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FERC Staff Technical Conference on Geomagnetic Disturbances to the Bulk-Power System (AD12-13-000)

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Good morning (afternoon) – my name is Scott Pugh and I have worked in the Science & Technology Directorate at the Department of Homeland Security since 2007.

Extreme space weather, coronal mass ejections and geomagnetic superstorms are not new problems. What is new since the last superstorm in 1921 is a continental power grid and more than 300 million Americans whose present lifestyles would be impossible without electricity.

Government, industry and academia have studied potential space weather impacts but their conclusions are not in agreement for two primary reasons:

- First, there is significant scientific uncertainty surrounding the potential magnitude of space weather events, mainly because we don't know whether limited space weather data collected over the past few centuries accurately represents the full range of possibilities.
- Second, there is technical uncertainty regarding whether a worst case geomagnetic storm would cause bulk power transmission transformers to fail in large numbers, small numbers or not at all.

A 2008 National Academies study included a worst case estimate that roughly one third of the country could lose power for several years in a "1921 equivalent" storm. Even if just 10% of this damage occurred it would still present an unprecedented recovery challenge.

A 2011 DHS-funded JASONs report argued for improved modeling and simulation capability, possibly at the National Infrastructure Simulation and Analysis Center (NISAC). The capability for accurate grid modeling on a national scale exists today, but it would require extensive technical data about equipment owned by more than 3500 utilities and 700 transmission companies.

The 2012 NERC report concluded that a major storm would probably cause system voltage collapse and large blackouts faster than the timeframe required for transformer

damage. This means that once the storm ended full recovery would be possible within several hours or a few days.

The Defense Department verifies reliability of the nuclear weapons stockpile by randomly selecting a few deployed warheads for destructive testing at Los Alamos every year. A program like this could develop data about the transformer fleet over a period of several years. If testing showed that transformers do not fail when exposed to worst case levels of induced current then we would know that methods to protect or replace them are not needed. If testing showed that failures frequently occur even at less than worst case conditions then we would know that pro-active action is urgently needed to avoid a long duration outage. Without this type of indisputable information it could be argued that we are essentially "flying blind" - hoping that NERC is right and the National Academies are wrong.

DHS has partnered with industry to develop a "recovery transformer" that is smaller, lighter and more transportable than a traditional transformer. Last month we demonstrated that a bank of 3 single phase 200 MVA recovery transformers could be moved from ABB's manufacturing facility in St Louis to a CenterPoint Energy substation near Houston where it was installed and energized in less than a week. Recovery transformers like these could significantly reduce recovery time if a limited number of transformers were damaged by a geomagnetic storm.

We usually know if a CME is directed towards earth more than a day before it arrives but NOAA cannot issue the final and most important warning until a CME reaches NASA's ACE spacecraft. Problematically, this does not happen until after a CME has already travelled 99% of the distance to earth. Industry has developed procedures to operate in more reliable modes when warnings are issued but a superstorm CME moves much faster than average and can reach earth in as little as 20 minutes after passing ACE. That is not much time to issue a warning and take pre-emptive operator action on a multinational scale. When a 1989 geomagnetic storm caused induced currents in Canada's HydroQuebec grid, operating personnel had only about 90 seconds to react – but that was not enough time to prevent a massive blackout and significant equipment damage.

Primarily because of the short reaction times associated with superstorms many experts think that it would be prudent on a prioritized basis to install features that could protect transformers and other critical grid components against geomagnetic induced current.

Thank you for the opportunity to represent DHS in this discussion.