Audit Request Regarding PUC for GOC Consideration

#	Topic Area	Possible Areas of Focus	Rough $ estimate	Covered by other topic?	Past or current efforts in this area?	Additional Information
2	Public Utilities Commission	Extent to which the PUC complied with requirements of LD 131 and if not to a great extent, why? • Why did the PUC report required by LD131 not include low-cost, mid-cost and upper-cost estimates for EMP? • Why is there no time schedule for mitigation steps? • Why, instead of performing the assigned governmental function of independent research on the electric grid, the PUC has relied on the utilities to do research for them? • Wouldn't this result in biased research? • Does this reflect a cultural bias on the part of the PUC in favor of the utilities and away from established experts? • If the electric utilities were experts, wouldn't the protections have been accomplished long ago? **OR** Review of selected cases to assess the extent to which the PUC is independently assessing risks and costs associated with ensuring safe, reasonable and adequate electrical service? If not to a great extent why?		No	Yes, prior PUC Review touched on this issue, but scope did not include detailed review of PUC cases	2013 Resolve Chapter 45, LD 131 directed the PUC to examine measures to mitigate the effects of Geomagnetic Disturbances and Electromagnetic Pulse on the State's Transmission System PUC Report issued January 20, 2014 A second study described in Appendix I of the Report is underway. *Public Utilities Commission* 35-A MRSA §101 *Statement of Purpose* *The purpose of this Title is to ensure that there is a regulatory system for public utilities in the State and for other entities subject to this Title that is consistent with the public interest and with other requirements of law and to provide for reasonable licensing requirements for competitive electricity providers. The basic purpose of this regulatory system as it applies to public utilities subject to service regulation under this Title is to ensure safe, reasonable and adequate service, to assist in minimizing the cost of energy available to the State's consumers and to ensure that the rates of public utilities subject to rate regulation are just and reasonable to customers and public utilities.*

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January 23, 2014

Senator Cain, Representative Kruger and Esteemed Members of the GOC Committee:

RE: Maine PUC Non-compliance with L.D. 131, Resolve, Directing the Public Utilities Commission to Examine Measures to Mitigate the Effects of Geomagnetic Disturbances and Electromagnetic Pulse on the State's Transmission System.

Last spring, the Legislature passed emergency legislation almost unanimously regarding electromagnetic pulse and geomagnetic storm protections for the grid. The resolve called for a PUC report to put together information on vulnerabilities, options for protection, costs of protections – low, medium and high and a timeline for putting recommendations into effect.

The report did not address costs and did not intend to. Rather, it left it to the Federal Energy Regulatory Commission. It did not give a timeline for instituting protections and it did not analyze cost estimate conflicts.

The PUC did not accept the offer of assistance by FERC's Office of Energy Infrastructure Security. In a 3-way phone call with Chair Thomas Welch, the director and me, they offered, "We have the studies, the expertise, and the staff to help you," referring to an Oak Ridge National Laboratories study. Maine has thus been deprived of key expertise.

This presents a clear and increasing danger, because the Maine Power Reliability Program, as designed, is raising our vulnerability to solar or EMP disaster, which will double in 2014 and 2015.

As we have heard from other sectors, the PUC seemed to favor the utility company's agenda for delay and disregarded much national expert input. Delay threatens our survival.

Maine had to act because Washington has been unable to. The utility companies have blocked good, bipartisan legislation in Washington for years, always calling for more studies. Maine PUC has recommended the same.

I request we put this item on the agenda for Jan. 24, to quickly review process issues with the PUC. National experts will be available next Wednesday and Thursday to comment or answer questions.

Respectfully,

Andrea

Andrea Boland

Please see attachment.

District 142 Sanford (part)

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HIGHLIGHTS OF H.P. 106 -L.D. 131 – MAINE RESOLVES 2013 CH. 45 AS ENACTED JUNE 10, 2013

Sec. 1 Examine vulnerabilities of Maine's electric transmission and distribution infrastructure to impacts of geomagnetic disturbance or electromagnetic pulse (EMP), including:

1. **most vulnerable components of the State's transmission system;**
2. **potential mitigation measures**
3. **estimate costs of potential mitigation measures and develop options for low-cost, mid-cost, and high-cost measures;**

   (Maine PUC did not perform any cost studies or develop cost options; PUC merely quoted cost figures of docket commenters and proposed a cost-study in the future that would be effectively controlled by the Maine utilities.)

4. **examine positive and negative effects of adopting a policy to incorporate mitigation measures into future construction and retrofitting.**
5. **examine potential effects of Maine adopting state mitigation policies on regional transmission**

   (Maine PUC did not make a written request to Federal Energy Regulatory Commission (FERC) for information or technical assistance, despite FERC's position as interstate regulator and an offer from FERC of such technical assistance.)

   (Maine PUC did not perform any modeling or technical assessment of effects of neutral blocking devices in Maine on regional transmission nor engage commercial modeling firms to perform such studies. Instead, Maine PUC proposes future modeling performed by Maine utilities.)

6. **develop a time frame for adoption of mitigation measures**

   (Maine PUC did not propose any time frame for mitigation measures such as Geomagnetically-Induced Current (GIC) monitors and neutral ground blocking devices. Maine PUC did not even propose a time frame for the proposed future cost study to be performed and effectively controlled by Maine utilities.)

7. **develop recommendations for cost allocations among shareholders & ratepayers.**

   (Maine PUC did not make a written request for information to FERC on tariffs, despite writing in its report, "Recovery of transmission costs is within FERC's jurisdiction. Thus, issues regarding cost recovery for GMD or EMP mitigation measures, to the extent these mitigation measures involved the transmission system, would be determined by FERC.")

Sec. 2. Monitor federal mitigation efforts

Black = Emergency Mandates addressed Red = Maine PUC Non-Compliance Blue = (Non-compliance examples)

CORONAL MASS EJECTION OF JULY 23, 2012
Assessed as having greater energy release than Carrington event of 1859,
would have endangered electric grids throughout the earth's northern hemisphere if aimed at earth

RECENT CONCERNS REGARDING THE MAINE PUBLIC UTILITIES COMMISSION
OPEGA Report No. SR-PUC-12, Sep. 2013 at pages 28-29

Excerpts from the Section on "Regulatory Capture"

"..... Often when people use the term "conflict of interest they do not mean a direct or financial conflict, but are referring more generally to a bias or shared perspective that adversely influences impartiality. We heard concerns about a revolving door between the PUC and utility companies because of ex-utility employees working at PUC, former PUC employees working directly for utilities or law firms representing utilities, and Commissioners having worked for or represented utilities prior to being appointed and/or after leaving the PUC..."

"We heard from intervenors who feel the PUC readily accepts the word of utility companies but questions evidence brought by others."

PLEASE NOTE: Legislative Information ***cannot*** perform research, provide legal advice, or interpret Maine law. For legal assistance, please contact a qualified attorney.

Resolve, Directing the Public Utilities Commission To Examine Measures To Mitigate the Effects of Geomagnetic Disturbances and Electromagnetic Pulse on the State's Transmission System

Emergency preamble. Whereas, acts and resolves of the Legislature do not become effective until 90 days after adjournment unless enacted as emergencies; and

Whereas, the North American Electric Reliability Corporation has identified 2013 as a peak year of solar activity that could result in a geomagnetic disturbance; and

Whereas, the impact of a significant geomagnetic disturbance or electromagnetic pulse on the reliability of Maine's electric grid is unknown; and

Whereas, the Public Utilities Commission may be able to identify measures to protect Maine's electric grid through a focused examination; and

Whereas, in the judgment of the Legislature, these facts create an emergency within the meaning of the Constitution of Maine and require the following legislation as immediately necessary for the preservation of the public peace, health and safety; now, therefore, be it

Sec. 1 Examination of vulnerabilities and mitigation. Resolved: That the Public Utilities Commission shall examine the vulnerabilities of the State's transmission infrastructure to the potential negative impacts of a geomagnetic disturbance or electromagnetic pulse capable of disabling, disrupting or destroying a transmission and distribution system and identify potential mitigation measures. In its examination, the commission shall:

1. Identify the most vulnerable components of the State's transmission system;

2. Identify potential mitigation measures to decrease the negative impacts of a geomagnetic disturbance or electromagnetic pulse;

3. Estimate the costs of potential mitigation measures and develop options for low-cost, mid-cost and high-cost measures;

4. Examine the positive and negative effects of adopting a policy to incorporate mitigation measures into the future construction of transmission lines and the positive and negative effects of retrofitting existing transmission lines;

5. Examine any potential effects of the State adopting a policy under subsection 4 on the regional transmission system;

6. Develop a time frame for the adoption of mitigation measures; and

7. Develop recommendations regarding the allocation of costs to mitigate the effects of geomagnetic disturbances or electromagnetic pulse on the State's transmission system and identify which costs, if any, should be the responsibility of shareholders or ratepayers; and be it further

Sec. 2 Monitor federal efforts regarding mitigation measures. Resolved: That the Public Utilities Commission shall actively monitor the efforts by the Federal Energy Regulatory

Commission, the North American Electric Reliability Corporation, ISO New England and other regional and federal organizations to develop reliability standards related to geomagnetic disturbances and electromagnetic pulse; and be it further

Sec. 3 Report. Resolved: That the Public Utilities Commission shall report the results of its examination required pursuant to section 1 and the progress of regional and national efforts to develop reliability standards under section 2 to the Joint Standing Committee on Energy, Utilities and Technology by January 20, 2014. The Joint Standing Committee on Energy, Utilities and Technology may submit a bill to the Second Regular Session of the 126th Legislature based on the report.

Emergency clause. In view of the emergency cited in the preamble, this legislation takes effect when approved.

Purpose

This document defines a proforma scope, as well as the processes and tooling, intent, and projected outcomes, of a project to perform a Geomagnetic Disturbance-Electromagnetic Pulse (GMD-EMP) risk analysis of the CMP network.

A GMD-EMP risk analysis of the CMP network would achieve the following:

- Identify network components with GMD-EMP vulnerabilities
- Classify vulnerable network components' sensitivities to GMD-EMP intensity
- Evaluate system and network components' performance for assumed GMD-EMP intensities
- Identify operating criteria violations and equipment damages projected under assumed GMD-EMP intensities
- Identify remedial measures that mitigate or avoid estimated GMD-EMP event risks
- Evaluate societal cost of remedial measures that mitigate or avoid GMD-EMP event risks
- Identify the lowest cost mix of remedial measures that mitigate or avoid estimated GMD-EMP event risks.

Summary

A GMD-EMP risk analysis of the CMP network should provide the basis for ongoing control of GMD-EMP risks within the CMP network as follows:

- Inventory the CMP network components vulnerable to GMD-EMP events
- Classify the relative GMD-EMP vulnerability of the CMP network components
- Quantify the potential impact of GMD-EMP events on vulnerable CMP network components, as a function of GMD-EMP event likelihood and severity,

then identify remedial measures to mitigate or avoid GMD-EMP event risks.

GMD-EMP event risks should be quantified as the product of GMD-EMP event likelihood and event-driven societal cost impacts. Costs of mitigating remedial measures should be commensurate with event impacts on both network-wide and individual component bases. In no case should remedial measures' investment cost exceed the estimated value of the GMD-EMP event risks they mitigate/avoid.

The proforma project scope defined here, as well as the processes and tooling, intent, and projected outcomes, evoke (and would thus comply with) topical FERC/NERC standards and guidelines which are emerging at this time. They would also support the approach evolved within the Maine Public Utilities Commission Docket 2013-00415 Notice of Inquiry.

Project management could be integrated into CMP's ongoing business operations, with a single workgroup assigned project manager responsibilities. Execution of this project would align and cohere CMP's NERC Compliance activities.

Project Scope

Phases --

Project Integration

Project Integration would engage project stakeholders (such as CMP, MPUC, emPRIMUS, and BHE), organize and agree the project plan and schedule with its stakeholders, and obtain required tooling to support subsequent project phases (such as the Ground Induced Current Module add-on for the PSLF or PSS/E loadflow program).

Event Classification

The Event Classification project phase would select Event Likelihood, as a function of either GMD severity (measured as nano-Tesla magnitude, at the "GMFΦ" phase orientation that maximizes GMD severity) or GMD-induced Geomagnetic Electric Field (GEF) intensity (measured as V/km, at the "GEFΦ" field direction that maximizes the field intensity).

In this, it would direct the processes and tooling required to be applied in the System Impact Assessment, Equipment Impact Assessment, and Risk Mitigation phases.

Project Scope (continued)

Phases -- (continued)

Initial Screening
The Initial Screening phase would determine which network components would be vulnerable to the GMD severity/GEF intensity identified previously in the Event Classification Phase, and determine their type and degree of vulnerability.

In this, it would identify the level of detail and complexity required to be employed in the Impact Assessment phases.

Using the variety of processes and tools indicated in Figure 1, this phase would assess network components' sensitivities to the GMD severity/GEF intensity identified previously in the Event Classification Phase.

Gating
The Gating phase would direct project activities into the appropriate set of processes and tooling in the subsequent phases, based on results produced in the Initial Screening phase.

Initial Screening phase results would be benchmarked to the gating criteria indicated in Figure 1, and network components that exhibit sufficient degree of GMD-EMP event vulnerability would be referred into the subsequent project phases.

System Impact Assessment (SIA)
The SIA phase would perform studies that would be very similar to the system planning and outage management studies commonly practiced across the industry. (These studies are aimed at maintaining safe and reliable power system operation.)

Within its "GIC Loadflow Contingency Analysis" process, the SIA phase would model planning studies' N-1 and N-1-1 network component contingencies, and loss of reactive power source contingencies, against the GIC loadflow base case developed in the Initial Screening phase, and then determine Ground-Induced Current (GIC) flows and associated transformer reactive power (VAR) losses.

Next, it would determine where voltage criteria are violated and/or thermal operating limits would be exceeded within the network, and classify the impacted components for handling in the Risk Mitigation phase.

Using output from the above process, within its "GIC Loadflow Results Analysis" process, the SIA phase would determine where voltage criteria are violated, and/or thermal operating limits would be exceeded within the network. It would also measure transformer reactive power absorptions and reactive power losses in neighboring networks.

Each of these four result sets would respectively classify GMD-EMP event- impacted components for impact-specific handling in the Risk Mitigation phase.

Figure 1 indicates required SIA tools, and correlates them to the processes defined above.

Equipment Impact Assessment (EIA)
This phase would assess the level of damage to vulnerable major equipment that could be expected from the GMD severity/GEF intensity identified previously in the Event Classification Phase. Studies performed in this phase would be aimed at maintaining the integrity of major assets.

Of special focus would be estimating damage to costly and long replacement lead time components such as generators, FACTS elements (SVCs, SVDs, etc.), and HV/EHV transformers. This phase would also assess GMD-EMP event impacts on capacitor banks, protective relaying, and network-supporting remote command, control, and communications (C^3) systems.

Within its "Transformer Impact Assessment" process, the EIA phase would screen for half-cycle saturation (e.g. "hot spot" heating) on HV and EHV transformers, using one of three methods (Transformer manufacturer GIC capability curves; Generic GIC capability curves; Thermal response simulation).

Within its "Harmonic Impact Assessment" process, the EIA phase would investigate electrical phase harmonic-related impacts of GMD-EMP events, using an Electromagnetic Transient Program (EMTP) software.

Figure 1 indicates required EIA tools, and correlates them to the processes defined above.

Project Scope (continued)

Phases -- (continued)

Risk Mitigation Planning

The Risk Mitigation Planning phase would integrate the results of the SIA and EIA phases, to identify remedial measures that would mitigate or avoid GMD-EMP event risks commensurate with event-driven societal cost impacts, measured on both individual component and network-wide bases.

For its simplicity and effectiveness, this document recommends a "top-down" approach to integrating SIA and EIA results, as follows:

1. Evaluate mitigating measures to maintain limits within SIA studies.
2. Determine if these measures also mitigate GMD-EMP event risks identified in the EIA studies.
3. If not, specify additional measures to mitigate EIA study-identified GMD-EMP event risks.
4. If EIA-driven measures require system reconfiguration, repeat the system studies and iterate.

The tools of the Risk Mitigation Planning phase would be the methods for estimating GMD-EMP event risks and the available measures to mitigate or avoid the risks related to GMD-EMP events.

Estimated GMD-EMP event risks would be quantified as the product of event likelihood (expressed in percent) and estimated event-driven societal cost impacts.

Available measures to mitigate or avoid the risks related to GMD-EMP events are as follows:

- Using GIC reduction devices (GRDs) --
  - On SVCs' transformers (to ensure they can provide reactive support during GMD-EMP events)
  - To maintain transformer currents below a threshold, independent of any GIC "waveshape"
  - To ensure that key transformers remain in service during a GMD-EMP event
- Reassign VAR resources
- System reconfiguration, normally by bringing critical circuits in and out of service
- Load rejection

This analysis would identify the lowest investment cost mix of remedial measures that mitigate or avoid estimated GMD-EMP event risks.

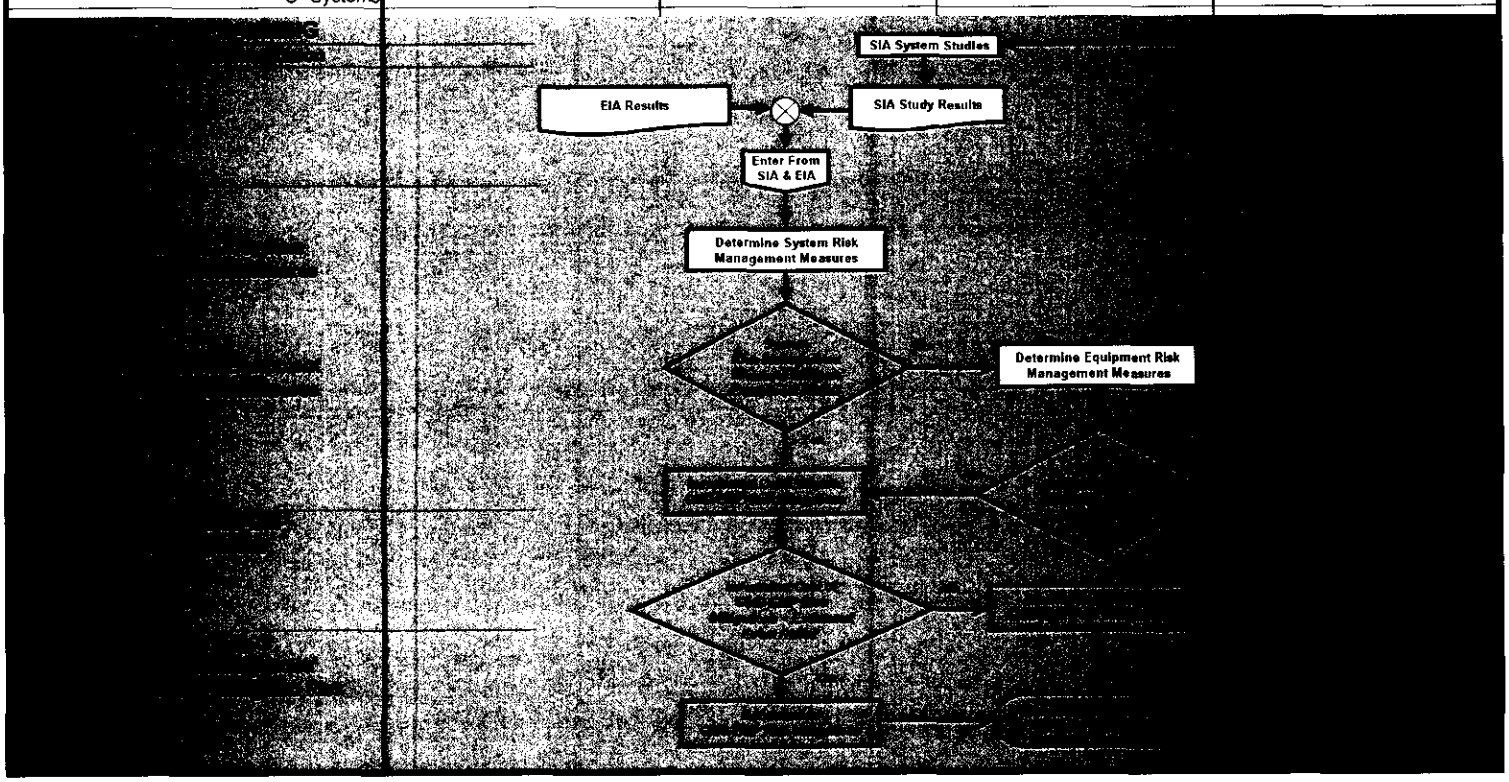
In no case should remedial measures' investment cost exceed the estimated value of the GMD-EMP event risks they mitigate/avoid.

FIGURE 1
GMD-EMP Risk Management Grid

CENTRAL MAINE POWER

Geomagnetic Disturbance (GMD) Event Likelihood

Process - Subprocess EVENT CLASSIFICATION	50-Year Event	100-Year Event	200-Year Event	500-Year Event
GEF Intensity *f (V/km; GEF Φ)*	14 V/Km$_0$ @ maximum GEFΦ_{50}	20 V/km @ *maximum* GEFΦ_{100}	23.5 V/km @ *maximum* GEFΦ_{200}	[illegible]
INITIAL SCREENING				
Impacted Component Inventory				
Historical Event Impact Review	↕ *All phase processes apply to all Likelihoods* ↔			
GIC Loadflow Base Case Development				
GIC Loadflow Base Case (N-0) Analysis				
Model Parameter Sensitivity Analysis				
▼ GATING ▼ **To** **[illegible] Assessment** **[illegible]** **[illegible] Assessment**		*? Historical Event Log Indications?* *? Voltage Fluctuations ≥ ± 3% ?* *? Results ≥ Thermal Operating Limits ?* *? Significant Model Parameter Sensitivities?*		
SYSTEM IMPACT ASSESSMENT (SIA)				
GIC Loadflow Contingency Analysis	► *Tool(s): PSLF V18..1_02, PSS/E V32.2/33.3, PowerWorld V17 Loadflow Program GIC Module add-on* ◄			
N-1 and N-1-1 Network Contingencies				
- Standard contingencies				
- Loss of reactive power sources				
GIC Loadflow Results Analysis				
Voltage Criteria Violations	*Analyze progressively ≥ Minimum Initial Screening Appearance Level*			
Thermal Operating Limit Violations				
Transformer Reactive Power Absorption				
Neighboring Network Reactive Power Loss				
EQUIPMENT IMPACT ASSESSMENT (EIA)				
Transformer Impact Assessment	► *Tool(s): GIC Capability Curves (Manufacturer-defined, or NERC-generic),*			
Thermal Impact Screening	*Thermal Response Simulation (GIC time-series analysis)* ◄			
Harmonic Impact Assessment	► *Tools: EMTP software (EMTP-RV, MT-EMTP, ATP, eMEGAsim, HYPERsim, et al)* ◄			
Generators				
Capacitor Banks	*Analyze progressively ≥ Minimum Initial Screening Appearance Level*			
FACTS (SVCs, SVDs, etc.)				
Protective Relay Systems				
C^3 Systems				



Storm Analysis Consultants

April 9, 2014

Senator Emily Cain
Representative Chuck Kruger &
Honorable Members of the Government Oversight Committee
State of Maine

Re: Maine L.D. 131 Utility Industry Investigations

Dear Senator Cain & Representative Kruger:

I am writing to you in order to convey concerns about the Maine electric power grid and investigations that are underway in response to the L.D. 131 legislation that was enacted in 2013.

I have been heavily involved in national policy discussions in regards to electric grid reliability and security against a number of emerging threat conditions. I have been a principal investigator for the US FERC and other US Government agencies such as FEMA and the National Academy of Sciences in review of the nation's electric grid vulnerability to severe geomagnetic storms and EMP. I have been a subject matter expert in this for over 30 years and also was employed in the electric utility industry for many years serving in senior engineering positions. I am quite familiar with the NERC and various electric industry self-assessment practices in regards to GMD and EMP and their inherent weaknesses and limitations. In short, in regards to severe space weather events and EMP threats, the findings of my various reports is that the nation could be subjected to one of the worst natural disasters possible through a widespread and long term crippling blackout of the electric grid that these storms could create. This was a threat that had not been understood by NERC and the electric power industry and was not discovered via their usual self-assessment process. I have urged the development of important regulations where industry actions have fallen woefully short, including recent actions of the FERC to compel the industry to develop meaningful regulatory standards to protect the nation's power gird against severe space weather.

In a more specific effort in relation to the State of Maine, I attended Maine legislative committee meetings in the consideration of the L.D. 131 bill and provided information on the specific threats to the Maine grid and the enormous increase in exposure that was possible with the MPRP additions in March of 2013. In various Maine PUC public docket filings subsequent to the enactment of the L.D. 131, I provided further studies showing that for GIC caused by either a naturally occurring geomagnetic storm or from an EMP event, that the MPRP additions would increase levels of GIC by as much as 80% from present exposure levels.

I was invited and participated in a teleconference on March 28 held by CMPC. Both Dr. Radasky (my colleague who I worked with in various US Government projects) and I pointed out that the Study Scope developed by CMPC was not adequate to examine EMP, only geomagnetic storms. CMPC then remarked that nothing could be added to the present study scope for the remainder of this year. I then noted that this type of delay would preclude a large number of low or zero-cost design modifications to

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each of the MPRP additions that would greatly increase their resilience to various EMP threat environments.

Since CMPC is not able or willing to engage in this review, the lowest cost options are not available to the ratepayers of Maine. Only more expensive retro-fit options can thus be considered.

The CMPC study is now poised to only do a partial review of the issues requested under the L.D. 131, as it is limited to a review of geomagnetic storms. Even in that truncated scope of investigation, the CMPC staff had a very limited depth understanding of transformer and other power system equipment damage mechanisms due to GIC, no real comprehension of storm intensity and their complex characteristics. Their stated guide was the draft NERC guides, which are very much in dispute and will ultimately need to face the scrutiny of FERC when they are submitted next year for approvals.

Still at the end of the meeting CMPC showed their work plan and showed how they were the self-declared "subject matter experts" that would be conducting the investigation. It was clear from my interactions in the State of Maine last year with a number of the same CMPC staff, that they had very limited understanding of the risks posed by GMD and EMP. This type of self-declaration of expertise is particularly troubling in that this same company proposed the MPRP projects as noted above which are enormously escalating the risks for the Maine power grid and the citizens of Maine. This becomes a legitimate concern about how to check the role of self-interest of CMPC over public interest and safety concerns for facilities that CMPC is adding in the state.

We should not overlook the facts as they are in regards to how the threats of GMD and EMP have been allowed to develop in electric grids. The industry has been woefully negligent in understanding the importance of the natural hazard threat posed by geomagnetic storms. They have had bad design practices over many decades that have allowed enormous risk to migrate into the electric grid infrastructures. This is a process that the industry engages in to make grid design decisions that can silently transfer this risk to the public without the public's knowledge or consent. This is now one of the largest systemic risks that the nation and the State of Maine face. Both the PUC and the electric industry have never had a design code that took this environmental threat into consideration. Federal regulatory efforts are being put in place to encourage the electric industry to remedially address and reduce this vulnerability to a reasonable level like they do for all other natural hazard threats. A similar focus is intended to be understood within Maine via the L.D.131. Electric utilities should work to have clear design codes and practices put in place and bring deficiencies up to standards. In regards to both EMP and geomagnetic storms, the lack of awareness of the power industry of this threat has allowed bad design practices to flourish in their industry that has made society enormously more vulnerable. In a number of cases there are no good cost reasons or rational for allowing the industry to engage in this faulty design engineering when more EMP-tolerant options do exist and can be put in place for little to no extra cost. In short, utilities have been designing systems to be unknowingly and enormously more vulnerable to these attack modes.

Sincerely,

John G. Kappenman, P.E.
Storm Analysis Consultants