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August 26, 1982

In reply, please
refer to LAC-8535

DOCKET NO. 50-409

Director of Nuclear Reactor Regulation
ATTN: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: DAIRYLAND POWER COOPERATIVE
LA CROSSE BOILING WATER REACTOR (LACBWR)
PROVISIONAL OPERATING LICENSE NO. DPR-45
SEP TOPIC VII-3, "SYSTEMS REQUIRED FOR SAFE SHUTDOWN", AND
SEP TOPIC III-1, "CLASSIFICATION OF STRUCTURES, COMPONENTS & SYSTEMS

REFERENCES: (1) NRC Letter, Crutchfield to Linder, dated December 22, 1980
(2) NRC Letter, Crutchfield to Linder, dated March 9, 1982, (enclosed)
(3) DPC Letter, Linder to Crutchfield, LAC-8382, dated July 2, 1982

Gentlemen:

A review of some material on Safe Shutdown Systems at LACBWR showed that DPC had not submitted comments on Reference 1, though an evaluation of the analysis had been performed. The report contained in Reference 1 was re-examined and rewritten where the facility differs from the assumptions made in the analysis. The addition of the Emergency Service Water Supply System is also reflected in the updated report, which is attached to this letter. DPC's additions are indicated in italics. Table 3.1 in Reference 1 has been revised to conform to the information provided in Reference 3.

Reference 2 contained the NRC staff's draft safety evaluation report on electrical aspects of SEP Topics III-1, "Classification of Structures, Components and Systems" and VII-3, "Safe Shutdown System", based on a contractor's technical evaluation. DPC has comments on the technical evaluation, which was Enclosure 2 of Reference 2. The comments will be discussed by report topic.

INSTRUMENTATION

A procedure does exist and has been used for shutdown of the plant when the Control Room is inaccessible or vital instrumentation is lost. It provides for an operator checking whether the reactor is shutdown by using a portable neutron detector in the Containment Building. It also covers use of a Heise gauge located in the Containment Building for measuring pressure during cooldown. A pressure-temperature curve is located adjacent to the Heise gauge. Since LACBWR is a boiling water reactor, primary temperature indication is not considered necessary if pressure indication is available.

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Makeup water for the shutdown condenser is controlled by a single controller. If the controller loses air or power both makeup valves will open fully, supplying adequate cooling water. A failure of the shutdown condenser shell side controller that maintained closing air pressure on the makeup valves, could be compensated for by stationing an operator at the shutdown condenser. The operator could monitor condenser water level from the local sightglass and either fail the makeup valves open or control shutdown condenser shell side water level using the bypass valve around the high pressure service water makeup control valve.

Neither the condensate water tank, nor the feedwater pumps are considered essential equipment. The reactor feedwater pumps are not supplied by essential power.

Safe Shutdown Systems with Offsite Power Unavailable

The High Pressure Service Water System (HPSW) is considered the essential makeup supply to the shutdown condenser shell side. The Demineralized Water System is expected to be operable during a loss of offsite power transient, but is not considered essential. If the HPSW diesel driven pumps fail, the Emergency Service Water Supply System (ESWSS) could be used to provide water to the High Pressure Service Water/Alternate Core Spray System. ESWSS consists of three portable gasoline engine driven pumps which can be connected in parallel to the HPSW line via an inside or outside manifold.

The High Pressure Core Spray System (HPCS) can also be used for cooling the core. The HPCS can be activated manually or automatically on a low water level signal (-12 inches). Operation of one of two HPCS pumps is required. The water supply is the Overhead Storage Tank (OHST) which has a capacity of 45,400 gallons. A minimum of 15,000 gallons must be maintained when HPCS is required to be operable. A low level on the OHST will cause automatic transfer of water from the virgin water storage tank, via one of the two demineralized water transfer pumps. Each HPCS pump is capable of supplying 50 gpm against a reactor pressure of 1450 psig to a core spray bundle which discharges the water to nozzles directly above each individual fuel assembly.

Safe Shutdown EI&C Features for Consideration by SEP Topic III-1

Electrical Distribution

The 2400V buses 1A and 1B are not needed for safe shutdown. Only the 1A and 1B 480V Essential Buses 1A and 1B are needed, not the 1A and 1B 480V Buses.

Instrumentation

Reactor temperature indication is not needed for safe shutdown. (See earlier discussion). The in-core monitoring system at LACBWR is not a process system and is not normally used. The only functions of the Nuclear Instrumentation System needed for safe shutdown are detection and initiation of a scram condition. The area and system radiation monitoring systems are not needed for safe shutdown. The shutdown condenser level controller and level indication are not safety grade.

Systems

Only the rod insertion function of the Control Rod Drive Mechanisms is needed for safe shutdown. The shutdown condenser is being upgraded to safety status. The Demineralized Water Transfer System is not considered essential, as discussed earlier. The Overhead Storage Tank, in its safe shutdown role, is considered part of the High Pressure Core Spray System. The Control Air System is not needed for safe shutdown, since valves needed for safe shutdown fail safe. Only instrumentation and emergency power needed for safe shutdown systems is considered safe shutdown equipment. The plant can be placed in a safe shutdown condition without any emergency power systems using the alternate method from within the plant.

If there are any questions, concerning these comments, please contact us.

Very truly yours,

DAIRYLAND POWER COOPERATIVE

Frank Linder

Frank Linder, General Manager

FL:LSG:eme

cc: J. G. Keppler, Regional Administrator, Region III
NRC Resident Inspector

Enclosures

SEP REVIEW

OF

SAFE SHUTDOWN SYSTEMS

FOR THE

LA CROSSE BOILING WATER REACTOR

WITH COMMENTS

BY

DAIRYLAND POWER COOPERATIVE

AUGUST 12, 1982

WP-1

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1.0 INTRODUCTION

The Systematic Evaluation Program (SEP) review of the "safe shutdown" subject encompassed all or parts of the following SEP topics, which are among those identified in the November 25, 1977 NRC Office of Nuclear Reactor Regulation document entitled "Report on the Systematic Evaluation of Operating Facilities":

1. Residual Heat Removal System Reliability (Topic V-10.B)
2. Requirements for Isolation of High and Low Pressure Systems (Topic V-11.A)
3. RHR Interlock Requirements (Topic V-11.B)
4. Systems Required for Safe Shutdown (Topic VII-3)
5. Station Service and Cooling Water Systems (Topic IX-3)
6. Auxiliary Feedwater System (Topic X)

The review was primarily performed during an onsite visit by a team of SEP personnel. This onsite effort, which was performed during the period May 22-24, 1978, afforded the team the opportunity to obtain current information and to examine the applicable equipment and procedures, and it also gave the licensee, Dairyland Power Cooperative, the opportunity to provide input into the review.

The review included specific system and equipment requirements for remaining in a hot shutdown condition (> 212°F) and for proceeding to a cold shutdown ($\leq$ 212°F). The review for transition from operating to hot standby considered the requirement that the capability exists to perform this operation from outside the control room. The review was augmented as necessary to assure resolution of the applicable topics, except as noted below:

Topic V-11.A (Requirements for Isolation of High and Low Pressure Systems) was examined only for application to the Residual Heat Removal (RHR) system. Other high pressure/low pressure interfaces were not investigated.

Topic VII-3 (Systems Required for Safe Shutdown) was completed except for determination of design adequacy of the systems.

Topic IX-3 (Station Service and Cooling Water Systems) was only reviewed to consider redundancy and to a limited extent seismic and quality classification of cooling water systems that are vital to the performance of safe shutdown system components. (No discussion of Topic IX-3 is included in this report. The information gathered in support of this topic will be used to resolve the topic later in the SEP).

The criteria against which the safe shutdown systems and components were compared in this review are taken from the: Standard Review Plan (SRP) 5.4.7, "Residual Heat Removal (RHR) System"; Branch Technical Position RSB 5-1, "Design Requirements of the Residual Heat Removal System"; and Regulatory Guide 1.139, "Guidance for Residual Heat Removal." These documents represent current staff criteria and are used in the review of facilities being processed for operating licenses.

This comparison of the existing systems against the current licensing criteria led naturally to at least a partial comparison of design criteria, which will be input to SEP Topic III-1, "Classification of Structures, Components and Systems (Seismic and Quality)."

As noted above, the six topics were considered while neglecting possible interactions with other topics and other systems and components not directly related to safe shutdown. For example, Topics II-3.B (Flooding Potential and Protection Requirements), II-3.C (Safety-Related Water Supply), III-4.C (Internally Generated Missiles), III-5.A (Effects of Pipe Break on Structures, Systems, and Components Inside Containment), III-6 (Seismic Design Considerations), III-10.A (Thermal-Overload Protection for Motors of Motor-Operated Valves), III-11 (Component Integrity), III-12 (Environmental Qualification of Safety-Related Equipment) and V-1 (Compliance with Codes and Standards) are among several topics which could be affected by the results of the safe shutdown review or could have a safety impact upon the systems which were reviewed. These effects will be determined by later review. This review did not cover, in any significant detail, the reactor protection system, nor the electrcial power distribution, both of which will be reviewed later.

The major factor in assessing the safety margin of any of the SEP facilities depends upon the ability to provide adequate protection for postulated Design Basis Events (DBEs). The SEP topics provide a major input to the DBE review, both from the standpoint of assessing the probability of the event and that of determining the consequences of events. As examples, the safe shutdown topics below pertain to the listed DBEs (the extent of applicability will be determined during the DBE review for La Crosse BWR).

Completion of the safe shutdown topic review (limited in scope as noted above), as documented in this report, provides significant input in assessing the existing safety margins.

Topic	DBE Group*	Impact Upon Probability or Consequences of DBE
V-10.B	VII (Spectrum of Loss of Coolant Accidents)	Consequences
V-11.A	VII (Defined Above)	Probability
V-11.B	VII (Defined Above)	Probability
VII-3	All (Defined as a Generic Topic)	Consequences
IX-3	III (Steam Line Break Inside Containment) (Steam Line Break Outside Containment)	Consequences
	IV (Loss of AC Power to Station Auxiliary) (Loss of all AC Power)	Consequences
	V (Loss of Forced Coolant Flow (Primary Pump Rotor Seizure) (Primary Pump Shaft Break)	Probability
	VII (Defined Above)	Consequences
X	II (Loss of External Load) (Turbine Trip) (Loss of Condenser Vacuum) (Steam Pressure Regulator [Closed]) (Loss of Feedwater Flow) (Feedwater System Pipe Break)	Consequences
	III (Defined Above)	Consequences
	IV (Defined Above)	Consequences
	V (Defined Above)	Consequences
	VII (Defined Above	Consequences

*For a listing of DBE groups and generic topics, see Reference 5.

2.0 DISCUSSION

2.1 Normal Plant Shutdown and Cooldown (Offsite Power Available, All Equipment Operable)

The plant conducts a controlled shutdown in accordance with written procedures by reducing generator load gradually with the main steam bypass valve closed and turbine inlet pressure controlled at 1225 psig. The initial pressure regulator is in "automatic". *Reactor power* is decreased by control rod insertion at *less than or equal to 15% power per hour*. The regulator closes down the inlet valve to maintain 1225 psig and feedwater flow is controlled in automatic. At about 10% power, station load is transferred to the reserve auxiliary transformer and control rods are inserted to achieve about 2 MWe power at which time the turbine is tripped. *Normally, all control rods are then fully inserted, though the option exists to remain in the low heating range if hot standby is desired.* Feedwater is automatically reduced to match steam flow and secured when this flow reaches its minimum value. These operations minimize pertubations and require minimum actions by operators.

Seal injection adds on the order of *10-15* gpm of subcooled water to the reactor coolant inventory. *The purification system cools, purifies and recirculates approximately 40 gpm.* Steaming continues to the steam jet air ejectors and gland seal thus removing heat and water. The decay heat blowdown valve is manually controlled to blow down via the decay heat removal system to the main condenser to maintain constant inventory.

When proceeding to cold shutdown, the air ejectors are secured; main condenser vacuum is reduced to atmospheric pressure; and the main steam isolation *valve is* closed to minimize the cooldown rate. At a reactor coolant system (RCS) temperature of 470°F, the Decay Heat Cooling System may be placed in service circulating reactor coolant through the tube side of the decay heat cooler. Component cooling water is circulated through the shell side and is in turn cooled in the shell side of the component cooling water coolers by circulating low pressure service water through the tube side. The cooling path to the Mississippi River is thus established and maintained to complete cooldown and remove decay heat while cold. Cool down rates are controlled to maintain reactor vessel temperatures in a range to avoid excessive stresses.

2.2 Shutdown and Cooldown with Loss of Offsite Power

On loss of offsite power the main condenser is unavailable for heat removal for cooldown and the feedwater pumps cannot be used for reactor coolant makeup. After the reactor is tripped, the shutdown condenser is activated manually, automatically by closure of either MSIV, or automatically by system pressure 1325 psig or greater. A cooling path is established by *the* opening *of* two *redundant* inlet valves and two *redundant* condensate return valves.

The shutdown condenser is a closed loop which establishes natural circulation by condensing steam boiled off from the reactor vessel in the tube side of the condenser and returning the condensed steam via gravity flow to a feedwater line and then to a reactor forced circulating loop. Being a closed loop the need for makeup water is minimized. Makeup water is not necessary to maintain adequate core cover. The condenser can transfer *at least 10% of rated reactor* power from the reactor coolant to the shell side water which is boiled off to the atmosphere. The condenser shell side water level is controlled to provide makeup from the demineralized water storge tank and at a lower level (if demineralized system supply is insufficient, exhausted or fails) by high pressure service water. The demineralizer water transfer pumps are powered from the diesel backed essential buses and are capable of adding up to 30,000 gallons of water stored in the virgin water storage tank to the condenser as needed.

Additional demineralized water may be obtained from the adjacent Unit 3 by making a flexible hose connection. Normally, however, the lower controlled level is reached, and high pressure service water system automatically provides makeup using either of two diesel powered pumps which take suction directly from the river. *The Emergency Service Water Supply System could be deployed to provide high pressure service water if neither diesel powered pump was available.* Redundant and diverse methods of makeup water with onsite or offsite power are thus available to the shell side of the condenser. The reactor coolant system cooldown rate may be controlled by controlling the position of the steam inlet valves. The system will cool the RCS *almost* to cold shutdown (about 212°F) and maintain it there indefinitely. Needed instrumentation is powered from the essential busses and provided in the control room.

The High Pressure Core Spray System (HPCS) can also be used for cooling the core. The HPCS can be activated manually or automatically on a low water level signal (-12 inches). Operation of one of two HPCS pumps is required. The water supply is the Overhead Storage Tank (OHST), which has a capacity of *greater than 42,000 gallons. A minimum of 15,000 gallons must be maintained when HPCS is required to be operable. A low level on the OHST will cause automatic transfer of water from the virgin water storage tank, via one of the two demineralized water transfer pumps. Each HPCS pump is capable of supplying 50 gpm against a reactor pressure of 1450 psig to a core spray bundle which discharges the water to nozzles directly above each individual fuel assembly.*

Another method of cooling is available, but is to be used only if other methods fail. This method requires the activation of the manual depressurization system (MDS) and subsequent use of alternate core spray. This is not included as a means for removal of decay heat in plant procedures since venting to containment requires plant downtime for cleanup and restoration to normal conditions. Use of alternate core spray has its primary purpose responding to loss of coolant events. The depressurization system contains two vent valves which open to the containment atmosphere. This function can be performed only if part of the shutdown condenser system is activated, i.e., the venting is performed by passing steam through the shutdown condenser steam inlet valves to and through *one of the two parallel* reactor *emergency* vent valves. Each vent valve is operated from the control room by its independent manual switch. The vent valves open on loss of *nitrogen and fail closed on* loss of power to the solenoids.

Following *use of MDS and* the decrease of system pressure to less than 150 psig, the alternate core spray is activated and delivers ample flow (about 900 gpm at a vessel pressure of 50 psig). This water is provided by two separate diesel driven pumps that take suction from the river and discharge through valves to a 4" line which penetrates the reactor vessel head. This water flows through the open end 4" pipe on to the high pressure core spray system tube bundle, through the flow deflector plate area and downward to the core. Note that operation of this system is procedurally required if the vessel water level is low enough *during a LOCA* coincident with containment pressure of 5 psig. The manual depressurization and alternate core spray systems are designed to comply with the interim acceptance criteria for ECCS. (Reference No. 1)

In addition, the Emergency Service Water Supply System can be used to provide cooling water to the Alternate Core Spray System if the diesel driven pumps fail. Three portable pumps can be connected to either an inside or outside manifold to provide river water to the ACS line inside the Turbine Building.

3.0 CONFORMANCE WITH BRANCH TECHNICAL POSITION 5-1 FUNCTIONAL REQUIREMENTS

The system(s) which can be used to take the reactor from normal operating conditions to cold shutdown shall satisfy the functional requirements listed below.

1. The design shall be such that the reactor can be taken from normal operating conditions to cold shutdown using only safety-grade systems. These systems shall satisfy General Design Criteria 1 through 5.

2. The system(s) shall have suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities to assure that for onsite electrical power system operation (assuming offsite power is not available) and for offsite electrical power system

operation (assuming onsite power is not available) the system function can be accomplished assuming a single failure.

3. The system(s) shall be capable of being operated from the control room with either only onsite or only offsite power available with an assumed single failure. In demonstrating that the system can perform its function assuming a single failure, limited operator action outside of the control room would be considered acceptable if suitably justified.

4. The system(s) shall be capable of bringing the reactor to a cold shutdown condition, with only offsite or onsite power available, within a reasonable period of time following shutdown, assuming the most limiting single failure.

3.1 Background

A "safety grade" system is defined, in the NUREG-0138 (Reference 2) discussion of issue #1, as one which is designed to seismic Category I (Regulatory Guide 1.29), quality group C or better (Regulatory Guide 1.26), and is operated by electrical instruments and controls that meet Institute of Electrical and Electronics Engineers Criteria for Nuclear Power Plant Protection Systems (IEEE 279). The La Crosse Plant was built and received its Provisional Operating Authorization prior to the issuance of Regulatory Guides 1.26 and 1.29 (as Safety Guides 26 and 29 on 3/23/72 and 6/7/72, respectively). Also, proposed IEEE-279, dated August 30, 1968, was not used in the design of the facility. Therefore, for this evaluation, the systems that should be "safety grade" systems are the systems identified in Table 3.1 and in Section 3.2.

General Design Criterion (GDC) 1 requires that systems important to safety be designed, fabricated, erected, and tested to quality standards, that a Quality Assurance (QA) program be implemented to assure these systems perform their safety functions, and that appropriate records of design, fabrication, erection, and testing are kept.

Regulatory Guide (RG) 1.26 provides the current NRC criteria for quality group classification of safety-related systems. Table 3.1 provides a comparison of the safe shutdown systems with RG 1.26. The classification of all systems important to safety for the La Crosse BWR will be determined under SEP Topic III-1, "Classification of Structures, Systems, and Components (Seismic and Quality)." Table 3.1 of this report will be used as input to Topic III-1).

At the time the La Crosse BWR Plant was first licensed, the NRC (then AEC) criteria for QA were not developed. However, the QA program for operation of La Crosse has been reviewed by the staff and found to be in conformance with 10 CFR 50, Appendix B (Reference 3). Appropriate records concerning design, fabrication, erection and testing of equipment important to safety are maintained by the licensee in accordance with the QA program and the plant Technical Specifications.

GDC 2 states that structures and equipment important to safety shall be designed to withstand the effects of natural phenomena without loss of capability to perform their safety function. Natural phenomena considered are: hurricanes, tornadoes, floods, tsunami, seiches and earthquakes.

The effects of tornadoes will be reevaluated during the course of the SEP in Topics II-2.A, "Severe Weather Phenomena," III-2, "Wind and Tornado-Loadings," and III-4.A, "Tornado Missiles." The effects of flood on the La Crosse Plant will be reassessed in the SEP review under Topics II-3.B, "Flooding Potential and Protection Requirements," and III-3, "Hydrodynamic Loads." And within the SEP review, the potential for and consequences of a seismic event at the La Crosse site will be reassessed under several review topics.

GDC 3 requires structures, systems, and components important to safety to be designed and located to minimize the effects of fires and explosions.

The La Crosse fire protection reevaluation resulting from the Browns Ferry fire is currently underway in the NRC Division of Operating Reactors. The results of this reevaluation will be integrated into the SEP assessment of the La Crosse Plant.

GDC 4 requires that equipment important to safety be designed to withstand the effects of environmental conditions for normal operation, maintenance, testing, and postulated accidents. Also the equipment should be protected against dynamic effects including internal and external missiles pipe whip, and fluid impingement.

The SEP will consider the various aspects of this criterion when reviewing topics III-12, "Environmental Qualification of Safety-Related Equipment," III-5.A, "Effects of Pipe Breaks Inside Containment," III-5.B, "Pipe Breaks Outside Containment," and III-4, "Missile Generation and Protection."

GDC 5 is not applicable for the La Crosse Station because it does not share any equipment with other facilities.

3.2 Shutdown Systems

The safe shutdown systems which should be "safety grade" are:

1. Reactor Protection and Control Systems (no discussion included)
2. Shutdown Condenser
3. *High Pressure Core Spray*
4. Manual Depressurization System (MDS)
5. Alternate Core Spray (ACS)/*High Pressure Service Water**
6. Reactor Building Main Steam Line Isolation Valve
7. Instrumentation for the Above Systems and Equipment
8. Emergency Power (AC and DC) for the Above Systems and Equipment

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* A single check valve isolates the Low Pressure Service Water System from the ACS *and High Pressure Service Water Systems*. Therefore, these systems should be of the same seismic and quality classification as the ACS. *The Low Pressure Service Water System and portions of the HPSW System* are not required to function for safe shutdown.

In addition to these systems, other systems may function as backup for the above systems and components. Some of the backup components are discussed in this and other Sections of the report to identify alternate ways that may provide an acceptable level of safety.

Shutdown Condenser System

The shutdown condenser system provides the capability to take the reactor from hot shutdown to cold shutdown; i.e., BTP 5-1 Functional Requirement No. 1, is described below:

The shutdown system consists of the shutdown condenser, piping, valves, and associated instrumentation.

The shutdown condenser is located on a platform 10 feet above the main floor in the reactor building. Steam from the 10-inch main steam line passes through a 6-inch line, two parallel inlet steam control valves, back to a 6-inch line and into the tube side of the condenser where it is condensed by evaporating cooling water on the shell side. The steam generated in the shell is exhausted to the atmosphere through a 14-inch line which penetrates the reactor building. An area monitor is located next to the steam vent line near the containment shell penetration in order to detect excessive activity release in the event of a shutdown condenser tube failure. The main steam condensate is collected and returned to the reactor vessel by gravity flow. The condensate line leaving the condenser is a 6-inch line along the horizontal run and is reduced to a 4-inch line for the remainder of the vertical section. Two parallel condensate outlet control valves are located in the 4-inch return line. The condensate line also contains two 2-inch vent lines which join together and return to the lower channel section of the condenser. The vents are provided for returning vapors and/or noncondensible gases which are carried into the condensate line back to the condenser to prevent perturbations in the condensate flow leaving the condenser. The lower channel section in turn is vented to the off-gas system through a 1-inch vent line. Flow in this vent line is restricted by a 1/16-inch orifice, which is built into and is an integral part of the shutdown condenser off-gas control valve seat.

A vent line containing two parallel control valves is connected to the 6-inch condensate return line. The valves discharge directly to the reactor building atmosphere and can be used, in an emergency, to vent air *or steam* from the reactor vessel in the event that it should become necessary to flood the reactor building due to a large leak below the reactor core. This would permit the water level *and pressure* in the building to equalize with that in the reactor vessel.

The shell, steam inlet channel, condensate outlet channel, and tube sheet are made of carbon steel. All parts in contact with the reactor steam are clad with monel, except the tubes which are made of 70 percent copper and 30 percent nickel. The shutdwon condenser is designed to absorb, without damage, the thermal and physical shock of going from ambient temperature to full load conditions in 5 seconds for 50 cycles during a 20-year unit lifetime. The thermal shock is equivalent to a temperature transient of 500°F in 5 seconds.

The tubes are seal welded to the tube sheet and the tube sheet is welded to the shell; however, a cutting ring is provided for tube bundle removal should the need arise.

Due to the large temperature differential between the reactor steam and the shell side cooling water, a thermal barrier is provided to reduce thermal stresses in the tube sheet. The barrier consists of a shield plate and individual tube ferrules which insulate the steam inlet channel and tube sheet from the cold water. The large temperature differential also has led to the use of finned tubes. The finned tubes present an irregular surface on the outside tube, which limits film boiling by breaking up the film. Film boiling tends to insulate the tubes, thus decreasing the heat transfer coefficient. The tube surface area is 3705 square feet and will handle 39.3 x 10^6 Btu/hr at a transfer rate of 27.7 Btu/hr/sq.ft/°F.

The system piping is designed for a maximum working pressure of 1400 psig at 650°F. *Primary* system operating pressure is ~ 1250 psig. The steam piping from the biological shield to the inlet of the shutdown condenser is constructed of Schedule 120 low-alloy steel. All other steam and condensate piping are of Type 304 stainless steel. The steam piping within the biological shield and the 6-inch section of the condensate return line is Schedule 120 and the 4-inch section is Schedule 80.

Valves in the system meet and are in accordance with ASME codes and standards.

The condenser has 2 -6" steam inlet angle valves in parallel. They are air operated, air to close, controlled by 125V DC control power. They fail open on loss of power and may be manually vented *(opened)* at the valve station on the platform at the shutdown condenser (about *3* minutes from the control room). The solenoids for control air to each valve are provided from separate DC sources. The position of each valve is indicated in the control room by a hand indicator-controller by selection and by indicating panel lights.

The condenser condensate return to reactor has 2 -4" angle valves in parallel. They are air operated, air to close, controlled by 125V DC control power. They fail open on loss of DC or air and may be manually vented *(opened)* at the valve station on the platform at the shutdown condenser (about *3* minutes from the control room). The solenoids for control air to each valve are provided from separate DC sources. The position of each valve is indicated in the control room by panel lights.

The only instrumentation required to know the status of Shutdown condenser cooling is reactor coolant system pressure. Redundant measurements are provided in the control room. Also, secondary side water level is provided in the control room and at the condenser platform. Other indications in the control room are tube side vent pressure, shell and tube side temperature, valve positions, and controls.

Reactor pressure channels 1 or 2 will automatically activate the condenser system at a pressure of 1325 psig. Closure of either the *Reactor Building Main Steam Isolation Valve or the* Turbine Building Main Steam Isolation Valve will automatically activate the shutdown condenser system. Simultaneous failure of either valve closure circuits (2) will result in high reactor pressure and activation of both channel 1 and 2 reactor pressure protection circuits and the condenser. Thus the protection is redundant and diverse on isolation valve closure.

The *shutdown* condenser system may be manually activated.

Secondary side water level is indicated locally by two gauge glasses; remote indication is provided by an air to current converter. The current to the indicator in the control room also provides high and low level alarms. The air supply is provided by plant air system. The level controller provides a 3 - 15 psi air signal split, 3 - 9 psi to high pressure service water system makeup valve and 9 - 15 psi for the demineralized water makeup valve.

Secondary side makeup water is provided by the demineralized water system with the high pressure service water (HPSW) system providing a backup supply.

The lines for demineralized makeup and HPSW are continually pressurized by pumps. The demineralized water transfer pumps are powered from separate essential buses and these buses are diesel generator backed. The HPSW pump is AC motor driven and takes a suction on the low pressure service water (LPSW) system. The HPSW pump is backed up by two pumps driven by separate diesel engines, the alternate core spray pumps, *taking suction directly from the river. The Emergency Service Water Supply System pumps can be deployed to provide HPSW if the diesel driven pumps are not available.*

The makeup water system relies on a single controller. Although the makeup water is provided from redundant sources each with its own piping and valves, a single failure of this controller in a fashion to keep air on the control valves would not indicate the failure in the control room, nor would makeup be provided. Following boil off of the contained water, system pressure would begin to rise. If the operator could not go to the condenser platform inside containment in time, the safety valves would open. *The makeup valves would fail open on loss of air or loss of power.*

Air is supplied to the shutdown condenser valves and the level controller from the containment building control air by the station air system. This system has two two-stage compressors. The system air provided for control comes from these compressors and is filtered and dried. This air is backed by a *backup air compressor that consists of* two compressors driven by a single motor. These compressors come on at a drop from a normal 100 psig to 75 psig. An adequate air supply is thus provided.

With only onsite power available, the backup instrument air system is the only source available since it is the only compressor powered from the essential bus. It is needed for operation of the secondary side level controller; however, on loss of instrument air the makeup valves fail open and provide a continuing makeup supply to the secondary side.

High Pressure Core Spray

The High Pressure Core Spray (HPCS) System can also be used for core cooling during a loss of offsite power. There are two redundant HPCS pumps, supplied from separate essential buses. During plant operation, the system is lined up to provide water to the vessel. To start water flowing to the core, one of the pumps needs to start, no valves need to be repositioned.

The HPCS System is capable of supplying water to the reactor at all primary pressures, up to and including relief valve lifting pressures.

Alternate Core Spray System

Alternate Core Spray (ACS) in conjunction with the manual depressurization system (MDS) is a redundant *method of cooling the core*. Its use in this mode is not included in plant procedures. To use alternate core spray requires reactor pressure to be below 150 psig. Therefore, the vent valves must be opened and pressure reduced if the shutdown condenser is not functioning. Heat added to the primary containment by the vent valves is transferred to the atmosphere through the containment dome wall. The vent valves are manually operated in this situation. They are separate and redundant and no single failure will prevent the manual depressurization system from performing its function (Reference 1). However, to use either vent valve requires *at least one shutdown condenser system steam inlet valve to be open*. These operations are controlled manually, understood by senior operators and are incorporated into the major primary leak plant procedures, *but not the shutdown or loss of power procedure*. The reason they are excluded is because the consequences of unneeded venting are severe and would require significant interruption in operations.

Emergency Service Water Supply System

The Emergency Service Water Supply System (ESWSS) provides a backup method of supplying High Pressure Service Water to the Alternate Core Spray line. The system is manually deployed. Three gasoline engine driven portable pumps are connected in parallel with the discharge hose connected to the High Pressure Service Water line via either an inside or outside manifold.

Decay Heat Cooling System

Following a normal reactor shutdown the decay heat cooling system is used to cool the reactor to 120°F. Usually the main condenser is preferred for decay heat removal until the RCS is considerably cooler than the allowed 470°F decay heat cooler initiation temperature because the cooling rate can be controlled better. After initiation the *Decay Heat System* is used to maintain the reactor water temperature below 120°F, *including* while the reactor vessel is open for refueling or alterations. Also it can be used to provide additional heat to the reactor to satisfy loop piping Nil Ductility Transition (NDT) temperature requirements and provides a path via the blowdown line to remove excess reactor water from the reactor to the main condenser.

The decay heat cooling system takes its suction from the *reactor side of the isolation valve on the* inlet line to the forced circulating pump 1A, reactor water then flows to the decay heat pump which discharges to the tube side of the decay heat cooler and returns it to the reactor side of the forced circulation pump isolation valves. The shell side of the decay heat cooler is cooled by the component cooling water system which is completely redundant in *active* equipment and power supply. The component cooling water system heat exchangers shell sides are cooled by the *low pressure* service water system which obtains its water from the Mississippi River. Since the service water system is not powered from the essential buses, a loss of offsite power renders the service water pumps inoperable thereby interrupting the heat exchange from the decay heat cooling system to the river. To reestablish the continuity of heat exchange the component cooling system heat exchanger shell side can be connected via a *cross-connect line, to the High Pressure Service Water System* which utilizes two diesel driven pumps that also receive their water supply from the Mississippi River. This is covered in operating procedures.

The decay heat pump is a single stage centrifugal pump powered from the essential bus diesel backed and fed through reactor building motor control center 1A. It is designed for continuous operation at 1500 psig and 585°F.

Control stations for the pump are located in the control room and locally at the pump, indication of pump status is provided at both locations. In addition to the pump status indications (*red* light-pump energized, *green* light-pump deenergized, white light-auto trip), an audible alarm annunciates in the control room whenever the automatic trip functions.

The decay heat cooler can serve as a cooler (normal mode) or as a heater. In the cooling mode, reactor water enters the tube side and makes two passes then exits, component cooling water enters the shell side also making two passes. In the heater mode, which is used to facilitate loop NDT requirements, heating steam enters the shell side.

The shell side of the cooler is rated by design at 150 psig and 375°F, the tube side is rated by design at 1500 psig and 470°F. The system design limit of 470°F is based on thermal stressing of the cooler tube sheet.

All piping and valves in the decay heat system with the exception of the blowdown line are designed to 1400 psig and 595°F and are made of 304 stainless steel. The blowdown line which is used to maintain a constant volume of water in the reactor is made of carbon steel and is designed to 1450 psig and 650°F.

The blowdown valve which is a 2-inch, 1500 psig, air operated valve can be controlled locally by handwheel or remotely from the control room. Approximately *10* gpm of subcooled water enters the primary system through the seals of the forced circulation pumps and rod drive mechanisms. During operation this *10* gpm serves as makeup water and is of no consequence, however, during shutdown when normal feedwater is reduced, the *10* gpm becomes excessive; therefore, the decay heat system is utilized to blowdown the excess inventory to the main condenser. The blowdown valve is electrically interlocked with the reactor protection system such that a low reactor water level scram will close the blowdown valve to preclude further reduction of reactor water level. The blowdown valve fails closed on a loss of control air or electric power thereby removing any possibility of draining the reactor.

During local operation of the blowdown valve, reactor *water level* is available for the operator to monitor. During remote operation the operator has available all of the parameters in the control room. Local operation is required during shutdown from outside the control room.

The decay heat system blowdown line can also be used during a "Feed and Bleed" operation using the HPCS pumps to feed the system and the blowdown line to reduce and maintain the reactor water level at a predesignated level. Thus the *primary system* can be cooled by this mode as an alternate cooldown method.

Although the decay heat system is normally used during routine shutdown of the reactor, it has no redundant components and lacks redundant power supplies; however, the function of cooldown is provided for by use of the shutdown condenser, *high pressure core spray system* or manual depressurization and alternate core spray systems thereby providing redundant diverse methods for cooldown.

We have concluded that all operations needed for safe shutdown with offsite or only onsite power available can be done from the control room. Nevertheless, with credit for limited action outside the control room, the shutdown condenser reliability can be improved. By dispatching an operator to the platform inside containment, the single failure vulnerability of the secondary side level controller can be overcome. The *double sight glass* shows water level, the makeup valves can be adjusted to provide makeup water and reactor pressure and water level are indicated in the control room. However, it should be noted that the condenser does not have to be immune from single failure considering the redundant and diverse depressurization coupled with alternate core spray *and the high pressure core spray system,* which provide alternate shutdown and cooldown methods without offside power. Likewise, in the temperature range below 470°F, the Decay Heat Cooling System can be used to cooldown and remove decay heat while cold. Manual operations are required for the loss of offsite power situation.

The shutdown condenser will bring the reactor to *almost* cold condition from operating conditions. The condenser relies on boil off of secondary water to accomplish cooldown. Therefore, it will bring the RCS temperature to *approximately* 212°F. The heat removal capacity is so large (equivalent to > 10% of rated power) that steam inlet flow must be controlled to avoid excessive thermal stress to the reactor vessel. Even with the failure of the secondary side level controller, and dispatch of the operator to the platform, the rate of cooldown will have to be controlled to avoid excessive thermal stresses. The controlled cooldown rates are reasonable.

When the manual depressurization and alternate core spray systems are used to cool down, the vent valves provide a rapid depressurization to atmospheric pressure and the alternate core spray will cool the core indefinitely. This sytem has been analyzed by the staff and found to be acceptable for emergency core cooling during a loss-of-coolant accident with only onsite or offsite power available and with the most limiting single failure.

The capacity of the combined cooling of the shutdown condener ($\geq$ *10%* of rated power) from operating temperature (or alternatively high pressure core spray or manual depressurization with the vent valves) to 470°F and the Decay Heat Cooling System below 470°F with a heat removal capability about 1/6 that of the shutdown condenser, the cooldown can be accomplished. This alternative will require longer to cooldown since *high pressure service* water must be connected to provide cooling to the secondary side of the component cooling heat exchanger.

TABLE 3.1 CLASSIFICATION OF SHUTDOWN SYSTEMS - LA CROSSE BOILING WATER REACTOR

	Quality Group		Seismic		
System, Subsystem, Component	R.G. 1.26	Plant Design	R.G. 1.29	Plant Design	Remarks
Shutdown Condenser (tube side)	ASME III Class 2	ASME VIII Case 1270N	Category I	Note 1	Note 1: Although not originally designed to withstand a seismic event, an analysis of the LACBWR concluded that the facility could withstand an earthquake with corresponding maximum horizontal ground acceleration of 0.12g
(shell side)	ASME III Class 3	ASME VIII Case 1270N	Category I	Note 1	
Piping from reactor vessel to shutdown condenser up to and including safety valves, main steam isolation valve 64-25-030, main feed shutoff valve, MDS valves (62-25-013, 014) and vent and drain lines larger than 1" diameter.	ASME III Class 1 & 2	*ASA B31.1 (1955)*	Category I	Note 1	
Vent and Drain piping smaller than 1" diameter.	ASME III Class 2	*ASA B31.1*	Category I	Note 1	Footnote 2(a) to 10 CFR 50.55a.
Overhead Storage Tank (OHST)	ASME III Class 2	AWWA D-100	Category I	Note 1	
High Pressure Core Spray System	*ASME III Class 1 & 2*	*ASA B31.1*	*Category I*		
Alternate Core Spray (ACS) Pumps (2 diesel driven)	ASME III Class 2 & 3	*S & L Spec. W 1924*	Category I	Note 1	These pumps are same as diesel fire pumps.
Diesel engine fuel supply	ASME III Class 3	*S & L Spec. W 1924*	Category I	Note 1	Portions of steam line are used for both MDS and Shutdown Condenser

TABLE 3.1 CLASSIFICATION OF SHUTDOWN SYSTEMS - LA CROSSE BOILING WATER REACTOR

	Quality Group		Seismic		
System, Subsystem, Component	R.G. 1.26	Plant Design	R.G. 1.29	Plant Design	Remarks
Piping from pumps to outermost containment isolation valve up to and including relief valves and HPSW supply, drain vent, and test line isolation valves, strainers, and valves which isolate non-essential portions of the system.	ASME III Class 2 & 3	*ASA B31.1(55)* *ASA B16.9(58)* *ASA B16.10(57)* *ASA B16.5 (61)*	Category I	Note 1	
Piping from outermost containment isolation valves up to reactor vessel including vent piping greater than 1" diameter.	ASME III Class 1 & 2	*B31.1*	Category I	Note 1	
Process Instrumentation and Controls	NA	--	Category I	Note 1	
Emergency Power Supply System	NA	--	Category I	Note 1	
Diesel generators			Category I	Note 1	
DC power supply systems			Category I	Note 1	
Distribution lines, switchgear, motor control centers			Category I	Note 1	
Reactor Control and Protection Systems	NA	--	Category I	Note 1	

4.0 SPECIFIC RESIDUAL HEAT REMOVAL AND OTHER REQUIREMENTS OF BRANCH TECHNICAL POSITION 5-1

4.1 RHR System Isolation Requirements

The RHR system shall satisfy the isolation requirements listed below.

1. The following shall be provided in the suction side of the RHR system to isolate it from the RCS.

   (a) Isolation shall be provided by at least two power-operated valves in series. The valve positions shall be indicated in the control room.

   (b) The valves shall have independent diverse interlocks to prevent the valves from being opened unless the RCS pressure is below the RHR system design pressure. Failure of a power supply shall not cause any valve to change position.

   (c) The valves shall have independent diverse interlocks to protect against one or both valves being open during an RCS increase above the design pressure of the RHR system.

2. One of the following shall be provided on the discharge side of the RHR system to isolate it from the RCS:

   (a) The valves, position indicators, and interlocks described in item 1(a)-(c),

   (b) One or more check valves in series with a normally closed power-operated valve. The power-operated valve position shall be indicated in the control room. If the RHR system discharge line is used for an ECCS function, the power-operated valve is to be opened upon receipt of a safety injection signal once the reactor coolant pressure has decreased below the ECCS design pressure.

   (c) Three check valves in series, or

   (d) Two check valves in series, provided that there are design provisions to permit periodic testing of the check valves for leak tightness and the testing is performed at least annually.

La Crosse Boiling Water Reactor does not have a low pressure redundant residual heat removal system. The system which performs the residual heat removal function for the latter stage of normal cooldown and for long term decay heat removal while depressurized is the Decay Heat Cooling System. Since it is designed for reactor coolant system (RCS) pressure, the isolation requirements listed above do not apply; i.e., the potential for an RCS break from overpressurization because of valving errors is of no safety consequence.

4.2 Pressure Relief Requirements

The RHR system shall satisfy the pressure relief requirements listed below.

1. To protect the RHR system against accidental overpressurization when it is in operation (not isolated from the RCS), pressure relief in the RHR system shall be provided with relieving capacity in accordance with the ASME Boiler and Pressure Vessel Code. The most limiting pressure transient during the plant operating condition when the RHR system is not isolated from the RCS shall be considered when selecting the pressure relieving capacity of the RHR system. For example, during shutdown cooling in a PWR with no steam bubble in the pressurizer, inadvertent operation of an additional charging pump or inadvertent opening of an ECCS accumulator valve should be considered in selection of the design bases.

2. Fluid discharged through the RHR system pressure relief valves must be collected and contained such that a stuck open relief valve will not:

   a. Result in flooding of any safety-related equipment.

   b. Reduce the capability of the ECCS below that needed to mitigate the consequences of a postulated LOCA.

   c. Result in a nonisolatable situation in which the water provided to the RCS to maintain the core in a safe condition is discharged outside of the containment.

3. If interlocks are provided to automatically close the isolation valves when the RCS pressure exceeds the RHR system design pressure, adequate relief capacity shall be provided during the time period while the valves are closing.

The Decay Heat Cooling System does have code required relief valves set at design pressure to protect against overpressurization while isolated, and it is protected from overpressurization while in service by code safeties. Again, it is a full pressure system and protection from accidental overpressurization is adequate with reactor vessel code safety valves. Its heat exchanger is temperature limited to operation below 470°F, and this limit is administratively controlled.

4.3 Pump Protection Requirements

The design and operating procedures of any RHR system shall have provisions to prevent damage to the RHR system pumps due to overheating, cavitation or loss of adequate pump suction fluid.

The pump is designed for continuous operation at 1500 psig and 585°F. The pump requires a net positive suction head (NPSH) of approximately 10 ft. to preclude cavitation and eventual impeller corrosion. Due to its location it has an available suction head of approximately 50 ft., cooling water to the pump bearings is supplied by the component cooling water system.

4.4 Test Requirements

The isolation valve operability and interlock circuits must be designed so as to permit on line testing when operating in the RHR mode. Testability shall meet the requirements of IEEE Standard 338 and Regulatory Guide 1.22.

Based on the previous discussion, the Decay Heat Cooling System does not require isolation and interlock circuits.

4.5 Operational Procedures

The operational procedures for bringing the plant from normal operating power to cold shutdown shall be in conformance with Regulatory Guide 1.33.

The licensee has procedures to perform safe shutdown operations including shutdown to hot standby, operation at hot standby, hot shutdown, operation at hot shutdown and cold shutdown including long-term decay heat removal. The licensee has also provided the operating staff procedures covering offnormal and emergency conditions for shutting down the reactor and decay heat removal under conditions of loss of system or parts of system functions normally needed for shutdown and cooling the core. Procedures for systems operation for systems used in safely shutting down the reactor are also included in the plant operating procedures. These procedures include provisions identified in Regulatory Guide 1.33. These procedures were reviewed and are in conformance with Regulatory Guide 1.33.

Some operations are not covered that should be addressed are:

1. Providing demineralized water from the onsite Unit 3 to the reactor plant demineralized water system.

2. Contingencies for failure of shutdown condenser secondary side water level controller and loss of air supply to controller.

3. Use of manual depressurization system in conjunction with alternate core spray as a backup safe shutdown system. Alternatively, we believe this method may be covered in the licnesse's retraining program and simply identified as a means of achieving cooldown in procedures, if the licensee desires. He has indicated that the severity of contamination following unneeded use of this method would interrupt plant operation for a long period to clean up the contamination, and he would prefer to omit from procedures to avoid use unless other methods have proven unsatisfactory.

5.0 RESOLUTION OF SEP TOPICS

The SEP topics associated with safe shutdown have been identified in the Introduction to this assessment. The following is a discussion of how the La Crosse Plant meets the safety objective of these topics.

5.1 Topic V-10.B RHR System Reliability

The safety objective of this topic is to ensure reliable plant shutdown capability using safety grade equipment subject to the guidelines of SRP 5.4.7 and BTP RSB 5-1. The La Crosse BWR systems have been compared with the criteria of BTP 5-1 and the results of these comparisons are discussed in Sections 3.0 and 4.0. Section 3.0 discusses the way the functional requirements are met and Section 4.0 discusses the Decay Heat Removal System which performs the function identified in BTP RSB 5-1 as Residual Heat Removal. The Decay Heat Removal System has very limited use in the La Crosse plant and it does not contain system redundancy. However, we have concluded that the other La Crosse systems acceptably fulfill the safety objective subject to the resolution of the following in the SEP integrated assessment:

1. The requirement for using only safety grade equipment to accomplish the shutdown and cooldown. The seismic and quality classification of safe shutdown systems identified in Section 3.0 will be established in further review of Topic III-1.

2. The need for improved shutdown condenser shell side level control to preclude a single failure disabling the condenser. Resolution of this item can be postponed until the integrated assessment because of the existence of a redundant cooldown method (MDS and ACS).

5.2 Topic V-11A Requirements for Isolation of High and Low Pressure Systems

The safety objective of this topic is to assure adequate measures are taken to protect low pressure systems connected to the primary system from being subjected to excessive pressure which could cause failures in some plants have the potential for causing a LOCA outside of containment. The topic in this review is concerned only with the decay heat cooling system; high/low pressure interfaces with other systems were not reviewed. Since this sytem is completely contained within containment, except for a portion of the blowdown line, and since it is designed for system pressure, the overpressure potential is minimal (i.e., the same as the rest of the RCS); and the topic is resolved for the decay heat cooling system.

5.3 Topic V-11.B RHR Interlock Requirements

The safety objective of this topic is identical with V-11.A. The interlock would close low pressure isolation valves when open and high pressure excursion occurs and would prohibit opening when high pressure exists. Again, this system is designed for full system pressure and the interlocks are unnecessary. This topic is resolved for the decay heat removal system.

In addition to these requirements, and as a matter to be resolved separately from the SEP, the NRC staff has determined that certain isolation valve configurations in systems connecting the high-pressure Primary Coolant System (PCS) to lower-pressure systems extending outside containment are potentially significant contributors to an intersystem loss-of-coolant accident (LOCA). Such configurations have been found to represent a significant factor in the risk computed for core melt accidents (WASH-1400, Event V). The sequence of events leading to the core melt is initiated by the failure of two in-series valves to function as a pressure isolation barrier between the high-pressure PCS and a lower-pressure system extending beyond containment. This causes an overpressurization and rupture of the low-pressure system, which results in a LOCA that bypasses containment.

The NRC has determined that the probability of failure of these valves as a pressure isolation barrier can be significantly reduced if the pressure at each valve is continuously monitored or if each valve is periodically inspected by leakage testing, ultrasonic examination, or radiographic inspection. NRC has established a program to provide increased assurance that such multiple isolation barriers are in place in all operating Light Water Reactor plants. This program has been designated DOR Generic Implementation Activity B-45.

In a generic letter of February 23, 1980, the NRC requested all licensees to identify susceptible valve configurations which may exist in any of their plant systems communicating with the PCS. For plants in which valve configurations of concern were found to exist, licensees were further requested to indicate: (1) whether, to ensure integrity, continuous surveillance or periodic testing was currently being conducted, (2) whether any valves of concern were known to lack integrity, and (3) whether plant procedures should be revised or plant modifications be made to increase reliability.

LACBWR is one of those plants identified as being susceptible to the potential failure because of the configuration of valves (two check valves in series) in the Alternate Core Spray System. Therefore, as noted, action *has been* taken independently of the SEP effort *and resolved* the "Event V" problem.

5.4 Topic VII-3 Systems Required for Safe Shutdown

The safety objectives of this topic are:

1. To assure the design adequacy of the safe shutdown system to (a) initiate automatically the operation of appropriate systems, including the reactivity control systems, such that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences or postulated accidents, and (b) initiate the operation of systems and components required to bring the plant to a safe shutdown.

2. To assure that the required systems and equipment, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown are located at appropriate locations outside the control room and have a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

3. To assure that only safety grade equipment is required for a PWR* plant to bring the reactor coolant system from a high pressure condition to a low pressure cooling condition.

Safety objective 1(a) will be resolved in SEP Design Basis Event Reviews. These reviews will determine the acceptability of the plant response, including automatic initiation of safe shutdown related systems, to Design Basis Events, i.e., accidents and transients.

Objective 1(b) relates to availability in the control room of the control and instrumentation systems in the control room are capable of following the plant shutdown from its initiation to its conclusion at cold shutdown conditions. The ability of the La Crosse plant to follow the shutdown is discussed in the preceding sections of this report. Based on these discussions and knowledge gained from the site visit, we conclude that safety objective 1(b) is met by the safe shutdown systems, actuation mechanisms, and control room displays, at La Crosse subject to the findings of related SEP Electrical, Instrumentation and Control topic reviews.

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* BTP 5-1 applies to both PWRs and BWRs.

Safety objective 2 requires the capability to shut down to both hot shutdown and cold shutdown conditions using systems, instrumentation and controls located outside the control room. La Crosse plant has a procedure, "Emergency Reactor Shutdown and Cooldown When the Control Room is Inaccessible." The procedure assumes lack of time to trip reactor prior to leaving the control room and indicates the location from which the reactor can be tripped. It covers emergency communications and locations of portable radios. It designates the operators stations and actions to be taken by them, provides adequate instructions for ascertaining the operability and condition of the essential plant equipment and indicates the surveillance instrumentation and instructions for interpreting the information. The plant relies on the Shutdown Condenser and Decay Heat System to control shutdown and cooldown.

The review team visited each designated operators station and assessed the capabaility of the plant staff to perform the necessary operations. We conclude that the plant can perform these shutdown operations and indeed has done so. Early in plant life power cables were cut inadvertently and the plant lost all AC power. Operators were dispatched to their local stations and the plant was successfully shut down and controlled.

The adequacy of the safety grade classification of safe shutdown systems at La Crosse, to show conformance with safety objective C, will be completed in part under SEP Topic III-1, "Classification of Structures, Components and Systems (Seismic and Quality)", and in part under Design Basis Review Event reviews.

5.5 Topic X Auxiliary Feed System (AFS)

The safety objective of this topic is to assure that the AFS can provide adequate cooling water for decay heat removal in the event of loss of all main feedwater using the guidelines of SRP 10.4.9 and BTP ASB 10-1.

This topic is not applicable to La Crosse.

6.0 REFERENCES

1. Safety Evaluation by the Office of Nuclear Reactor Regulation Supporting Amendment No. 6 to Provisional Operating License No. DPR-45, Dairyland Power Cooperative, La Crosse Boiling Water Reactor, Docket No. 50-409, August 12, 1976.

2. Staff Discussion of Fifteen Technical Issues Listed in Attachment to November 3, 1976 Memorandum from Director, NRR to NRR Staff, NUREG-0138, November 1976.

3. NRC Letter, R. Reid to J. Madgett, dated February 14, 1977.

4. La Crosse Boiling Water Reactor Operating Manual, Volume I through V.

5. Systematic Evaluation Program, Status Summary Report, NUREG-0485.

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

March 9, 1982

Docket No. 50-409
LS05-82-03-059

Mr. Frank Linder
General Manager
Dairyland Power Cooperative
2615 East Avenue South
LaCrosse, Wisconsin 54601

Dear Mr. Linder:

SUBJECT: SEP TOPICS III-1, CLASSIFICATION OF STRUCTURES, COMPONENTS AND SYSTEMS AND VII-3, SAFETY SHUTDOWN SYSTEMS - DRAFT SAFETY EVALUATION REPORT FOR LACROSSE

Enclosure 1 is the staff's draft safety evaluation report (SER) on the electrical aspects of SEP Topics III-1 and VII-3.

Enclosure 2 is our contractor's technical evaluation of your plant. This technical evaluation is the basis for Enclosure 1.

The staff recommends that an additional electrical source be provided so that safe shutdown operations can be conducted from the control room in the event of a failure of an instrument bus. We also recommend a second shutdown system level controller be added for the same reason.

The need to actually implement these changes will be determined during the integrated plant safety assessment. This topic assessment may be revised in the future if your facility design is changed or if NRC criteria relating to this topic are modified before the integrated assessment is completed.

Sincerely,

Dennis M. Crutchfield

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

Enclosures:
As stated

cc w/enclosures:
See next page

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SYSTEMATIC EVALUATION PROGRAM
TOPICS III-1 AND VII-3

LACROSSE

TOPICS: III-1 CLASSIFICATION OF STRUCTURES, COMPONENTS AND SYSTEMS
VII-3 SYSTEMS REQUIRED FOR SAFE SHUTDOWN

I. INTRODUCTION

The systems aspects of the review of Systems Required for Safe Shutdown was conducted as part of Topic V-10.B (RHR Reliability). This safety evaluation is limited to the electrical instrumentation and control systems identified as being required for safe shutdown. Plant systems that are needed to achieve and maintain a safe shutdown condition of the plant, including the capability for prompt hot shutdown of the reactor from outside the control room were reviewed. Included also, was a review of the design capability and method of bringing the plant from a high pressure condition to low pressure cooling assuming the use of only safety grade equipment. The objectives of the review were to assure:

(1) The design adequacy of the safe shutdown system to (a) initiate automatically the operation of appropriate systems, including the reactivity control systems, such that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences or postulated accidents and (b) initiate the operation of systems and components required to bring the plant to a safe shutdown.

(2) That the required systems and equipment, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, are located at appropriate places outside the control room and have a potential capability for subsequent cold shutdown of the reactor through the suitable procedures.

(3) That only safety grade equipment is required to bring the reactor coolant system from a high pressure condition to a low pressure cooling condition.

In reviewing the SDCS and systems required for safe shutdown, the major electrical components and systems required for the protection of public health and safety were identified.

II. REVIEW CRITERIA

The review criteria are presented in Section 2 of EG&G Report 0058J, "Electrical, Instrumentation, and Control Features of Systems Required for Safe Shutdown."

III. RELATED SAFETY TOPICS AND INTERFACES

Review areas outside the scope of this topic and safety topics that are dependent on the present topic information for completion are identified in Section 3 of EG&G Report 0058J.

IV. REVIEW GUIDELINES

The review guidelines are presented in Section 4 of EG&G Report 0058J.

V. EVALUATION

Section 7 of EG&G Report 0058J lists the major electrical components and systems that are required at LaCrosse to protect the public health and safety.

As noted in EG&G Report 0058J, the systems required to take LaCrosse from hot shutdown to cold shutdown, assuming only offsite power is available or only onsite power is available and a single failure, are capable of initiation to bring the plant to safe shutdown and are in compliance with current licensing criteria and the safety objectives of SEP Topic VII-3, except that redundant instrumentation is powered from one Class IE source. In addition, there is only one SDCS level control system.

VI. CONCLUSIONS

LaCrosse satisfies all of the requirements for Safe Shutdown except for a lack of adequate electrical supply. An additional set of instruments and valves (from an independent Class IE power source) is required for the Shutdown Condenser System level control.

Enclosure 2

0058j

SYSTEMATIC EVALUATION PROGRAM

TOPIC VII-3
ELECTRICAL, INSTRUMENTATION AND CONTROL FEATURES OF
SYSTEMS REQUIRED FOR SAFE SHUTDOWN

LA CROSSE BOILING WATER REACTOR

Docket No. 50-409

February 1982

R. O. Haroldsen
EG&G Idaho, Inc.

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PDR ADOCK
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Draft 2-2-81

CONTENTS

SYSTEMATIC EVALUATION PROGRAM

TOPIC VII-3
ELECTRICAL, INSTRUMENTATION AND CONTROL FEATURES OF SYSTEMS REQUIRED FOR SAFE SHUTDOWN

LA CROSSE BOILING WATER REACTOR

1.0 INTRODUCTION

This report is part of the Systematic Evaluation Program (SEP) review of Topic VII-3, "Systems Required for Safe Shutdown." The objective of this review is to determine whether the electrical, instrumentation, and control (EI&C) features of the systems required for safe shutdown, including support systems, meet current licensing criteria.

The systems required for safe shutdown have been identified by the NRC SEP. The systems were reviewed to ensure the following safety objectives are met:

(1) Assure the design adequacy of the safe shutdown system to automatically initiate operation of appropriate systems, including reactivity control systems, such that fuel design limits are not exceeded as a result of operational occurrences and postulated accidents, and to automatically initiate systems required to bring the plant to a safe shutdown

(2) Assure that required systems, equipment, and controls to maintain the unit in a safe condition during hot shutdown are appropriately located outside the control room and have the capability for subsequent cold shutdown of the reactor using suitable procedures

(3) Assure only safety grade equipment is required to bring primary coolant systems from a high pressure to low pressure cooling condition.

The scope of this review specifically includes an evaluation of the electrical, instrumentation, and control features necessary for operation of the identified safe shutdown systems.

The review evaluates the systems for operability with and without off-site power and the ability to operate with any single failure. The EI&C review of safe shutdown systems only includes those features not covered under other SEP Topics. Specific items which will be covered under other SEP reports are identified in Section 3.0, Related Safety Topics and Interfaces.

2.0 REVIEW CRITERIA

Current licensing criteria for safe shutdown are contained in the following:

(1) IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"

(2) GDC-5, "Sharing of Structures, Systems, and Components"

(3) GDC-13, "Instrumentation and Control"

(4) GDC-17, "Electric Power Systems"

(5) GDC-19, "Control Room"

(6) GDC-26, "Reactivity Control System Redundancy and Capability"

(7) GDC-34, "Residual Heat Removal"

(8) GDC-35, "Emergency Core Cooling"

(9) GDC-44, "Cooling Water."

3.0 RELATED SAFETY TOPICS AND INTERFACES

The following list of SEP topics are related to the safe shutdown topic with respect to EI&C features, but are not being specifically reviewed under this topic:

(1) SEP III-10.A, "Thermal Overload Protection for Motors of Motor-Operated Valves"

(2) SEP VI-7.A.3, "ECCS Actuation System"

(3) SEP VI-7.C.1, "Independence of Onsite Power"

(4) SEP VI-10.A, "Testing of RTS and ESF Including Response Time Testing"

(5) SEP VII-1, "Reactor Trip System"

(6) SEP VII-2, "ESF Control Logic and Design"

(7) SEP VIII-2, "Onsite Emergency Power Systems--Diesel Generators"

(8) SEP VIII-3, "Emergency DC Power Systems"

(9) SEP IX-3, "Station Service and Cooling Water Systems"

(10) SEP IX-6, "Fire Protection."

Where safe shutdown system EI&C response is affected by the above-mentioned topics, that particular SEP review has been consulted for determination of overall safe shutdown system performance. Where the SEP topic review is not available, the effect on safe shutdown system performance is based on an assumed operating condition of the effecting system. The safe shutdown review will be considered preliminary until resolution of the effecting topic is completed and found to be in accordance with assumptions made in this review.

The completion of this review impacts upon the following SEP topics, since capabilities relating to safe shutdown are required in the topic:

(1) SEP VIII-1.A, "Potential Equipment Failures Associated with a Degraded Grid Voltage"

(2) SEP VIII-2, "Onsite Emergency Power Systems--Diesel Generators."

4.0 REVIEW GUIDELINES

The capability to attain a safe shutdown has been reviewed by evaluating the systems used for normal shutdown (onsite power not available) and emergency shutdown (offsite power not available). SRP 7.4 was applied to each system to ensure the following guidelines were meet:

(1) They have the required redundancy (SRP 7)

(2) They meet the single failure criterion (RG 1.53, ICSB BTP 18)

(3) They have the required capacity and reliability to perform intended safety functions on demand (SRP 7).

Additionally, SRP 5.4 requirements contained in BTP RSB 5-1 were reviewed to determine if the systems required for residual heat removal meet the following criteria:

(1) The systems are capable of being operated from the control room with only offsite or only onsite power available

(2) The systems are capable of bringing the reactor to cold shutdown with only offsite or only onsite power available within a reasonable period, assuming the most limiting single failure

(3) The RHR system has the required isolation features to prevent overpressurization when RCS pressure is above RHR design pressure

(4) Protection from RHR pump overheating, cavitation, or loss of suction is provided

(5) Isolation and interlock circuitry is testable during RHR operation and is tested in preoperational and initial startup test programs.

The electrical equipment environmental qualification and physical separation are being reviewed under other topics, as is the seismic equipment qualification, and are not reviewed in this report. Section 7.0 consists of a list of safety related EI&C equipment necessary for safe shutdown to be used in resolving SEP Topic III-1, "Classification of Structures, Components, and Systems."

5.0 DISCUSSION AND EVALUATION

5.1 Instrumentation

The NRC SEP Review of Safe Shutdown Systems identified the instrumentation available in the control room necessary to bring the reactor from the hot shutdown to cold shutdown condition. Various system parameters, such as pump running or valve position indications, are not included in the list of safe shutdown instruments of the SEP Review as indication is provided by the control/operate circuitry. Availability of control/operate circuitry to run the system also means availability of the required indication. Similarly, if the control/operate circuitry is unavailable such that system operation is not possible, then system indication is not mandatory.

The source range nuclear instrumentation has redundant channels but all are powered from the same vital non-interruptible bus. Failure of this bus would result in the loss of shutdown indication from the nuclear instruments.

The control rod positions are indicated by two independent display systems. An indication that all rods are inserted is a reasonable indication that the nuclear reaction in the reactor has been shutdown. However, loss of offsite power and one of the non-interruptible power buses would disable both rod position indicating systems.

Reactor coolant level is indicated in the Control Room on redundant independent indicators powered from independent non-interruptible power buses. There are no single electrical failures that would result in the loss of this critical reactor parameter indication. Reactor coolant temperature and pressure are indicated redundantly in the control room but are all powered from the common vital non-interruptible bus 1B.

Other control room indicating instruments used to monitor supporting safe shutdown systems are generally non-redundant. There are, therefore, single electrical failures that would render the monitors on these systems inoperable. For example, the water level on the shell side of the shutdown condenser is monitored in the control room by the single LG-62-42-803 level indicator operating from the non-interruptible bus 1B. Valve position indicators for this system are all powered from the 125 volt DC distribution bus. Make-up water for the shutdown condenser is controlled by a single controller. The condensate make-up water tank has both level indication and an independent level alarm in the control room but both are powered from the same power source. The feedwater pumps have supply interlocks.

5.1.1 Evaluation. The instrumentation necessary for reaching and maintaining cold shutdown at La Crosse does not meet current licensing criteria since single failures may result in loss of instrumentation required to shutdown the reactor and/or maintain the reactor in shutdown condition. Suitable direct reading local indicators and manual override could be used if operators were stationed at local indicators and controls. Such action may be justified by the licensee under the topic of limited operator action outside the control room.

5.2 Safe Shutdown Systems

The SEP review of Safe Shutdown Systems identified the systems required for safe shutdown for conditions when only onsite power is available or only offsite power is available. The systems identified do not include the Turbine Bypass or Decay Heat Removal Systems, which are the systems used for normal shutdown.

Normal shutdown utilizes short-term cooling provided by bypassing steam to the main condenser via the turbine bypass valve or steam jet air ejectors and gland seal. The feedwater system then returns the condensate water to the reactor. When the reactor coolant temperature drops below 470°F, the decay heat cooling system may be placed in service. On loss of offsite power, the main condenser is unavailable for cooldown and the feedwater pumps cannot be used for reactor coolant make-up because onsite power has insufficient capacity.

The systems identified for safe shutdown in the SEP review are systems that are operational either with onsite power unavailable or offsite power unavailable.

5.2.1 Onsite Power Unavailable. During normal operations all power for the reactor systems is supplied from the unit auxiliary transformer connected to the generator. Loss of the main generator power during operation will result in automatic transfer to the reserve auxiliary transformer connected to the 69 KV bus of the external grid.

There are no single failures of EI&C features that can disable the normal short-term cooldown methods. The Decay Heat Removal System normally used for long-term cooldown is subject to single EI&C failure but this system is not required for shutdown. The Shutdown Condenser System provides backup for both short and long-term cooling.

5.2.1.1 Evaluation. The systems required for short-term and long-term cooling at La Crosse are capable of providing the required cooling assuming no onsite power is available and a single EI&C failure. However, loss of either the non-interruptible bus 1A or 1B will result in loss of some non-redundant parameter indications in the control room for these systems.

5.2.2 Offsite Power Unavailable. During normal operation a loss of offsite power would probably result in the loss of the main condenser and a reactor trip. The feedwater pumps require more power than could be supplied from the emergency diesel powered generators. Shutdown with offsite power unavailable would utilize the Shutdown Condenser System (SCS) which is capable of providing both the short and long-term cooling requirements of the reactor.

The SCS operates on convection on the reactor side at the condenser and has redundant parallel control valves on the inlet and outlet to the condenser. These pneumatically operated valves fail open on loss of air or electrical power. The condenser shell side water level is controlled from a single controller that provides make-up water from the demineralized water storage tank. If the demineralized water is insufficient, water is taken from the High Pressure Service Water Systems (HPSW). The two demineralized water transfer pumps are powered from separate diesel generator supplied essential buses. The HPSW automatically provides make-up water using either of two diesel powered pumps which takes suction directly from the river.

Another method of cooling is available but is to be used only if other methods fail. This method requires activation of the manual depressurization system (MDS) and subsequent use of the alternate core spray (ACS) system. This is not included as a means for removal of decay heat in plant procedures since venting to containment requires significant plant downtime for cleanup and restoration to normal conditions. The primary purpose of the ACS system is responding to loss of coolant events.

5.2.2.1 Evaluation. The systems required for short-term and long-term cooling at La Crosse are capable of providing the required cooling assuming offsite power is not available and a single failure (other than the diesel powered generators). Loss of the SCS level controller will result in the requirement for manual local control (inside containment), and loss of either the non-interruptible bus 1A or 1B will result in loss of parameter indications in the control room for these systems.

5.3 Shutdown and Cooldown Capability Outside the Control Room

The capability to shut down and maintain the plant in hot shutdown from outside the control room exists at La Crosse. Reactor parameters can be monitored at locations outside the control room. Local control stations exist for pumps and valves of the systems required for safe shutdown. Critical control valves are capable of being manually operated. Procedures exist and have been demonstrated for reactor shutdown from outside the control room.

5.3.1 Evaluation. Adequate capability exists to shut down, to maintain the reactor in hot shutdown and to take the reactor from hot to cold shutdown from outside the control room.

5.4 RHR System Reliability and Interlocks

The RHR system was evaluated with respect to BTP RSB 5-1 (SEP Topic V-II.B) and reported as a part of Topic V-II.A.

6.0 SUMMARY

With the exception of instrumentation, the systems required to take the reactor from hot shutdown to cold shutdown, assuming only offsite power is available or only onsite power is available and a single failure, are capable of automatic initiation to bring the plant to a safe shutdown and are in compliance with current licensing criteria, and the safety objectives of SEP Topic VII-3.

The instrumentation available in the control room to monitor the shutdown systems parameters does not meet current licensing criteria since a loss of one of the non-interruptible power buses would result in the loss of critical parameter indication. The level controller for the shutdown condenser has no backup and is similarly subject to power supply failure.

The capability to maintain the reactor in hot shutdown from outside the control room exists and is in compliance with the safety objectives of SEP Topic VII-3. Procedures exist to take the plant from hot to cold shutdown from outside the control room which satisfies the safety objective of SEP Topic VII-3. The SDC system safety criteria of SEP Topic V-II.B for RHR System Reliability and Interlocks are satisfied.

7.0 SAFE SHUTDOWN EI&C FEATURES FOR CONSIDERATION BY SEP TOPIC III-1

ELECTRICAL DISTRIBUTION (including support structure, but not individual loads)

1. 2400 volt buses 1A and 1B, 480 volt buses 1A and 1B, 120 volt non-interruptible buses, reactor protection buses; including all feeders, incoming and outgoing, control circuits, indicating circuits bus work and support structures

2. ALL DC BUSES--including 125 V batteries, chargers, inverters, breakers, bus work, and support structures

3. DIESEL GENERATORS--including control and indicating circuitry, and control and indication of vital DG auxiliaries such as lube oil, fuel, and cooling

INSTRUMENTATION (including support structures)

1. REACTOR LEVEL
2. REACTOR PRESSURE
3. REACTOR TEMPERATURE
4. REACTOR PROTECTION SYSTEM
5. NEUTRON MONITORING (including in-core monitoring)
6. AREA AND SYSTEM RADIATION MONITORING
7. SHUTDOWN CONDENSER LEVEL CONTROLLER AND LEVEL INDICATION

SYSTEMS (includes pumps, valves, control, indication, and support structures)

1. CONTROL ROD DRIVE SYSTEM
2. SHUTDOWN CONDENSER SYSTEM
3. DEMINERALIZED WATER TRANSFER SYSTEM
4. HIGH PRESSURE SERVICE WATER SYSTEM
5. ALTERNATE CORE SPRAY SYSTEM
6. EMERGENCY CORE SPRAY SYSTEM
7. OVERHEAD STORAGE TANK
8. CONTROL AIR SYSTEM
9. INSTRUMENTATION
10. EMERGENCY POWER

8.0 REFERENCES

1. Technical Evaluation Report--"Systems Needed for Safe Shutdown--La Crosse Boiling Water Reactor" Franklin Research Center, October 9, 1981.
2. Dairyland Power Cooperative letter, Frank Linder to Director of Nuclear Reactor Regulation, dated February 2, 1981.

3. Dairyland Power Cooperative letter, Frank Linder to Director of Nuclear Reactor Regulation, dated March 13, 1980.

4. Dairyland Power Cooperative letter, Frank Linder to Director of Nuclear Reactor Regulation, dated November 26, 1980.

5. Code of Federal Regulations, 10 CFR 50, Appendix A, "General Design Criteria for Nuclear Power Plants."

6. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."

7. NUREG 0800, Nuclear Regulatory Commission Standard Review Plan 7.4, "Systems Required for Safe Shutdown" and 5.4.7, "Residual Heat Removal."