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# Electrical Safety With Microgrids

There are many different definitions of “microgrid” available, but generally, the microgrid has three basic attributes. First, it is local in the sense that it has a limited size and coverage. Second, it can operate independently, although most microgrids are still connected to a larger utility system. Third, it has some intelligence built in, so it can operate reliably under varying conditions of load and generation. To gain a general understanding of the issues with the operation and integration of microgrids, see the *IEEE Access* paper “A Review on Microgrids’ Challenges & Perspectives,” by Saeed et al. [1].

A microgrid, like any source of electrical energy, has expected safety issues, such as shock hazards and arc flash hazards. These can be dc or ac hazards or both. There are some additional safety issues that come to mind:

- 1) There may be a lack of concern by users, who may think of the microgrid a smaller system and therefore do not consider the inherent hazards of an electrical system.
- 2) Changing conditions of generation in the microgrid’s sources

may raise or lower the voltage and/or fault current and so can vary the hazards based on those conditions.

- 3) Frequent maintenance or switching may be required.
- 4) Special training may be needed for the users of these systems.
- 5) Grounding may not be properly designed or installed.

Each of these safety issues could be the starting point of a useful discussion. The first requirement is for the engineer, installer, and user to get educated on these systems and learn from the experience of others. Parise and Lombardi called for the safe design of these complex uses of energy in their September/October 2022 article in this magazine, “Ethics and Eco-Design for Complex Uses of Energy: What We Need for a Sustainable Future” [2]. Part of the ethical design of systems is to ensure that users and workers will be safe when operating or maintaining microgrid systems.

There are many resources available to learn more about the safety of microgrid systems. When searching for “safety” and “microgrid” at *IEEE Xplore*, the results showed 122 journal and magazine articles on the topic. Here are some publications to start with:

- 1) The IEEE book by Araneo and Mitolo *Electrical Safety Engineering of Renewable Energy Systems* [3] discusses the distributed generation of energy, including electric vehicles acting as generators, and the integration of microgrids into the power grid.
- 2) Shock hazards with smaller dc systems (such as residential installations) are considered in a recent transactions paper, “A Comparative Study on Voltage Level Standard for DC Residential Power Systems,” by Li et al. [4].
- 3) Several technical papers on the grounding issues of microgrids should be in every system designer’s library: “Grounding Microgrid Systems in Metropolitan and Commercial Areas,” by Parise et al. [5], and “Grounding the AC Microgrid” and “Grounding the DC Microgrid,” by Mohammadi et al. [6], [7].

Starting with these papers, and looking through their thorough bibliographies, would guide the engineer in learning about these systems and ensuring that any microgrid system is safe wherever it is installed—in residences, universities, commercial locations, or industrial facilities.

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to Increase the Effectiveness of Boom Shockers.” They developed a boat-mounted multimode boom array electric fishing system [13]. They also developed weeklong seminars in conjunction with the U.S. Fish and Wildlife Service Fishery Academy, where the attendees were required to complete the course before being allowed to fish with electricity. Their work led to the development of commercially available safe and reliable electrofishing boats and equipment [14]; see Figures 3 and 4.

Electrofishing guidelines, training, and practices were developed by both U.S. and European jurisdictions in the latter part of the 20th century and as recently as the second decade of the 21st century. In 1991, the European Inland Fisheries Advisory Commission met in Rome, Italy, and developed the “Code of Practice and Guidelines for Safety With Electric Fishing.” The goal was to establish a common code of practice for both European and U.S. jurisdictions for electric fishing by reviewing existing protocols and developing recommendations for inclusion in policy documents. Although not mandatory, the hope was that all national and/or local jurisdictions would adopt these regulations and guidelines for the safety of the operators [15].

The National Safety Council is the United States’ leading nonprof-

it safety advocate. In April 2016, it produced Data Sheet 696, “Electrofishing.” This document provided specific safety guidelines for the operators of modern electrofishing systems. As more standardized methods for electrofishing are adopted, the potential injury to both the operators and the fish species being studied should be eliminated [16].

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