November 29, 1982

Docket No. 50-409
LS05-82-11-083

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

Dear Mr. Linder:

SUBJECT: SEP TOPIC III-4.A, TORNADO MISSILES
LACROSSE BOILING WATER REACTOR

Enclosed is our final evaluation of SEP Topic III-4.A, "Tornado Missiles." This evaluation compares your facility as described in the Safety Analysis Report you supplied on August 16, 1982, other information available on Docket No. 50-409, and information obtained during a site visit with criteria used by the staff for licensing new facilities.

The evaluation concludes that systems and components exist at your facility which are inadequately protected from tornado missiles.

This evaluation will be a basic input to the integrated safety assessment for your facility. This topic may be changed in the future if your facility is modified or if NRC criteria relating to this topic are changed before the integrated assessment is completed.

Sincerely,

Original signed by

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

Enclosure:
As stated

cc w/enclosure:
See next page

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LACROSSE BOILING WATER REACTOR
TOPIC III-4.A - TORNADO MISSILES

I. Introduction

Tornado generated missiles could cause sufficient damage to a plant so that the actual safety of the plant is reduced. Topic III-4.A is intended to review the plant design to assure that those structures, systems and components important to safety can withstand the impact of an appropriately postulated spectrum of tornado generated missiles.

These include those required to assure:

1. The integrity of the reactor coolant pressure boundary,
2. The capability to shut down the reactor and maintain it in a safe shutdown condition, and
3. The capability to prevent accidents which could result in unacceptable offsite exposures.

Scope of Review

The scope of the review is as outlined in the Standard Review Plan (SRP) Section 3.5.1.4, "Missiles Generated By Natural Phenomena."

An assessment of the adequacy of a plant to withstand the impact of tornado missiles includes:

1. Determination of the capability of the exposed systems, components and structures to withstand key missiles (including small missiles with penetrating characteristics and larger missiles which result in an overall structural impact); and

2. Determination of whether any areas of the plant require additional protection.

II. Review Criteria

The plant design was reviewed with regard to General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena" which requires that structures, systems, and components essential to safety be designed to withstand the effects of natural phenomena such as tornadoes and General Design Criterion 4, "Environmental and Missile Design Bases" which requires that these same plant features be protected against missiles. The plant was also reviewed against the guidance contained in Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Bases," 1.27, "Ultimate Heat Sink for Nuclear Power Plants," 1.117, "Tornado Design Classification," and 1.76, "Design Basis Tornado for Nuclear Power Plants" with regard to plant protection against tornado missiles.

III. Related Safety Topics

Topic II-2-A, "Severe Weather Phenomena" describes the tornado characteristics for the plant. Topic III-2, "Wind and Tornado Loadings" reviews the capability of the plant structures, systems and components to withstand wind loadings. Topic VII-3, "Systems Required for Safe Shutdown" reviews those systems needed to achieve and maintain the plant in a safe shutdown condition.

IV. Review Guidelines

The review was performed in accordance with Standard Review Plan (SRP) 3.5.1.4, "Missiles Generated By Natural Phenomena," Revision 1. This SRP states that the assessment of possible hazards due to missiles generated by the natural phenomena is based on the applicant having met the requirements of General Design Criteria 2 and 4 by: (1) meeting Regulatory Guide 1.76, Positions C-1 and C-2 and (2) meeting Regulatory Guide 1.117, Positions C-1 and C-3. SRP 3.5.1.4 further states that plants which were not required at the construction permit stage to design to the missile spectrum in Revision 0 to the SRP should show the capability to withtand the two postulated missiles discussed below.

The following missiles are described in SRP 3.5.1.4 as being appropriate for evaluating OL applications for plants which were not required to be protected against the full tornado missile spectrum during the CP stage:

1. Steel Rod, 1" dia., 3' long, 8 lbs, horizontal velocity-0.6 x total tornado velocity.
2. Utility Pole, 13 1/2" dia., 35' long, 1490 lbs, horizontal velocity - 0.4 x total tornado velocity.

The systems, structures, and components required to be protected because of their importance to safety are identified in the Appendix to Regulatory Guide 1.117.

V. Evaluation

A. Tornado Event Description

In accordance with Regulatory Guide 1.76, the LaCrosse Boiling Water Reactor is in Tornado Region I. Accordingly, the design basis tornado is characterized by a maximum wind speed of 360 miles per hour. The tornado characteristics described in SEP Topic II.2.A for the LaCrosse site are of similar severity.

Since the LaCrosse Boiling Water Reactor was built prior to the establishment of tornado loading criteria, a tornado having an annual probability of 1×10^{-4} was utilized to assess the capability of the structures to withstand tornado missiles. Such a design basis tornado would have a maximum windspeed of 132 mph. Therefore, in accordance with SRP 3.5.1.4 Revision 0, the total horizontal velocities for the two postulated missiles are:

1. Steel Rod, 116 ft./sec.
2. Utility Pole, 78 ft./sec.

At these missile velocities it was determined that the containment building and all systems housed within it would be adequately protected from missile penetration.

However, current criteria state that the maximum tornado windspeed of a design basis tornado is now 360 mph. Thus in accordance with SRP 3.5.1.4 Revision 0, the total horizontal velocities for the two postulated missiles are:

1. Steel Rod, 317 ft./sec.
2. Utility Pole, 211 ft./sec.

These missiles are considered to be capable of striking in all directions with vertical speeds equal to 80% of the horizontal speeds listed above.

For the review, our evaluation is based on the higher missile velocity spectrum.

B. Structural Considerations

In our evaluation, we have considered the adequacy of the following structures for tornado missile protection:

1. Containment Building;
2. Turbine Building;
3. Waste Disposal Building;
4. Diesel Generator Building; and
5. River Cribhouse.

In order to assess the adequacy of tornado missile protection of these structures, we have compared their wall and roof thicknesses to the current NRC requirements of the two postulated missiles for the Region I design basis tornado. Based on an extrapolation of the full scale tornado missile data test (EPRI Report NP 440) and an analysis by the staff on the required reinforced concrete barrier thickness to prevent penetration and spalling, the following criteria were obtained and used for this review:

1. A thickness of 8 inches is required to provide protection against the 1" steel rod tornado missile;
2. A thickness of 12 inches is required to provide protection against the utility pole tornado missile; and
3. Concrete block walls do not provide adequate resistance against tornado missiles.

For walls constructed of steel shells or plates, a plate thickness of 1 inch is required to prevent penetration of either missile.

C. System Considerations

The following systems and components were reviewed by the licensee in his SAR for Topic III-4.A:

1. Reactor Control and Protective Systems;
2. Shutdown Condenser;
3. Manual Depressurization System;
4. Alternate Core Spray System;
5. Emergency Service Water Supply System;
6. Reactor Building and Turbine Building Main Steam Line Isolation Valves;
7. Instrumentation for the above systems and components;

8. Emergency power (ac and dc) for the above systems;
9. Control Room;
10. Spent Fuel Storage Pool;
11. The Reactor Core and Individual Fuel Assemblies, including during refueling.

Any other systems or components not included may or may not be protected from tornado missiles, but were excluded from the review because the licensee does not consider them essential to achieve and maintain safe shutdown.

The following structures, systems and components as listed in the Appendix to Regulatory Guide 1.117 were evaluated to determine their susceptibility to the postulated tornado generated missiles.

1. Reactor Coolant Pressure Boundary

The reactor coolant pressure boundary, up to the main steam isolation valves is located in the containment building. The containment building walls enclosing the reactor coolant system up to the main steam isolation valves consists of a steel shell 1.16 inch thick, lined by 9 inches of concrete. The containment dome consists of only a 0.60 inch thick steel shell. Thus, the containment building does not provide adequate tornado missile protection for the reactor coolant pressure boundary because the steel shell forming the dome will not prevent penetration by the steel rod.

It is postulated that the utility pole does not travel above 30 feet above grade and thus, will not penetrate containment; the dome is above 30 feet above grade.

The staff has further evaluated the energy loss associated with penetration of the dome for the steel rod and has determined that reduction of velocity would be such that the postulated missile would not penetrate the reactor coolant pressure boundary piping.

The shutdown condenser did not possess sufficient thickness to prevent penetration; RCPB items other than piping and the shutdown condenser were not investigated.

Penetration of the dome by the steel rod will not occur for tornado velocities below 245 mph. Using the results from SEP Topic II-2.A, this windspeed has a probability of exceedence in one year of approximately 5×10^{-6} using the upper 95th percentile confidence interval value.

It should be noted that, although the dome can be penetrated, a water tank exists behind a large portion of the dome. If penetration of the dome occurs in that region, the missile will have to travel through the water and then penetrate the water tank to exit before safety-related equipment can be affected.

Calculations have not been performed for this particular configuration but is expected that the missile will either have low velocity if it is able to pass through the water and penetrate the water tank or the water will slow the missile sufficiently to prevent penetration of the water tank.

2. Reactor Core

The reactor vessel which houses the core constitutes a portion of the reactor core pressure boundary which is discussed in Item 1 above. The fuel assemblies in the reactor vessel are adequately protected from the tornado missile damage by the biological shield surrounding the reactor and the shield plug. The biological shield is a concrete barrier greater than 12 inches thick.

3. Systems or Portions of Systems Required for Safe Shutdown

As previously stated, those systems, structures, and components required to be protected because of their importance to safety are identified in the Appendix A to Regulatory Guide 1.117. However, for the SEP Evaluation, SEP Topic VII-3, "Systems Required for Safe Shutdown" covers those systems or portions of systems required for safe shutdown. Therefore, in this portion of our review, we examined those systems identified in SEP Topic VII-3.

a. Reactivity Control Systems

The reactivity control systems consists of the control rod drive and the boron injection system.

The mechanical components of the control rod drive are located within the lower elevations of the containment building. The floor slabs in conjunction with the steel dome will prevent tornado missiles from impacting the control rod drive system. Any damage to the rod control systems or supporting power systems - outside of containment (such as loss of offsite power) would result in automatic insertion of the rods. We conclude that the control rod drive system is adequately protected from tornado missiles.

The boron injection system and associated pumps and tanks, are also located within the containment building. The boron injection system functions as a back up to the rod control system by injecting a sufficient quantity of a borated solution into the primary system to make the reactor subcritical in the event of problems with the rod control system. As it is housed within the upper most floor elevation of the containment building, the boron injection system is not considered to be adequately protected from tornado missiles.

b. Shutdown Condenser

The shutdown condenser is used for heat removal and cooldown following a loss of offsite power. 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 condensate via gravity flow to a feedwater line and then to a reactor forced circulating loop. The shell side water is controlled to provide makeup from the demineralized water storage tank, by high pressure service water or by the emergency service water system.

The shutdown condenser can be controlled manually from local stations. The shutdown condenser is located in the containment building, but is susceptible to tornado missiles.

The demineralized water storage tank and high pressure service water system are both vulnerable to tornado missiles. The licensee does not consider the high pressure service water system necessary to achieve and maintain safe shutdown. The emergency service water system is addressed in Section III.d of this SER.

c. Manual Depressurization and Alternate Core Spray

The purpose of the manual depressurization system (MDS) is to depressurize the reactor vessel in the event of a LOCA where primary pressure is greater than 50 psig. Following the use of the MDS and the decrease of system pressure to less than 150 psig, the alternate core spray (ACS) is activated to provide core makeup and cooling. This water can be provided by two separate diesel driven pumps located in the river cribhouse, or by the emergency service water supply system. (The emergency service water supply water system is discussed under Item 3.d.)

The MDS is located inside the containment building next to the shutdown condenser and is also susceptible to vertical tornado missiles. The ACS pumps are located at the river cribhouse. The cribhouse walls are constructed of insulated aluminum sidings and are not designed to withstand the effects of tornadoes and tornado missiles.

d. Emergency Service Water Supply System

The emergency service water supply system (ESWSS) basically consists of three portable gasoline engine pumps which take suction from the Mississippi River. The pump discharge lines can be connected to manifolds either inside or outside the turbine building to provide water to the ACS line inside the turbine building. The ESWSS pumps are stored in a portion of the turbine building which does not provide protection against missiles. The manifold connections, and piping inside the turbine building are not tornado missile protected.

e. High Pressure Core Spray

The high pressure core spray (HPCS) system can be used for core cooling during a loss of offsite power. The HPCS pumps and local controls are located on the mid floor level of the containment building and thus are adequately protected from tornado missiles.

4. Systems Which are Safety Related but not Needed for Safe Shutdown

a. Diesel Generators

Two emergency diesel generators provide AC power to the essential buses in the event of a loss of offsite power. The diesel generators and auxiliary components associated with the 1A bus is located in the turbine building. The diesel generator and auxiliary components associated with the 1B bus is located in the diesel building.

The portion of the turbine building where the diesel generators are located is not fully designed to withstand the effects of tornado missiles. The north, south and east walls are concrete walls at least 12 inches thick and are of sufficient thickness to prevent missile penetration. The west wall is an interior wall and is shielded from the effects of tornado missiles. However, the cooling radiators for the diesels are not tornado missile protected. The diesel generator building is not designed to withstand the effects of tornado missiles. However, loss of all electrical power will not prevent the safe shutdown of the plant since the needed systems and components can be operated manually at the local control stations.

b. 125V DC Buses

There are three 125V buses and power sources which serve the facility. The reactor plant, and generator plant batteries and battery chargers are located in the electrical equipment room in the turbine building. The diesel building battery and battery charger are located in the diesel generator building. The south and east walls of the electrical equipment room will prevent penetration of tornado missiles. The west wall is an interior wall and is shielded from the missiles. The north wall is insulated aluminum siding and it is not designed to withstand tornado missiles. The diesel generator building walls are masonry block walls and will not withstand the impact of tornado missiles. However, loss of DC electrical power will not prevent the safe shutdown of the plant, since the needed systems, and components can be operated manually at the local control stations. Local instrumentation is not dependent on electrical power.

e. Control Room

The south and east walls, and the roof of the control room are 24" thick concrete walls and will prevent missile penetration. The west wall is an interior wall of the turbine building and is shielded from the effects of tornado missiles. The north wall of the control room is a composite wall of insulated aluminum siding and 1/4" armalloy steel. This composite wall will not prevent missile penetration. Evacuation of the control room or damage to equipment within the control room will not prevent the safe shutdown of the plant. Shutdown can be accomplished manually at the local stations.

5. Systems Whose Failure May Result in the Release of Unacceptable Amounts of Radioactivity

a. Fuel Element Storage Well (Spent Fuel Pool and Pool Cooling)

The fuel element storage well (FESW) cooling system is designed to remove heat from the storage well (pool), which is generated by stored spent fuel. The fuel storage well itself is susceptible to vertical tornado missiles. However, the fuel pool cooling system is housed within the lower floor elevations of the containment building and is thus protected from tornado missiles. These pumps can be powered from a diesel bus. In the event of a loss of all AC power, the thermal capacity of the pool would permit at least 8 hours to provide alternate cooling and makeup before boiling occurs.

Since the missiles entering the spent fuel pool would have to travel to heights greater than 30 feet above grade and the utility pole is not postulated to travel above 30 feet, the pool is only susceptible to the steel rod.

The effects of the one inch steel rod have been evaluated in previous analyses (e.g., written staff testimony and responses to interrogatories on spent fuel pool protection against tornado missiles for North Anna Units 1 and 2). The results indicate that the potential offsite radiological consequences are well within 10 CFR Part 100 Guidelines. In view of the above considerations, we conclude that the interior of the LaCrosse spent fuel pool meets the intent of current licensing criteria regarding tornado missile protection.

b. Waste Disposal Building

The waste disposal building is a temporary storage area for high level resin and solid waste, and low level compacted solid waste. Only the high level resin waste and low level compacted waste are located above grade level.

The walls of the waste disposal building are composed of insulated concrete blocks and are not designed for tornado missiles. Failure of the building could possibly result in an unacceptable release of radiation. The licensee has not completed such an evaluation. This concern should be addressed during the integrated assessment.

VI. Conclusions

Based upon our evaluation of the information provided by the licensee, we conclude that the following portions of LaCrosse are adequately protected from the effects of tornado missiles:

1. reactor core
2. reactivity control systems
3. high pressure core spray

Therefore, the above features meet the requirements of General Design Criteria 2 and 4 with respect to missiles and environmental effects.

However, we also conclude that LaCrosse does not meet the current criteria for tornado missile protection in the following areas:

1. reactor coolant pressure boundary
2. shutdown condenser
3. manual depressurization and alternate core spray
4. emergency service water supply system
5. demineralized water storage tank
6. diesel generators (turbine building and diesel generator building)
7. 125V dc buses
8. control room
9. waste disposal building
10. high pressure service water

The adequacy of the minimum number of systems required for safe shutdown should be coordinated with SEP Topic VII-3 during the integrated assessment.

The need for providing additional tornado missile protection to these systems should be evaluated during the integrated assessment of the LaCrosse Boiling Water Reactor.