operated and powered from a vital bus (Division IV). In order to prevent potential single failures resulting from failure of this bus the licensee installed a second solenoid in each of the three flow control valves with the second solenoid deriving power from a separate vital ac bus. The licensee also noted that power can be provided to the steam admissiom valve from emergency bus 7 by means of a local selector switch. Thus, the required emergency feedwater flow is supplied even in the event of a single active failure.

The turbine driven pump receives bearing cooling water directly from a connection to the pump discharge; thus, the pump is independent of all ac power sources. In addition, of the three valves in the steam admission line to the turbine, two are designed to fail open on loss of air. The third valve, the containment isolation valve is designed to fail closed on loss of air. However, this valve is supplied with an air accumulator which will hold the valve open for at least two hours in the event of loss of all ac. Therefore, the turbine-driven AFW pump is capable of operating for at least two hours on loss of all ac.

The turbine driven pump and its associated flow path is capable of being operated independently of any AC power source and can be manually started from a single switch from the control room. The licensee has stated that the turbine driven pump is not required, or relied upon, to mitigate the effects of any postulated design basis accident. However, the turbine driven pump may be used in the event some unusual or unexpected occurrence causes both EFW trains to become inoperable.

As Maine Yankee is a single unit site there is no sharing of structures, systems, and components. Thus the requirements of General Design Criterion 5, "Sharing of Structures, Systems and Components," is not applicable.

The EFW system, including its components and piping are safety-related, seismic Category I, and are located in a tornado-missile proof building. The primary water supply system, including the demineralized water storage tank (DWST) is seismically designed and is Quality Group C up to the flow control valves, and Quality Group B from the flow control valves to the steam generators. Regarding the guidelines of Regulatory Guide 1.29, "Seismic Design Classification," we conclude that for Maine Yankee these guidelines were met when MPA C-14 was found to be acceptable. All other water sources are of nonseismic design and nonsafety-related. Although the turbine driven pump train is not fully seismic Category I, its failure due to seismic event will in no way compromise the two motor driven trains (See Section V of this report concerning seismic qualification of the AFW system). Thus, the EFW system meets the requirements of General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

The EFW system is located in the AFW pumphouse and the turbine driven pump is located in the main steam and feedwater valve area. The three main steam and feedwater lines pass through the main steam and feedwater valve area before entering the turbine generator. A break in any one of these pipes could incapacitate the turbine driven pump; however, it would not effect the two motor driven pumps located in the AFW pumphouse.

Should a pipe break take place in the piping for one of the two motor driven pumps, that break would not incapacitate both motor driven pumps as the escaping water would be at a temperature which would not create a harsh environment in the compartment. Further, the two motor driven pumps are

sufficiently separated within the compartment so that the water escaping from the break would not strike both pumps. In addition, the compartment is open to the extent that a water build-up from flooding would not take place. The turbine driven pump, which is located in a separate compartment, is not vulnerable to a pipe break in the AFW pumphouse.

Regarding internally generated missiles any missile which originates in the compartment which houses the motor driven pumps can not strike the turbine driven pump as it is located in a separate compartment. The reverse of this statement also is true. Further, we conclude that the motor driven pumps are widely separated in the AFW pump room so that a missile from one pump could not damage the other pump train. In any case, the turbine driven pump serves as a backup in the event some unforeseen mishap were to damage both motor driven pump trains.

Thus, the design is in conformance with General Design Criterion 4, "Environmental and Missile Design Bases" as it relates to protection against internally generated missiles.

The EFW system can be operated for approximately four to eight hours from the time the water in the DWST reaches the low level alarm (100,000 gallons). Therefore, the EFW system complies with the guidelines of BTP RSB 5-1 and the requirements of General Design Criterion 19 with regard to achieving cold shutdown from the control room using only safety-related equipment.

The AFW system has the capability to transfer decay heat loads from the secondary (steam) system under all conditions. The EFW system is required to supply a minimum of 450 gpm total flow to at least one of the three steam generators and is capable of supplying at least that amount to a minimum of two steam generators even with the occurrence of a single failure for the following conditions:

(1) loss of normal feedwater

(2) loss of offsite power followed by reactor trip

(3) secondary system pipe rupture

(4) cooldown following steam generator tube rupture

(5) loss-of-coolant accident, small break

The motor driven pump and the turbine driven pump all have a design flow of 500 gpm. A miniflow line for these pumps contains a flow limiting device to assure against excess flow in this line.

The EFW system has been designed to permit periodic testing. In addition, the licensee will perform periodic monthly tests in conformance with the Standard Technical Specifications for Combustion Engineering Pressurized Water Reactors, NUREG-0212. This meets the requirements of General Design Criterion 46, "Testing of Cooling Water System."

The EFW system has been designed to permit inservice inspection and periodic inspection of valves and pumps, thus meeting the requirements of General Design Criterion 45, "Inspection of Cooling Water System."

The EFW system motor driven pumps can be operated from power sources which consist of offsite or onsite (Class 1E) AC power. The turbine driven pump is driven by steam extracted from the steam generators. There are no auxilaries in the train for the turbine-driven pump which require AC power to maintain operation of the train. This meets the guidelines of BTP ASB 10-1.

The EFW system is so designed that the turbine-driven pump portion of the AFW system can be isolated from the portion containing the motor-driven pumps.

The EFW system is designed to supply water to the steam generators without throttling, thus avoiding throttling as a potential source of waterhammer (see also discussion below under GS-3). Waterhammer is also prevented by the lines being full of water by the main feedwater system prior to EFW system initiation.

II. An Evaluation Against the Generic Recommendations of NUREG-0635

We have evaluated the AFW system against the short and long term recommendations of NUREG-0635, "Generic Evaluation of Feedwater Transients and Small Break Loss-Of-Coolant Accidents in Combustion Engineering Designed Operating Plants". The results of our review are discussed below:

Short Term Recommendations

Recommendation GS-1 "The licensee should propose modifications to the Technical Specifications to limit the time that one AFW system pump and its associated flow train and essential instrumentation can be inoperable. The outage time limit and subsequent action time should be as required in current Technical Specifications; i.e., 72 hours and 12 hours, respectively."

The present Maine Yankee limiting conditions for operation (LCO) require that both motor driven pumps be operable when the reactor is in the power operation condition. There is presently no technical specification for the turbine driven pump. In the event one of the motor driven pumps becomes inoperable the LCO permits continued operation of the reactor for seven days; the plant must then proceed to hot shutdown within 6 hours and be in cold shutdown within 30 hours.

We have performed independent evaluations on the subject of AFW pump inoperability due to maintenance outages and its effect on system unavailability with respect to the risk of core melt. These studies do not show significant improvement in systen unavailability or effect on core melt risk between a 72 hour and 7 day LCO for assumed infrequent outages when applied to the motor driven AFW pumps. Thus, we concur with the licensee that the Technical Specifications may be revised to allow a motor driven pump to be inoperable for seven days prior to beginning hot shutdown. However, the studies do indicate that a major accident sequence contributor to the total plant risk of core melt, namely station blackout (loss of all AC power), is affected by the unavailability of the turbine driven AFW pump. The availability of the motor driven AFW pumps is not as critical in the sequence as no credit can be given them in a total loss of AC power condition.

We will require the licensee to include a Technical Specification for the turbine driven pump which would indicate that every measure possible will be taken (including continuous work on all shifts) to restore that pump to operable status within 72 hours. However, if all efforts have failed to restore the pump to the status of operable within the 72 hour period the pump may remain inoperable up to seven days before initiating hot shutdown.

Based on the above, we conclude that the licensee is in compliance with this recommendation, pending incorporation of the change in the proposed technical specifications concerning the turbine driven pump.

Recommendation GS-2 - The licensee should lock open single valves or multiple valves in series in the AFW system pump suction piping and lock open other single valves or multiple valves in series that could interrupt all AFW flow. Monthly inspections should be performed to verify that these valves are locked in the open position. These inspections should be proposed for incorporation into the surveillance requirements of the plant Technical Specifications. See Recommendation GL-2 for the longer-term resolution of this concern.

In response to this recommendation, the licensee indicated in a letter dated November 20, 1979, that all manual valves in the AFW system necessary to assure flow from the primary water source to the steam generators, are currently locked in the open position. Those valves have been added to the plant's ECCS locked valve check list and as such are inspected monthly. The licensee submitted a proposed Technical Specification on February 22, 1980 which incorporated the locked valve alignment and flow path. We have reviewed the licensee's response and conclude that the recommendation has been met and that the Technical Specification submitted February 22, 1980 is acceptable as presently included in the Maine Yankee Technical Specifications. Therefore, we considered this matter to be resolved. However, in a new submittal dated January 14, 1985, the licensee proposed to change Section 4.6B of the Maine Yankee Technical Specifications so that only the manual valves in the emergency feedwater system, i.e., valves in the motor-driven pump trains, would be checked to assure their being locked in the proper position. We find this change unacceptable since this change excludes checking of the position of manual valves in the turbine-driven pump train. We consider this matter closed provided the licensee withdraws the change proposed in the January 14, 1985 submittal.

Recommendation GS-3 - The licensee has stated that it throttles AFW system flow to avoid water hammer. The licensee should reexamine the practice of throttling AFW system flow to avoid water hammer.

The Maine Yankee licensee does not throttle AFW system flow to avoid water hammer. The valves in each of the three lines which contain the pumps are primarily manual valves locked open. Each line containing an AFW pump also contains a stop check valve, an isolation valve and a flow control valve, in series. The stop check is fully open or fully closed so neither it nor the locked open manual valves can be used to throttle flow. The isolation valve and flow control valve are kept fully open. They require an appropriate isolation signal to close, thus they cannot throttle flow. After AFW flow is initiated, the operator may use the flow control valve to adjust flow to each steam generator. Therefore, this recommendation does not apply to Maine Yankee.

Recommendation GS-4 - Emergency procedures for transferring to alternate source of AFW supply should be available to the plant operators. These procedures should include criteria to inform the operators when, and in what order, the transfer to alternate water sources should take place. The following cases should be covered by the procedures:

(1) The case in which the primary water supply is not initially available. The procedures for this case should include any operator actions required to protect the AFW system pumps against self-damage before water flow is initiated; and

(2) The case in which the primary water supply is being depleted. The procedure for this case should provide for transfer to the alternate water sources prior to draining of the primary water supply.

The licensee in a letter dated November 20, 1979, stated that existing emergency procedures will be upgraded to provide instructions for transferring to alternate sources of AFW supply. These procedures should include criteria to inform the operator when, and in what order the transfer to alternate water sources should take place. The case in which the primary water supply is initially not available, as well as the case in which the primary water supply is being depleted, will both be covered. We have been informed that these procedure modifications have been completed. We therefore conclude that this matter is closed.

Recommendation GS-5 The as-built plant should be capable of providing the required AFW flow for at least two hours from one AFW pump train independent of any ac power source. If manual AFW system initiation or flow control is required following a complete loss of ac power, emergency procedures should be established for manually initiating and controlling the system under these

conditions. Since the water for cooling of the lube oil for the turbine-driven pump bearings may be dependent on ac power, design or procedural changes shall be made to eliminate this dependency as soon as practicable. Until this is done, the emergency procedures should provide for an individual to be stationed at the turbine-driven pump in the event of the loss of all ac power to monitor pump bearing and/or lube oil temperatures. If necessary, this operator would operate the turbine-driven pump in an on-off mode until ac power is restored. Adequate lighting powered by direct current (dc) power sources and communications at local stations should also be provided if manual initiation and control of the AFW system is needed. (See Recommendation GL-3 for the longer-term resolution of this concern.)

As stated previously the AFW system design contains a turbine driven pump that can provide 100% of the required flow without ac power dependency. Cooling water for turbine bearings and lube oil is provided by a tap on the pump discharge and is therefore independent of all ac power sources. The air operated containment isolation valve for this pump has an independent air receiver which provides in excess of two hours of reserve air. The remaining two solenoid operated valves in the steam supply to the AFW pump turbine are designed to fail open on loss of power. The turbine driven AFW pump and its associated flow path is capable of being operated independently of any ac power source and the pump may be started by activating a single switch from the control room.

The licensee stated that the turbine driven AFW pump is not required, or relied upon, to mitigate the effects of any postulated design basis accident. However, the turbine driven pump may be used if multiple single failure in the motor driven EFW pumps or power supplies or other nondesign basis events are postulated.

We conclude that the Maine Yankee AFW system design complies with this recommendation regarding manual initiation. See GL-3 regarding automatic initiation.

Recommendation GS-6 - The licensee should confirm flow path availability of an AFW system flow train that has been out of service to perform periodic testing or maintainance as follows:

(1) Procedures should be implemented to require an operator to determine that the AFW system valves are properly aligned and a second operator to independently verify that the valves are properly aligned.

(2) The licensee should proposed Technical Specifications to assure that, prior to plant startup following an extended cold shutdown, a flow test would be performed to verify the normal flow path from the primary AFW system water source to the steam generators. The flow test should be conducted with AFW system valves in their normal alignment.

The licensee in a letter dated November 20, 1979, stated that the valves in the AFW system, by procedure, are placed in their operational configuration as part of restoring the system to service following maintenance or testing. An independent verification of this valve alignment will be made. The licensee further stated that a Technical Specification change will be made by February 1, 1980, to require a flow test of the AFW system prior to plant startup following an extended cold shutdown. The proposed Technical Specification, which was provided on February 22, 1980, included the required flow test. This has been incorporated into the Maine Yankee Technical Specifications. Therefore, we considered this matter to be resolved. However, in a new submittal dated January 14, 1985, the licensee proposed to change Section 4.6B of the Maine Yankee Technical Specifications, to require that a flow test be conducted prior to startup, after an extended cold shutdown with the emergency feedwater

valves, i.e., the valves in the trains containing the motor driven pumps, in their normal position. We find this unacceptable since this change would exclude the train containing the turbine-driven pump from such tests. We consider this matter closed, provided the licensee withdraws the change proposed in the January 14, 1985 submittal.

Recommendation GL-7 - The licensee should verify that the automatic start AFW system signals and associated circuitry are safety-grade. If this cannot be verified, the AFW system automatic initiation system should be modified in the short-term to meet the functional requirements listed below. For the longer term, the automatic initiation signals and circuits should be upgraded to meet safety-grade requirements as indicated in Recommendation GL-1.

(1) The design should provide for the automatic initiation of the AFW system flow.

(2) The automatic initiation signals and circuits should be designed so that a single failure will not result in the loss of AFW system function.

(3) Testability of the initiation signals and circuits shall be a feature of the design.

(4) The initiation signals and circuits should be powered from the emergency buses.

(5) Manual capability to initiate the AFW system from the control room should be retained and should be implemented so that a single failure in the manual circuits will not result in the loss of system function.

(6) The ac motor-driven pumps and valves in the AFW system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.

The control grade circuitry to automatically start the two motor driven pumps was evaluated under GS-8.

Recommendation GS-8 - The licensee should install a system to automatically initiate AFW system flow. This system need not be safety-grade; however, in the short-term, it should meet the criteria listed below, which are similar to Item 2.1.7a of NUREG-0578. For the longer term, the automatic initiation signals and circuits should be upgraded to meet safety-grade requirements as indicated in Recommendation GL-1.

(1) The design should provide for the automatic initiation of the AFW system flow.

(2) The automatic initiation signals and circuits should be designed so that a single failure will not result in loss of AFW system function.

(3) Testability of the initiating signals and circuits should be a feature of the design.

(4) The initiating signals and circuits should be powered from the emergency buses.

(5) Manual capability to initiate the AFW system from the control room should be retained and should be implemented so that a single failure in the manual circuits will not result in the loss of system function.

(6) The ac motor-driven pumps and valves in the AFW system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.

(7) The automatic initiation signals and circuits should be designed so that their failure will not result in the loss of manual capability to initiate the AFW system from the control room.

The licensee in a letter dated November 20, 1979, committed to install a control grade system for the short term. That commitment was acceptable to the staff. The licensee also committed to upgrade the system to safety grade following receipt of equipment - see GL-1 for evaluation of safety grade control system.

Recommendation 1- The licensee should proposed a revision to the Technical Specification to require periodic AFWS operability testing on a monthly frequency rather than quarterly in conformance with current Standard Technical Specifications.

In a submittal dated September 22, 1983, the licensee committed to submit a proposed change to the Technical Specifications to require monthly auxiliary feedwater system operability testing in lieu of the present testing on a quarterly basis. The licensee proposes to perform these pump tests at minimum recirculation flow with separate cycle testing of key valves. We conclude that this commitment is acceptable provided that the licensee staggers the tests so that a single error cannot make more than one train or pump inoperative. Pending receipt of a clarification on this open point we considered this item resolved. However, in a new submittal dated January 14, 1985, the licensee proposed to change Section 4.6B of the Maine Yankee Technical Specifications to require monthly operability testing of the emergency feedwater pumps, i.e., the motor-driven pumps. We find this unacceptable since this change would exclude the turbine-driven pump from such tests. We consider this matter closed, provided the licensee withdraws the change proposed in the January 14, 1985 submittal.

Recommendation 2 - A pneumatic-operated valve in the steam supply line to the turbine-driven AFW pump, and the three pneumatic-operated AFW flow control valves derive their power from the same AC vital instrument bus. Although these valves are designed to fail open upon the loss of air or power, thereby assuring auxiliary feedwater flow to the steam generators upon such losses, it cannot be concluded that all failures will result in opening the valves. The consequences of voltage degradation should be analyzed as well as other failures (e.g., restricted air flow) to assure that such events would not incapacitate the auxiliary feedwater system. Establish suitable emergency procedures to assure AFWS function for such events. (See Long-Term Recommendation Number 3.)

In a submittal dated August 21, 1981, the licensee specified that the Maine Yankee emergency procedures include direction for manual control of feedwater control valves, if necessary. In a meeting on June 28, 1983, the licensee stated that the emergency procedures for loss of all ac power include manual control of the valves in the line carrying steam to the turbine of the AFW steam-driven pump. On loss of ac the valves would normally fail in the open position (see Long Term Recommendation GL-3 for detailed discussion); manual control serves as a precautionary measure in the event an unusual failure should occur. We conclude that this matter is resolved.

Recommendation 3 - The licensee should verify that the air accumulator will hold the containment isolation valve in the turbine driven pump steam supply line open for at least two hours following loss of all AC power.

In a letter dated November 20, 1979, the licensee stated that a test to confirm that the air accumulator will hold the air operated valve in the turbine driven pump steam supply line open for at least two hours following loss of the normal air supplies will be conducted.

The test was conducted on the accumulators and the valves were held open for the required two hours.

We conclude that this matter is resolved.

Additional Short-Term Recommendations

Recommendation 1 - The licensee should provide redundant level indication and low level alarms in the control room for the AFW system primary water supply to allow the operator to anticipate the need to make up water or transfer to an alternate water supply and prevent a low pump suction pressure condition. The low level alarm setpoint should allow at least 20 minutes for operator action, assuming that the largest capacity AFW pump is operating.

In a letter dated November 20, 1979, the licensee stated that the control board presently has a level indicator, a low level alarm and a low-low level alarm for the demineralized storage tank. In addition, there is a local gauge available at the tank which measures in feet of water. Since the low level alarm will alert the operator at approximately 100,000 gallons thus providing four to eight hours for action to be taken, the licensee feels that a redundant alarm or indication is unnecessary. The operator will also receive an additional low-low level alarm at 10,000 gallons, which provides 30 minutes to line up to another water source.

While the low-low level alarm sensor and the indicating level sensor are independent of each other, it is not clear to the staff that the low level alarm is separate from both of these sensors. In any case, we conclude that the licensee should provide redundant level indicators and alarms at 20 minutes to alert the operator prior to reaching minimum allowable water level in the tank. We will report resolution of this matter in a supplement to this SER.

Recommendation 2 - The licensee should perform a 72-hour endurance test on all AFW system pumps, if such a test or continuous period of operation has not been accomplished to date. Following the 72-hour pump run, the pumps should be shut down and cooled down and then restarted and run for one hour. Test acceptance criteria should include demonstrating that the pumps' bearing/bearing oil

temperatures and vibration remain within design limits and that pump room ambient conditions (temperature, humidity) do not exceed environmental qualification limits for safety-related equipment in the room (This recommendation was subsequently changed to 48 hours).

In a letter dated February 20, 1980 the licensee provided the results of their 72 hour endurance test on the AFW system pumps. The results were acceptable in that the above stated test criteria were met. We conclude that this matter is resolved.

Recommendation 3 - The licensee should implement the following requirements as specified by Item 2.1.7.b on page A-32 on NUREG-0578:

(1) Safety-grade indication of AFW flow to each steam generator should be provided in the control room.

(2) The AFW flow instrument channels should be powered from the emergency buses consistent with satisfying the emergency power diversity requirements for the AFW system set forth in Auxiliary Systems Branch Technical Position 10-1 of the Standard Review Plan, Section 10.4.9.

The licensee's submittal was previously reviewed and approved by the SER dated September 3, 1982, forwarded to the licensee by a letter. The SER concluded that the AFW flow indication complied with the applicable criteria. Based on this SER we conclude that this issue is resolved.

Recommendation 4 - Licensee with plants which require local manual realignment of valves to conduct periodic tests on one AFW system train, and which have only one remaining AFW train available for operation should propose Technical Specifications to provide that a dedicated individual who is in communication with the control room be station at the manual valves. Upon instruction from

the control room, this operator would realign the valves in the AFW system from the test mode to its operational alignment.

As stated previously in this SER the Maine Yankee EFW system consists of two motor driven feedwater pumps. If either of the two trains is in a test mode the turbine driven pump is available as backup thereby providing two pumps for operation.

We, therefore, conclude that this recommendation does not apply to Maine Yankee.

Long Term Recommendations

Recommendation GL-1 - For plants with a manual starting AFW system, the licensee should install a system to automatically initiate the AFW system flow. This system and associated automatic initiation signals should be designed and installed to meet safety-grade requirements. Manual AFW system start and control capability should be retained with a manual start serving as backup to automatic AFW system initiation.

The licensee's submittal regarding a safety grade start circuit for the EFW system was previously reviewed by the SER forwarded to the licensee by a letter dated September 3, 1982. (See GL-3 for evaluation of automatic start for the turbine driven pump).

We understand that this item is still open due to the fact that the Technical Specification has not been approved because of some concern regarding surveillance of logic circuits.

Recommendation GL-2 - Licensees with plant designs in which all (primary and alternate) water supplies to the AFW systems pass through valves in a single flow path should install redundant parallel flow paths (piping and valves).

Licensees with plants in which the primary AFW system water supply passes through valves in a single flow path, but the alternate AFW system water supplies connect to the AFW system pump suction piping downstream of the above valve(s) should install redundant valves parallel to the above valve(s) or provide automatic opening of the valve(s) from the alternate water supply upon low pump suction pressure. The licensee should propose Technical Specifications to incorporate appropriate periodic inspections to verify the valve positions.

The primary water supply for the Maine Yankee AFW system (from the demineralized water storage tank - DWST) passes through a valve in a single flow path with the alternative water supply (from the primary water storage tank - PWST) connecting to the AFW pump suction piping downstream of the single valve. In a submittal dated September 22, 1983, the licensee proposed to remove the internals from the valve in order to avoid possible valve failure which would block the flow of water from the DWST to the AFW pumps. The licensee committed to remove the valve internals during the next refueling outage. Pending verification that the valve internals have been removed we conclude that the first part of this recommendation is resolved.

In accordance with Recommendation GS-2 under Short Term Recommendations, Maine Yankee committed to include in the plant Technical Specifications the requirement that all manual valves in the AFW system necessary to assure flow from the primary water source to the steam generators be locked in the proper position. A proposed change to Maine Yankee's Technical Specifications which will meet this commitment was submitted on February 22, 1980 and found acceptable (see GS-2). We conclude that the second part of the recommendation has also been resolved.

Recommendation GL-3 - At least one AFW system pump and its associated flow path and essential instrumentation should automatically initiate AFW system flow and be capable of being operated independently of any ac power source for at least two hours. Conversion of dc power is acceptable.

As stated previously in this evaluation the Maine Yankee AFW system design consists of a turbine-driven pump and the EFW system which in turn consists of two motor driven pumps. The licensee has stated that the turbine-driven pump is not depended upon to mitigate the effects of any postulated design basis accident. However it may be used if multiple single failures in the motor driven EFW pumps or power supplies or other nondesign basis events are postulated. The turbine-driven pump can be started manually from the control room by the use of a single switch to provide water to the steam generators in the case of a complete loss of all ac.

Based on the low probability of this particular event, complete loss of all ac, and the fact that the dry out time of the steam generators under such condition is of the order of 30 minutes, we conclude that for Maine Yankee the manual start of the turbine-driven pump is acceptable.

Recommendation GL-4 - Licensees having plants with unprotected normal AFW system water supplies should evaluate the design of their AFW systems to determine if automatic protection of the pumps is necessary following a seismic event or a tornado. The time available before pump damage, the alarms and indications available to the control room operator, and the time necessary for assessing the problem and taking action should be considered in determining whether operator action can be relied on to prevent pump damage. Consideration should be given to providing pump protection by means such as automatic

switchover of the pump suctions to the alternate safety-grade source of water, automatic pump trips on low suction pressure, or upgrading the normal source of water to meet seismic Category I and tornado protection requirements.

The EFW system, including components and piping are safety-grade, seismic Category I and are located in tornado-missile proof buildings. The primary water supply system, including the demineralized water storage tank is seismically designed and is Safety Class 3 up to the regulating valves and Class 2 from the regulating valves to the steam generators. We, therefore, conclude that this recommendation does not apply to Maine Yankee.

Recommendation GL-5 - The licensee should upgrade the AFW system automatic initiation signals and circuits to meet safety-grade requirements.

The AFW system automatic initiation signals and circuits have been installed to meet safety-grade requirements - see GL-1 for evaluation.

Recommendation 3 - Modify the AFWS design to eliminate the potential for adverse response of the three AFW flow control valves and one of the steam admission valves to the turbine pump due to degradation of power of the Division IV vital bus, e.g., provide service to these valves from different Division.

In a letter dated November 20, 1979, the licensee stated that the AFW system design will be modified to eliminate the potential for adverse response of the three AFW flow control valves and one of the steam admission valves to the turbine pump due to degradation of power to these valves, e.g., provide service to these valves from different vital power supplies. This potential problem was corrected by the installation of an additional solenoid to operate each valve with one solenoid receiving power from vital bus 1, the other solenoid receiving power from vital bus 3. The licensee further stated that the

steam admission valve to the turbine driven pump is normally powered from vital bus 4; power can be provided from emergency bus 7 by means of a local selector switch. We conclude that this matter is resolved.

Recommendation 4 - The licensee should evaluate the following concerns:

Part a. A pipe break in the auxiliary feedwater system common discharge header could result in the loss of auxiliary feedwater system function even without a postulated single active failure. The licensee indicated that in such an event the auxiliary feedwater can be manually routed through the main feedwater lines to the steam generators after isolating the header from the AFW pumps. We conclude that this matter is resolved.

Part b. In the event of a steam or feedwater line break (main or auxiliary), isolation of the auxiliary feedwater flow path to the affected steam generator is accomplished manually. The licensee should evaluate these postulated pipe breaks and (1) determine any AFW system design changes or procedures necessary to detect and isolate the break and direct the required feedwater flow to the steam generator(s) before they boil dry or (2) describe how the plant can be brought to safe shutdown condition by use of other systems which would be available following such postulated events. The licensee reported that the AFW system had been modified during the cycle 6 outage as follows:

(1) Provision of automatic starting of the two motor-driven AFW pumps upon low water level signal from any one of the three steam generators,

(2) Modification of the auxiliary feedwater control valves so that each closes individually upon a low steam generator pressure signal. In the event of a steam line break this will isolate the steam generator in the train which contains the ruptured piping,

(3) Provision of a five-minute delay in initiation of the two motor-driven AFW pumps (or tripping of the two motor-driven pumps for five minutes if already running) upon receipt of the steam generator low pressure signal, in order to prevent an overpower transient in the event of a steamline break.

Note that this design requires operator intervention to direct AFW flow to the undamaged steam generators, if the control valve in the damaged steam generator were to fail and remain open after receipt of the EFCV signal, in order to prevent steam generator "dryout" because most of the water from the AFW system would then be diverted to the damaged steam generator.

In a further submittal dated September 22, 1983, the licensee stated their plans to install additional AFW valves, in series with the existing flow control valves and to remove the 5-minute delay (or pump trip and delay in the event of operating AFW pumps) in starting the motor-driven AFW pumps. In this way the auxiliary feedwater will be isolated from the affected steam generator and no operator intervention will be require to assure continued water flow to the unaffected steam generators in the event of a feedwater or steam-line break. The system design has been examined and has been found to be single-failure proof. Therefore we consider this matter closed.

With regard to failure of the common AFW system discharge manifold, the licensee noted that each AFW pump discharge can be directed to the feedwater pump discharge lines upstream of the first point heaters. This involves closing one AFW pump discharge valve, opening another valve at the discharge of each AFW pump (leading to the normal feedwater lines) and opening one valve in the common manifold to the normal feedwater lines). Thus, three valves will need to be operated (one closed, two opened) to switch the first AFW pump flow

to the alternate flow path (each of the other two pumps only requires closing one discharge valve and opening another if either pump is needed). The licensee should show that the AFW pumps can be diverted by the plant operators in sufficient time to prevent steam generator dryout in the event of an AFW manifold break when either (or both) motor driven pump is being used in its normal operating mode (not for accident mitigation). Pending receipt of a satisfactory submittal regarding operator diversion time, we find the portion of the recommendation relating to an AFW line break incomplete.

III An Evaluation Of System Reliability Based On NUREG-0635 Reliability Study And Subsequent System Updates

A reliability analysis was conducted by the staff for all CE operating plants by the Bulletins and Orders Task Force in 1979 after the TMI-2 event as documented in NUREG-0635. This analysis considered AFW system availability for the following three demand transients/accidents:

Case 1: Loss of Main Feedwater
Case 2: Loss of Main Feedwater/Loss of Offsite Power
Case 3: Loss of Main Feedwater/Loss of All Alternating Current Power

The above study found the Maine Yankee AFW system to be in the low reliability range for Cases 1 and 2, and in the medium range for Case 3. The primary reason for this conclusion (dominant contributor to unavailability) was that all AFW pumps originally required manual starting by the control room operators. This reliance significantly reduced the system availability when compared to AFW systems with automatic pump initiation. Since the original study, the licensee has made a number of modifications to the AFW system to improve its reliability including the addition of automatic start capability for the two motor driven pumps as previously described. It is our judgement that the Maine Yankee AFW system now demonstrates acceptable reliability for assuring its safety function.

IV An Evaluation Of The Design Basis For The Flow Capability For The System

Basis for AFW System Flow Requirement - "In Enclosure 2 to our letter of October 18, 1979, we requested the licensee to provide certain information regarding the design basis for AFW flow requirements."

The licensee stated in a letter dated November 20, 1979, that the required information would be submitted at a later date."

In a submittal dated August 21, 1981, the licensee noted that the design basis events for the Maine Yankee AFW system were those shown in Table 1, below. The bounding event for the design of the AFW system is the loss-of-main-feedwater (LMFW). The licensee reported that loss of all ac and feedwater line break were not part of the spectrum of design basis events for Maine Yankee.

TABLE 1

1) Loss of Main Feedwater (LMFW)
2) LMFW w/loss of Offsite AC Power
3) Turbine Trip With And Without Bypass
4) Main Steam Isolation valve closure
5) Main Steam Line Break
6) Small Break LOCA

In the event a LMFW event occurred, the licensee stated that the steam generators would dry out in 13 minutes with offsite power available and in 30 minutes with offsite power unavailable assuming the AFW system did not start. Further, the licensee noted that, in the event of a loss of all ac, the operator would have 30 minutes in which to start the turbine driven AFW pump before steam generator dryout occurred.

The licensee reports that a single AFW pump is capable of removing the total combined heat resulting from reactor coolant pump operation and decay heat seven minutes after the LMFW event begins. In addition, the minimum inventory of 100,000 gallons of water available (discussed above in Additional Short Term Recommendation 1) to the AFW system in the DWST is sufficient to remove the combined heat load (generated by reactor coolant pumps and decay heat) for at least four hours -- eight hours if the reactor coolant pumps do not operate.

We find the licensee's design basis flow requirements for the AFW system acceptable because the licensee has shown that the design flow rate is capable of mitigating those transients and accidents and for which use of the AFW system is necessary to assure a safe plant shutdown.

Conclusion

Except as noted below, we conclude that the AFWS complies with the requirements of General Design Criteria 2, 4, 5, 19, 45 and 46 with regard to protection against natural phenomena, missile protection, sharing, shutdown from the control room, and inspection and testing of the AFWS; the guidelines of Regulatory Guides 1.29, and BTPs RSB 5-1 and ASB 10-1 regarding seismic classification, shutdown from the control room with a single failure and AFWS power diversity; and the recommendations of NUREG-0635 concerning generic improvements to the AFWS design, procedures and specifications.

Based on the AFW system reliability analysis as documented in NUREG-0635 and the system upgrades as discussed in this SER it is our judgement that the Maine Yankee AFW system now demonstrates acceptable reliability and meets criteria 34 and 44.

V. Multiplant Action Item C-14, "Seismic Qualification Of Auxiliary Feedwater System"

Introduction

Since the accident at Three Mile Island attention has been focused on the ability of pressurized water reactors to provide reliable decay heat removal. While it is recognized that alternate methods may be available to remove decay heat following transients or accidents, heat removal via the steam generators is the first choice for accomplishing a safe shutdown of the plant. Therefore, there should be reasonable assurance that the auxiliary feedwater (AFW) system can withstand the postulated Safe Shutdown Earthquake (SSE), consistent with other safety-related systems in the plant.

To address this concern, the NRC developed and initiated Multiplant Action C-14, "Seismic Qualification of Auxiliary Feedwater Systems." The objective of this plan is to increase, to the extent practicable, the capability of those plants without seismically qualified AFW to withstand earthquakes up to the SSE level. This program was implemented with the issuance of NRC Generic Letter 81-14, dated February 10, 1981. Our review of the licensee's responses to this letter is the subject of this evaluation.

Evaluation

The attached* technical evaluation report (TER) dated August 19, 1982 was prepared by our consultant, Lawrence Livermore National Laboratory. The report provides our consultant's technical evaluation of the licensee's conformance to the criteria of Generic Letter 81-14. We have reviewed our consultant's report and agree with its content.

In the TER, our consultant concludes that the AFW system is seismically qualified for the safe shutdown earthquake, with certain exceptions. The exceptions are, (1) the AFW system piping, (2) the AFW system valves/actuators, and (3) AFW power supplies. These concerns have been resolved as discussed below.

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* This TER was previously, provided to the licensee by letter dated August 9, 1984.

1. The AFW System Piping

Subsequent to issuance of our consultant's TER, we obtained additional information regarding the AFW system seismic boundaries. The licensee stated in a letter dated October 10, 1984 that all the piping and components of the AFW system except as discussed below are seismically qualified to FSAR SSE criteria. The only AFW system piping not explicitly analyzed to the SSE are two small diameter lines which connect locally at the turbine driven AFW pump. These lines are the lube oil cooling outlet line and the minimum flow recirculation line for the turbine driven pump. Postulated failure of these lines is not a major concern since the turbine driven pump is not required for shutdown following an SSE and leakage will not impact the operation of the two motor driven pumps.

Even so the licensee has committed to upgrade the line as follows:

(a) A check valve will be installed in the lube oil cooling outlet line, and the line will be seismically analyzed from the suction line connection upstream of the check valve to a point of orthogonal restraint.

(b) The minimum recirculation line will ne analyzed from the pump discharge line connection downstream of the flow restricting orifice to a point of orthogonal restraint. The flow orifice will limit leakage from a downstream break to approximately 5-6 pgm which is acceptably small, and will not compromose AFW safety function following an SSE.

We consider this matter resolved.

2. Valves Actuators

The licensee stated in a letter dated October 10, 1984 that the flow control valve/actuator assemblies have been upgraded to meet FSAR SSE criteria. The pneumatic/electric control system used for remote manual throttling of each control valve is not qualified to operate during a seismic event, but is

fully expected to be functional post-earthquake. However, should a failure of this remote manual throttling control scheme occur, flow can be restored and regulated locally by utilizing the full flow bypass valves. Such a failure would be identifiable in the control room by AFW flow indication and steam generator water levels.

We consider this matter resolved.

3. AFW Power Supplies

The licensee also stated in the October 10, 1984 letter that the electric power cables associated with the AFW system are run in both conduit and cable trays. Design records indicate that the cable tray systems at Maine Yankee were designed to FSAR SSE criteria.

The original Stone and Webster Electric Standard specified that conduit be installed in accordance with the latest standards of the National Electrical Code. The seismic adequacy of conduit installations will be addressed in the generic Seismic Qualification Utility Group (SQUG) evaluation program. Although the experience data base has not yet been fully developed, there is strong evidence that conduit does not fail in seismic events given adequate cabinet anchorages, i.e., there are no inertial failures. Upgrades to these anchorages at Maine Yankee were presented to the staff on September 18, 1984. The licensee stated in a telephone conference call with the staff that all upgrades to cabinet anchorages have been completed. The documentation of these improvements will be provided to the staff in April 1985.

Pending receipt of acceptable documentation of the anchorage upgrades we consider this matter resolved.

Walk-Down Of AFW System

The licensee stated in the October 10, 1984 letter that complete walkdowns of the AFW system piping both small diameter and large diameter were made.

Based on previous licensee statements concerning the small diameter piping connected to the turbine driven pump as being the only AFW system piping not explicitly seismically analyzed, and resolution of the concern regarding seismic qualification of AFW piping, we conclude that no further walkdowns are necessary.

Conclusion

The staff and its consultant, Lawrence Livermore National Laboratory (LLNL) have reviewed the licensee's submittals for Maine Yankee in response to Generic Letter 81-14. As a result of its review, our consultant has provided a TER. The staff has reviewed the TER and concurs with its findings. The TER is a part of this safety evaluation report. Subsequent to the consultant's technical review, the staff obtained additional information from the licensee regarding the open issues identified in the TER. Based on our review of the consultant's TER and the additional information provided by the licensee, we conclude that there is reasonable assurance that the auxiliary feedwater system at Maine Yankee has sufficient capability to withstand a safe shutdown earthquake and accomplish its safety function. Further, postulated failure of the turbine driven pump train is not a major concern since this train is not required for shutdown following an SSE and leakage will not impact the operation of the emergency feedwater system. Accordingly, we are not contemplating requiring any seismic upgrading of the Maine Yankee AFW system under Multiplant Action C-14 beyond that identified by the licensee.

VI Open Items And Items For Verification

A. Open Items

1. The licensee should propose modifications to the Technical Specifications to limit the time that the turbine driven pump can be inoperable - GS-1.

2. The licensee should provide redundant level indicators and alarms for the DWST - Additional Short-Term Recommendation 1.

3. Safety grade automatic start circuit for motor driven pumps do not have approved Technical Specifications. As stated in the SER, ICSB is pursuing this matter - GL-1.

B. Items For Verification

1. Recommendation GL-2 - The licensee should provide verification that the valve internals have been removed from the valve in the AFW supply line.

2. Long Term Recommendation 4 - The licensee should provide information regarding operator diversion time in the event a break occurs in the AFW header.

3. Short Term Recommendation 2 - The licensee should verify that monthly surveillance testing of the AFW system will include staggered testing so that a surveillance error will not effect more than one train.

4. Seismic Qualification Item 3, AFW Power Supplies - The licensee should provide documentation to show that all upgrades to cabinet anchorages have been completed.