RS-002, "PROCESSING APPLICATIONS FOR EARLY SITE PERMITS"

ATTACHMENT 2

2.4.7 ICE EFFECTS

REVIEW RESPONSIBILITIES

Primary - Mechanical and Civil Engineering Branch (EMEB)

Secondary - None

I. AREAS OF REVIEW

The hydrometeorologic design basis is developed in this section of the site safety assessment for an early site permit (ESP) application to ensure that safety-related facilities and water supply are not affected by ice flooding or blockage. The areas of review include:

1. The regional history and types of historical ice accumulations (i.e., ice jams, wind-driven ice ridges, floes, etc.).

2. The potential for ice-produced forces on, or blockage of, safety-related facilities.

3. The potential effects of ice-induced high or low flow levels on safety-related facilities and water supplies.

If there is evidence of potential structural effects, EMEB will ascertain whether these effects are properly considered in the site safety assessment. The staff will develop a position based on the analysis; resolve, if possible, differences between the applicant's and staff's estimates of ice effects; and write the safety evaluation report (SER) input accordingly.

II. ACCEPTANCE CRITERIA

Acceptance criteria for this section of this review standard are based on meeting the requirements of 10 CFR Parts 52 and 100 (Refs. 1 and 2) as they relate to identifying and evaluating hydrologic features of the site.

Compliance with 10 CFR 52.17(a) and 10 CFR 100.20(c) requires that the site's physical characteristics (including seismology, meteorology, geology, and hydrology) be taken into account when determining its acceptability for a nuclear power reactor. To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's safety assessment should contain a description of any icing phenomena with the potential to result in adverse effects to the intake structure or other safety-related facilities for a nuclear power plant or plants of specified type (or falling within a plant parameter envelope [PPE]) that might be constructed on the proposed site. Ice-related characteristics historically associated with the site and region should be described, and an analysis should be performed to determine the potential for flooding, low water, or ice damage to safety-related structures, systems, or components. (Ref. 3) The analysis should be sufficient to evaluate the site's acceptability and to assess the potential for those characteristics to influence the design of structures, systems, or components

important to safety for a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site. Meeting this requirement provides reasonable assurance that the effects of potentially severe icing conditions would pose no undue risk to the type of facility proposed for the site.

For those cases where a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting limiting values of parameters. Important PPE parameters for safety assessment Section 2.4 include but are not limited to precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

Note: Though not required at the ESP stage, the applicant for a combined license (COL) will need to demonstrate compliance with General Design Criterion 2 (Ref. 4) as it relates to structures, systems, and components important to safety being designed to withstand the effects of natural phenomena.

Appropriate sections of the following documents are used by the staff to ensure that the Commission regulations identified above are met: Regulatory Guide 1.59[1] (Ref. 5) provides guidance for developing the hydrometeorologic design basis.

To meet the requirements of 10 CFR Parts 52 and 100 as they relate to ice effects the following specific criteria are used:

1. Publications of the National Oceanic and Atmospheric Administration (NOAA), the United States Geologic Survey (USGS), the Corps of Engineers, and other sources are used to identify the history and potential for ice formation in the region. Historical maximum depths of icing should be noted, as well as mass and velocity of any large floating ice bodies. The phrase "historical low water ice affected" or similar phrases in stream flow records (USGS and State publications) will alert the reviewer to the potential for ice effects. The following items should be considered and evaluated, if found necessary.

    a. The regional ice and ice jam formation history should be described to enable an independent determination of the need for including ice effects in the design basis.

    b. If icing has not been severe, based on regional icing history, design considerations should be presented (e.g., return of a portion of low-grade heat to the intake) to ensure that icing or ice blockage of intake screens and pumps would not adversely affect safety-related facilities and water supplies. (This item is to be addressed at the COL stage.)

    c. If the potential for icing is severe, based on regional icing history, it should be shown that water supplies capable of meeting safety-related needs are available from under the ice formations postulated and that safety-related equipment could

[1] In using Regulatory Guide 1.59, references to ANSI N170-1976 should be read as references to ANSI/ANS-2.8-1992 (Ref. 6), which has superseded the earlier document.

be protected from icing as in item b. above. If this cannot be shown, it should be demonstrated that alternate sources of water are available, that they could be protected from freezing, and that the alternate source would be capable of meeting safety-related requirements in such situations.

d. If floating ice is prevalent, based on regional icing history, potential impact forces on safety-related intakes should be considered . The dynamic loading caused by floating ice should be included in the structural design basis. (This item is to be addressed at the COL stage.)

e. If ice blockage of the river or estuary is possible, it should be demonstrated that the resulting water level in the vicinity of the site has been considered. If this water level would adversely affect the intake structure, or other safety-related facilities of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site, it should be demonstrated that an alternate safety-related water supply would not also be adversely affected.

2. The applicant's estimates of potential ice flooding or low flows are acceptable if the estimates are no more than 5% less conservative than the staff's estimates. If the applicant's estimates are more than 5% less conservative than the staff's,[2] the applicant should fully document and justify its estimates or accept the staff's estimates.

III. REVIEW PROCEDURES

Applicable literature describing historical occurrences of icing in the region is reviewed to determine if icing protection should be considered in the design of safety-related facilities. (Ref. 7) If considered necessary, the most likely types of icing conditions (floating ice, river blockage by ice buildup, frazil, etc.) are listed, and the potential impact of each type on the design of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site is identified. Criteria of the Corps of Engineers and others (Refs. 8 through 16) provide a means of assessing icing impact and methods of mitigating adverse effects. For each type of icing condition, preliminary independent estimates of the "worst case" will be made by either conservative statistical or deterministic techniques.

If the applicant's estimates of ice effects are comparable to the staff's preliminary analysis, the staff will concur with the applicant's estimates. If the preliminary analysis indicates the applicant's estimates of ice effects are not comparable to the staff's estimates, the staff's analysis will be repeated using more realistic techniques.

The above reviews are performed only when applicable to the site or site regions. Some items of review may be done on a generic basis.

IV. EVALUATION FINDINGS

For ESP reviews, the findings will summarize the applicant's and staff's estimates of the potential for ice flooding, ice blockage of water intakes, and the minimum low water levels (from upstream ice blockage). If the applicant's estimates are within acceptable margins (described

[2] Based on the difference between normal water levels and the flood event or low water.

in Acceptance Criteria), staff concurrence with the applicant's estimate will be stated. If the applicant's estimates are not within acceptable margins, if the staff predicts potential blockage of the intake, or if the effects of potentially severe icing conditions would pose an undue risk to the type of facility proposed for the site (or to a facility falling within the applicant's PPE), a statement of the staff bases will be made. If the icing conditions do not constitute a design basis, the findings will so indicate.

A sample ESP statement follows:

> As set forth above, ice flooding, which is common on the A River at the makeup intake structure, could only affect the river intake structure of a nuclear power plant of type specified by the applicant [or of a facility falling within the plant parameter envelope (PPE) submitted by the applicant]; this would not result in any adverse effects to the plant's safety-related facilities. Ice flooding may possibly raise the water surface near the A River intake to a maximum elevation of about 170 m (555 ft) MSL. Also, ice and ice flooding on the A River tributaries outside the cooling lake will not affect the facilities of a nuclear plant of the type specified by the applicant that might be built at the site [or a facility falling within the PPE submitted by the applicant]. The major tributary nearest the site is the B Creek with the closest point located about 1.6 km (1 mi) to the southeast of the site. Because of the distance from the proposed site and the wide floodplain of the river, the effects of severe icing conditions would not pose an undue risk to the type of facility proposed for the site [or to a facility falling within the PPE submitted by the applicant] due to ice in the river and consequent flooding.
>
> Therefore, the staff concludes that, with respect to ice flooding, the applicant has adequately described the potential adverse impacts of icing on the safety-related facilities of a nuclear power plant of type specified by the applicant [or on a facility falling within the PPE submitted by the applicant] that might be constructed on the proposed site. In addition, the applicant has adequately described the ice-related characteristics historically associated with the site and region. The safety assessment demonstrates that the site is acceptable and meets the requirements of 10 CFR Part 52 and 10 CFR Part 100.

V. IMPLEMENTATION

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

This section will be used by the staff when performing safety evaluations of ESP applications submitted by applicants pursuant to 10 CFR Part 52. 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 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."
2. 10 CFR Part 100, "Reactor Site Criteria."
3. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."
4. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."
5. Regulatory Guide 1.59, "Flood Design Basis for Nuclear Power Plants."
6. ANSI /ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites."
7. Regulatory Guide 1.29, "Seismic Design Classification."
8. "River Ice Jams - A Literature Review," Engineer Technical Letter No. 1110-2-58, Corps of Engineers (1969).
9. EM 1110-2-1612 "Engineering and Design - Ice Engineering," Corps of Engineers, October 2002.
10. Roscoe E. Perham, "Forces Generated in Ice Boom Structures," SR 200, CRREL, Hanover, New Hampshire, January 1974.
11. George D. Ashton, "Air Bubbler Systems to Suppress Ice," SR 210, CRREL, Hanover, New Hampshire, September 1974.
12. Darryl J. Calkins and George D. Ashton, "Arching of Fragmented Ice Covers," SR 222, CRREL, Hanover, New Hampshire, April 1975.
13. W. H. Brierley, et al., "Lock Wall Deicing with Water Jets: Field Tests at Ship Locks in Montreal, Canada, and Sault Sainte Marie, Michigan," SR 239, CRREL, Hanover, New Hampshire, December 1975.
14. Bernard Michel, "Ice Pressure on Engineering Structures," CRREL, Hanover, New Hampshire, June 1970.
15. F. D. Haynes, et al., "Ice Force Measurements on the Pembina River, Alberta, Canada," SR 269, CRREL, Hanover, New Hampshire, October 1975.
16. K. L. Carey, et al., "Ice Engineering for Civil Works, Baseline Study," CRREL, Hanover, New Hampshire, August 1973.