Report on
Smart Grid and NFPA Electrical Safety Codes and Standards
Report of Tasks 1 through 4
Technology Review and Safety Assessment, Regulatory Review and Gap Assessment, Workshop Comments, and Roadmap

SGIP Document Number: 2011-00X, version 1.0

Document Source: SGIP PMO Leadership
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Production Date: 8 August 2011
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Introduction

The NFPA has conducted a review of their documents, including the National Electric Code (NEC) to identify Smart Grid technologies that may impact the rules and regulations that are imposed by their documents. That report starts out with acknowledgement to NIST and the Smart Grid Framework, definitions, Conceptual Model and the Customer Domain. The important part of this report is the notion that the Smart Grid changes the electrical distribution system from a one-way system to a two-way system. The report says that

*Under the Smart Grid, electrical power generation and distribution become a two-way process between the customer and the grid. To work effectively and safely, the processes of power generation and distribution, as well as those of instrumentation and control, must be closely coordinated and managed.*

The Tasks Covered in the Report

The NFPA report covers four tasks that the participants undertook in 2010. The first task is a Technology Review and Safety Assessment, which includes Smart Meters and many energy production systems. A template for Assessment of Potential Smart Grid Technology Failures is begun in this chapter.

The second task is Regulatory Review and Gap Assessment, based on Task One. There were 22 areas noted that had impact on the safety principles embedded in the National Electric Code (NEC). A preliminary assessment of the inconsistencies and gaps within the NFPA standards was conducted reviewing these standards:

- NFPA 70, The National Electrical Code
- NFPA 70E, Electrical Safety in the Workplace
- NFPA 110, Standard for Emergency and Standby Power Systems
- NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems
- Standards referenced by the National Electrical Manufacturers Association (NEMA), Underwriters Laboratories, Inc (UL), the National Institute of Standards and Technology (NIST), and the Institute of Electrical and Electronic Engineers (IEEE).

More than 55 recommendations for changes, deletions, and augmentation of the NEC and other NFPA documents are recommended in this part of the report. The recommendations cover about 60 pages of the report and appear to be well thought out. The figure below, noted as Figure 1-3, is from that report and describes the tasks and the process.
The NFPA report follows four tasks that focused on the customer domain. The NEC collected the most comments, but the other codes and standards were also well-reviewed. The safety issues associated with the communications needed for Smart Grid are addressed in the NFPA report, as are generation technologies, energy storage, demand response, estimating energy usage and load shedding, power quality, utilization of historical data, and more.

Task 3 of the report period was a two-day workshop that presented the findings of the first two tasks. The workshop was presented in Washington, DC, to NEC panel leaders and collected their observations and suggestions. The tasks one and two were revised to include the suggestions gathered at the workshop.

Task 4 of the report led to developing a safety standards roadmap. Intended to address the changes needed for the identified codes and standards, the report says that the roadmap identifies:

- the expected stages of implementation of the Smart Grid
- the specific NEC (and NFPA 70E, 110, and 111) provisions to be impacted
- the scope of the needed changes or the new provisions
- a proposed timeline which is consistent with the NEC revision cycle.

They then developed a second roadmap that identified the gaps that need to be filled in order to address the needs identified. They have prioritized the needs and technologies that they believe are important. The highest priorities are the residential and small commercial customers, because those will
be needed as technology develops. On-site generation is becoming important as the number of vendors and installers grows. Small wind was added to the 2011 edition of the NEC and future revisions will add additional technologies.

**Conclusion**

Industrial and hospitals are complex electrical facilities and the owners are well informed and assisted by qualified electricians. They are given a lower priority on the basis of economic and resource optimization.

The report includes tables and charts detailing the changes needed in the NEC and related standards, including NFPA 70, NFPA 70E, NFPA 110, and NFPA 111. The revision cycles for the NFPA codes and standards are three or five years. The schedule requires that recommendations and suggestions must be submitted by November, 2011, in order to become part of the 2014 revision. Code making panels may add suggestions in their meeting in January or February, 2012. The research required by the recommendations will have to be completed by those dates.

The report concludes with a listing of the 56 recommendations made at the March, 2011, workshop and the disposition of those recommendations. The appearance is that all of the recommendations were addressed and will be referred to the code-making panels in their next meetings.

The report identified four gaps in the standards that require additional research. Those are shown in this table:

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<table>
<thead>
<tr>
<th>Additional Research Area</th>
<th>Substantiation</th>
<th>Articles Potentially Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-linear loads and harmonics generation</td>
<td>Increased use of inverters and large non-linear loads, such as in PEV/PHEV charging, may cause unwanted harmonics and could necessitate a new method of determining current requirements in lines.</td>
<td>70-210.19(A) 70-215.2(A)(4)</td>
</tr>
<tr>
<td>Communications between smart devices, EMS, and smart meters</td>
<td>Some communications systems are already addressed in Chapter 8, and smart device related communication might need to be addressed as well.</td>
<td>70-422.31 70-424.19 70-430.75 70-440.11 70-445.18</td>
</tr>
<tr>
<td>PEVs, PHEVs, and associated charging systems</td>
<td>These vehicles are gaining market share and can represent a substantial load, especially at a residence.</td>
<td>70-210.2 70-210.52 70-220.14 70-220.44 70-625.26</td>
</tr>
<tr>
<td>Required emergency electrical systems used to provide non-emergency electricity</td>
<td>In some cases, the code allows required emergency electrical systems to provide electricity for other purposes such as peak load shaving. If this becomes common, it might be beneficial for the code to address this practice, especially if other EVs are in use in the same facility.</td>
<td>70-706.4 70-701.4 70-704 70-706.5 110-6.2.2 111-5.4.2 111-7.1.4 111-8.4.1</td>
</tr>
</tbody>
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