We need more "smarts" for the Society activity in Smart Grid.

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There is much interest in the Smart Grid (SG) in the US and internationally. SG will deliver electricity from suppliers to consumers by use of two-way digital technology to control appliances at consumers' homes to save energy, reduce cost, and increase reliability and transparency. It overlays the electricity distribution grid with an information network and bidirectional metering system (See: http://en.wikipedia.org/wiki/Smart_grid). The need for standards and in particular EMC standards is very evident and hence it will be the focus of this column. Major standards players internationally are the International Electrotechnical Commission (See http://www.iec.ch/zone/smartgrid/) and the IEEE (See http://smartgrid.ieee.org/). In the US, the National Institute of Standards and Technology (NIST) is facilitating the national approach (See http://www.nist.gov/smartgrid/). Members of the EMC Society Standards Development committee (SDCom) are working in both the national and international arenas to make sure that EMC is a major consideration in making the SG work.

Last May, "ConnectivityWeek 2010" was held in Santa Clara. It was a collection of events that together focused on the application of Information Technology (IT) to the energy challenges presented by climate change and the need for sustainability. The thrust was to see how IT can be leveraged towards this new energy paradigm. So where was EMC discussed? Well as it turns out, Galen Koepke of NIST in Boulder, CO chaired a session on EMC for the SG. The standards associate editor asked Galen to share his report with our EMC Society newsletter readers. Here is his report, with some additional augmentation by the editor.

At ConnectivityWeek, an initial meeting of interested parties was held to discuss electromagnetic compatibility for smart grid systems. The session was part of the Smart Grid Interoperability Panel (SGIP) workshops on SG standards. This session featured four EMC experts with experience in the electrical power grid and related systems. These experts presented various perspectives on interference and compatibility concerns both in the existing grid and the proposed Smart Grid.

The session began with Dr. Robert Olsen (Washington State University) explaining the "traditional" power grid environment (high 50/60 Hz fields, corona and spark discharge, harmonic fields, power system communications). These environments can cause human health and safety issues, and interference to shared right-of-way railroads, pipelines, and communications systems. In particular, power line communications can interfere with radio navigation (LORAN-C) and open-wire telephone systems. The corona causes radio noise that

may interfere with broadcast services, radio navigation, and communications systems, in addition to audible noise and possible damage to insulators. The SG will increase exposure to these effects by the introduction of "Flexible AC Transmission", increased use of broadband over power line communications, smart metering systems, and other communications systems. The power grid environment also presents challenges to optical fiber lines due to lightning and dry band arcing damage, and can cause electronic measurement instruments to malfunction.

Andy Drozd (ANDRO Computational Solutions) expanded on the SG system of systems concept and how it is a "confluence of power and energy, communications, IT, EMC, reliability, and cyber security technologies". He indicated that there should not be isolated or stovepiped specialties in the traditional sense, as EMC, spectrum sensing, security, reliability, etc. are all intertwined. Recognizing these relationships would allow a cross dialog with other groups and underscore the importance of the "EMC/EM effects" as part of the SG life cycle. The characteristics of the SG include self-healing (fault tolerant), resilience against physical and cyber attacks, enabling of new applications, efficient operation with high-quality power, active participation by consumers, and, most importantly, accommodating the connection of all generation and storage options. Andy then described the NIST SG interoperability standards program and the IEEE P2030 (Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), and End-Use Applications and Loads) development and why EMC must be addressed in order for the new SG to achieve its potential. Four categories of events could cause the SG to be vulnerable:

- Common events such as ESD, fast transients, power line disturbances;
- RF interference from various emitters/transmitters;
- Coexistence of various wireless devices;
- High-level EM disturbances including lightning, geomagnetic storms, intentional EMI, and high-altitude EMP.

IEEE, IEC, and ANSI standards related to these effects were also identified.

Note: The essence of the above EMC issues has been presented to the IEC Strategic Group 3 (SG3), which is the focus of the IEC activity in Smart Grid. This presentation was at the SG3 Technical Committee/Subcommittee officer's workshop in early July. Another presentation was at the IEC Advisory Committee on EMC (ACEC) in June. Both presentations were by the newsletter associate standards editor.

Dr. William Radasky (Metatech Corporation) presented an overview of the high-power electromagnetic (HPEM) threats to the electric power system. The high-impact, low-frequency events include high-altitude electromagnetic pulse (HEMP), intentional electromagnetic interference (IEMI), and severe geomagnetic storms from solar activity. The possible consequence to the power grid infrastructure from the HEMP would be widespread cascading failure. The power, energy transport, telecommunications, and financial systems are particularly vulnerable and interdependent. This disruption would have a significant impact on

all aspects of society. A somewhat more likely threat is posed by IEMI or intentional electromagnetic interference. This is defined as "Intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes," (IEC 61000-2-13:2005-"EMC-Part 2-13: Environment–High Power electromagnetic (HPEM environments—Radiated and Conducted"). IEMI can induce effects similar to HEMP but more localized, unless a coordinated attack is performed. The protection methods for electronic systems are similar for both IEMI and E1 HEMP. In the case of IEMI, security measures to physically separate attackers from target systems and the use of EM monitors should be part of the protection plan. The discussion of a severe geomagnetic storm began with a dramatic photo of a coronal mass ejection on the surface of the sun. These events can induce high levels of quasi-dc current on the high-voltage power grid. These currents can cause transformer saturation, voltage instability leading to blackouts, and hot spot heating damage in large transformers. Without adequate protection, recovery (due to long replacement periods for large transformers) could be prolonged – months to years. These threats have been recognized for many years and efforts are being made to apply protection techniques to the existing grid. The Smart Grid will introduce more potential points of failure from these high-power EM threats, and protection must be considered early in development rather than as a retrofit. The first step is to have a robust EMC program for all electronics used to control the grid, then to consider specific high power EM threats one by one and determine the most cost effective manner for protection.

IEC standards and publications related to protection from these threats are available. Note: The EMCS has a standards project chaired by Dr. Radasky on IEMI. It is P1642, "Recommended Practice for Protecting Public Accessible Computer Systems from Intentional EMI". A draft for balloting is expected by the end of the year.

Jerry Taylor (FERC) discussed the role of the Federal Energy Regulatory Commission (FERC) related to the EMC and high-power EM threats. The FERC regulates the North American high-voltage grid, but not the distribution and metering sectors. There is ongoing work at FERC, the Department of Energy (DoE), and North American Electric Reliability Corporation (NERC) to study the issues. A report on some of this work is due out in June. (Note: The NERC report has been issued; see http://www.nerc.com/files/HILF.pdf). There is no single government authority responsible in the event there is a major physical or cyber attack on the power grid. The relationship of FERC to the NIST SG project was also discussed. NIST identifies various standards that FERC may consider for incorporating into the rule-making process.

The use of the word "standard" seems to be confused in many discussions (including this meeting) and is used interchangeably to mean "physical standards", "voluntary documentary standards", "best practices", and "regulations". Most standards organizations call their output "standards" if the document contains "shall" statements that are normative, and any application contained therein ***shall*** be used and not substituted by another approach.

To summarize, here are the key points that were "take aways" from the session:

- EMC is much less expensive when done early in the design rather than as a retrofit.
- There are EMC issues in all aspects of the power grid and communication/control systems.
- The Smart Grid concepts will introduce significantly more vulnerable equipment and connections. In order to preserve reliability, these systems must provide proper immunity to EM interference.
- The US does not require EM immunity standards for products, as immunity is considered a quality issue and not one of a regulatory issue. (Note: other regions of the world do impose product immunity requirements such as that of the European Union under its EMC Directive.) Nonetheless, immunity requirements and standards should be a high priority for Smart Grid systems.
- EMC standards and best practices are generally available (IEEE, IEC, etc.). These resources should be part of the Smart Grid development.
- High impact low frequency events such as HEMP, IEMI, and severe geomagnetic storms can possibly be catastrophic to society, both economically and physically. The information is available to protect against these threats, but there is no clear policy or priority for protection. This may change with pending legislation in the US.
- Protection against high-power EM threats depends on a solid foundation of EMC in all systems.

Galen took the action to refer this topic to the NIST and SGIP leadership to clarify what course of action is appropriate and the desired outcome this group should produce.

From the standards editor's perspective, the EMC Society Standards Development Committee (SDCom) continues to solicit those that have expertise in the above areas to step forward and help get EMC into the SG project. Contacts are shown in this web site: http://www.ewh.ieee.org/soc/emcs/standards-committees.html

Click on the SDCom title and then click on one of the names shown to launch an email. The primary contact is Andy Drozd, SDCom chair. The standards associate editor is also a point of contact—Don Heirman, at d.heirman@ieee.org