U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 3.5.1.4 MISSILES GENERATED BY NATURAL PHENOMENA

REVIEW RESPONSIBILITIES

Primary - Accident Analysis Branch (AAB)

Secondary - Structural Engineering Branch (SEB)
Auxiliary and Power Conversion Systems Branch (APCSB)

I. AREAS OF REVIEW

The applicant's assement of possible hazards due to missiles generated by the design basis tornado, flood, and any other natural phenomena identified in Section 2.2.3 of the safety analysis report (SAR) is reviewed. The purpose of the review is to assure that hazards due to these missiles are acceptably small so that they need not be included in the plant design basis, or that appropriate design basis missiles have been chosen and properly characterized. Currently, only missiles from the design basis tornado (Ref. 1) are considered in plant design bases.

The APCSB, under Standard Review Plan (SRP) 3.5.2 identifies those structures, systems, and components that should be protected against missile impact and the SEB, under SRP 3.5.3, assures that adequate protection is provided by structures and missile barriers.

II. ACCEPTANCE CRITERIA

1. The identification of appropriate design basis missiles generated by natural phenomena is considered acceptable if the methodology is consistent with the acceptance criteria defined for the evaluation of potential accidents from external sources in SRP 2.2.3 (Ref. 2).

2. The staff's position regarding the systems to be protected against tornado missiles is covered in Branch Technical Position AAB 3-2 (Ref. 3). A representative spectrum of tornado missiles is described in WASH-1361 (Ref. 4) and currently acceptable impact velocities are listed in item 4 under Review Procedures (Section III, below).

III. REVIEW PROCEDURES

The reviewer selects and emphasizes aspects of the area covered by this review plan as may be appropriate for a particular case. The judgment on areas to be given attention and emphasis in the review is to be based on an inspection of the material presented to see whether it is similar to that recently reviewed on other plants and whether items of special safety significance are involved.

1. The reviewer obtains from SAR Section 2.2.3 the identification of the design basis natural phenomena which could possibly generate missiles.

2. The total probability per year of missiles generated by a specific design basis phenomena striking a critical area of the plant is estimated. This total probability per year (P_T) may be estimated by using the following expression:

$$P_T = P_{NP} \times P_{MR} \times P_{SC} \times N$$

where

P_{NP} = frequency of occurrence (per year) of the design basis phenomenon (as calculated in SAR Section 2.2.3).

P_{MR} = probability of the generated missiles reaching the plant,

P_{SC} = probability of missiles that reach the plant striking a critical area of the plant, and

N = number of missiles generated by the design basis natural pnenomenon.

P_{MR} and P_{SC} are assumed to be equal to 1 unless analyses demonstrate lower values.

3. If P_T is greater than about 10^{-7} per year the reviewer should verify that the proper design basis events have been chosen and the missiles properly characterized.

4. All plants are required to be designed against tornado-generated missiles (i.e., the probability of a tornado strike is between 10^{-3} and 10^{-4} per year and therefore P_T is assumed greater than 10^{-7} per year). The following missiles (described in Ref. 4) and associated impact velocities are presently accepted as an adequate design basis until more definitive guidelines, based on the review of several topical reports and independent analytical work under way by the staff, are developed.

		Fraction of total tornado velocity
A.	Wood plank, 4 in. x 12 in. x 12 ft, weight 200 lb.	0.8
B.	Steel pipe, 3 in. diameter, schedule 40, 10 ft long, weight 78 lb.	0.4
C.	Steel rod, 1 in. diameter x 3 ft long, weight 8 lb.	0.6
D.	Steel pipe, 6 in. diameter, schedule 40, 15 ft long, weight 285 lb.	0.4
E.	Steel pipe, 12 in. diameter, schedule 40, 15 ft long, weight 743 lb.	0.4
F.	Utility pole, 13-1/2 in. diameter, 35 ft long, weight 1490 lb.	0.4
G.	Automobile, frontal area 20 ft^2, weight 4000 lb	0.2

These missiles are considered to be capable of striking in all directions. Missiles A, B, C, D, and E are to be considered at all elevations and missiles F and G at elevations up to 30 feet above all grade levels within 1/2 mile of the facility structures.

The staff has, as an interim position, accepted the "no-tumbling" horizontal missile velocities presented in the Topical Report TVA-TR74-1 (Refs. 5 and 6, provided that a 4000-lb automobile at 70 mph and elevations up to 30 feet above grade level is added. These velocities are:

		Horizontal Velocity ft/sec
A.	Wood plank, 4 in. x 12 in. x 12 ft, weight 200 lb.	368
B.	Steel pipe, 3 in. diameter, schedule 40, 15 ft long, weight 115 lb.	268
C.	Steel rod, 1 in. diameter x 3 ft long, weight 8 lb.	259
D.	Steel pipe, 6 in. diameter, schedule 40, 15 ft long, weight 285 lb.	230
E.	Steel pipe, 12 in. diameter, schedule 40, 30 ft long weight 1500 lb.	205
F.	Utility pole, 14 in. diameter, 35 ft long, weight 1500 lb.	241
G.	Automobile, frontal area 20 ft^2, weight 4000 lb.	100

Vertical velocities equal to 80% of the TVA horizontal velocities are also acceptable on an interim basis.

At the operating license stage, applicants who were not required at the construction permit stage to design to one of the above missile spectra and the corresponding velocity set, should show the capability of the existing structures and components to withstand at least missiles "C" and "F." The adequacy of existing protection and any requirements for improvements will be determined on a case-by-case basis in conjunction with APCSB. The AAB Branch Chief should be consulted in making such determinations.

5. The capability of structures to withstand the postulated missile impacts is reviewed by the SEB and vital target areas are defined by the APCSB.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and the review and calculations support conclusions of the following type, to be included in the staff's safety evaluation report:

"These analyses result in a probability of missiles generated by __________________ having consequences worse than the design basis accident of less than 10^{-7} per year. We, therefore, conclude that the probability of missile impacts due to ____________ causing radiological consequences greater than the design basis events analyzed is so small that it does not present an undue risk to the health and safety of the public.

"These analyses verify that design basis missiles have been properly chosen and characterized."

V. REFERENCES

1. Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants."

2. Standard Review Plan 2.2.3, "Evaluation of Potential Accidents."

3. Branch Technical Position AAB 3-2, "Tornado Design Classification," attached to this plan.

4. "Safety-Related Site Parameters for Nuclear Power Plants," WASH-1361, U. S. Atomic Energy Commission (1975).

5. "The Generation of Missiles by Tornadoes," TVA-TR74-1, Tennessee Valley Authority (1974). (Topical report under review by the staff.)

6. Regulatory Staff, "Preliminary Evaluation of Topical Report TVA-TR74-1," U. S. Nuclear Regulatory Commission, February 1975.

BRANCH TECHNICAL POSITION AAB 3-2

TORNADO DESIGN CLASSIFICATION

A. BACKGROUND

General Design Criterion 2 requires, in part, that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability to perform their safety functions. Criterion 2 also requires that the design bases for these structures, systems, and components reflect (1) appropriate combinations of the effects of normal and accident conditions with the effects of natural phenomena and (2) the importance of the safety functions to be performed.

General Design Criterion 4 requires, in part, that structures, systems, and components important to safety, be protected against the effects of missiles from events and conditions outside the plant.

Nuclear power plants should be designed so that the plants can be placed and maintained in a safe shutdown condition in the event of the most severe tornado that can reasonably be predicted to occur at a site as a result of severe meteorological conditions. Protection of structures, systems, and components necessary to place and maintain the plant in a cold shutdown condition may generally be accomplished by designing protective barriers to preclude missile strikes. For example, the primary containment, reactor building, auxiliary building, and control structures should be designed against collapse and should provide an adequate barrier against missiles. However, the primary containment need not necessarily maintain its leak-tight integrity under pressure loadings due to the pressure differentials developed by the tornado. If protective barriers are not installed, the structures and components themselves should be designed to withstand the effects of the tornado, including tornado missile impacts.

It is not necessary to maintain the functional capability of all seismic Category I structures, because the combined probability of a joint occurrence of low probability events (loss-of-coolant accident with design basis or smaller tornado, or earthquake and design basis or smaller tornado) is so small as to not warrant consideration in the plant design basis. However, a source of water should be available to provide long-term core cooling.

Similarly, it is not necessary to protect radioactive liquid waste holdup tanks since even in the event of gross failure, the spills would be limited to small amounts of waste and would be expected to be collected in the building foundations, which are designed for that purpose.

Structures, systems, and components important to safety which should be designed to withstand the effects of a design basis tornado are those necessary to ensure:

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.

3. The capability to prevent accidents which could result in potential offsite exposures that are a significant fraction of the guideline values of 10 CFR Part 100. Designs which differ substantially from those now in use may require reevaluation with respect to this objective.

The physical separation of redundant or alternative structures or components required for the safe shutdown of the plant is generally not considered an acceptable method for protecting against tornado effects, including tornado-generated missiles.

This branch position describes a method acceptable to the staff for identifying those structures, systems, and components of light-water reactors which should be designed to withstand the effects of the design basis tornado (as defined by Regulatory Guide 1.76), including tornado missiles, and to remain functional.

B. BRANCH TECHNICAL POSITION

1. Those structures, systems, and components, including foundations and supports, which should be designed to withstand the effects of a design basis tornado (as defined in Regulatory Guide 1.76), including tornado missiles, without loss of capability to perform essential safety functions are listed below.

   a. The reactor coolant pressure boundary.[1/]

   b. Those portions of the main steam and main feedwater systems of pressurized water reactors (PWRs) up to and including the outermost isolation valves.

   c. The reactor core and reactor vessel internals.

   d. Systems[2/] or portions of systems, and those auxiliary systems necessary to support these systems (for example, service water, cooling water source, component cooling and auxiliary feedwater) that are required for (1) reactor shutdown, (2) residual heat removal, (3) cooling the spent fuel storage pool, or (4) makeup water for the primary system.

   e. The spent fuel storage facility to the extent necessary to preclude significant loss of watertight integrity of the storage pool and to prevent missiles from contacting fuel within the pool.

   f. The reactivity control systems, e.g., control rod drives and boron injection systems.

[1/] As defined in 10 CFR § 50.2

[2/] The system boundary includes those portions of the system required to accomplish the specified safety function and connecting piping up to and including the first valve (including a safety or relief valve) that is either normally closed or capable of automatic closure when the safety function is required.

g. The control room, including its associated vital equipment, cooling systems for the vital equipment and life support systems, and any structures or equipment inside or outside of the control room whose failure could result in an incapacitating injury to individuals occupying the control room.

h. Those portions of the gaseous radwaste treatment systems which by design are intended to store or delay gaseous radioactive waste and portions of structures housing these systems including isolation valves, equipment, interconnecting piping, and components located between the upstream and downstream valves used to isolate these components from the rest of the system (e.g., charcoal delay tanks in a boiling water reactor (BWR) plant and waste gas storage tanks in a PWR plant).

i. Systems or portions of systems that are required for (1) monitoring systems important to safety and (2) actuating and operating systems important to safety.

j. All electric and mechanical devices and circuits between the process sensors and the input terminals of the actuator systems involved in generating signals that initiate protective action.

k. Those portions of the long-term emergency core cooling system that would be required to maintain the plant in a safe condition for an extended time after a loss-of-coolant accident.

l. Primary reactor containment and other safety-related structures, such as the control room building and auxiliary building, should be protected against collapse. The primary containment need not necessarily maintain its leak-tight integrity under pressure loadings due to pressure differentials developed by the tornado, tornado-borne missiles which could jeopardize contained safety-releated systems and components.

m. Class 1E electric systems, including the auxiliary systems for the onsite electric power supplies that provide emergency electric power needed for functioning of plant features included in items a through k above.

2. Those portions of structures, systems, or components whose continued function is not required but whose failure could reduce to an unacceptable safety level the functional capability of any feature included in the items listed above should be designed and constructed so that the effects of the design basis tornado would not cause failure (for example, of the containment walls).

C. REFERENCES

1. 10 CFR Part 100, "Reactor Site Criteria."

2. Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants."

11/24/75

SRP 3.5.1.5