# POLICY ISSUE
## NOTATION VOTE

October 26, 2004 SECY-04-0200

FOR: The Commissioners

FROM: Luis A. Reyes
Executive Director for Operations

SUBJECT: A RISK-INFORMED APPROACH TO DEFINING THE DESIGN BASIS TORNADO FOR NEW REACTOR LICENSING

PURPOSE:

In SECY-03-0227, "Review Standard RS-002, Processing Applications For Early Site Permits," dated December 31, 2003, the staff requested Commission approval of the staff's plans to issue a final version of Review Standard RS-002. In its March 15, 2004, staff requirements memorandum (SRM) for SECY-03-0227, the Commission approved issuance of Review Standard RS-002 subject to comments, including the following:

> The staff should also develop options in applying a risk-informed approach to the selection of a design basis tornado and make a proposal to the Commission. In applying the risk-informed approach, the staff should factor in security and emergency preparedness considerations, as appropriate, in their analysis.

This paper responds to this Commission request.

SUMMARY:

In evaluating potential approaches to risk-informing the design basis tornado, the staff reviewed current external event design basis criteria as well as existing risk-informed regulatory guidance and risk-informing efforts currently under consideration. The staff has developed several options. The staff recommends the option of maintaining the current approach for defining the

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design basis tornado as a tornado having a mean frequency of $10^{-7}$ per year. The staff also recommends developing a risk informed alternative approach that would permit using a less conservative design basis tornado of higher frequency (i.e., lower maximum wind speed but a higher probability that the maximum could be exceeded). The unbudgeted estimated resources required to develop a risk-informed approach are 3.2 FTE and $1,800K. The staff plans to update the applicable regulatory guidance to address the option(s) selected from this paper.

BACKGROUND:

The Commission directed the staff in the SRM for SECY-02-0199, "Denial of Petition for Rulemaking To Use Information From Prior Licensing Actions as Resolved Information for Early Site Permit and Combined License Applications," to complete a review standard or standard review plan for early site permit application reviews in which the staff would "explain its review process, including specific criteria that the staff will use to make its determination as to whether new siting information or a program modification is necessary." The staff developed Review Standard RS-002 and forwarded it to the Commission for approval in SECY-03-0227.

In the process of approving Review Standard RS-002, the Commission expressed concerns regarding an apparent inconsistency between the maximum tornado wind speeds assumed for the Nuclear Regulatory Commission (NRC) certified standardized reactor designs and the guidance related to wind speeds in Review Standard RS-002 that would be applied to sites that might host reactors of those designs. The advanced light water reactor (ALWR) standardized designs have used a maximum assumed tornado wind speed of 300 mph (as discussed in SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs") whereas the guidance in Review Standard RS-002 for early site permit reviews calls for the use of (1) Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants," dated April 1974 which specifies a maximum wind speed of 360 mph for much of the United States east of the Rocky Mountains, (2) a staff interim position which specifies a maximum wind speed of 330 mph for much of the United States east of the Rocky Mountains, or (3) a site-specific analysis to justify a different wind speed.[1] The regulatory history of the evolution of the differing design basis tornado wind speeds among Regulatory Guide 1.76, SECY-93-087, and the staff interim position referenced in Review Standard RS-002 is presented in Attachment 1.

Regulatory Guide 1.76, SECY-93-087, and Review Standard RS-002 all specify maximum tornado wind speeds that can be used in the design but also provide options to perform additional analyses instead of selecting a specified maximum wind speed. None of the guidance documents specify whether the additional analyses would be (1) a site-specific meteorological analysis to reduce the maximum wind speed associated with a frequency of $10^{-7}$ per year, (2) an analysis demonstrating that the risk from tornados is acceptably low even though the wind speed the facility is designed to withstand is lower and more frequent than the wind speed associated with a frequency of $10^{-7}$ per year, or (3) an alternative approach. A risk-informed approach would help define what types of evaluations would be acceptable.

[1]The staff recognizes the inconsistency between the design basis wind speed required by RG 1.76 and that required by the staff interim position. The staff will correct this inconsistency when the applicable regulatory guidance is updated to address the option(s) selected from this paper.

The Commission directed in its SRM for SECY-03-0227 that the staff update the review guidance, including Regulatory Guide 1.76, to reflect the more recent tornado wind speed data that are available. The staff and its contractor, Pacific Northwest National Laboratories, are finalizing an updated analysis of expected tornado wind speeds to be included in a revision to the basis document for the staff's interim position (NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," dated May 1986). This updated analysis revises certain aspects of the NUREG/CR-4461 best-estimate methodology and recalculates tornado wind speed frequencies using the most recently available tornado data. The new analysis will provide the estimated annual frequency of different wind speeds in the different regions of the United States. Once a metric (e.g., wind speed frequency) and its value (e.g., less frequent than $10^{-7}$ per year) are defined for the design basis tornado, the updated analysis can be used as an option for selecting an appropriate design basis tornado wind speed for new reactor licensing. The staff will then update applicable review guidance as appropriate to address the new data and the selected options from this paper.

DISCUSSION:

In evaluating potential approaches to "risk-informing" the design basis tornado, the staff reviewed and considered the following:

1. Existing external event design basis criteria (e.g., Standard Review Plan (SRP) Section 2.2.3, "Evaluation of Potential Accidents," and Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion")

2. Risk-informed regulatory guidance (e.g., Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis," and Attachment 1 to SECY-00-0198, "Framework for Risk-Informed Changes to the Technical Requirements of 10 CFR 50") and

3. Risk-informing efforts currently under consideration (e.g., the draft pre-decisional NUREG "Framework for a Regulatory Structure for New Power Plant Licensing" being developed by Office of Nuclear Regulatory Research (RES)).

Each is discussed below.

The staff also evaluated security and emergency preparedness considerations in response to the directive contained in the SRM. The security and emergency preparedness considerations are discussed in Attachment 2.

Current External Event Design Basis Criteria

The staff has used probabilistic criteria since the mid-1970s in certain specialized areas of the licensing review, such as tornados, where initiating frequencies are used to assess site suitability. The regulatory guidance used to review the current fleet of operating power reactors (e.g., Section 2.2.3 of Regulatory Guide 1.70 and Section 3.3.2 of the SRP) sets probabilistic guidelines for considering external initiators that have potential consequences serious enough to affect the safety of the plant to the extent that 10 CFR Part 100 guidelines could be exceeded. In practice, this criterion has generally been conservatively interpreted to mean the initiating event should have a probability of occurrence of less than $10^{-7}$ per year. In the case of the design basis tornado (as defined in the basis document for Regulatory Guide 1.76 (WASH-1300, "Technical Basis for Interim Regional Tornado Criteria," dated May 1974), the staff interim position, and SECY-93-087), the external initiating event need not be accounted for in the structural design if the probability of occurrence of the event is less than $10^{-7}$ per year.

Similar to tornados, seismic events simultaneously affect many nominally independent structures, systems, and components (SSCs) and are hazards whose frequencies decrease with increasing magnitude. Therefore, the approach to risk-informing the design basis tornado can benefit from previous work on risk-informing the design basis seismic event. Appendix A to 10 CFR Part 100 defines a safe shutdown earthquake (SSE) as that earthquake which is based on an evaluation of the potential maximum earthquake, considering the regional and local geology and seismology and specific characteristics of local subsurface material. A staff review of a set of 29 currently operating plants of recent design (as documented in Appendix B to Regulatory Guide 1.165) found that 50 percent were designed to survive an SSE that had a frequency of $10^{-5}$ per year. Consequently, Regulatory Guide 1.165 specifies that new plants should perform a site-specific hazard analysis to define an SSE that has a median reference frequency of $10^{-5}$ per year. The SRM for SECY-93-087 states that licensees also need to use a seismic margin analysis to demonstrate a low likelihood of seismic-induced failure of SSCs that function to mitigate the consequences of seismic events that have a ground motion acceleration which is up to a factor of 1.b greater than the ground motion acceleration of the design basis SSE.

Recent Risk-Informed Regulatory Guidance

The Commission's 1986 Safety Goal Policy Statement (51 FR 30028) established qualitative safety goals supported by quantitative health objectives. For currently operating plants, a risk-informed framework including subsidiary objectives related to accident prevention and mitigation (i.e., core damage frequency (CDF) and large early release frequency (LERF)) has been developed as described in Regulatory Guide 1.174 and has been successfully implemented in a number of licensing actions and, more recently, rule changes.

Regulatory Guide 1.174 states that risk-informed changes to the licensing basis are considered to be very small if the associated increases in CDF and LERF are less than $10^{-6}$ per year and $10^{-7}$ per year, respectively. However, Regulatory Guide 1.174 provides no guidance on acceptable initiating event frequencies. In comparison, SECY-00-0198 proposes less conservative criteria than the SRP criterion by suggesting that SSC's need not be designed to cope with events having a frequency of less than $10^{-6}$ per year.

The foregoing suggests (or is at least consistent with) a relaxation of the design basis tornado frequency from $10^{-7}$ per year to $10^{-6}$ per year for future reactor designs. However, in 1985, the Commission issued its "Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants" (50 FR 32138), the main focus of which was the criteria and procedures the Commission intends to use to certify new designs for nuclear power plants. The Commission stated that it fully expects that vendors engaged in designing new standard (or custom) plants will achieve a higher standard of severe accident safety performance than their prior designs. To achieve this goal, an increase in risk from one source (i.e., external events such as tornados) would have to be more than balanced by a reduction in risk from other sources.

Risk-Informed Regulatory Structure for New Reactor Licensing

A draft pre-decisional NUREG entitled "Framework for a Regulatory Structure for New Plant Licensing" is being developed by RES to provide guidance and criteria for a risk-informed regulatory structure for licensing new reactors. The resulting regulatory structure is intended to address risks from both internal and external events, including risk from high winds and tornados.

The goal of this framework document is to ensure that new plants achieve a level of safety at least equivalent to that expressed in the Commission's Safety Goal Policy Statement. For currently operating plants, subsidiary objectives related to accident prevention (e.g., $10^{-4}$ per year for CDF) and accident mitigation (e.g., $10^{-5}$ per year for LERF) have been developed and used as surrogates for the quantitative health objectives expressed in the Safety Goal Policy Statement. The draft framework document discusses developing corresponding surrogates for new plants that are independent of technology (plant size, performance, source terms, etc.) that could be applied to address accident prevention and mitigation while remaining consistent with the level of safety implied by the Safety Goal Policy Statement.

The framework document also proposes that the staff develop technology-neutral risk-informed criteria for defining design basis events that could be applied to any new reactor design on a plant-specific basis. For certain internal and external events (including seismic events, high winds, and floods), the document states that criteria for defining design basis accidents may be retained (e.g., external initiators with a frequency of greater than $10^{-7}$ per year per Regulatory Guide 1.70). Likewise, the document states that, for new reactors, initiating events (internal and external) with lower frequencies should be defined as extremely rare events that would not have to be considered in the plant design.

ANALYSIS:

The staff believes that there are advantages to maintaining the current SECY-93-087 definition of the values of the design basis tornado parameters as those of a tornado having a mean frequency of $10^{-7}$ per year. Initiating tornado frequency is a relatively direct metric that can be used in conjunction with a site-specific tornado hazard curve to define the design basis tornado wind speed. An example of a typical site-specific tornado hazard curve is presented in Attachment 3. The use of initiating tornado frequency does not require the additional analysis needed to estimate the risk metrics CDF and LERF. The additional analysis that is required to establish the risk metrics introduces more uncertainty and, consequently, it becomes more difficult to demonstrate with reasonable assurance that the applicable regulatory criteria have

been met. Notwithstanding the above, the SRM for SECY-93-087 endorsed a risk-informed design basis seismic methodology that uses risk insights to support the use of lower magnitude events as the seismic design basis at some specific sites.

The methodology for a high-wind PRA is similar, with adaptations, to that for a seismic PRA. The risk from tornado strikes is derived from the wind hazard characterizing the tornados' frequencies and speeds, the population and characteristics of potential missiles, the impact effects of missile strikes onto buildings and exposed equipment, wind fragility for the buildings and other structures, and a comprehensive evaluation of wind-caused initiating events and other SSC failures that can cause core damage or large early release. The high-wind methodology does not appear to be as fully developed as the seismic methodology. For example, seismic hazard estimates based on formal expert elicitation have been developed by Lawrence Livermore National Laboratory (LLNL) and by the Electric Power Research Institute. A comparable process for tornado hazards would need to be initiated to support plant design decisions.

The current guidance documents (i.e., Regulatory Guide 1.76, SECY-93-087, and Review Standard RS-002) permit the option at either the standard design certification stage or the combined license stage to perform additional analyses to justify a maximum wind speed other than that endorsed by the staff. A risk-informed methodology could permit a design basis tornado of higher mean frequency than $10^{-7}$ per year if a risk-informed analysis satisfactorily demonstrates that the risk from tornado strikes with frequencies between the selected design basis frequency and $10^{-7}$ per year is sufficiently small. An example of how such a risk-informed methodology might work is given in Attachment 3. Although the staff is not aware of any applications that have used risk-informed methods to justify a design basis tornado wind speed with a frequency greater than $10^{-7}$ per year by demonstrating that the risk associated with tornado strikes remains acceptably low, the Commission has encouraged the use of risk methods. The staff anticipates that the designs of new reactors will eventually apply risk methods to determine design basis tornado wind speeds.

OPTIONS:

In evaluating potential approaches to risk-informing the design basis tornado, the staff has developed the following three options:

**Option 1:** Maintain the current SECY-93-087 definition of the values of the design basis tornado parameters as those of a tornado having a mean frequency of $10^{-7}$ per year for new reactor licensing. One acceptable source for the $10^{-7}$ per year wind speed will be the update of NUREG/CR-4461, scheduled for completion later this year. Preliminary results indicate that the updated wind speed for tornados having a mean frequency of $10^{-7}$ per year will be on the order of 300 mph in Region I (i.e., similar to the wind speed specified in the ALWR design certification documents). Alternatively, licensees and applicants could choose to perform a site-specific analysis following the NUREG/CR-4461 methodology (or a similar methodology) utilizing regional data to define the $10^{-7}$ per year design basis tornado for their site.

Pros:

- Initiating tornado frequency is a relatively direct metric, and its use precludes the need for additional analysis to estimate CDF and LERF conditional on the occurrence of a tornado strike. The additional analysis necessary to establish the risk metrics introduces more uncertainty and, consequently, it becomes more difficult to demonstrate with reasonable assurance that the applicable regulatory criteria have been met.

- The criterion for defining the design basis tornado remains consistent with the criterion currently used to exclude other external initiators from consideration as design basis events per Regulatory Guide 1.70 and the SRP.

- This option, when fully implemented in applicable NRC regulatory guidance documents, will remove any inconsistency between the maximum wind speed in Regulatory Guide 1.76 (360 mph), the ALWR design certification documents (300 mph), and RS-002 for early site permits (330 mph).

- This option has the potential to achieve the highest level of safety among the three options because all SSCs whose failure could result in exposures comparable to the guideline exposures of 10 CFR Part 100 must be designed to cope with wind speeds with a mean frequency of $10^{-7}$ per year.

Cons:

- The design of plants to cope with the high wind speeds characterizing these low-frequency events may place a greater regulatory burden on new plants than can be justified based on the risk posed by the events.

**Option 2:** Develop an approach that is consistent with risk informed approach described in RG 1.174. An example of how such a risk-informed methodology might work is given in Attachment 3. This approach would permit a design basis tornado of higher mean frequency than $10^{-7}$ per year if a risk-informed analysis satisfactorily demonstrates that the risk from tornado strikes with frequencies between the selected design basis frequency and $10^{-7}$ per year is sufficiently small. Risks related to security may be explicitly evaluated as needed in this approach. The staff anticipates that additional study and research will be needed to appropriately include uncertainty in the wind hazard characterizing the tornados' frequencies and speeds and in the evaluation of the population and characteristics of potential missiles. Additional study and research may also be necessary to finalize this approach.

Pros:

- Licensees would be afforded the option to use risk-assessment methods to identify and address those vulnerabilities most sensitive to the effects of high winds and subsequent missiles, resulting in the protection of sensitive locations.

- A similar approach for design basis seismic analysis has been endorsed by the staff in Regulatory Guide 1.165 and the Commission in the SRM for SECY-93-087 as an acceptable approach for risk-informing the design of a plant for a complex hazard whose magnitude increases with decreasing frequency.

Cons:

- The quantitative results of risk analyses are more uncertain than the approaches associated with either Options 1 or 3; consequently, it may be more difficult to demonstrate with reasonable assurance that the applicable regulatory criteria have been met.

- Considerable resources may be required for licensees to perform and the staff to review the necessary risk analyses.

**Option 3:** Relax the definition of the design basis tornado to the criteria suggested in recent risk-informed regulatory guidance (e.g., to an initiating frequency of less than $10^{-6}$ per year per SECY-00-0198). Because of the similarity between Option 3 and Option 1, the first three Pros are the same.

Pros:

- Initiating tornado frequency is a relatively direct metric, and its use precludes the need for additional analysis to estimate CDF and LERF conditional on the occurrence of a tornado strike. The additional analysis necessary to establish the risk metrics introduces more uncertainty and, consequently, it becomes more difficult to demonstrate with reasonable assurance that the applicable regulatory criteria have been met.

- The criterion for defining the design basis tornado remains consistent with the criterion currently used to exclude other external initiators from consideration as design basis events per Regulatory Guide 1.70 and the SRP.

- This option, when fully implemented in applicable NRC regulatory guidance documents, will remove any inconsistency between the maximum wind speed in Regulatory Guide 1.76 (360 mph), the ALWR design certification documents (300 mph), and RS-002 for early site permits (330 mph).

- This option can reduce the regulatory burden arising from designing SSCs to cope with events having a frequency as small as $10^{-7}$ per year.

Cons:

- This option could result in a design with a slightly greater decrease in the plant's ability to survive potential loads that may have been previously subsumed in the tornado design basis (such as the consequences of sabotage) as compared to the other two options.

- The relaxation of the tornado design basis wind speed criterion for new nuclear reactors could appear to be inconsistent with the Commission's Severe Reactor Accidents Policy Statement, which states that new reactor designs should achieve a higher standard of severe accident safety performance than prior designs.

- This option potentially achieves the lowest level of safety among the three options because all SSCs whose failure could result in exposures comparable to the guideline exposures of 10 CFR Part 100 need only be designed to cope with tornados more frequent (i.e., with lower wind speed) than $10^{-6}$ per year.

RECOMMENDATION:

The staff recommends that the Commission approve the implementation of both Options 1 and 2; that is, approve the option of maintaining the current approach for defining the design basis tornado parameter as a tornado having a mean frequency of $10^{-7}$ per year while also approving the development of an alternative approach that would permit using a design basis tornado of higher mean frequency than $10^{-7}$ per year if a risk-informed analysis satisfactorily demonstrates that the risk from tornado strikes with frequencies between the selected design basis frequency and $10^{-7}$ per year is sufficiently small. Approval of Option 1 will resolve any inconsistency between the current guidance documents in the near term, and approval of Option 2 will support the development of methods for applying a risk-informed approach to the selection of a design basis tornado in the longer term.

The implementation of Option 3 is not recommended because Option 3 could result in a design with a slightly greater decrease in the plant's ability to survive potential loads that may have been previously subsumed in the tornado design basis (such as the consequences of sabotage) as compared to the other two options. The implementation of Option 3 could also appear to be inconsistent with the Commission's Severe Reactor Accidents Policy Statement which states that new reactor designs should achieve a higher standard of severe accident safety performance as compared to previous designs.

The staff plans to update the applicable review guidance as appropriate to address the selected options from this paper.

RESOURCES:

The resources for Option 1 are budgeted. Option 2 is divided into two phases. The first phase is to evaluate the available methodologies and data to develop a plan, schedule, and resource estimates for developing a risk-informed approach to the selection of a design basis tornado. The estimated resources to complete phase one of Option 2 are 0.2 FTE and $100K for Nuclear Reactor Regulation (NRR) and 0.5 FTE and $200K for RES. Phase two of Option 2 is to develop the risk-informed approach and associated guidance documents. A preliminary estimate of the required resources for phase two of Options 2 is 2.5 FTE and $1,500K.

Given the relative priorities of this activity and other risk-informed initiatives, the staff recommends that Option 2 be initiated in FY 07. If the commission chooses to perform Option 2 in FY 05 or FY 06, the staff will need to revisit existing budgeted initiatives and propose changes to accommodate this activity.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objection.

The Office of the Chief Financial Officer has reviewed this Commission paper for resource implications and has no objections.

***/RA Martin J. Virgilio Acting For/***

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Attachments: 1. Regulatory History
2. Security and Emergency Preparedness Considerations
3. An Example of A Risk-Informed Methodology

Regulatory History of the Evolution of the Differing Design Basis Tornado Wind Speeds

The Nuclear Regulatory Commission (NRC) licensing regulations related to the consideration of tornados in the siting and design of nuclear power reactors include 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 2, "Design Bases for Protection Against Natural Phenomena," GDC 4, "Environmental and Dynamic Effects Design Bases," 10 Code of Federal Regulations (CFR) §100.20(c), "Factors To Be Considered When Evaluating Sites," and §100.21(d), "Non-Seismic Siting Criteria." Specific guidance regarding the implementation of these regulations has traditionally been provided in regulatory guides and the Standard Review Plan (SRP), NUREG-0800.

Currently licensed reactors are designed to Regulatory Guide 1.76. The design basis tornado wind speeds in Regulatory Guide 1.76 are based on assumptions and mathematical models in the 1974 document WASH-1300, "Technical Basis for Interim Regional Tornado Criteria." As set forth in this document, the staff calculated the expected frequency of different tornado wind speeds using two years of available tornado data (1971-1972) in three different regions in the continental United States. The staff selected maximum design basis wind speeds based on the premise that the probability of occurrence[1] of a tornado that exceeds the design basis tornado should be on the order of $10^{-7}$ per year per nuclear power plant. This evaluation concluded that a maximum wind speed of 360 mph would be consistent with this probability of occurrence for much of the United States east of the Rocky Mountains (Region I) as defined in Regulatory Guide 1.76. The regulatory guide specified that nuclear plants should be designed to withstand the design basis tornado for each region, or a comprehensive analysis be provided to justify the selection of a less conservative design basis tornado.

The staff subsequently issued an interim position on the design basis tornado[2] based on NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," dated May 1986. NUREG/CR-4461 revised certain aspects of the WASH-1300 methodology and recalculated tornado wind speed frequencies using 30 years of more detailed tornado data (1954-1983). The resulting wind speed estimates were lower than the wind speed estimates presented in WASH-1300 and Regulatory Guide 1.76 for most of the United States. To account for uncertainties in the database and analyses, the staff concluded in its interim position that the $10^{-7}$ per year probability of occurrence wind speed at the upper end of the middle 90 percent confidence level from NUREG/CR-4461 should be used as the wind speed for the design basis

[1] *Probability of occurrence per unit time* and *frequency* are quantitatively the same for values much less than one and can be used interchangeably in the discussions provided here. Current risk-informed guidance documents normally use frequency. Many earlier documents use probability of occurrence per unit time. This document uses frequency unless referring directly to a parameter in an earlier document where probability of occurrence was used.

[2] Lester S. Rubenstein letter to Edwin E. Kintner, "ALWR Design Basis Tornado," dated March 25, 1988.

tornado.[3] On this basis, the document recommended a maximum wind speed of 330 mph for Region I.

The staff recommended in SECY-93-087 that a $10^{-7}$ per year mean probability of occurrence instead of the more conservative upper 90 percent confidence level used in the staff interim position should be used as the basis for the certified standardized design basis tornado wind speed. The staff estimated that this corresponded to a maximum wind speed of 300 mph for Region I. SECY-93-087 also stated that the staff expected that this criterion would not preclude siting the advanced light water reactor (ALWR) plant designs on most sites in the United States. Furthermore, if a hazard at a selected site exceeded the approved certified standardized design envelope, the combined license applicant would have the option of performing a site-specific analysis to demonstrate that the design is acceptable for the site.

[3]The middle 90 percent confidence interval extends from the five percent confidence limit to the 95 percent confidence limit. The upper end of the middle 90 percent is the 95 percent confidence limit.

## Security and Emergency Preparedness Considerations

### Security Considerations

As the SRM for SECY-03-0227 anticipates, decisions involving the design basis for external events such as tornados and earthquakes could have an impact on security issues since they affect the "survivability" of the design. Relevant security issues involved in risk-informing the design basis tornado are discussed here in response to the SRM directives. The tornado design basis has been used to evaluate the adequacy of structures (such as concrete wall thicknesses) to protect nuclear plant SSCs against effects not explicitly addressed in review guidance. Events that are not included in the design basis (such as a commercial airliner striking at high speed) are to a certain extent afforded protection by conservative design specifications. For example, the staff has in the past reviewed external impact hazards (such as general aviation light aircraft crashes, nearby explosions, and explosion debris and missiles), taking into account the provisions for tornado protection. Consequently, to ensure that the plants do not lose significant robustness in surviving these events, these conservative design specifications should be taken into account when evaluating any reduction in the tornado design basis wind speed.

To the extent that the options in this paper incorporate tornado design basis criteria that are slightly less conservative than the criteria to which most of the current operating reactors were designed, future plants designed to any of the proposed option criteria could have a slightly decreased ability to survive the loads that may have been previously subsumed in the tornado design basis (such as the consequences of extreme events of sabotage). The staff is not currently contemplating proposing structural design criteria associated with beyond design basis threat events. If as a result of vulnerability assessment analyses of the current operating reactors, the staff identifies the need for such structural design criteria, the staff will advise the Commission separately.

### Emergency Preparedness Considerations

The SRM for SECY-03-0227 directed the staff to consider relevant emergency preparedness issues involved in risk-informing the design basis tornado. Emergency preparedness considerations arise because the destruction caused by a tornado can hinder the evacuation of the local population as well as impact plant integrity. The risk-informed metric associated with accident prevention (core damage frequency (CDF)) is not affected by emergency planning and evacuation. However, the risk-informed metric associated with accident mitigation (large early release frequency (LERF)) is affected by evacuation. LERF events are sequences that can cause early fatalities. Delayed or ineffective evacuation can change a sequence that would not normally cause early fatalities into one that would.

The guidance for estimating LERF[1] which was endorsed by the staff in Regulatory Guide 1.174 specifies consideration of whether effective warning and evacuation may be precluded due to disruption of the warning systems and evacuation paths. The guidance states that sequences arising from initiating events such as tornados that preclude effective evacuation should be

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[1]W. T. Pratt et al, "An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events," NUREG/CR-6595, January 1999.

allocated to the LERF metric unless the licensee can demonstrate that evacuation would not be affected. Consequently, if the Commission approves the staff's recommendation to use the quantitative CDF and LERF guidelines in developing a risk-informed approach to the definition of a design basis tornado, the proper application of current guidance should suffice to ensure that emergency preparedness considerations are included in the analysis.

An Example of A Risk-informed Methodology

A risk-informed methodology for determining a design basis tornado wind speed for a specific site might be based on a tornado hazard curve such as the one shown below. Tornado hazard curves are usually expressed in terms of the frequency per year of exceedance of various wind speeds. A risk-informed methodology could permit a design basis tornado of higher mean frequency than $10^{-7}$ per year if a risk-informed analysis satisfactorily demonstrates that the risk from tornado strikes with frequencies between the selected design basis frequency and $10^{-7}$ per year is sufficiently small. Using the tornado hazard curve shown below as an example, the selection of an initiating tornado frequency of $10^{-6}$ per year instead of $10^{-7}$ per year as the criterion for the design basis tornado wind speed would result in reducing the design basis tornado wind speed from 268 mph to 222 mph. The reduction in the design basis wind speed will mean that structures, systems, and components may begin to fail when exposed to wind speeds in excess of 222 mph that would otherwise not have failed until wind speeds exceeded 268 mph. The likelihood of these failures can be combined with the frequency of wind speeds between 222 mph and 268 mph to estimate the increase in risk associated with reducing the design basis wind speed from 268 mph to 222 mph. This increase in risk could be compared to some acceptance criteria such as the guidelines in Regulatory Guide 1.174 to determine if the increase is sufficiently small.

This approach and acceptance criteria are consistent with current risk informed practices and decision criteria as described in Regulatory Guide 1.174. The approach is also similar to the approach used to demonstrate an acceptable seismic design that is being used in the early site permit applications. This approach may need to be further developed and modified in accordance with other risk informed guidelines developed by the Commission and the analytic methods available to evaluate the risk of high winds.