



UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

August 8, 2011

MEMORANDUM TO: ACRS Members

FROM: Girija Shukla, Senior Staff Engineer */RA/*
Technical Support Branch
Advisory Committee on Reactor Safeguards

SUBJECT: CERTIFICATION OF THE MINUTES OF THE MEETING OF THE
SUBCOMMITTEE ON REGULATORY POLICIES & PRACTICES
REGARDING REVIEW OF DRAFT FINAL REGULATORY GUIDE 1.115,
"PROTECTION AGAINST TURBINE MISSILES," ON OCTOBER 4, 2010

The minutes for the subject meeting were certified on July 12, 2011. Along with the transcripts and presentation materials, this is the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc w/o Attachment: E. Hackett
C. Santos
Y. Diaz-Sanabria

cc w/ Attachment: ACRS Members

Certified: July 12, 2011
Certified By: John Stetkar

**ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF THE MEETING OF
THE SUBCOMMITTEE ON REGULATORY POLICIES & PRACTICES
REGARDING REVIEW OF DRAFT FINAL REGULATORY GUIDE 1.115,
"PROTECTION AGAINST TURBINE MISSILES,"
OCTOBER 4, 2010, ROCKVILLE, MARYLAND**

On October 4, 2010, the ACRS Subcommittee on Regulatory Policies & Practices held a meeting in Room T-2B3, 11545 Rockville Pike, Rockville, Maryland. The purpose of the meeting was for the NRC staff to brief the Subcommittee regarding potential consequences and protection against turbine missiles, as discussed in the draft final Regulatory Guide 1.115, "Protection against Turbine Missiles." The meeting was convened at 8:30 AM and adjourned around 5:00 PM the same day. The meeting was open to the public.

ATTENDEES:

ACRS Members

John Stetkar (Chairman)
Bill Shack
Dennis Bley

ACRS Staff

Girija Shukla (DFO)

NRC Staff

John Ridgely (RES)
John Honcharik (NRO)
Steve Jones (NRR)
David Terao (NRO)
Rick Jervey (RES)

Others

Jorge Hernandez (Bechtel)
Christopher Kaplan (Bechtel)
Bruce Knobloch (Mitsubishi)
(by phone)

The presentation slides and handouts used during the meeting are attached to the Office Copy of the meeting transcript. The presentation to the Subcommittee is summarized below.

OPENING STATEMENT

Mr. John Stetkar, Chairman of the Subcommittee opened the meeting by stating that this is a meeting of the Advisory Committee on Reactor Safeguards Subcommittee on Regulatory Policies & Practices; and subcommittee members in attendance are Bill Shack, and Dennis Bley. Mr. Girija Shukla of the ACRS staff is the Designated Federal Official for this meeting.

The chairman stated that the subcommittee will hear presentations from the NRC staff regarding potential consequences and protection against turbine missiles, as discussed in the draft final Regulatory Guide 1.115, "Protection against Turbine Missiles." We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting. This meeting is open to public attendance.

The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee. The rules for participation in today's meeting have been announced as part of the notice of this meeting published in the *Federal Register* on September 21, 2010.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register Notice. Therefore, we request that participants in this meeting use the microphones located throughout the meeting room when addressing the Subcommittee. The participants

should first identify themselves and speak with sufficient clarity and volume so that they may be readily heard.

The chairman concluded the opening remarks by calling upon the NRC staff to make the presentation.

BACKGROUND

Mr. Stetkar had recommended that the ACRS should review RG 1.115 before its final issuance, based on the following observations.

1. It is not clear whether the RG applies to missiles that may damage only safety-related SSCs (as specified in the Introduction), or whether the applicability of SSCs in Appendix A (e.g., Items 4, 9, 10, 11, 13, 14) extends to systems such as RTNSS systems in passive new plant designs or "risk significant" non-safety-related SSCs in the new plant Design Reliability Assurance Program lists.
2. The numerical criteria in Table 1 are apparently derived from a 1986 analysis of Hope Creek (NUREG-1048) and general industry operating experience through about 1995. It is not apparent why these specific numerical screening criteria are relevant for new plant designs with substantially lower estimated core damage frequencies and large release frequencies.
3. The Staff has explicitly rejected a proposed methodology that accounts for the quantified risk contribution from turbine missiles.
4. The scope of RG 1.115 has been extended to include high trajectory missiles. However, it is not clear how the screening and evaluation criteria for those missiles are derived. For example, a "Monte Carlo analysis that considers turbine casing resistance" is cited as a basis.

DISCUSSION

In July 1977, the U.S. Nuclear Regulatory Commission issued Regulatory Guide 1.115, "Protection against Low-Trajectory Turbine Missiles," Revision 1. In July 1986, the NRC revised its guidance on turbine missiles in Appendix U to NUREG-1048, which has been used to date by the industry in its owners group and plant-specific applications related to turbine missiles and by the NRC in its safety evaluation of these applications. However, the revised guidance was not incorporated in a revision to Regulatory Guide 1.115, which makes identification of the current NRC guidance on this issue difficult.

Therefore, revision of Regulatory Guide 1.115 was necessary to accomplish the following four objectives:

1. incorporate NRC guidance on the turbine missile issue, which is currently documented in several documents, into one document, the proposed RG 1.115, Revision 1;
2. expand the scope of guidance to include concerns about high-trajectory missiles;
3. assess the failure data from the past 15 years to determine whether a risk-informed approach is ready for implementation; and

4. present a better organization of the regulatory guide by removing contradictory statements and adding new information and technical discussions throughout the guide.

The NRC has revised Regulatory Guide 1.115, Revision 1, taking into consideration the operating experience and failure data from the last 15 years and combining guidance for low-trajectory and high-trajectory turbine missiles.

- **Earlier RG 1.115, Revision 1, July 1977**

Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles," Revision 1, was issued in July 1977. This guide described methods acceptable to the NRC staff for protecting safety-related structures, systems, and components against low-trajectory missiles resulting from turbine failure by appropriate orientation and placement of the turbine-generator set. The Advisory Committee on Reactor Safeguards was consulted concerning this guide and had concurred in the regulatory position.

General Design Criterion 4, "Environmental and Missile Design Bases," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires, in part, that structures, systems, and components important to safety be appropriately protected, against the effects of missiles that might result from equipment failures. Failures that could occur in the large steam turbines of the main turbine-generator sets have the potential for producing large high-energy missiles.

Protection of safety-related portions of nuclear power plants from turbine missiles is an appropriate safety consideration. The two broad categories of turbine failures are usually referred to as design overspeed failures and destructive overspeed failures. Missiles resulting from design overspeed failures are the result of brittle fracture of turbine blade wheels or portions of the turbine rotor itself. Failures of this type can occur during startup or normal operation.

Missiles resulting from destructive overspeed failures would be generated if the overspeed protection system malfunctions and the turbine speed increases to a point at which the low pressure wheels or rotor will undergo ductile failure. The kinetic energy of ejected missiles can be sufficient to damage even substantial reinforced concrete slabs and panels. Thus turbine missiles have the potential for damaging safety-related structures, systems, and components of the plant.

Missiles from a turbine failure can be divided into two groups: "high-trajectory" missiles, which are ejected upward through the turbine casing and may cause damage if the falling missile strikes an essential system and "low-trajectory" or "direct" missiles, which are ejected from the turbine casing directly toward an essential system.

RG 1.115, Rev. 1, outlined acceptable methods of protection against low-trajectory turbine missiles, but did not include high trajectory missiles.

- **Current Proposed RG 1.115, Revision 2, September 2010**

The proposed Revision 2 to Regulatory Guide 1.115 now includes high trajectory missiles with the previously discussed low trajectory missiles.

The proposed Revision 2 to Regulatory Guide 1.115 was issued as DG-1217 for public comment on November 2, 2009. The public comment period closed on December 22, 2009. Comments were received and appropriate changes were made to incorporate those comments. Regulatory Guide 1.115 provides guidance related to protecting safety-related structures, systems, and components against missiles resulting from turbine failure by the appropriate orientation and placement of the turbine-generator set, the management of the probability of turbine missile generation, and the use of missile barriers.

Although little information is available on failures of large turbines, cumulative failure data based on the operating history for conventional plants indicate that the protection of safety-related portions of nuclear power plants from turbine missiles is an appropriate safety consideration. The two broad categories of turbine failures are usually referred to as “design overspeed” (up to approximately 130 percent of the rated speed) failures and “destructive overspeed” (up to approximately 190 percent of the rated speed) failures.

Design overspeed conditions are expected to occur one or more times per year of operation, whereas destructive overspeed conditions are expected to occur rarely. Missiles resulting from design overspeed failures are the result of the brittle fracture of turbine blade wheels or portions of the turbine rotor itself. Failures of this type can occur during startup or normal operation. Missiles resulting from destructive overspeed failures would be generated if the overspeed protection system malfunctions and if the turbine speed increases to a point at which the low-pressure wheels or rotor will undergo ductile failure.

Regardless of failure types, RG 1.115, Rev. 2, addresses only large missiles that might be ejected in the event of a turbine failure that will have sufficient kinetic energy to damage even substantial reinforced concrete slabs and panels. Large turbine missiles, therefore, have the potential to damage safety-related structures, systems, and components of the plant.

RG 1.115, Rev. 2, outlines acceptable methods of protection against both high-trajectory and low-trajectory turbine missiles.

NRC STAFF PRESENTATION IN THE MEETING

The staff started the presentation with an overview of the GDC 4 Requirement, the Current NRC position on protection against turbine missiles, objectives of the proposed RG 1.115, Operating Experience since 1977, enhancements in the proposed RG 1.115, and Industry Comments.

The staff stated that the current NRC position on protection against turbine missiles are (1) by Turbine Orientation RG 1.115, dated July 1977; (2) By Control of Turbine Missile Generation Frequency - Hope Creek SER, dated July 1986; and SRP 3.5.1.3, “Turbine Missiles,” dated March 2007; and (3) By Missile Barriers RG 1.115, dated July 1977.

The objectives of the proposed RG 1.115 are to assure that turbine failure is a negligible contributor to risk; make the RG self-contained including all acceptable protection methods against turbine missiles; identify SSCs to be protected from turbine missiles, which includes common RTNSS functions (e.g., makeup water, heat sink, and long-term decay heat removal), but excludes functions necessary only for other unlikely design basis events (e.g., high-head safety injection and containment); and to include operating experience since 1977 to explore the

possibility of revising the current P_1 (probability of turbine missile generation) and P_4 (probability of failure of an essential system caused by turbine missiles) criteria. Outcome of review of turbine operating experience was that operating experience is consistent with the turbine failure rate of $1E-4$ per turbine-year (RG 1.115) and supports the current criteria of P_1 (Hope Creek SER) and P_4 (RG 1.115).

Further the staff discussed the application of a risk-informed approach for this Reg. Guide. The staff stated that turbine failure is similar to tornado effects and defense-in-depth principles are satisfied by protecting essential equipment commensurate with frequency/consequences of challenges by maintaining very low frequency of missile generation; or protecting essential equipment from missile strike.

The staff stated that enhancements in the proposed RG 1.115 are made to provide guidance for high-trajectory missiles; to clarify the current NRC emphasis on P_1 (in the 1986 Hope Creek SE and the 2007 SRP); to permit the approach of considering P_1 , P_2 , and P_3 , and to validate operating experiences (NUREG-1275, LERs, IRS, INPO, etc.) since 1977.

Reg. Guide 1.115 provides guidance for high-trajectory missiles; clarifies the current emphasis on P_1 and provides different P_1 s for low-trajectory and high-trajectory missiles

The staff further discussed the industry comments, which stated that the proposed RG 1.115 allows consideration of pathways for high trajectory missiles; consideration of robust rotor designs; and regulatory process for approving new rotor designs. It allows the BWR turbine radiation shielding enclosures as barriers and provides guidance for sites with multiple units. However, the RG has not incorporated recommended changes to the SRP; comments on changing the probability for low-trajectory turbine missiles; and the Risk-Informed approaches.

NRC staff conclusion

The NRC staff concluded that the proposed RG 1.115 is self-contained. It provides preferred and acceptable approaches and acceptance criteria against low-trajectory" missiles and high-trajectory" missiles, and is consistent with the current criteria.

COMMENTS AND OBSERVATIONS FROM THE SUBCOMMITTEE MEMBERS

ACRS members at the meeting asked several pertinent questions and made several comments to the presenters. These members' questions and comments and their responses are provided in the transcript of this meeting. Following are some main points made by the members:

- Does scope of RG 1.115 applicable to safety-related SSCs.
- What is meant by negligible contribution to risk on Slide 5.
- RG does not address new reactors, designs without RTNSS function such as high head safety injection are not included.
- What is the basis for not going outside the nuclear industry for operating experiences.
- Hope Creek SER refers to RG 1.115 and RG 1.115 refers to Hope Creek SER, why.
- What guidance is provided to reviewers to review the methodology of various vendors. There should be a guide for the reviewers.
- There is no credibility to the Bush report of 1973.
- Risk-Informed approach is contradictory to RG 1.115.
- We need to be careful about how RG 1.115 will be applied to new reactors.

SUBCOMMITTEE CONCLUSION

Chairman Stetkar concluded the meeting by thanking the staff for the presentation. He stated that the presentations and discussions were very informative. However, the Subcommittee concluded that RG 1.115 needs to be revised to incorporate committee members' comments and the committee needs more information from the staff before formulating proposed positions and actions for deliberation by the Full Committee. The meeting was adjourned at 5:00 PM.

REFERENCES

- Draft final Regulatory Guide 1.115 (DG-1217), "Protection against Turbine Missiles," Revision 2, September 2010 (ML101650671)
- NRC Responses to Public Comments on DG-1217 (Draft RG 1.115 Rev. 2)
- Regulatory Analysis, Protection against Turbine Missiles, Proposed Revision 2 of Regulatory Guide (RG) 1.115, (MI101670039)
- Redline-Strikeout Version of the Changes to the Draft Regulatory Guide 1.115
- Draft Regulatory Guide DG-1217 (Proposed Revision 2 of Regulatory Guide 1.115, dated July 1977), October 2009 (ML092250316)

NOTE:

Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, One White Flint North, 11555 Rockville Pike, Rockville, MD, (301) 415-7000, downloading or view on the Internet at <http://www.nrc.gov/reading-rm/doc-collections/acrs/> or it can be purchased from Neal R. Gross and Co., 1323 Rhode Island Avenue, NW, Washington, D.C. 20005, (202) 234-4433 (voice), (202) 387-7330 (fax), nrgross@nealgross.com (e-mail).
