COMMENTS OF THE FOUNDATION FOR RESILIENT SOCIETIES
TO THE STANDARD DRAFTING TEAM
NERC PROJECT 2013-03 – STANDARD TPL-007-1
TRANSMISSI0N SYSTEM PLANNED PERFORMANCE FOR GEOMAGNETIC DISTURBANCE EVENTS
October 10, 2014

Answer to Question 1: No, we do not agree with these specific revisions to TPL-007-1. Detailed responses are below.

Requirement R3 should contain steady state voltage "limits" instead of the subjective term "performance."

Measure M3 should contain steady state voltage "limits" instead of the subjective term "performance."

Table 1, "Steady State Planning Events" has been changed to allow "Load loss as a result of manual or automatic Load shedding (e.g. UVLS) and/or curtailment of Firm Transmission Service" as primary means to achieve BES performance requirements during studied GMD conditions. When cost-effective hardware blocking devices can be installed, load loss should not be allowed. Protective devices that keep geomagnetic induced currents (GICs) from entering the bulk transmission system extend service life of other critical equipment, allow equipment to "operate through" solar storms, reduce reactive power costs and support higher capacity utilization. In contrast, load shedding while GSU transformers remain in operation tend to reduce equipment life and continue to allow GICs into the bulk power system, risking grid instabilities. Capacitive GIC blocking devices are, to first order, insensitive to uncertainties in GMD currents and thus protect the grid against a large range of severe GMD environments.

Table 1, "Steady State Planning Events" has been changed to allow Interruption of Firm Transmission Service and Load Loss due to "misoperation due to harmonics." When cost-effective hardware blocking devices can be installed, misoperation due to harmonics should be prevented.

On page 12, text has been changed to "For large planning areas that span more than one β scaling factor from Table 3, the most conservative (largest) value for β ~~should~~ may be used in determining the peak geoelectric field to obtain conservative results." "May" is not a requirement; the verb "should" needs to be retained in the standard.

Under "Application Guidelines," Requirement R6 now reads: "Transformers are exempt from the thermal impact assessment requirement if the maximum effective GIC in the transformer is less than 15 Amperes per phase as determined by a GIC analysis of the System. Justification for this screening criterion is provided in the Screening Criterion for Transformer Thermal Impact Assessment white paper posted on the project page. A documented design specification exceeding the maximum effective GIC value provided in Requirement R5 Part 5.2 is also a justifiable threshold criterion that exempts a transformer from Requirement R6."

These exemptions from the assessment requirements of this standard, both singly and in combination, defeat a key purpose of FERC Order No. 779, which is to protect the bulk power system from severe geomagnetic disturbances:

(1) By failing to require the utilization of now-deployed and future-deployed GIC monitors, of which there were at least 102 in the U.S. in August 2014 (see Resilient Societies' Additional Facts filing, Aug 18, 2014, FERC Docket RM14-01-000), and now at least 104 GIC monitors, NERC fails to mandate use and data sharing from actual GIC readings, and cross-monitor corroboration of regional GIC levels. This systematic failure to use available risk and safety-related data may enable "low-ball modeling" of projected GIC levels both at sites with GIC monitors and at other regional critical facilities within GIC monitoring;

(2) The so-called "benchmark model" developed by NERC significantly under-projects GICs and electric fields. The Standard Drafting Team, in violation of ANSI standards and NERC's own standards process manual, has failed to address on their merits, or refute with scientific data and analysis, the empirically-backed assertions of John Kappenman and William Radasky in their White Paper submitted to the Standard Drafting Team of NERC on July 30, 2014. See also the Resilient Societies' "Additional Facts" filing in FERC Docket RM14-01-000, dated Aug. 18, 2014. Using a smaller region of Finland and the Baltics as a modeling foundation, the NERC Benchmark model under-estimates geoelectric fields by factors of 1.5. To 1.9. This systematic under-estimation of geoelectric fields will have the effect of excluding entities that should be subject to the assessment requirements, thereby reducing the analytic foundation for purchase of cost-effective hardware protective equipment thus allowing sizable portions of the grid to be directly debilitated, with cascading effects on other portions of the grid.

(3) In the NERC Standard Drafting Team's review of the Kappenman-Radasky White Paper submitted on July 30, 2014, the STD Notes claim: "They [the Standard Drafting Team] did not agree with the calculated e-fields presented in the commenter's white paper for the USGS ground model and found that the commentator's result understated peaks by a factor of 1.5 to 1.9" Meeting Notes, Standard Drafting Team meeting, August 19 [20014] Comment Review, page 2, para 2b, at page 3. This is altogether garbled. The commenters, using empirical data from solar storms in the U.S. and not in Finland, found the benchmark model understated GICs and volts per kilometer by a factor of 1.5 to 1.9. The Standard Drafting Team has submitted the standard to a subsequent ballot without addressing the Kappenman-Radasky White Paper critique on its merits. This is a violation of both ANSI standards and the NERC standards process manual requirements.

(4) To exempt mandatory assessments if a transformer manufacturer's design specifications claim transformer withstand tolerances above the benchmark-projected amps per phase is to place grid reliability upon a foundation of quicksand.

(A) Manufacturers generally do not test high voltage transformers to destruction, so their certifications of equipment tolerances are scientifically suspect;

(B) As the JASON Summer study report of 2011, declassified in December 2011, indicates: a review of the warranties included with most high voltage transformer sales contracts exclude liability for transformer failures due to solar weather, so "transformer ratings" are not guaranteed and are not backed by financial reimbursement for equipment losses or resulting loss of business claims. The JASONs concluded it was more prudent to purchase neutral ground blocking devices than to pay to test extra high voltage transformers and still risk equipment loss in severe solar weather;

(C) The claims of transformer manufacturers have been disputed by national experts, so without testing by a neutral third party, such as a DOE national energy laboratory, these claims are

suspect, and should not, without validated third party testing, be an allowable exclusion from mandatory assessment by all responsible entities. See, for example, the Storm Analysis Consultants Report Storm R-112, addressing various unsubstantiated claims by ABB for various transformers. Storm-R-112 noted a number of ABB claims that could not be substantiated. Moreover, in transformer ratings provided to American Electric Power, Kappenman asserts that manufacturer reports have failed to address the most vulnerable winding on the transformer, the tertiary winding. John Kappenman informed the Standard Drafting Team that measurable GIC withstand was much lower than what the manufacturer had estimated for one tested transformer. He further explains that tests carried out by manufacturers only have been able to go up to about 30 amps per phase and were set up to actually exclude or inhibit looking at the most vulnerable tertiary winding on tested transformers. Papers submitted to IEEE and CIGRE discuss these tests but ignore the tertiary winding vulnerabilities. Hence these nonrigorous, manufacturer-biased "ratings" should not, without third party validation, exempt an entity from assessment responsibilities under this standard.

(5) The submission of comments today, October 10, 2014, by John Kappenman and Curtis Birnbach, further invalidates the NERC Benchmark model as a basis to design vulnerability assessments. Both the *alpha* factor and the *beta* factor of the NERC model significantly under-project GICs and geoelectric field of anticipated quasi-DC currents. The so-called "benchmark" standard is not ready for prime time. If the Standard Drafting Team fails to address the systematic biases in its modeling effort, if it fails to utilize U.S. data and not Finland and Baltic region data, if it fails to require modeling based on the full set of 104 GIC monitors and future added GIC monitors, NERC will be in violation of its ANSI obligations and in violation of the standard validation process set forth in NERC's own Standards Process Manual adopted in June 2013.

(6) Resilient Societies reported to the GMD Task Force as far back as January 2012 that vibrational impacts of GICs were the proximate cause of a 12.2 day outage of the Phase A 345 kV three-phase transformer at Seabrook Station, New Hampshire on November 8-10, 1998. *Magnetostriction* and other vibrations of critical equipment are associated with moderate solar storms. A moderate North-South/South-North reversing solar storm caused ejection of a 4 inch stainless steel bolt into the winding of the Phase A transformer at Seabrook, captured by FLIR imaging as the transformer melted on November 10, 1998. NERC's own compilations on the March 1989 Hydro-Quebec storm records contain dozens of separate reports of vibration, humming, clanging, and other audible transformer noise at locations within the U.S. electric grid at the time that the GSU transformer at Salem Unit 1 melted. More recently, tests at Idaho National Laboratory in 2012, reported by INL and SARA in scientific papers in 2013, confirm that GICs injected into 138 kV transmission lines cause adverse vibrational effects; and that neutral blocking devices eliminate these vibrational effects. It is arbitrary and capricious for the NERC Standard Drafting Team to fail to address vibrational effects of GMD events, and vibrational elimination when neutral ground blocking equipment is installed. Even if the Standard Drafting Team would *prefer* a standard that discourages any obligation to install neutral ground blocking devices, such an outcome does not comply with ANSI standards. Evidence-based standards are needed. Excluding an entire category of risks (*magnetostriction* and other vibrations) that are well documented in literature on vibrational risks in electric grids should be unacceptable to NERC, to FERC, and to ANSI.

(7) The Standards Drafting Team did not act to address our comments submitted on July 30, 2014, in violation of ANSI requirements that comments be addressed. Areas not addressed include, but are not limited to:

(A) No adjustment for e-field scaling factors at the edge of water bodies.

(B) No standard requirement for the assessment of mechanical vibration impacts.

(C) No requirement for testing of transformers to validate thermal and mechanical vibration withstand when subjected to DC current limits.

(8) Our concerns with NERC's speculative "hot spot" conjecture for GIC impacts over wide areas were not addressed. Under separate cover to NERC, we are submitting data and analysis that shows NERC's "hot spot" conjecture is inconsistent with real-world data.

In conclusion, we note that the Federal Energy Regulatory Commission in its Order No. 779 [143 FERC ¶ 61,147, May 16, 2013) ordered "that any benchmark events proposed by NERC have **a strong technical basis**." Emphasis added, quoting Order No. 779 at page 54.

For the above reasons, among others, NERC's draft standard TPL-007-1 does not presently have a "technical basis" for its implementation, let alone a "strong technical basis" as required by FERC's Order.