August 2, 1982

Docket No. 50-213
LS05-82-08-002

Mr. W. G. Counsil, Vice President
Nuclear Engineering and Operations
Connecticut Yankee Atomic Power Co.
Post Office Box 270
Hartford, Connecticut 06101

Dear Mr. Counsil:

SUBJECT: SEP TOPIC III-4.A, TORNADO MISSILES - HADDAM NECK

Enclosed is a copy of our final evaluation of SEP Topic III-4.A, "Tornado Missiles". This evaluation was developed using the Safety Analysis Report provided by you on August 31, 1981 and subsequent exchanges between your staff and ours.

This evaluation will be a basic input to the Integrated Safety Assessment for your facility unless you identify changes needed to reflect the as-built conditions at your facility. This assessment may be revised in the future if your facility design is changed.

Sincerely,

SE04

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

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As stated

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HADDAM NECK PLANT

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 necessary to ensure:

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.

   Can withstand the impact of an appropriately postulated spectrum of tornado generated missiles.

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 Phenomana."

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),

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 Guides 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 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 through 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 provided 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 Haddam Neck 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 Haddam Neck site prescribe a windspeed of 300 mph with an occurrence frequency of 10^{-7} per year. The Safety Analysis Report prepared by the licensee used a windspeed of 360 mph. Therefore, Regulatory Guide 1.76 will provide a conservative design basis tornado for the Haddam Neck Plant.

Therefore, 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.

B. Structural Considerations

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

1. Primary Auxiliary Building

2. Turbine Building

3. Spent Fuel Building

4. Screenwell House/Intake Structure

5. Diesel Generator Building

6. Containment

7. Service Building

8. Auxiliary Feedwater Building/Terry Turbine Building

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 Region I as stated below.

CONCRETE STRENGTH F'C in psi	REQUIRED WALL THICKNESS(INCHES)	REQUIRED ROOF THICKNESS(INCHES)
3000	23	18
5000	18	14

C. System Consideration

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

1. Reactor Coolant Pressure Boundary

The reactor coolant pressure boundary is totally enclosed within the containment structure. The walls of the containment consists of steel reinforced 3000 psi concrete 54 inches thick. The roof dome of the containment also consists of steel reinforced 5000 psi concrete 30 inches thick. In comparing these concrete thicknesses to the thicknesses provided on the previous page it can be seen that the containment structure provides an adequate level of tornado missile protection for the reactor coolant pressure boundary.

2. The Main Steam and Main Feedwater Systems

As with the reactor coolant pressure boundary those portions of the main steam and main feedwater systems from the steam generators up to the area they penetrate containment are considered to be adequately protected from tornado missiles. There are no isolation valves for these two systems inside containment.

The main steam and main feedwater lines exit containment very close together and the main steam line isolation and relief valves, and the main feedwater isolation valves are located at elevation 49'8" in the auxiliary feedwater Terry turbine building. The upper two levels of this building consists of steel superstructure with a metal siding.

We conclude that this arrangement provides little or no protection from tornado missiles for those portions of these two systems just outside containment.

3. Reactor Core and Individual Fuel Assemblies

The reactor vessel which houses the core constitutes a portion of the reactor coolant pressure boundary discussed in Item 1 above. The fuel assemblies of the core are protected from damage by tornado missiles while they are the reactor vessel by the containment structure. Protection provided stored spent fuel assemblies is discussed in Item 5 below.

4. Systems or Portions of Systems Required for Attaining Safe Shutdown

We have reviewed the tornado missile protection provided for the following components and systems listed in the SEP Topic VII-3, "Systems Required for Safe Shutdown" prepared by Franklin Research Center and dated September 9, 1981.

a. Atmospheric Dump Valve, Steam Generator Vents, and Auxiliary Vent Paths

The atmospheric dump valves, the steam generator vents and auxiliary vent paths are located at the upper level of auxiliary feedwater/Terry turbine building. The walls of this building are constructed of metal siding supported on structural steel. And the roof consists of metal panels covered with insulation and builtup roofing over a steel super-structure. These structures are not capable of providing tornado missile protection to the atmospheric dump valves and auxiliary vent paths. Therefore we conclude that the atmospheric dump valves and vent paths are not tornado missile protected.

b. Auxiliary Feedwater System

Those portions of th auxiliary feedwater system which are located inside the containment are considered to be

protected from tornado missiles. However, those portions of the auxiliary feedwater system outside containment are located within the auxiliary feedwater/Terry turbine building. As discussed in Items 2 and 4a above, this building does not provide tornado missile protection. Therefore, those portions of the auxiliary feedwater system located in the auxiliary feedwater/Terry turbine building are not tornado missile protected.

c. Water Sources - Demineralized Water Storage Tank (DWST), Primary Water Storage Tank (PWST) and Primary Water Transfer Pump

The demineralized water storage tank and primary water storage tank are located just south of the containment building and are not tornado missile protected. The primary water transfer pumps are located at the ground level of the primary auxiliary building. These pumps and associated piping are also not considered to be tornado missile protected.

d. Service Water System

The service water system (SWS) consists of four pumps which supply water to a dual header system in which two parallel 100% capacity headers supply both the primary and secondary plants. The connecting piping between the screen house and the plant consist of buried pipe. The pumps are located in the screenwell house. The walls of screenwell house consist of insulated Galbestos panels over a steel super-structure. We conclude that this structure does not provide adequate tornado missile protection for the motors of the four pumps.

e. Chemical and Volume Control System

The chemical and volume control system (CVCS) consists of two centrifugal charging pumps, the regenerative heat exchangers, pressure reducing valves, the volume control tank (VCT), and refueling water storage tank (RWST) and are located at the lower level of the primary auxiliary building. The associated piping is underground inside the primary auxiliary building. The walls of the lower level of the primary auxiliary building at an elevation up to 21 feet and 6 inches consists of steel reinforced concrete of thickness up to 18 inches. We conclude that the concrete thickness provides acceptable tornado missile protection for the CVCS.

f. Emergency Power Systems

The two emergency diesel generators and their corresponding switchgear are located within the diesel generator building which consists of a reinforced concrete roof and walls two feet thick. Fuel for the two diesels is contained in two 5000 gallon tanks which are buried such that the high point of each tank is below more than seven feet of soil. We conclude that this portion of the emergency power system is tornado missile protected. Our review also concludes that a large part of the emergency power distribution system is tornado protected since it is located within the containment and the lower portions of the primary auxiliary building. However, a vital portion of the emergency power system is located in the emergency switchgear room. Since this room is enclosed by a metal-sided structure, we conclude that this structure is not capable of providing tornado missile protection for the emergency power distribution system located in the switchgear room.

g. Instrumentation for the Safe Shutdown Equipment

Indication for the shutdown equipment instrumentation is located within the control room. The control room is located on the top floor of the service building and consists of reinforced concrete walls 20 inches thick and a 22 inch thick reinforced concrete roof. We conclude that the control room construction meets the current NRC requirements for concrete wall and roof thickness as discussed in Section V of this SER and that it provides adequate tornado missile protection to the instrumentation located inside. While it is recognized that the majority of instrument sensors are located within containment and thus are adequately protected, the cables that electrically connect these sensors to the control room instruments pass through the switchgear room. As discussed above in item 4f the switchgear room does not provide tornado missile protection. Therefore, instrumentation required for safe shutdown may not be available following a tornado event.

h. Component Cooling Water (CCW) System

The component cooling water (CCW) system is an intermediate cooling system for transfer of heat from components containing reactor coolant to the service water cooling system. The CCW consists of three pumps, two heat exchangers, a surge tank, cooling water lines to various components being cooled, and associated valves and instrumentation. This system is located in the lower level of the primary auxiliary building. The CCW system has the same protection against tornado missiles as those system discussed in item 4e above with the exception of the surge tank which is located in the upper level of the primary auxiliary building. This upper level is enclosed in a metal sided structure. With this one exception we conclude that the CCW system is tornado missile protected.

i. Pressure Control and Relief System

The pressure control and relief system consists of a pressurizer vessel containing a two-phase mixture of steam and water, immersion heaters, spray systems, safety and relief valves, and associated piping. Valves and instrumentation are located inside the containment building. These components located inside the containment have the same protection against tornado missiles as the reactor coolant pressure boundary discussed in item 1 above. Therefore, we conclude that this system is adequately protected from the tornado missiles.

j. Control Air System

The air compressors and the air receivers are located at the ground level in the turbine building. The exterior walls from ground level to roof consists of metal siding supported on structural steel. This structure is not capable of providing protection against tornado missiles. Therefore, we conclude that the control air system is not tornado missile protected.

k. Residual Heat Removal (RHR) System

The residual heat removal (RHR) system consists of RHR pumps and heat exchangers, bypass valve, RHR heat exchangers controls and RCS/RHR motor operated valves (MOVS). The system is located in the lower level of the primary auxiliary building except for RCS/RHR MOVS and interconnecting piping which are located inside the containment. The RHR system has the same protection against tornado missiles as those systems discussed in item 4e above. Therefore, the RHR system is considered to be tornado missile protected.

5. Spent Fuel Pool Storage & Spent Fuel Pit Cooling System

The exterior walls of the spent fuel building consists of steel reinforced concrete, from elevation 21 feet and 6 inches up to elevation 47 feet except around the spent fuel pool which has walls 6 feet thick. The exterior walls from elevation 47 feet to the roof consists of insulated galbestos panels over a steel super-structure. The roof consists of steel reinforced concrete 8 inches thick with a hatch extending partially over the spent fuel area. The hatch is covered by 1/4 inch steel plate. The operating floor of the spent fuel building consists of steel reinforced concrete 12 inches thick. On the east side of the building there is a 14 feet x 14 feet and a 10 feet x 23 feet galvanized steel roll-up door. Therefore, the spent fuel pool is not protected from missiles which could enter through the metal siding above the 47' elevation or the roof hatch opening. However, we note that the elevation of the concrete structure surrounding the spent fuel pool reduces the probability of large missile impacts.

Current criteria (SRP 3.5.1.4, Rev. 1, Section 1) limit the hypothetical missiles for older plants, to the two described in Section IV of this SER; the steel rod and the utility pole. Utility poles are assumed to reach heights no greater than 30 feet above grade during a tornado event. Since grade is at 21 feet and 6 inches, the walls of the building provide protection for 25' 6" of the 30 feet height. We consider this protection to be adequate since the 30 feet was originally selected as a conservative value.

It is possible for the one inch steel rod to penetrate the spent fuel pool areas above elevation 47' through the roof or the sides of the building. 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 indicates that the potential offsite radiological consequences are well within 10 CFR Part 100 guidelines.

In view of the above considerations, we conclude that the Haddam Neck spent fuel pool is acceptable regarding tornado missile protection.

The spent fuel pit cooling system consists of heat exchanger, spent fuel pit pump, spent fuel pit filter and associated valves and piping. These components are located in the spent fuel building and are adequately protected by a reinforced concrete enclosure.

6. The Reactivity Control Systems

The reactivity control systems consists of a control rod drive system and a boron injection system and the associated piping. The boron injection system is located in the lower level of primary auxiliary building and the control rods and their drives are located in the containment building. These components have the same protection against the tornado missiles as we have discussed in items 1 and 4E above. Therefore, an acceptable level of protection is provided with regard to tornado missile protection. However, the cables for the control rod drives are located in the switchgear room. As we have stated in the item 4f, the switchgear room is not tornado missile protected.

7. The Control Room

The control room is adequately protected from tornado missile as described in 4g above. However, we note that the ventilation system which supports the control room environment is

located in the mechanical equipment room which is adjacent to the control room. This room is enclosed by a metal sided structure and therefore does not afford adequate tornado missile protection for the ventilation system.

8. Gaseous Radwaste Treatment System

The gaseous radwaste treatment system is located in a separate building whose roof and walls are composed of 24" reinforced concrete. This structure affords adequate tornado missile protection for the system with the exception of the piping connecting the gaseous radwaste tank and the stack. This line is unprotected. However, the inventory of the system, which is limited by technical specifications, if released due to a tornado missile strike, would not result in an unacceptable offsite dose.

Due to the large number of systems considered vulnerable to tornado missiles, the licensee has submitted additional information by letter dated March 31, 1982, to show that a plant safe shutdown could be accomplished with damage from the postulated tornado missiles. The method described in the submittal relied on natural circulation in the primary loop with the auxiliary feedwater pumps providing water to the steam generators from the demineralized water storage tank (DWST) or the primary water storage tank (PWST). The auxiliary feedwater pumps although not completely protected from tornado missiles, are afforded missile protection on the east by the containment and by a missile barrier to the west They are shielded by masonry block walls and the alternate auxiliary feedwater pump to the north and south and above by piping. Also, there are two auxiliary feedwater pumps and it is unlikely that both would become disabled. Necessary instrument readings can be taken manually. The method described above, although substantially protected is subject to single failure in that the common steam header from which the pumps draw steam is not protected.

An alternate safe shutdown path for the reactor would be using the "feed and bleed" method described in a letter from CYAPCo to the staff dated February 5, 1975. To utilize this method the plant requires that a charging pump, a PORV, a source of water from either the volume control tank (VCT), the refueling water storage tank (RWST), or the primary water storage tank (PWST), and a diesel generator for power be available. The diesel generator requires cooling water via the service water pumps or the diesel fire pumps. The PORV is missile protected since it is located inside containment; the charging pump and VCT are missile protected as they are located in the lower portion of the primary auxiliary building (PAB) whose walls are reinforced concrete, 12" - 18" thick. The PWST and RWST have not been shown to be able to withstand tornado missiles. Electrical cables to the charging pumps are routed along different paths. One cable runs from the diesel generator through conduit along the outside of the PAB to the pump. Another cable runs through underground conduit to the switchgear room and then to the charging pumps. The conduit provides the only protection for one of the cables and the other cable is protected while underground but is not considered protected when inside the switchgear room as the switchgear room is not a tornado missile resistant structure. The diesel generator is adequately protected; however, the service water pumps and their associated electrical cables or the diesel fire pumps needed to cool the generator are not. Cooling water to the diesel generators can also be achieved through an agreement between CYAPCo and the Haddam Neck Volunteer Fire Company (Station Emergency Plan, Rev. 10, February 1, 1982) whereby personnel and equipment can be provided by the fire company to pump water into the fire system to cool the diesel generators.

Even though the natural circulation method to safely shutdown is substantially protected, it is possible to disable the cooling water with a single failure. However, alternate safe shutdown could also be accomplished by "feed and bleed." Although this back-up method is not completely tornado missile protected it does provide a redundant shutdown path. It is the judgement of the staff that the probability of a tornado striking the site and generating missiles that would disable both the natural circulation and feed and bleed to safely shutdown is acceptably low for the interim.

VI. CONCLUSIONS

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

1. Reactor coolant pressure boundary.

2. Reactor core and individual fuel assemblies located within the core.

3. Chemical and volume control system.

4. Emergency diesel generators and their corresponding switchgear.

5. Component cooling water system (with the exception of its surge tank).

6. Primary pressure control and relief system.

7. Residual heat removal system.

8. Spent fuel storage pool.

9. Boron injection system.

10. Control room.

11. Spent fuel pit cooling system.

12. Gaseous radwaste treatment system.

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

However, we have concluded that the Haddam Neck Plant does not meet the current cirteria for tornado missile protection in th following areas:

1. Atmospheric dump valve (ADV) and associated steam vent path piping located in the Auxiliary Feedwater Building.

2. Main Steam and Feedwater Isolation Valves

3. Auxiliary Feedwater System.

4. Water Sources - Demineralized water storage tank, primary water storage tank, and primary water transfer pump.

5. Service Water System;

6. Emergency Switchgear Room including portions of the emergency power distribution system,

7. Safe Shutdown instrumentation

8. Control Air System

9. Control Rod Drive System

10. Life Support Equipment for the Control Room.

The need for providing additional tornado missile protection to these systems will be evaluated during the integrated assessment for Haddam Neck Plant.

The staff concludes that the facility can be safely operated until this issue is resolved in the integrated assessment.