Solar America Board for Codes and Standards

The Ground-Fault Protection BLIND SPOT: A Safety Concern for Larger Photovoltaic Systems in the United States

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A Solar ABCs White Paper

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White Paper Overview

This Solar American Board for Codes and Standards (Solar ABCs) white paper addresses an important safety issue in the design of many U.S. photovoltaic (PV) systems. This safety issue—undetected faults in grounded PV array conductors—came to light during investigations into two well-publicized PV system fires. The first occurred on April 5, 2008, in Bakersfield, California, and the second occurred on April 16, 2011, in Mount Holly, North Carolina.

This paper provides a basic explanation of the cause of these fires, followed by an outline of a limited research plan designed to develop solutions. It also includes fire mitigation strategies and equipment recommendations to reduce fire danger in new and retrofit applications based on preliminary results of the fire investigations.

Why this Information Is Important

Fires resulting from inadequate ground-fault protection pose a danger to people and property. Because investigation results from the Bakersfield and Mount Holly fires have been made public, these fires present an opportunity to explore the safety implications of inadequate ground-fault protection in a public forum. As investigators develop an understanding of the root causes of these fires, they also develop a better understanding of the complex nature of faults and fault currents in PV arrays, which will benefit all stakeholders.

The process will require awareness of the issues as well as the development of solutions. The PV industry must clearly understand the current level of danger so that it can properly address the safety hazards. Based on preliminary results of the fire investigations, effective ground-fault detection should be a high priority for improving the safety of PV systems in the United States.

Related changes such as designing ungrounded or resistively grounded systems—common practice in Europe and Japan—may also emerge as important strategies for improving system safety.

Issue

It appears that at some time before the ignition of the Bakersfield and Mount Holly fires, a ground fault in a grounded conductor occurred and was allowed to continue. In recent months, it has become obvious that faults on grounded conductors in PV arrays can be difficult to detect with the typical methods used in ground-fault protection equipment today. This is because the conductor is already grounded, so additional grounds on the conductor have less voltage differential to drive the current necessary to blow the protective ground-fault fuse. This condition can allow ground faults on the grounded conductor to exist indefinitely in a PV array, establishing a new “normal” condition that renders the ground-fault protection device unable to interrupt the second ground-fault current. More seriously, the activation of the ground-fault fuse in the event of an ungrounded conductor fault to ground actually helps to drive the fire event.

Key Findings

This report identifies mitigation strategies that can reduce the danger of fires resulting from inadequate ground-fault protection, including:

- proper installation techniques with close attention to wire management,
- annual preventative maintenance to identify and resolve progressive system damage,
- detailed data acquisition to monitor the operation of all PV systems at a level sufficient to determine if unscheduled maintenance is required, and
- additional ground-fault and PV array isolation sensing devices that can be incorporated into the data system to alert operators about potential problems.

The Solar ABCs research will help determine which inverters and which ground-fault detector interrupter schemes are most susceptible to the blind spot phenomenon, but larger inverters with the blind spot represent a potential fire hazard that should be addressed. Protective devices and system retrofit modifications can provide protection from grounded conductor ground faults and can be tailored for the leakage current of the specific PV arrays. These can eliminate the blind spot without requiring redesign of the system.

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Download the Full Report:

www.solarabcs.org/blindspot

For more information, visit the Solar ABCs website:

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Solar America Board for Codes and Standards

The Solar America Board for Codes and Standards (Solar ABCs) is a collaborative effort among experts to formally gather and prioritize input from the broad spectrum of solar photovoltaic stakeholders including policy makers, manufacturers, installers, and consumers resulting in coordinated recommendations to codes and standards making bodies for existing and new solar technologies. The U.S. Department of Energy funds Solar ABCs as part of its commitment to facilitate wide-spread adoption of safe, reliable, and cost-effective solar technologies.

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