Position:
"If You Can Measure It, You Can Improve It" (Lord Kelvin)

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ABSTRACT

The authors return to the points made in their article published in the inaugural edition of this journal to expand upon recommendations to healthcare industry leadership regarding electrical power security. If best practice is to be data driven, then healthcare executives can take action by funding front-line experts to participate in the United States standards system as a user-interest to assure best practice has been discovered by a balance of interests. As of yet, there is no standard approach for developing resilience metrics for hospitals in Italy, in the European Union, or the United States. When that condition is present, then leaders and managers will default to federal agencies or the market itself – an imperfect taskmaster. Engineers learn from failures, but they do not like to learn the hard way. Perhaps artificial intelligence will assist this journey in reconciling the competing requirements of safety and economy in healthcare facilities. In any case, best practice discovery should rest upon the foundation of data recommended by Lord Kelvin.

KEYWORDS

ANSI, blackout, Electrical power security, innovation, Institute of Electrical and Electronic Engineers, NFPA, resilience, Sapienza Università di Roma, standardization, University of Michigan

INTRODUCTION

We return to the points made in our paper published in the inaugural edition of this journal to expand upon recommendations to healthcare industry leadership regarding electrical power security. (M. Anthony, Healthcare Management Standards Journal, 2021). Construction spend rate in the United States runs about $60 billion annually in this industry - not including the life-cycle cost of utilities, operation and maintenance. (United States Department of Commerce, June 2023). Among the 5400 hospitals tracked in 2021 by *HospitalView* average operations and maintenance cost runs about $209.4 million per hospital. (Operations and Maintenance Report, Definitive Healthcare). Those are representative numbers for a "typical" hospital; and likely would be below the operations and maintenance cost of a university-affiliated hospital which receives the most critically ill and is located in regionally expensive neighborhoods. Overall, the US healthcare industry occupies upwards of 20 percent of United States gross domestic product. (IBISWorld Industry Reports).

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The foregoing numbers are enough to steer by as we revisit our claim that healthcare facilities can be made safer, simpler, lower-costing and longer-lasting if leadership grants access to operational information to those of us who study power security for all industries.

As the lead author from the Sapienza University of Rome infers, the paucity of data needed for standards setting is not unique to the United States.(Parise, et. al, 2021, IEEE Industry Transactions) Much of the reluctance originates in the following:

- Higher priorities that need immediate attention with scarce resources remaining for lower tier priorities; no matter how well meaning.
- Fears that exposing power system failures will result in lawsuits, penalties by enforcement agencies or both (Parise, et. al, 2921 IEEE Industry Transactions).
- Reluctance to cede competitive advantage. Standardization and innovation are nearly reciprocals of one another. Conforming to a standard means "everyone knows what everyone else is doing" and in many domains trade secrets are protected.

The slow-walking of operational data beyond requisite accreditation reporting minimums is commonplace.

Consider a project now underway by the NFPA, IEEE and *Mazzetti Associates* to rationalize plug load; the 120V receptacles found in walls or patient bed headwall units (Fire Protection Research Foundation, February 2022). There are thousands of them in a typical hospital and, in many cases, too many of them. While they supply power to the special patient care systems required in a hospital (direct current supply for vital sign monitors, infusion pumps, pulse oximeters, ventilators, point of care testing devices, ultrasound, etc.) the cumulative effect of so many of them at 120 VAC is that they result in oversized building interior power chains (branch circuit wiring, feeders and transformers), (Anthony, et. al 2010 IEEE Industry Transactions). Oversized building power chains result in oversized on-site backup generators. Oversized generators present risk that "rightsized" generators do not. Oversized generators also emit more pollution during testing and operation.

What information would engineers like more access to?

- Generator starting failures. Diesel generators start faster but require ninety-six hours of on-site diesel fuel storage. Natural gas generators start slower but require natural gas from a merchant utility pipeline at specific pressure. Batteries for starting motors present common mode failures.
- Automatic transfer switch performance. Hospitals have a large network of transfer switches for life safety, critical, equipment and three types of essential systems that need testing under full load.
- System operating data for water pumps, backflow pressure, communication, elevators, signaling and internet access.

The foregoing very short list applies to large in-patient hospitals. There are many smaller, outlying auxiliary (satellite facilities) that support the "mothership" hospital with hardened defend-in-place systems with relevant operations and maintenance data.

Engineers are generally a circumspect lot – many inventors themselves – and are respectful of patent secrecy rules in service of innovation. Standards developers such as the IEEE, NFPA, ASHRAE and others convene meetings with statements about controlled participation and intellectual property rights. Engineers are a trustworthy lot.

In 2014 for example, a collaboration by the University of Michigan and the University of Houston led to changes in building lighting system standards in all 50-states, significantly cutting total cost of ownership in illumination systems. (M. Anthony, et. al, 2016 IEEE Industry Transactions) Another collaboration led by University of Michigan and *Big Ten and Friends* financed another Fire Protection Research Foundation project that led to more changes to National

Electrical Code requirements for illumination system power chains in all building types. (Gammon, Fire Protection Research Institute, January 2017)

The success of the 2014 collaboration is the result of Executive Directors of Plant Operations in higher education green-lighting managers to permit front line electricians to contribute data to technical committees so that the codes and standards keep pace with the rate of obsolescence; notoriously brisk in electrotechnologies.

Another University of Michigan collaboration with the *Institute of Electrical and Electronic Engineers, US Army Corp of Engineers* and *North Point Defense* sought to update national reliability standards for homeland security. (Standards Michigan, June 2020-; United States Army Corps of Engineers Power Reliability Enhancement Program). Workpoint experts faced headwinds gathering sufficient data to reach statistically significant results. Technical committees updating IEEE's leading power engineering titles – IEEE C2 National Electrical Safety, and Guide for Electrical Power Distribution Reliability Indices 1366, and the IEEE 3006 Reliability Series – also need workpoint data to inform the standards that are usually incorporated by reference into public safety laws. (IEEE Standards Association, et. al)

If best practice is to be data driven then healthcare executives can take action by funding front-line experts to participate in the United States Standards System as a user-interest to assure best practice has been discovered by a balance of interests and is suitable for use by conformance interests. (Due process requirements for American National Standards, 2022, American National Standards Institute)

After the familiar standards known to leadership and management – J*oint Commission*, *Centers for Medicare and Medicaid* and their state variants – it is remarkable how thin the literature gets. Filling the gaps in this literature was one of the drivers for forming the *IEEE Education & Healthcare Facilities Committee.* (IEEE Industrial Applications Society, Industrial and Commercial Power Systems Power & Energy Committee). While most healthcare systems are for-profit, or quasi-non profit, university-affiliated hospitals provide perfect study units for all hospitals with the additional feature of district energy systems such as at the University of Michigan (August 2003 North American Blackout, August 2023 IEEE Southeastern Michigan Wavelengths),

To return to Dr. Parise's paper: As yet there is no standard approach for developing resilience metrics for hospitals in Italy, in the European Union, and there is none in the United States. When that condition is present then leaders and managers will default to federal agencies (Federal Energy Regulatory Commission), consortia agencies. (National Electric Reliability Council), or the market itself – an imperfect taskmaster.

Engineers learn from failures but they do not like to learn the hard way. Perhaps artificial intelligence will assist our journey in reconciling the competing requirements of safety and economy in healthcare facilities. In any case, best practice discovery should rest upon the foundation of data recommended by Lord Kelvin.

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Mike Anthony was the first full time high voltage engineer directly employed by any college or university in the United States. He worked there from 1982 until his retirement in 2016; after which he co-founded Standards Michigan (and 49-other state affiliates) which he leads today; while mentoring engineering students at the University of Michigan College of Engineering. He has been a technical committee member on the National Electrical Code since 1999, chairs the IEEE Education & Healthcare Facilities Committee and participates in the IEEE Power System Reliability and IEEE Forensics Committee. He has authored many papers for IEEE, for trade journals and is the author of three engineering textbooks published by McGraw-Hill.