August 27, 1982

Docket No. 50-219
LS05-82- 08-069

Mr. P. B. Fiedler
Vice President and Director - Oyster Creek
Oyster Creek Nuclear Generating Station
Post Office Box 388
Forked River, New Jersey 08731

Dear Mr. Fiedler:

SUBJECT: SEP TOPIC III-4.A, TORNADO MISSILES
OYSTER CREEK NUCLEAR GENERATING STATION

Enclosed is our final evaluation of SEP Topic III-4.A. The evaluation is based on information available on Docket No. 50-219 and on a site visit conducted by the staff on May 18 and 19, 1982. Following exchanges between your staff and ours, we have revised the draft evaluation sent to you on June 21, 1982.

This evaluation will be a basic input to the Integrated Safety Assessment of your facility.

Sincerely,

SE04

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5 DSU USE(51)
Division of Licensing

G. Staley

Enclosure:
As stated

cc w/enclosure:
See next page

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OYSTER CREEK

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 shutdown 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 withstand 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 Oyster Creek Plant is in Tornado Region I. Accordingly, 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 SEP Topic II-2.A for the Oyster Creek site are of less severity, namely, a windspeed of 250 mph. The results of SEP Topic II-2.A will be used as the basis for this review.

Therefore, in accordance with SRP 3.5.1.4, Revision 0, the total horizontal velocities for the two postulated missiles are:

1. Steel Rod, 220 ft./sec.
2. Utility Pole, 147 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. Structural Considerations

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

1. Reactor Building;
2. Turbine Building;
3. Office Building (Control Room and Cable Spreading Room);
4. Radwaste Building;
6. Intake Structure; and
7. Reactor Building Exhaust Structure.

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 for the two postulated missiles for the Region I design basis tornado (360 mph windspeed). For a concrete strength of f c = 4000 psi, the required concrete thicknesses are as stated below:

MISSILE	REQUIRED WALL THICKNESS (INCHES)	REQUIRED ROOF THICKNESS (INCHES)
Telephone pole	12	12
1" steel rod	8	8

These wall thicknesses will be used as a guide in performing this review. All systems and components found to be adequately protected are housed within structures having thicknesses equal to or greater than above. Those systems and components not found to be adequately protected are not housed inside structures or were identified by the licensee as not being adequately protected.

The buildings of interest were constructed of 3500 psi concrete, but it is assumed that the strength of this concrete after aging is at least 4000 psi.

C. System Considerations

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 outboard main steam isolation valves and containment isolation valves, is located in the reactor building. The portion of the reactor coolant system inside the drywell is completely enclosed by a five foot thickness of reinforced concrete. The reactor building walls enclosing the remainder of the reactor coolant system up to the outboard containment isolation valves are reinforced concrete 18 inches to 30 inches thick. The drywell enclosure and reactor building provide adequate tornado missile protection for the reactor coolant pressure boundary because the concrete thicknesses are greater than the 12 inch minimum requirement.

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 tornado missile damage by the drywell enclosure and reactor building structure surrounding the drywell.

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. Automatic Pressure Relief System

The automatic pressure relief system valves are located within the drywell. Tornado missile protection is provided by the drywell enclosure and reactor building structure surrounding the drywell as discussed in Item 1 above. We have concluded that these structures provide adequate protection for the automatic pressure relief valves against damage from tornado missiles because the reactor building walls are reinforced concrete at least eighteen inches thick and the drywell enclosure is a five foot thick concrete barrier.

b. Feedwater Coolant Injection System

The major components in this system are the condensate pumps, and reactor feed pumps. One feedwater train is needed for safe shutdown and includes one condensate pump, and one feedwater pump. These pumps take suction from the condenser hot well and deliver water to the reactor vessel for shutdown. Makeup to the condenser is from the condensate storage tank (see Condensate Storage Tank). All of the pumps in the feedwater coolant injection system are located at the lowest elevation of the turbine building The turbine building walls are reinforced concrete and are, at least, 12 inches thick. The turbine building roof structure above elevation 119 feet is not designed to withstand tornado generated missiles. However, the refueling floor is reinforced concrete and is at least 12 inches thick. Finally, since the feedwater coolant system pumps are located at the lowest elevation of the turbine building they are protected by multiple barriers of reinforced concrete (walls and floor slabs). We conclude that the feedwater coolant injection system is adequately protected against tornado missiles.

c. Service Water and Emergency Service Water Systems-

The service water pumps and emergency service water pumps are used for safe shutdown of the plant. All of the pump motors located at the intake structure are open to the atmosphere. We conclude that the water and emergency service water pumps are unprotected against both horizontal and vertical tornado missiles.

d. Low Pressure Coolant Injection/Containment Spray System

The LPCI/Containment Spray system pumps are located in the reactor building. Piping and valves for this system are located in the reactor building and inside the drywell. Protection for this system is the same as described in Item 1. We conclude that the tornado missile protection for the LPCI/Containment Spray System is adequate based on the reactor building walls being at least 18 inches thick of reinforced concrete.

e. Emergency Power System - Switchgear

There are four 4160V switchgear bus sections, two are powered from normal or startup sources (1C and 1D). The latter are normally fed from the 1A and 1B buses with emergency power being supplied from the emergency diesel generators. They are located inside the turbine building in a seismic/fireproof enclosure. There are no openings in the turbine building that would allow a tornado missile to impact a safe shutdown system or safety related system. Because the turbine building walls and floor slabs are at least 12 inches thick, these barriers are adequate to withstand tornado missiles. Finally, because of the switchgear location, they are protected by multiple barriers. Based on our evaluation we conclude that the switchgear is adequately protected against tornado missiles.

f. Station Batteries

The 125 volt batteries supply power for operation of vital control circuits without interruption. The batteries and DC switchgear are installed in areas enclosed by reinforced concrete walls and meet requirements for Class I equipment. The redundant DC power supply cables to 4KV and 480 volt switchgear, and motor control centers, are physically separated by a floor slab in the turbine building and the reactor building. Because the turbine and reactor building walls are greater than the minimum requirement of 12 inches as specified on page 5 of this report, we conclude that the station batteries are adequately protected and/or separated within the reactor and turbine building to preclude damage by tornado missiles.

g. Emergency Diesel Generators

The emergency diesel generator(s) provide onsite emergency power and one unit is assumed to be adequate for safe shutdown in the event of a tornado. They are housed in a reinforced concrete building with separation between the two diesel generators. The oil tank is in a separate enclosure internal to the diesel generator building. By letter dated April 30, 1982, the licensee submitted a design evaluation memorandum relevant to tornado missile protection. In this design evaluation, the licensee stated that the walls and roof structure are not designed to withstand either the tornado wind load or the tornado missiles. The roof panels were identified as the weakest element in the building structure.

Based on our evaluation of this information and the site visit, we conclude that the diesel generator building and the fuel oil tank are unprotected against tornado missiles coming from any direction.

h. Instrumentation and Control for Safe Shutdown Equipment

Instrumentation and control for safe shutdown equipment is located in the control room. The majority of the cables are routed from the control room through the cable spreading room and into the reactor building. Other cables are routed through the turbine building to the switchgear.

We conclude that the reactor building and turbine building enclosure walls provide adequate tornado missile protection for the cables located in these two structures because the wall thickness is at least 18 inches. The control room and cable spreading room also provide adequate tornado missile protection because the walls are reinforced concrete at least 18" thick.

i. Space Coolers

The space coolers serving safe shutdown equipment are located within compartments housing the safe shutdown equipment and would have the same protection afforded the safe shutdown equipment as discussed above. We therefore conclude that the tornado protection provided these units is adequate.

j. Reactivity Control System

The reactivity control system consists of a control rod drive system and the standby liquid control system. Essential components for these systems are located in the reactor building and drywell. These components are adequately protected by the 18 inch thick reactor building walls and the drywell enclosure. All cables for the reactivity control systems are routed from the control room through the cable spreading room directly below and through the reactor building directly adjacent to the cables room. See Item 3.h and 4.e for the protection afforded cables/ equipment in these areas. Based on the above considerations, we conclude that the reactivity control systems are adequately protected against the effects of tornado missiles.

k. Control Room

The control room is adequately protected against the effects of tornado missiles as discussed in Item 3.h above. However, the control room HVAC system is vulnerable to damage from tornado missiles (see Item 4).

4. Systems or Portions of Systems Not Required for Safe Shutdown But Safety Related

a. HVAC Systems

Both the reactor building and the turbine building HVAC systems are located on the office building roof and open to the outside environment. Therefore, no tornado missile protection is provided except that the office building roof elevation (above 30 feet) precludes the assumption of a telephone pole type tornado missile. The intake for the control room HVAC system is located in the reactor building wall and is not protected against tornado missiles. Should a missile strike the control room HVAC air intake, then the HVAC system would be disabled because the air handling unit is positioned at the wall.

Based on our review, we conclude that the control room HVAC system and its air intake are not adequately protected against tornado missiles. We also conclude that the reactor building and turbine building HVAC systems are unprotected against tornado missiles.

b. Condensate Storage Tank

The condensate storage tank provides an alternate makeup water source to the condenser which is in turn the source of water for the feedwater coolant injection system for safe shutdown. The tank is located in the yard at grade and is fully exposed to the outside environment.

While we understand that this tank will provide an alternate makeup water source to the condenser and in turn to the feedwater coolant injection system we believe it would be prudent to consider its protection from tornado missiles during the integrated assessment of the Oyster Creek Nuclear Plant.

c. Torus Water Storage Tank

The torus water storage tank is positioned in the open at grade level and, therefore, is not protected against tornado missiles. We understand that the torus water storage tank is not required for safe shutdown. However, we believe it would be prudent to consider its protection from tornado missiles during the integrated assessment of the Oyster Creek Nuclear Plant.

d. Reactor Building Exhaust System

The reactor building exhaust system includes the fan motors/blowers and a 394 foot elevated exhaust stack. The exhaust system components are vulnerable to tornado missiles because they are open to the atmosphere at grade level. The elevated exhaust stack is not designed to withstand a tornado wind load. Its ability to withstand this load is being performed in SEP Topic III-2. The utility pole will not penetrate the stack below 30 feet above grade because the stack walls are greater than 12" thick at these elevations. Penetration by the rod may occur in the upper elevations, but is not a concern since the stack is not required for safe shutdown. It is the staff's judgement that should such a penetration occur in the upper elevation of the stack, radioactive releases would not significantly increase at site boundary. It is the staff's judgement that gross stack failure will not occur if struck by either of these missiles. Because the reactor building exhaust system is not required for safe shutdown, we conclude that the reactor building exhaust structure is adequate regarding tornado missile protection.

e. Reactor Building Railroad Doors

Two metal air lock doors are located, at grade level, in the reactor building for the purpose of railroad car access. These double leaf doors are not tornado missile resistant. Possible missile targets just inside these high bay doors include; one bank of CRD scram accumulators, a containment spray system supply pipe, and several cable trays/conduits.

Only one bank of the CRD scram accumulators are located within "view" of the reactor building railroad doors. However, a massive reinforced concrete column is located between the doors and the CRD scram accumulator location. The projected net area of this column is sufficient to screen the CRD accumulators against any incoming tornado missiles. Based on our onsite inspection of this area, we conclude that these CRD scram accumulators are not vulnerable to tornado missiles.

The containment spray supply header is exposed and vulnerable to a tornado missile. However, this supply header is not required for safe shutdown and is not normally functioning. Therefore, we conclude that no tornado missile protection is required for the containment spray supply header and that the current plant arrangement is acceptable.

Finally, there are safety related cable trays and condutis in this area that could be struck by a missile entering via the railroad doors. During our site visit, we ascertained that no redundant safe shutdown cables/conduits existed in this area, and, hence, safe shutdown would not be compromised. Therefore, no further missile protection is required and the plant arrangement is acceptable.

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

a. Spent Fuel Pool Cooling System

The spent fuel pool cooling system removes residual heat from the spent fuel stored in the pool. The spent fuel pool cooling system is designed to clarify the pool water and to remove the residual heat produced by the stored spent fuel elements while maintaining the pool water temperature at or less than 125°F. The spent fuel pool cooling system consists of two cooling pumps and two heat exchangers. The spent fuel pool pump draws water from the pool, circulates it through the heat exchangers, and returns it to the pool. Service water cools the spent fuel pool heat exchangers. The spent fuel pool is located on the reactor building refueling floor, which is enclosed by the metal siding starting at the 119 foot elevation.

Of the two postulated missiles, only the one inch steel rod could be expected to impact the top of the spen t fuel pool. Utility poles are assumed to reach heights no greater than 30 feet above the maximum grade elevation within one-half mile of the plant.

The 18 inch thick reactor building walls provide protection against utility pole impact up to an elevation of 119 feet.

It is possible for the one inch steel rod to penetrate the spent fuel pool area through the metal-sided roof or walls. above the 119 foot elevation. However, the effects of the one inch steel rod have been evaluated in previous analyses (e.g., within staff testimony and responses to interrogations on spent fuel pool protection against tornado missiles for North Anna and Palisades). 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 Oyster Creek spent fuel pool is acceptable regarding tornado missile protection.

The spent fuel pool cooling system consists of two pumps, two heat exchangers, filters, piping, valves and instrumentation. Most of this equipment is located in the reactor building and is protected by the 18 inch thick reinforced concrete structure. The spent fuel pool cooling system is cooled by the reactor building closed cooling water (RBCCW) system. All RBCCW system components are located in the reactor building. We therefore conclude that adequate tornado missile protection is afforded the spent fuel pool cooling system RBCCW. However, the RBCCW heat exchangers reject spent fuel heat to the service water system which is not adequately protected (see Item 3.c).

In our judgement, failure of these systems because tornado missiles will not result in significant radiological consequences.

b. Radwaste Treatment Systems

1. Off Gas System

This system processes and disperses radioactive waste gases from the main condenser steam jet air ejectors, the turbine gland seal exhauster and mechanical vaccuum pump and discharges them via a stack to the atmosphere. In case of breaks, the offgas system can be isolated by isolation valves inside the reactor building. The licensee has analyzed the radiological consequences of failure of the off-gas treatment system. The results of this analysis yield doses well below 10 CFR 100 limits.

In our judgement, failure of the gaseous radwaste systems will not result in significat radiological consequences.

2. Liquid and Solid Radwaste Systems

The liquid and solid radwaste systems are located in two radwaste buildings. These radwaste buildings are constructed of metal siding and would be vulnerable to a tornado. Although the liquid and solid radwaste systems are not identified in the Appendix to Reg Guide 1.117, we believe it is noteworthy that these systems could produce a radiological consequence given a tornado event. We conclude that the liquid, and solid radwaste systems are unprotected against the effects of tornado missiles

6. As a result of a site visit conducted by the NRC staff, the following components were identified as vulnerable to tornado missiles that penetrate through a nearby roll-up door. They are located in the Reactor Building within the vicinity of the Reactor Building mechanical equipment access opening.

   a. MCC-DC-1, MCC-1AB21B
   b. Control Rod Drive Hydraulic Filter
   c. Control Rod Drive Control Station
   d. Isolation Condenser fill piping
   e. Containment spray and Torus fill valves

IV. CONCLUSIONS

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

1. Reactor coolant pressure boudary;
2. Reactor and individual fuel assemblies located within the core;
3. Automatic pressure relief system;
4. Feedwater coolant injection system
5. Low pressure coolant injection/containment spray system;
6. Safe shutdown cables (control room, cable vault, reactor buildings;
7. Spent fuel pool;
8. Emergency power system switchgear
9. Station batteries
10. Spent fuel pool cooling system;
11. Reactor building closed cooling water system;
12. Reactivity control system;
13. Control room; and
14. Space coolers
15. Offgas Treatment System
16. Reactor Building Exhaust System

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

However, we have concluded that Oyster Creek does not meet the current criteria for tornado missile protection in the following areas:

1. Condensate storage tank;
2. Torus water storage tank;
3. Service water and emergency service water pumps;
4. Emergency diesel generators and fuel oil day tank;
5. Control room, reactor building and turbine building HVAC system;
6. Radwaste treatment buildings
7. Components located within the vicinity of the Reactor Building mechanical equipment access opening.

The need for providing additional tornado missile protection to these systems should be evaluated during the integrated assessment of the Oyster Creek Nuclear Power Plant.