



**U.S. NUCLEAR REGULATORY COMMISSION**  
**STANDARD REVIEW PLAN**  
**OFFICE OF NUCLEAR REACTOR REGULATION**

**3.5.1.4 MISSILES GENERATED BY NATURAL PHENOMENA**

**REVIEW RESPONSIBILITIES**

Primary - Auxiliary Systems Branch (ASB)

Secondary - None

**I. AREAS OF REVIEW**

The applicant's assessment of possible hazards due to missiles generated by the design basis tornado, flood, and any other natural phenomena identified in Section 3.5 of the safety analysis report (SAR) is reviewed and evaluated by the ASB to assure that appropriate design basis missiles have been chosen and properly characterized, and to assure that the effects caused by these missiles are acceptable. Currently, only missiles from the design basis tornado are consistently considered in the plant design bases. Missiles from other phenomena are considered on a case-by-case basis when they are identified.

The ASB also reviews the identification of those structures, systems and components that should be protected against missile impact under Standard Review Plan (SRP) Section 3.5.2.

The Structural Engineering Branch (SEB) determines the acceptability of the design analysis, procedures and criteria used to establish the ability of seismic Category I structures and/or missile barriers to withstand the effects of tornado missiles as part of its primary review responsibility for SRP Section 3.5.3. The acceptance criteria and their methods of application are combined in that SRP section.

**II. ACCEPTANCE CRITERIA**

The acceptability of the assessment as described in the applicant's Safety Analysis Report (SAR) is based on compliance with: General Design Criteria 2 and 4 as it relates to the capability of structures, systems, and components important to safety to withstand the effects of tornadoes and other natural phenomena. Acceptance is based on meeting the guidelines of Regulatory Guide 1.76 and 1.117. The

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**USNRC STANDARD REVIEW PLAN**

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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methodology of identification of appropriate design basis missiles generated by natural phenomena shall be consistent with the acceptance criteria defined for the evaluation of potential accidents from external sources in SRP Section 2.2.3.

### III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

Upon request from the primary reviewer, SEB will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The reviewer will select and emphasize material from this SRP section, 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 SAR is reviewed for the identification of the design basis natural phenomena which could possibly generate missiles. Postulated missiles are reviewed for proper characterization.
2. The probability per year of damage to the total of all important structures, systems, and components (as discussed in Regulatory Guide 1.117) due to a specific design basis natural phenomena capable of generating missiles is estimated.
- 3.. If this probability is greater than the acceptable probability stated in Regulatory Guide 1.117, then specific design provisions must be provided to reduce the estimate of damage probability to an allowable level.
4. All plants are required to be designed to protect safety-related equipment against damage from missiles which might be generated by the design basis tornado for that plant. The reviewer verifies that the applicant has postulated missiles that include at least three objects: a massive high kinetic energy missile which deforms on impact, a rigid missile to test penetration resistance, and a small rigid missile of a size sufficient to just pass through any openings in protective barriers. Until more definitive guidelines are established, these missiles may be assumed to be an 1800 Kg automobile, a 125 Kg 8" armor piercing artillery shell, and a 1" solid steel sphere, all impacting at 35% of the maximum horizontal windspeed of the design basis tornado. The first two missiles are assumed to impact at normal incidence, the last to impinge upon barrier openings in the most damaging directions. These missiles are identified as Spectrum I.

Alternately, the missiles selected by the National Bureau of Standards as representative of construction site debris in report NBSIR 76-1050 may be

used. These are identified as Spectrum II missiles. Tornado regions are defined in WASH-1300.

| SPECTRUM II<br>MISSILE | Mass (Kg) | Dimensions (m)     | Velocity (m/sec) |           |            |
|------------------------|-----------|--------------------|------------------|-----------|------------|
|                        |           |                    | Region I         | Region II | Region III |
| A Wood Plank           | 52        | .092 x .289 x 3.66 | 83               | 70        | 58         |
| B 6" Sch 40 pipe       | 130       | .168 D X 4.58      | 52               | 42        | 10         |
| C 1" Steel rod         | 4         | .0254D x .915      | 51               | 40        | 8          |
| D Utility pole         | 510       | .343D x 10.68      | 55               | 48        | 26         |
| E 12" Sch 40 pipe      | 340       | .32D x 4.58        | 47               | 28        | 7          |
| F Automobile           | 1810      | 5 x 2 x 1.3        | 59               | 52        | 41         |

Vertical velocities of 70% of the postulated horizontal velocities are acceptable in both spectra except for the small missile in Spectrum I or missile C above. These missiles, which are used to test barrier openings, should be assumed to have the same velocity in all directions. Missiles A, B, C, and E are to be considered at all elevations and missiles D and F at elevations up to 30 Feet above all grade levels within 1/2 mile of the facility structures.

Applicants who were required at the construction permit stage to design to one of the missile spectra (A or B) of the November 24, 1975 version of this SRP section (or a review modification such as a 24" vertical and 21" horizontal wall thickness commitment in Region I), shall have the option at the OL stage of showing conformance with either their original commitment or Rev. 2 (same as Rev. 1) to this SRP section. Partial compliance with each is not acceptable.

SRP Section 3.5.1.4, November 24, 1975 MISSILE SPECTRUM A

|   | <u>Fraction of total<br/>tornado velocity</u> |
|---|---|
| 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 <sup>2</sup> , weight 4000 lb.        | 0.2   |

SRP Section 3.5.1.4, November 24, 1975 "NO TUMBLING" MISSILE SPECTRUM B

|   | <u>Horizontal Velocity<br/>ft/sec</u> |
|---|---------------------------------------|
| 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 <sup>2</sup> , weight 4000 lb.        | 100                                   |

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

**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:

Structures, systems, and components important to safety are designed to withstand the effects of natural phenomena without loss of capability to perform their safety functions.

The basis for acceptance in the staff review is the conformance of the applicants design and design criteria for the protection from the effects of natural phenomena to the Commission's regulations as set forth in the General Design Criteria, and to applicable Regulatory Guides and National Standards.

The staff concludes that the assessment of possible hazards due to missiles generated by the design basis tornado, flood, and other natural phenomena is acceptable and conforms to the requirements of General Design Criterion 2 and General Design Criterion 4 as they relate to tornado-generated missiles. This conclusion is based on the applicant having met the requirements of General Design Criteria 2 and 4 by: (a) meeting Regulatory Guide 1.76 Positions C-1 and C-2 and (b) meeting Regulatory Guide 1.117 Positions C-1 thru C-3.

**V. IMPLEMENTATION**

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

#### VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Basis for Protection Against Natural Phenomena."
2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Basis."
3. Regulatory Guide 1.76; "Design Basis Tornado for Nuclear Power Plants."
4. Regulatory Guide 1.117, "Tornado Design Classification."
5. "Tornado-Borne Missile Speeds," NBSIR 76-1050, National Bureau of Standards (April 1976).
6. "Technical Basis for Interim Regional Tornado Criteria," WASH-1300, U.S. Atomic Energy Commission (May 1974).

**BRANCH TECHNICAL POSITION ASB 3-2  
TORNADO DESIGN CLASSIFICATION**

**(This Branch Technical Position has been superseded by Regulatory Guide 1.117.)**