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August 16, 1982

In reply, please
refer to LAC-8505

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 III-4.A - TORNADO MISSILES

Reference: (1) DPC Letter, LAC-7387, Linder to Eisenhut,
dated February 27, 1981

Gentlemen:

In accordance with Reference 1, please find enclosed the Safety Evaluation Report (SER), Tornado Missiles (SEP Topic III-4.A).

If there are any questions regarding this report, please contact us.

Very truly yours,

DAIRYLAND POWER COOPERATIVE

Frank Linder

Frank Linder, General Manager

FL:DLW:af

Enclosure

cc: J. G. Keppler, Reg. Adm., NRC-DRO III
NRC Resident Inspector

A035

LA CROSSE BOILING WATER REACTOR

SYSTEMATIC EVALUATION PROGRAM
SAFETY EVALUATION REPORT

TOPIC III-4.A
TORNADO MISSILES

I. INTRODUCTION

General Design Criteria 2 and 4 of Appendix A, 10 CFR Part 50, as implemented by Regulatory Guide 1.117, requires respectively, that structures, systems and components important to safety be designed to withstand the effects of natural phenomena, and also be protected from missiles originating from events and conditions outside the plant, without loss of capability to perform their safety functions, tornado missiles, i.e., objects and debris blown before tornado winds, are hazards which may be considered as included in either or both of these criteria. Review Topic III-4.A directs the evaluation of the plant's protection against these hazards to determine whether or not it is sufficient to assure:

A. The integrity of the reactor coolant pressure boundary.

B. The capability to shut the reactor down and maintain it in a safe shutdown condition, and

C. The capability to prevent accidents which could result in offsite exposures in excess of 25% of the dose guidelines of 10 CFR Part 100.

II. REVIEW CRITERIA

A structure, system or component is considered to be adequately protected from a postulated missile if either itself or a structure which surrounds it is sufficient to stop that missile without perforation or collapse.

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. The as-built capacity of the LACBWR and Genoa #3 stack with respect to wind and tornado loads is addressed under this topic. 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) 3.3.2, "Tornado Loadings," 3.5.3, "Barrier Design Procedure," and 3.5.1.4, "Missiles Generated by Natural Phenomena," Revision 1. SRP 3.5.1.4 identifies two missile sets known as Spectrum I and Spectrum II missiles, each of which contains a variety of missiles and their corresponding velocity. A plant applying for a construction permit would be required to design for one of these missile sets. This SRP states that plants which were not required at the construction permit stage to design to the missile spectrum provided in Revision 0 to the SRP should show the capability to withstand two of the postulated missiles in the Revision 0 spectrum.

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 Regulatory Guide 1.117.

V. EVALUATION

A. Tornado Event Description

In accordance with Regulatory Guide 1.75, the La Crosse Site is in Tornado Region I, where the design basis tornado is characterized by a maximum wind speed of 360 miles per hour with an occurrence frequency of no greater than 10^{-7} per year. The tornado characteristics described in the staff review of SEP Topic II-2.A, Severe Weather Phenomena, for the La Crosse Site, are of similar severity. (Reference 1)

However, the La Crosse Boiling Water Reactor was built prior to the establishment of tornado loading criteria. Wind loading, tornado wind loading, tornado missiles, and tornado pressure drop loading were not considered in the original design of the La Crosse Boilding Water Reactor. According to data included with Table 3-10 of the LACBWR Safeguards Report, the highest wind of record in the La Crosse area is 69 MPH in October 1949. Section 3.4.4.6 of the LACBWR Safeguards Report, Reference 2, states that the La Crosse area reported approximately 10 tornadoes in a 50 mile square from 1920 to 1949. This led to the conclusion in the Safeguards Report that in the La Crosse area, there is an annual probability of 1/2000 that a tornado will affect a given square mile and that the chance that a tornado will pass directly over the reactor site is even smaller.

Therefore, for purposes of assessing the capability of the structures, the tornado having an annual probability of 1×10^{-4} was utilized. This tornado has a mean recurrence level (Ref. 1) of 10,000 years and maximum wind speeds of 132 mph. (The expected windspeed of a 1×10^{-4} probability tornado is only 96 mph according to Ref. 1). 1×10^{-4} is equal to or less than the NRC accepted probability of occurrence of the design base earthquake. In addition, a recent EPRI report (Ref. 3) states that "analysis of velocity characteristics of the current missile spectrum indicates that the expected values of the equivalent (normal-collinear) impact velocities are generally significantly less than the currently acceptable design basis values. For example, in Region I, these values are approximately 40 to 60 ft/sec for the five penetrator type missiles as compared to current design values of 155 to 273 ft/sec."

Therefore, a tornado with a mean recurrence level of 10,000 years has been assumed to provide an adequate design basis tornado for La Crosse. Assuming a maximum total tornado windspeed of 132 mph, and in accordance with SRP 3.5.1.4, Revision 0, the total horizontal velocity for the two postulated missiles is:

1. Steel rod, 116 ft/sec.

2. Utility pole, 78 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.

B. Review of Safe Shutdown Vulnerability

The safe shutdown systems at LACBWR requiring protection from tornado-generated missiles are:

a. Reactor Control and Protective Systems
b. Shutdown Condenser
c. Manual Depressurization System
d. Alternate Core Spray System
e. Emergency Service Water Supply System
f. Reactor Building and Turbine Building Main Steam Line Isolation Valves
g. Instrumentation for the above systems and equipment
h. Emergency Power (AC and DC) for the above systems and equipment

In addition, Regulatory Guide 1.117 requires that the following structures and components be protected from the effects of tornado generated missiles:

i. Control Room
j. Spent Fuel Storage Pool
k. The reactor core and individual fuel assemblies, including during refueling

We have reviewed these systems with respect to their location, degree of protection against missiles, and the availability of back-up systems. We have found that although some equipment important to safety is located in the turbine building, electrical equipment room, diesel generator building, and control room (which may be subject to penetration by tornado-driven missiles as described in Section C of this evaluation), pressure boundary integrity and safe shutdown and cooldown of the reactor is still assured. The safety related systems and equipment inside containment, including the Control Rod Drive, Shutdown Condenser, Overhead Storage Tank, Low Pressure Cooling System, Manual Depressurization and local instrumentation and control are sufficient to assure and maintain safe shutdown. Even in the event of loss of power, the shutdown condenser would be able to dissipate decay heat during the first 5 hours after shutdown (Safeguards Report Section 5.2.2). This should be sufficient time to restore power.

C. Structural Considerations

An evaluation of major LACBWR plant structures with respect to their ability to withstand tornado wind loadings was performed as part of LACBWR's application for a full-term operating license (Reference 4). Plant structures evaluated with respect to missile impact included the Containment Building, Waste Disposal Building, and Turbine Building and Control Room. The postulated missiles employed in the analysis were determined to be appropriate for LACBWR in accordance with the guidelines of Reference 5 and included:

1. Wood board, 108 lb, 4"x12"x10'-0" traveling end-on at 300 mph.

2. Steel pipe, 76 lb, 3" Sch. 40, 10'-0" long, traveling end-on at 100 mph. Vertical surfaces less than 25 ft. above ground.

3. Automobile,4,000 lb, 20 sq.ft. frontal area, traveling at 50 mph.

Calculations of tornado wind loading and pressure drop loading were based on a tornado wind velocity of 300 mph.

Supplemental evaluations of the north wall of the control room and electrical equipment room, the turbine building west wall, the waste disposal building, and the containment head were performed. The postulated missiles in the analyses included those described in Section V.A of this evaluation. In addition, the containment head was evaluated for SRP 3.5.1.4, Rev. 2, Spectrum II missiles A, B, C, and E as well as the missiles described in Section V.A. The results of the analyses performed as part of LACBWR's application for a full-term operating license (Ref. 4) and the supplemental analyses are summarized below.

Control Room

The south and east walls (and the roof) of the control room are 24" thick concrete walls and will easily prevent missile penetration. The west wall is an internal wall and is treated below. The north wall is a composite wall, with an exterior of insulated aluminum siding mounted on a steel frame and an internal liner of 1/4" thick armalloy steel to a height of 7'6", therefore, only the control room north exterior wall was reexamined.

Supplemental analyses of the penetration resistance of the north wall for the utility pole (at 78 ft/sec) and the steel rod (at 116 ft/sec) show the pole would penetrate the liner. The required thickness to just prevent penetration is 0.3 inches. No credit was taken for the metal insulated siding.

Analysis of the penetration resistance of the north control room wall to the 1" rebar missile (with velocities of up to 116 ft/sec) showed that no penetration would occur (to a height of 7'6"). Should a tornado missile strike the north side of the control room, there is a 5% chance that it could strike (and possibly punch out) a 1-1/8" plexiglass, bullet resistant window.

The west wall of the control room is a 6" thick solid concrete block wall. This wall would not be able to withstand the direct impingement of tornado missiles or wind forces. However, this wall is an inside wall of the turbine building and as such would be shielded from the direct effects of a tornado.

In summary, while the control room was not designed to withstand the effects of tornado missiles, the roof and the exposed exterior walls (with the exception of the north wall) do have the ability to withstand tornado missiles.

Electric Equipment Room

The south and east walls are 24 inches thick reinforced concrete (same as the control room) and are designed such that they will withstand the effects of tornado missiles.

The north wall of the electric equipment room is insulated aluminum siding. The results of the analyses for a tornado with maximum wind speed of 132 mph, and a hazard probability of 1×10^{-4} per year, show the north wall is not designed to withstand the assumed tornado missiles (utility pole and 1" steel rod).

The north wall of the electric equipment room is a very small wall, and (as indicated in Ref. 6, Section 4.4.5) loss of the equipment room and the control room would not affect safe shutdown of the plant. In addition, plant procedures require protective action to be taken in the event of a tornado warning (see Ref. 4).

The west wall is an interior wall of the turbine building and is shielded from tornado missiles.

Waste Disposal Building

The walls of the waste disposal building are composed of insulated concrete block 11-5/8" thick. The more radioactive components (spent resin tank and evaporator) are shielded by 2-1/2 to 3 foot thick concrete block walls. These walls were not designed for tornado missiles.

Turbine Building

Safety related equipment in the turbine building below elevation 668' is protected by 24" thick reinforced concrete walls on the south and east sides. On the north side, the office facilities and a 12" thick wall provide shielding and protection from the effects of tornado missiles. The west wall is a 12" thick composite wall of concrete block and brick. While this wall would absorb some of the postulated tornado missiles energy, it is not designed to prevent tornado missile penetration. Above elevation 668'-0", the walls are of insulated metal siding and are subject to penetration by tornado driven missiles as evaluated in Reference 1.

However, as indicated in Section 3.2.1 and 4.4.1 of Ref. 6, loss of safety related equipment in the turbine building would not prevent safe shutdown of the plant. An assessment of the impact on the ability to shutdown the reactor is provided in Table 4-1 of Reference 6. In addition, plant procedures require protective action to be taken in the event of a tornado warning (see Ref. 4).

The 1-B Diesel Generator Building

This structure was not designed to tornado wind and missile criteria. The masonry block walls surrounding the structure offer some protection, but it will not be able to withstand the impact forces from tornado missiles. However, there is a redundant diesel generator (1-A) and the loss of diesel generator 1-B would not preclude safe shutdown.

As described in Ref. 6 (Section 4.4.3) disabling the 1-B diesel generator would not affect safe shutdown capabilities.

Containment Building

Analyses for the cylindrical shell and concrete liner were performed as part of the 1974 application. It was demonstrated that the shell and liner would not be perforated by missiles resulting from a tornado.

Supplementary analyses of the containment upper hemispherical dome were performed for the utility pole and steel rod (described in Section V.A) and for the Spectrum II missiles (A, B, C, and E) of Standard Review Plan 3.5.1.4. Rev. 2, using the Ballistic Research Laboratory Formula. None of the missiles could penetrate the head.

LACBWR Emergency Procedural Changes

As discussed in Reference 4, Section 3.3.4 of the LACBWR Operations Manual has been revised to include specific operating instructions to insure plant safety and integrity in the event of a tornado.

VI. CONCLUSIONS

Despite the fact that no specific tornado missile protection had been designed into the plant, those structures, systems, and components at LACBWR required to assure the integrity of the reactor coolant pressure boundary, and safely shutdown the reactor are adequately protected from the effects of tornado missiles. This protection, coupled with the LACBWR Emergency Procedures, provides sufficient protection to insure plant safety and integrity from the effects of tornado missiles.

REFERENCES

1. McDonald, James R., "Tornado and Straight Wind Hazard Probability for La Crosse Nuclear Power Reactor Site, Wisconsin," (Enclosure to Crutchfield to Linder letter, dated December 15, 1980).

2. "La Crosse BWR Safeguards Report," ACNP-65544, August 1967.

3. EPRI NP-768 "Tornado Missile Risk Analysis," May 1978, p 4-4.

4. DPC Transmittal LAC-2788, La Crosse Boiling Water Reactor - Full-Term License Application, Madgett to Giambusso, dated October 9, 1974.

5. Bechtel Corporation, "Tornado and Extreme Wind Design Criteria for Nuclear Power Plants," Report BC-TOP-3, Rev. 1, December, 1972.

6. Fire Hazard Analysis of the La Crosse Boiling Water Reactor to USNRC BTP A PCSB 9.5.1, Including Appendix A. DPC Transmittal LAC-4482, Madgett to Stello, Jr., dated February 14, 1977.