

**Ice Loading**

**The NEI Assessment Report incorrectly concludes that the maximum radial ice experienced in New Hampshire during the December 2008 ice storm was only 1/2 inch, and that an equivalent storm can be expected to occur once every ten years. This conclusion is not supported by the evidence.**

In support of this conclusion NEI cites a study commissioned by NEI, and performed by the Army Corp of Engineers Cold Regions Research and Engineering Laboratory (CRREL). The report developed by the CRREL, and titled “The December 2008 Ice Storm in New Hampshire,” is provided as Appendix D to the NEI Assessment Report. Citing to this report, Chapter IV of the Self Assessment Report states “CRREL reports that the maximum radial ice seen in New Hampshire was in the Manchester area and was 1/2 inch.” The Self Assessment Report further states, “Only 4/10 inch of radial ice was found to have occurred in southwestern New Hampshire in the Jaffrey area.” Reference Page IV-36. In fact, neither of these conclusions appears in the CRREL report. Instead, it appears NEI inappropriately derived these conclusions from the CRREL report without considering the gaps and limitations of the data, which were clearly identified in the CRREL report.

The CRREL report, authored by Kathleen F. Jones, provides a summary of data reported from weather stations and used to estimate the equivalent radial glazed ice thickness,  $R_{eq}$ . This takes the form of three types of estimates: 1) direct estimates from freezing-rain sensors using Automated Surface Observing System (ASOS) one-minute data; 2) a Simple ice accretion model developed from precipitation type, precipitation amount, and wind speed; and 3) a more detailed CRREL ice accretion model that uses air temperature and dew point data to calculate how much of the impinging precipitation freezes. Reference Page D-6. In all cases, estimates of ice accretion are derived from sensors or data provided by weather stations.

As clearly explained in the CRREL report, data from weather stations may be lost during freezing rain storms due to power outages. *“The stations have battery backup for only one-half hour, so in lengthy power outages, which are common in significant freezing rain storms, data may not be collected for a portion of the storm.”* Reference Page D-6. This is reinforced throughout CRREL report, as variations in results are extensively attributed to missing data. For example, in explaining the variations in precipitation shown in Figure 1, the CRREL report states *“Some of the small scale variation shown on the map may be due to variation in the measurement time from station to station. But some of the variation is likely because of power outages at hourly weather stations because of the ice storm. For example, the bulls eye in the middle of Massachusetts comes from the Worcester weather station where no data was archived from 0700 December 12 through 1300 December 13.”* Reference Page D-6. Similar variations in precipitation are evident in Figure 1 in Southwestern New Hampshire, and in Southeast New Hampshire.

In estimating  $R_{eq}$ , the CRREL report makes clear that where there is missing data, the estimated ice thicknesses should be considered the “lower bounds” of  $R_{eq}$ . For example, in discussing the results for Lawrence and Worcester, the report states “*Data is missing at the height of the storm, so these should be considered lower bounds on  $R_{eq}$  in the vicinity of these two stations.*” Reference Page D-7. Furthermore, examinations of the results in Table D-1 and Figure D-1 reveals most (or all) of the stations in the worst hit areas were designated with “+” signs, indicating missing data. In fact, eliminating these points from Figure D-7 would mean that there is virtually no accurate data available in any of the worst-hit areas. It is also evident, that the highest ice accumulations were derived from stations that either didn’t lose power, or experienced the shortest interruption in data. If anything, a simple visual comparison of Figure D-7 with the variations in precipitation in Figure D-1 (e.g., the “Worcester bulls eye”) suggests that precipitation totals were much higher than reported, and therefore icing was most likely much higher than reported.

The CRREL report also references an “Ice Storm Team” which performed human measurements of ice in the field. According to the report, “*On December 14 the CRREL Ice Storm Team measured  $R_{eq}=14$  mm (0.6 in.) on a twig (Figure D-6a) from the top of a birch tree bent over under the weight of ice by the parking lot at Temple Mountain State Reservation (Figure D-6b), about 4 miles east of Peterborough on Route 101, and 7 miles northeast of the Jaffrey airport.*” Reference Page D-7. This in itself contradicts the conclusion that the maximum radial ice seen in New Hampshire was in the Manchester area and was 1/2 inch. More important, the CRREL Ice Storm Team did not make these measurements until December 14<sup>th</sup>, fully two days after the storm, by which time extensive melting had occurred in most locations. The team states that “air temperature was still below freezing at this location at an elevation of about 1,500 ft, two days after the freezing rain storm, and the ice appeared to be intact.” However, ice thickness would have reduced due to both melting (sun hitting underlying branch regardless of air temperature) and due to sublimation. Furthermore, there is no way to know whether other areas experienced thicker ice, but had already melted, and there is no information on which areas the CRREL team examined. For example, did the team travel to New Ipswich, Rindge, Danville, Newton?

Finally, examination of the weather stations in Figure D-2 reveals that there were no stations at all in many of the worst hit areas of the state. E.g., in southwest New Hampshire. There were stations in Jaffrey and Fitchburg MA, but no other stations in large sections of the worst hit areas. Similarly, there are no stations in the hard hit border towns along southeastern New Hampshire (South Hampton, Newton, Danville, Plaistow, etc.) As already stated, to the extent there *were* stations, most of the stations in these areas lost power and stopped reporting data.

The NEI report chooses to ignore all these problems with the data, and instead concludes that the maximum radial ice seen in New Hampshire was in the Manchester area and was 1/2 inch. This conclusion is incorrectly arrived at due to the fact that the Manchester station did not lose data whereas the others all did. The NEI report also states that only 4/10 inch of radial ice was found to have occurred in southwestern New Hampshire in the

Jaffrey area, despite the CRREL report stating that they directly measured 0.6” in this area two full days after the storm (after extensive melting). In fact, there is no clear data or evidence to support any conclusion as to the maximum radial ice seen in New Hampshire.

In general, any conclusions derived from the CRREL report suffers from the following problems with data:

*1. Too few weather stations; insufficient coverage in the worst hit areas.*

Examination of the weather stations in Figure D-1 reveals that there were no stations and therefore no data in some of the worst hit areas. For example, the only stations in proximity to Southwest New Hampshire were the stations in Jaffrey and Fitchburg, MA. There were no other stations. Similarly, there are no weather stations along the border towns of Southeast New Hampshire (South Hampton, Newton, Danville, Plaistow, etc.).

Even if the limited stations in proximity to these areas did not lose power and were able to report data throughout the storm (which they didn't), they do not provide sufficient coverage to conclude that these locations are representative of the icing at all locations.

*2. No consideration of the location and elevation of weather stations*

As witnessed during the 2008 ice storm, icing and damage could be dramatically different in locations only a few linear miles apart. This was primarily due to changes in elevation. Significantly less icing was experienced in lower elevations than higher elevations. As one example, the weather station in Fitchburg MA is located at an elevation of 348 feet. Icing and damage in this area was far less severe than icing and damage in Ashby at an elevation of 997 feet with higher elevations in the hills. The weather station at Worcester airport sits at an elevation of 1009 feet, and recorded substantial icing.

No consideration was given to the elevation of weather stations, or the elevation of areas that experienced the greatest damage.

*3. Weather stations lost power in the worst hit areas, and therefore provided incomplete data.*

It is clear in both Table D-1 and Figure D-7 that data is missing from all the stations in the worst hit areas. In fact, if all the stations marked with notations indicating “no data” and “missing data” are excluded from the results, there is essentially no data in Southwest New Hampshire and North Central Massachusetts. Nor is there any data in Southeast New Hampshire. In fact, there is virtually no data anywhere along the New Hampshire/Massachusetts border. Given that these were in fact the worst hit areas, there is essentially no reliable data anywhere in the areas with the most damage.

- 4. The maximum icing and  $R_{eq}$  occurred at locations where weather stations did not lose power, or did not lose data.*

This suggests two things. First, there the primary cause of lower icing estimates occurred solely due to incomplete data. Second, the higher totals may have actually occurred in areas with less icing and less damage since they didn't lose power.

- 5. Conclusions drawn from the CRREL report are inconsistent with the pattern of damage.*

Perhaps the most important evidence contradicting the conclusions of maximum icing is the damage experienced in different areas. The pattern of damage clearly contradicts the conclusions drawn from the CRREL report, and suggests that icing was much higher in some areas than was suggested in the report. Clearly, Manchester New Hampshire was not the worst hit area in the state.

**Conclusion: The NEI Assessment Report incorrectly concludes that the maximum radial ice experienced in New Hampshire during the December 2008 ice storm was only 1/2 inch, and that an equivalent storm can be expected to occur once every ten years. This conclusion is not supported by the evidence.**