Interim Staff Guidance
on Assessment of Normal and Extreme Winter
Precipitation Loads on the Roofs of Seismic Category I Structures

Purpose:

The purpose of this interim staff guidance (ISG) is to clarify the U.S. Nuclear Regulatory Commission (NRC) position on identifying winter precipitation events as site characteristics and site parameters for determining normal and extreme winter precipitation loads on the roofs of Seismic Category I structures.

Background:

1. Regulatory Requirements

General Design Criterion (GDC) 2 in Appendix A to Title 10 of the *Code of Federal Regulations,* Part 50 (10 CFR Part 50) states, in part, that structures, systems, and components (SSCs) important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these SSCs shall reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Similarly, the regulations concerning the content of a standard design certification (DC) application (Subpart B to 10 CFR Part 52) state in 10 CFR 52.47(a)(1) that these applications must include the site parameters postulated for the design and an analysis and evaluation of the design in terms of those site parameters.

Analogous to GDC 2, the regulations concerning the content of early site permit (ESP) and combined license (COL) applications (Subparts A and C to 10 CFR Part 52, respectively) state that ESP and COL applications must identify the meteorological characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated (§ 52.17(a)(1)(vi) and § 52.79(a)(1)(iii), respectively). For those COL applicants who reference a DC, § 52.79(d)(1) states that the COL application must contain information sufficient to demonstrate that the site characteristics fall within the site parameters specified in the DC.

2. Regulatory Guidance

Guidance on the information to be provided in a COL application is contained in Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)." The contents of future ESP applications are also expected to generally follow the format specified in RG 1.206, as applicable.

Section C.I.2.3.1.2 of RG 1.206, “Regional Meteorological Conditions for Design and Operating Bases,” states, in part, that the applicant should provide meteorological conditions for consideration in evaluating the design and operation of the proposed facility, including:

> …estimates of the weight of the 100-year return period snowpack and the weight of the 48-hour probable maximum winter precipitation for the site vicinity for use in determining the weight of snow and ice on the roof of each safety-related structure…

Sections C.I.3.8.1.3, C.I.3.8.2.3, C.I.3.8.3.3, and C.I.3.8.4.3 of RG 1.206, “Loads and Load Combinations,” pertaining to “Concrete Containment,” “Steel Containment,” “Concrete and Steel Internal Structures of Steel or Concrete Containments,” and “Other Seismic Category I Structures,” respectively, state, in part, that the applicant should discuss and specify the loads used in the design of these structures, including loads sustained during normal plant operation and loads sustained in the event of severe and extreme environmental conditions.

Guidance to NRC staff in performing safety reviews of ESP, COL, and DC applications under 10 CFR Part 52 is provided in NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants.” Section 2.3.1 of the Standard Review Plan (SRP), “Regional Climatology,” identifies average and extreme climatic conditions that could affect the safe design and siting of a nuclear power plant (NPP) as site characteristics and site parameters. SRP Section 2.3.1 states, in part:[1]

> “Consistent with the staff’s branch position on winter precipitation loads (Reference 16), the winter precipitation loads to be included in the combination of normal live loads to be considered in the design of a nuclear power plant that might be constructed on the proposed site should be based on the weight of the 100-year snowpack or snowfall, whichever is greater, recorded at ground level. Likewise, the winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a nuclear power plant that might be constructed on the proposed site should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP at ground level for the month corresponding to the selected snowpack. Depending on the location of the site, the 48-hour PMWP may not necessarily be in the form of frozen precipitation. A CP, OL, or COL applicant may choose and justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on the top of the snowpack and/or building roofs.
>
> The weight of the 100-year return period snowpack should be based on data recorded at nearby representative climatic stations (e.g., Reference 17) or obtained from appropriate standards with suitable corrections for local conditions (e.g., References 10, 11). For the purposes of determining the extreme winter precipitation load, the 48-hour PMWP is defined as the theoretically greatest depth of precipitation for a 48-hour period that is physically possible over a 25.9-square-kilometer (10-square-mile) area at a particular geographical location during those months with the historically highest snowpacks. The weight of the

[1] The reference citations listed below refer to the references listed at the end of this ISG.

48-hour PMWP should be determined in accordance with reports published by NOAA's Hydometeorological Design Studies Center (e.g., References 18-22).

Guidance to the staff in reviewing information pertaining to normal, severe and extreme environmental design loads and various load combinations thereof is provided in SRP Sections 3.8.1, "Concrete Containment," 3.8.2, "Steel Containment," 3.8.3, "Concrete and Steel Internal Structures of Steel or Concrete Containment," and 3.8.4, "Other Seismic Category I Structures."

Issues:

1. Normal Live Load Winter Precipitation Events

The use of an extrapolated 100-year return period to identify normal live load winter precipitation events was intended to address situations where the period of record at a particular climatic station may not extend over a significant time interval to capture cyclical extremes. However, in order to be compliant with § 52.17(a)(1)(vi) or § 52.79(a)(1)(iii), as appropriate, the highest among the 100-year return period snowpack (or snow depth), the historical maximum snowpack, the 100-year return period snowfall event, or the historical maximum snowfall event in the site region should be used in identifying a site characteristic and a site parameter for use in establishing the normal winter precipitation loads on the roofs of Seismic Category I structures.

- The use of the 100-year return period snowpack value alone is not sufficient since such values are typically developed from an extreme-value statistical analysis of weather records of snow on the ground and the results represent statistical values, not maximum observed values.

- Historical snowpack data are not as readily available as historical snowfall data. Additionally, at warm weather sites, the snow may not remain on the ground for very long and the historical snowpack database may not capture a historic snowfall event.

2. Extreme Live Load Winter Precipitation Events

Section 2.3.1 of the SRP states that the winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a NPP should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP at ground level for the month corresponding to the selected snowpack. Previous ESP applicants have contended that the 48-hour PMWP for their sites, as derived from NOAA's Hydrometeorological Design Studies Center, would be in the form of rainwater, all of which would not remain on the roof.

- The liquid 48-hour PMWP is a useful site characteristic for evaluating the potential consequences of rainwater falling on an antecedent snowpack. The temporary roof load contributed by a heavy rain on top of an existing snowpack can be significant. Its magnitude will depend on the duration and intensity of the design rainstorm, the drainage characteristics of the snow on the roof, the geometry of the roof, and the type of drainage provided. Where adequate slope to drain does not exist, or where drains are blocked by ice or snow, snow melt water and rainwater may pond in low areas on the roof. This mechanism has been responsible for several roof failures at commercial facilities under combined rain and snow loads.

- Extreme load winter precipitation events should also consider the situation where additional frozen precipitation falls on top of an existing normal live load winter precipitation snowpack.

3. Resulting Normal and Extreme Winter Precipitation Live Roof Loads

There are several SRP sections that provide guidance to the staff regarding various environmental loads, *e.g.*, wind loads (SRP 3.3.1), tornado loads (SRP Section 3.3.2), and earthquake loads (SRP Sections 3.7.1, 3.7.2, and 3.7.3). Also, SRP Sections 3.8.1, 3.8.2, 3.8.3, and 3.8.4 provide staff guidance about how these environmental loads should be considered in combination with other loads for the design of Category I structures. However, no SRP sections currently provide guidance regarding how snow loads at ground level due to normal and extreme winter precipitation events should be used for design of seismic Category I structures.

Final Interim Staff Guidance:

1. Normal and Extreme Winter Precipitation Events

Normal and extreme winter precipitation events should be identified as ESP and COL site characteristics and DC site parameters in SRP Section 2.3.1 for use in SRP Section 3.8.4 in determining the normal and extreme winter precipitation loads on the roofs of Seismic Category I structures. The winter precipitation event site characteristics/site parameters identified in SRP Section 2.3.1 are ground-level values; SRP Section 3.8.4 will be revised as indicated in this ISG to discuss the conversion of these site characteristics/site parameters to roof loads and the resulting applicable design loads and various combinations thereof.

The normal winter precipitation event is used to determine the normal winter precipitation live roof load. The winter precipitation events to be included in the combination of extreme winter precipitation live roof loads are based on the weight of the antecedent snowpack resulting from the normal winter precipitation event plus the larger resultant weight from either (1) the extreme frozen winter precipitation event or (2) the extreme liquid winter precipitation event. The extreme frozen winter precipitation event is assumed to accumulate on the roof on top of the antecedent normal winter precipitation event whereas the extreme liquid winter precipitation event may or may not accumulate on the roof, depending on the geometry of the roof and the type of drainage provided.

a. *Normal Winter Precipitation Event*

The normal winter precipitation event should be the highest ground-level weight (in lb/ft^2) among (1) the 100-year return period snowpack, (2) the historical maximum snowpack, (3) the 100-year return period snowfall event, or (4) the historical maximum snowfall event in the site region.

An appropriate source for the 100-year return period snowpack is the American Society of Civil Engineers (ASCE) Standard No. 7-05, “Minimum Design Loads for Buildings and Other Structures” (Reference 3). Figure 7-1 of ASCE 7-05 presents a map of the continental United

States showing ground snowpack values (in lb/ft^2) with a 50-year mean recurrence interval. Table C7-3 of ASCE 7-05 suggests that 1.22 is a reasonable factor to convert the 50-year mean recurrence interval values to 100-year mean recurrence interval values (i.e., the 50-year value divided by 0.82). Note that Figure 7-1 of ASCE 7-05 specifies areas where site specific detailed case studies are required to establish ground snow loads due to extreme local variations in climate and topography. Tobiasson and Greatorex (Reference 10) present a methodology for determining the ground snow load at locations where there are extreme variations in local snow load.

An appropriate source for the 100-year return period snowfall event and the historical maximum snowfall event is the National Climatic Data Center's (NCDC's) Snow Climatology web site (Reference 11). The two-day 100-year return period and observed historic two-day maximum snowfall amounts available from this web site (e.g., see "Extreme Snowfall Amount Corresponding to 4 Return Periods" under General Statistics for both values, and see "Greatest Snowfall Amount for One-Day and Multiple-Day Snowfall Events" and "Greatest Snowfall Amount for 1-Day, 2-Day, and 3-Day Snowfall Events" under Daily Statistics for observed maxima) are appropriate for use in defining the 100-year return period snowfall event and the historical maximum snowfall event, respectively.

Appropriate sources of historical maximum snow depth and snowfall data include Local Climatological Data Annual Summary with Comparative Data (Reference 12) for first-order National Weather Service (NWS) Stations, Climatography of the United States No. 20 series (Reference 13), NCDC's Daily Surface Data (TD3200/3210) (Reference 14), and NCDC's Storm Events Database (Reference 15).

The historical maximum snowpack, the 100-year return period snowfall event, and the historical maximum snowfall event are usually reported in terms of inches of snow and need to be converted to a ground snow load in $lb/ft.^2$

An appropriate algorithm for converting historical maximum snowpack depth to a ground snow load is given in Equation 1:

Equation 1

$$L = 0.279D^{1.36}$$

where *D* is the snowpack depth in inches and *L* is the resulting snow load in $lb/ft.^2$ Equation 1 is based on a correlation between 50-year snow depths and 50-year snow loads at 204 first-order NWS stations in the continental United States (Reference 10).

An appropriate algorithm for converting the 100-year return period snowfall event to a ground snow load is given in Equation 2:

Equation 2

$$L = 0.15S \times 5.2$$

where *S* is the 100-year return period snowfall event in inches, *5.2* is the weight of one inch of water in lb/ft,^{2} and *L* is the resulting snow load in lb/ft.^{2} Equation 2 is based on a snow density (defined as the ratio of the volume of melt water that can be derived from a sample of snow) of 0.15.

The liquid equivalent of the historical maximum snowfall event as indicated by the corresponding precipitation record (from Reference 14) should be used to determine the snow load for historical maximum snowfall events. If such information is not available, the use of Equation 2 is acceptable as an alternative.

b. *Extreme Frozen Winter Precipitation Event*

The extreme frozen winter precipitation event should be the higher ground-level weight (in lb/ft^2) between (1) the 100-year return period snowfall event and (2) the historical maximum snowfall event in the site region. Appropriate methodologies for determining the 100-year return period and historical maximum snowfall site characteristic/site parameter values are discussed in the previous paragraphs of this ISG.

c. *Extreme Liquid Winter Precipitation Event*

The extreme liquid winter precipitation event is defined as the theoretically greatest depth of precipitation (in inches of water) for a 48-hour period that is physically possible over a 25.9-square-kilometer (10-square-mile) area at a particular geographical location during those months with the historically highest snowpacks. The extreme liquid winter precipitation event should be determined in accordance with the Hydrometeorological Reports (HMR) published by NOAA's Hydrometeorological Design Studies Center (*e.g.*, References 5–9).

2. <u>Resulting Normal and Extreme Winter Precipitation Live Roof Loads</u>

Normal and extreme winter precipitation event site characteristics/site parameters described above (to be included in SRP Section 2.3.1) shall be used to determine normal and extreme winter precipitation live loads on the roofs of Seismic Category I Structures. SRP Section 2.3.1 identifies the winter precipitation event site characteristics/site parameters at ground level. Therefore, these site characteristics/site parameters should be converted to corresponding roof loads.

a. *Normal Winter Precipitation Event Live Roof Load*

Guidance provided in ASCE 7-05 may be used for converting the ground snow load due to a normal winter precipitation event to a roof snow load. Terrain (surface roughness) Category C may be assumed for determination of exposure factor. Flat roofs with a parapet should be considered as a sheltered roof. ASCE 7-05 specifies an exposure factor of 1.1 for sheltered roofs in terrain Category C. A thermal factor may be considered to be 1.0. An importance factor of 1.2 corresponding to Category IV buildings is considered appropriate for Seismic Category I structures. However, an importance factor of 1.0 may be used with the 100-year return period snowpack and snowfall events as well as with the historical maximum snowpack and snowfall events. Drift loads on roofs should be considered using guidance provided in ASCE 7-05.

The roof load due to a normal winter precipitation event shall be treated as a normal live load on the roof in all loading combinations for Seismic Category I structures. Other miscellaneous live loads on a roof may be added to the normal winter precipitation load if such loads are likely to be present concurrently.

b. *Extreme Winter Precipitation Event Live Roof Load*

Extreme winter precipitation event roof loads shall be based on the roof load due to the normal winter precipitation event plus the roof load due to the extreme winter precipitation event. Roof loads due to the extreme winter precipitation event shall be the higher roof load resulting from either the extreme frozen winter precipitation event or the extreme liquid winter precipitation event. Extreme frozen winter precipitation event values at ground level should be converted to corresponding roof loads using the guidance provided in ASCE 7-05 as stated in (a) above. Extreme liquid winter precipitation event values on the roof are the same as the ground level extreme liquid winter precipitation event values described above. Potential blockage of primary and other roof drainage due to antecedent snowpack on the roof shall be considered for the determination of roof loading due to an extreme liquid winter precipitation event.

Roof load due to extreme winter precipitation events may be considered as an extreme live load and treated similarly to other extreme environmental loads (e.g., seismic or tornado loads) in loading combinations for Seismic Category I structures. Other miscellaneous live loads on the roof may be added to the extreme winter precipitation load if such loads are likely to be present concurrently.

Rationale:

1. Normal and Extreme Winter Precipitation Events

In order to be compliant with § 52.17(a)(1)(vi) and § 52.79(a)(1)(iii), as appropriate, the normal winter precipitation load takes into consideration the weight of the highest among (1) the 100-year return period snowpack, (2) the historical maximum snowpack, (3) the 100-year return period snowfall event, or (4) the historical maximum snowfall event in the site region at ground-level. Both of these regulations state, in part, that the meteorological characteristics of the proposed site should be identified with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. Therefore, the historical maximum snowpack should be identified. At warm weather sites, the snow may not remain on the ground for very long. Therefore, the historical maximum snowfall event should be also determined as it might exceed the historical maximum snowpack recorded for the same event because historical snowpack (snow depth) data may not be as readily available as historical maximum daily snowfall data. The 100-year return period snowpack and the 100-year return period snowfall event values are also determined to include situations where the historical data used to characterize a site may not extend over a significant time interval to capture cyclical extremes. For the purposes of this ISG, a snowfall event is assumed to occur over a two-day period to ensure that snow storms that may persist for more than a one-day recording period are accurately captured.

In addition to the weight of the normal winter precipitation event, the extreme winter precipitation loads on the roofs of Seismic Category I structures take into consideration both the extreme frozen winter precipitation event and the extreme liquid winter precipitation event. The extreme frozen winter precipitation event is defined as the higher ground-level weight between the 100-year return period snowfall event and the historical maximum snowfall event. The extreme liquid winter precipitation event is the same phenomenon currently described in SRP Section 2.3.1 as the 48-hour PMWP. The extreme frozen winter precipitation event is useful for evaluating the potential consequences of additional snowfall on the antecedent normal winter precipitation event; similarly, the extreme liquid precipitation event is useful for evaluating the potential consequences of rainwater falling on the antecedent normal winter precipitation event.

Data reported as snowfall or snow depth must be converted to an equivalent weight (or load) using a relationship between depth and density. The American Meteorological Society's Glossary of Meteorology (Reference 16) states that freshly fallen snow usually has a snow density of 0.07 to 0.15. Equation 2, which is based on a snow density of 0.15, is used to convert the 100-year return period snowfall event to a snow load. The snow loads for historical maximum snowfall events are based on the actual total precipitation (i.e., liquid equivalent in inches of water) recorded concurrently with historical maximum snowfall event.

The density of fallen snow will increase over time due to snow settlement. Tobiasson and Greatorex (Reference 10) present an algorithm for determining snowpack weight based on a correlation between the maximum depth of snow on the ground each winter and the maximum water equivalent for each concurrent winter at a number of NWS stations. This algorithm, presented as Equation 1, was used to generate the 50-year ground snow load map (Figure 7-1) in ASCE 7-05.

Figure 1 presents a comparison of snow load as a function of (1) snowpack depth using the Tobiasson and Greatorex correlation presented in Equation 1 and (2) snowfall event depth using the 0.15 snow density correlation presented in Equation 2. Figure 1 shows that Equation 2 predicts slightly higher snow loads for snowfall events less than 17 inches as compared to snow loads resulting from snowpack depths less than 17 inches. Similarly, Equation 1 begins to predict higher snow loads for snowpack depths greater than 17 inches as compared to snowfall events greater than 17 inches. This shows a reasonable correlation between Equations 1 and 2 in that snowpack depths greater than 17 inches are most likely the result of multiple snowfall events where the older snow previously on the ground becomes denser than newly fallen snow.

2. <u>Resulting Normal and Extreme Winter Precipitation Live Roof Loads</u>

Seismic Category I structures are required to be designed to withstand the effects of natural phenomena to meet the requirements of GDC 2 in Appendix A to 10 CFR Part 50. Therefore, Seismic Category I structures must be designed to withstand the effects of winter precipitation events.

Roofs of Seismic Category I structures not protected by a shield building will be subject to loading due to accumulation of winter precipitation. SRP Section 2.3.1 identifies winter precipitation event site characteristics/site parameters at ground level. Therefore, these site characteristics/site parameters must be converted to corresponding roof loads.

Currently, no guidance is included in any of the SRP sections regarding how snow loads at ground level should be converted to snow loads on the roofs of Seismic Category I structures. Further, SRP sections pertaining to design of Seismic Category I structures do not provide any guidance as to how roof loads due to normal and extreme winter precipitation events should be included in loading combinations for design of Seismic Category I structures. This ISG includes guidance for NRC staff members for acceptable methods for (a) converting winter precipitation site characteristics/site parameters (as ground snow loads) to roof loads, and (b) including roof loads due to normal and extreme winter precipitation events into loading combinations for the design of Seismic Category I structures.

(a) *Converting Ground Snow Loads to Roof Loads*

ASCE 7-05 provides detailed guidance regarding how snow loads on the ground should be converted to snow loads on roofs. It establishes a procedure to generate a flat roof snow load (Equation 7-1) by applying multiplying factors to the ground snow load with consideration given to (1) roof exposure, (2) roof thermal condition, and (3) occupancy and function of the structure. Detailed instructions are also included to account for roof slope, snow drifts, sliding snow, partial loading, etc.

The guidance provided in ASCE 7-05 for estimating snow loads on roofs is not developed specifically for nuclear structures. However, ASCE 7-05 is a recognized industry standard that is extensively used for estimating loadings on structures in the United States. It is stated in the standard that the factors used in the standard to account for the thermal, aerodynamic, and geometric characteristics of the structure in its particular setting were developed using the National Building Code of Canada as a point of reference. Several case study references were also examined in detail. It is further stated that an extensive program of snow load case studies was conducted by eight universities in the United States, the U.S. Army Corps of Engineers' Alaska District, and the U.S. Army Cold Regions Research and Engineering Laboratory for the Corps of Engineers. The results of this program were used to modify the Canadian methodology to better fit conditions in the United States. Measurements obtained during the severe winters of 1976-1977 and 1977-1978 were included. The experience and perspective of many design professionals, including several with backgrounds in building failure analysis, were also incorporated. Based on the above, the staff believes that the guidance provided in ASCE 7-05 for converting ground snow load to snow load on roofs may be used for nuclear structures by choosing appropriate values for the factors used to account for exposure, thermal condition, and classification of the structure as well as following the guidance provided in the standard to include other considerations.

ASCE 7-05, Table 7-2 provides factors to be used to account for roof exposure. Since most nuclear power plants are located in relatively open country, terrain (surface roughness) Category C is recommended for use. Surface roughness C is defined as open terrain with scattered obstructions having heights generally less than 30 ft. This category includes flat open country, grasslands, and all water surfaces in hurricane prone regions. Also, it is recommended that roofs with a parapet be considered as sheltered roofs. Sheltered roofs in terrain Category C correspond to an exposure factor of 1.1.

ASCE 7-05, Table 7-3 provides values to be used as thermal factors. Since NPP structures are provided with HVAC systems to maintain operating temperatures, it is considered acceptable to use a value of 1.0 as a thermal factor.

The importance factor has been included to account for the need to relate design loads to the consequences of failure. ASCE 7-05, Table 7-4 provides values of importance factors to be used to account for occupancy and function of a structure. ASCE 7-05, Table 1-1 defines structures designated as essential facilities as Occupancy Category IV and ASCE 7-05, Table 7-4 assigns an importance factor of 1.2 to Category IV facilities. Section C7.3.3 of ASCE 7-05 states that an importance factor of 1.2 establishes the average design value on an annual probability of being exceeded of about 1 percent (about a 100-year mean recurrence interval). The ground snow loads provided as input to the roof design loads are already based on the 100-year return period snowpack, the 100-year return period snowfall event, the historical maximum snowpack, and/or the historical maximum snowfall event values. Using 100-year return period and historical maximum snowpack and snow fall events (as well as the 48-hour PMWP as the extreme liquid winter precipitation event) with an importance factor of 1.0 corresponds to an occupancy Category IV and is therefore considered acceptable.

(b) *Including Roof Loads Due to Winter Precipitation into Loading Combinations*

Normal winter precipitation loads are considered to be severe environmental loads. Therefore, the staff considers that normal winter precipitation loads should be included as normal live loads in loading combinations. This should be added to all other live loads that may be expected to be present at the time to determine the design live load on the roof. Appropriate load factors shall be applied to this design live load in loading combinations.

Extreme winter precipitation loads are considered to be extreme environmental loads. Therefore, the staff considers that this load should be included in loading combinations in this category as a live load with a unit load factor. Other extreme environmental loads (e.g., seismic and tornado loads) need not be considered as occurring at the same time. This staff position is consistent with the International Atomic Energy Agency (IAEA) report IAEA-TECDOC-1341, “Extreme External Events in the Design and Assessment of Nuclear Power Plants” (Reference 17). The staff considers this position reasonable considering the extreme low probability of occurrence of this event.

Final Resolution:

This ISG provides guidance for (1) identifying normal and extreme winter precipitation events as site characteristics for ESP and COL applicants and as site parameters for DC applicants and (2) converting normal and extreme winter precipitation events to roof loads and defining the applicable design loads and various load combinations thereof for DC applicants. The contents of this ISG will be incorporated into upcoming revisions to Sections 2.3.1 and 3.8.4 of the SRP and appropriate sections of RG 1.206.

Applicability:

This ISG is applicable to all ESP, COL, and DC applications submitted under 10 CFR Part 52. This ISG shall be implemented on the day following its approval. It shall remain in effect until it has been superseded, withdrawn, or incorporated into a revision to the SRP and RG 1.206.

Backfit Determination:

This ISG limits the review called for in the SRP to meet current requirements in 10 CFR Part 52. No backfit is required.

References:

1. "Site Analysis Branch Position — Winter Precipitation Loads," NRC memorandum from H.R. Denton to R.R. Maccary, March 24, 1975, available in ADAMS under Accession No. ML050630277.

2. U.S. Department of Commerce, "NCDC Cooperative Station Data," 3-volume CD-ROM set divided geographically into regions (Eastern, Central, and Western United States) with the period-of-record varying among stations but falling within the period from the 1850s through 2001, National Climatic Data Center, NOAA.

3. ASCE Standard No. 7-05, "Minimum Design Loads for Buildings and Other Structures," ASCE/SEI 7-05, American Society of Civil Engineers, 2006.

4. U.S. Department of Commerce, "Engineering Weather Data," CD-ROM, National Climatic Data Center, NOAA.

5. U.S. Department of Commerce, "Probable Maximum Precipitation Estimates: Colorado River and Great Basin Drainage," Hydrometeorological Report No. 49, NOAA, Reprinted 1984.

6. U.S. Department of Commerce, "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105^{th} Meridian," Hydrometeorological Report No. 53, NOAA, April 1980.

7. U.S. Department of Commerce, "Probable Maximum Precipitation Estimates: United States, Between the Continental Divide and the 103^{rd} Meridian," Hydrometeorological Report No. 55A, NOAA, June 1988.

8. U.S. Department of Commerce, "Probable Maximum Precipitation: Pacific Northwest States, Columbia River (including portions of Canada), Snake River and Pacific Coastal Drainages," Hydrometeorological Report No. 57, NOAA, October 1994.

9. U.S. Department of Commerce, "Probable Maximum Precipitation for California," Hydrometeorological Report No. 59, NOAA, February 1999.

10. Wayne Tobiasson and Alan Greatorex, "Database and Methodology for Conducting Site Specific Snow Load Case Studies for the United States," Snow Engineering: Recent Advances, Izumi, Nakamura & Sack (eds), 1997, Balkema, Rotterdam, ISBN 90 5410 865 7.

11. U.S. Department of Commerce, "United States Snow Climatology," National Climatic Data Center, NOAA, available at http://www.ncdc.noaa.gov/ussc/index.jsp.

12. U.S. Department of Commerce, "Local Climatological Data — Annual Summary with Comparative Data," National Climatic Data Center, NOAA, published annually for all first-order NWS stations.

13. U.S. Department of Commerce, "Climatography of the United States No. 20, 1971-2000," National Climatic Data Center, NOAA, published for all first-order NWS stations.

14. U.S. Department of Commerce, "Daily Surface Data (TD3200/3210)," National Climatic Data Center, NOAA, available at http://cdo.ncdc.noaa.gov/pls/plclimprod/poemain.accessrouter?datasetabbv=SOD.

15. U.S. Department of Commerce, "Storm Events Database," National Climatic Data Center, NOAA, available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

16. American Meteorological Society, "Glossary of Meteorology," Second Edition, available at http://amsglossary.allenpress.com/glossary.

17. IAEA, Report No. IAEA-TECDOC-1341, "Extreme External Events in the Design and Assessment of Nuclear Power Plants," March 2003.

Figure 1

Snow Load versus Snow Depth