Foundation for Resilient Societies
52 Technology Way
Nashua NH 03060

Thursday, June 18, 2015

Mr. Dean Curtland
Site Vice President
NextEra Energy Seabrook, LLC
626 Lafayette Road
Seabrook, NH 03874

Dear Mr. Curtland:

The Foundation for Resilient Societies, Inc. is a non-profit research and education foundation based in New Hampshire. Our core research priorities relate to improving the resilience of critical infrastructures of 21st century societies; hence we are committed to a resilient electric grid.

On behalf of Resilient Societies, I am attending tonight's presentation of the Nuclear Regulatory Commission (NRC) findings regarding NextEra Energy Seabrook's 2014 safety and inspection record. We are pleased to learn that NextEra Seabrook has managed its operations with without major incident in year 2014.

The safe and prudential management of all baseload power plants in New England becomes of increasing importance as electric generation at five coal-fired power plants winds down. As New England loses Brayton Point, the largest-capacity coal-fired plant in New England, and others, there will be fewer baseload plants capable of meeting electric demand.

It is in this context that Resilient Societies wishes to communicate our concern that NextEra Energy Seabrook has missed an opportunity to protect its new Generator Step Up (GSU) transformer manufactured in Austria by Siemens. NextEra could have protected this transformer against solar storms by installation of neutral ground blocking equipment during the refueling outage scheduled for October 2015. However, due to required lead times for equipment ordering, this opportunity has been lost.

As you may be aware, Seabrook Station is one of three nuclear power plants along the Northeastern Atlantic seaboard that are known to have suffered severe damage or loss of a GSU transformer during or shortly after solar geomagnetic storms over the past 26 years.

The first of the three GSU transformers to fail was the GSU transformer at the Salem-1 nuclear power plant adjacent to the saline waters of Delaware Bay, during a March 13, 1989 solar storm. Geomagnetically induced currents (GIC) entered the high voltage (345 kV) side, and melted windings at the low voltage side of the transformer. This same storm caused a province-wide blackout in Quebec, Canada.

The second of the three GSU transformers to fail was also damaged in the March 13, 1989 solar storm. The damage occurred at the 345 kV GSU transformer at Site X-14 of the Maine Yankee nuclear plant, in Wiscasset, Maine. Due to indicators of transformer distress, managers at Maine Yankee committed to install a backup GSU transformer at Site X-16 just 15 days after the March 13th solar storm.

On April 28, 1991 during a relatively modest solar storm (about 80 nanoTeslas/minute), the main GSU transformer in Wiscasset overheated, and at 6:32 p.m. the following day hydrogen gases caused an explosion and total loss. The backup 345 kV transformer was able to serve Maine load pockets in 1991-1993. But without GIC current blockers, the second GSU transformer at Site X-16 also suffered distress. Hence in July 1993 Maine Yankee management replaced both these 345 kV transformers with new transformers.

Maine Yankee procured 3 extra GSU transformers over a four year period due to solar storm damage, at significant cost to ratepayers. Ultimately, with loss of public confidence in management, Maine Yankee was decommissioned in year 1996. It is unfortunate that neutral ground blockers for GSU transformers were not available at the time.

Seabrook Station suffered damage to the Phase A unit of the three-phase GSU transformer during a solar storm on November 8-9, 1998. Again at that time, there were no geomagnetically induced current (GIC) monitors available, so Public Service of NH was unaware of the proximate cause—two geomagnetic storms in rapid succession, with the second storm overtaking the first and causing a “sudden impulse” event. The result was a 12.2 day outage of Seabrook Station, starting on November 10, 1998.

The Seabrook Phase A transformer had operated successfully for about eight years out of an expected 40 year life. During the November 8-9 storm, a 4 inch stainless steel bolt vibrated loose , via *magnetostriction* that is common during injection of quasi-DC currents, and caused the failure.

In January 2012 NextEra engineers asserted that the melting of the Phase A transformer could not have been caused by a solar storm because the damage was to the low voltage winding, not

the high voltage winding. National experts we consulted confirmed that the GIC enters at the high voltage winding but often cause damage at the low voltage winding and its insulation.

In an ongoing appeal of a proposed reliability standard for hardware protection during solar storms (see FERC Docket RM15-4-000), Resilient Societies has cited research on vibration damage to transformers. Moreover, a Defense Threat Reduction Agency test of a neutral ground blocking device at Idaho National Lab in year 2013 demonstrated that DC currents caused significant vibration of a 150-ton transformer; and that the vibrations ceased when a neutral ground blocking device was switched in and that the vibrations returned when the blocking device was switched out. One concern is that vibration-related damage can occur at lower amperage than thermal overloads, so it is important to protect GSU transformers from both vibration and overheating.

Because NextEra Energy Seabrook, LLC has opted not to procure a neutral ground blocking device to protect its new Siemens 345 kV transformer, it is our understanding that installation of protective hardware will not now be feasible until a planned Seabrook Station outage in the Spring of 2017. This means that Seabrook Station electric generation and its new GSU transformer will remain unprotected for about another 20 months, or nearly 2 years.

Moreover, from our participation in the NERC GMD Task Force and other research projects, it is our understanding that Seabrook's new GSU transformer will be rated by its manufacturer for only 60 amps of DC current during solar storms, compared to the rating of 200 amps of DC current for the old GE-manufactured GSU transformer -- a transformer that was actually damaged in the immediate aftermath of a moderate solar storm.

In summary, a less resilient transformer will now operate at Seabrook Station without hardware protection. This outcome is perplexing in the aftermath of high GIC readings at Seabrook Station taken during moderate level solar storms since measurements commenced in 2012.

We note with concern the July 16, 2012 Reuters article, "NextEra cuts N.H. Seabrook output due to solar activity." The article discloses a significant reduction in power during the July 2012 solar storm.

A developing consensus among space weather scientists (using Poisson distribution statistics) indicates that the probability of a severe solar geomagnetic storm impacting planet earth is about 12 percent per decade, or about 50% over a half century. (See the Emprimus Report of January 5, 2015 filed in Maine PUC Docket 2013-00415; comments of Resilient Societies in its

Level 2 standard setting appeal now before NERC; and Resilient Societies comments filed on the White House's National Space Weather Strategy docket submitted on May 29, 2015.)

It appears that NextEra Energy Seabrook, LLC is needlessly accepting risk of GSU transformer damage during a severe solar geomagnetic storm in the next two years—a probability of about 2%. To the best of our knowledge, solar storms are most significant unmitigated hazard to the safe and reliable operation of Seabrook Station.

NextEra Energy Seabrook managers should take note of the recently enacted public policy of the State of New Hampshire, via Acts of 2015, Chapter 89, to strengthen the electric reliability of electricity transmitted and distributed in this state. Because Seabrook Station generates about 40 percent of New Hampshire's electricity, managerial prudence is essential to protect the reliability of Seabrook Station electric generation, for the welfare of the state's residents and businesses, and also for the welfare of retail customers in Maine and Massachusetts who also depend upon Seabrook's electricity.

Resilient Societies has several questions for NextEra Energy Seabrook, LLC managers:

1. Are you aware that the cost of the 12.2 day Seabrook Station generation outage in November 1998 was more than the present-day cost of purchasing several dozen neutral ground blocking devices?
2. Are you aware that the lost revenues from down-powering of Seabrook Station in the July 15-16, 2012 solar storm would have paid for at least two neutral ground blocking devices, designed to enable "operate through" capabilities during solar geomagnetic storms?
3. Will NextEra Energy Seabrook, LLC consider installation of neutral ground blocking equipment during the year 2017 scheduled refueling outage for Seabrook Station?
4. Will NextEra Energy Seabrook release to the NRC and to the public any assessment or report it produced or which was contracted by NextEra Energy, assessing the pros and cons of installing neutral ground blocking equipment for Seabrook Station?

Sincerely,

William R. (Bill) Harris
Secretary and Member of the Board
Foundation for Resilient Societies, Inc.

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