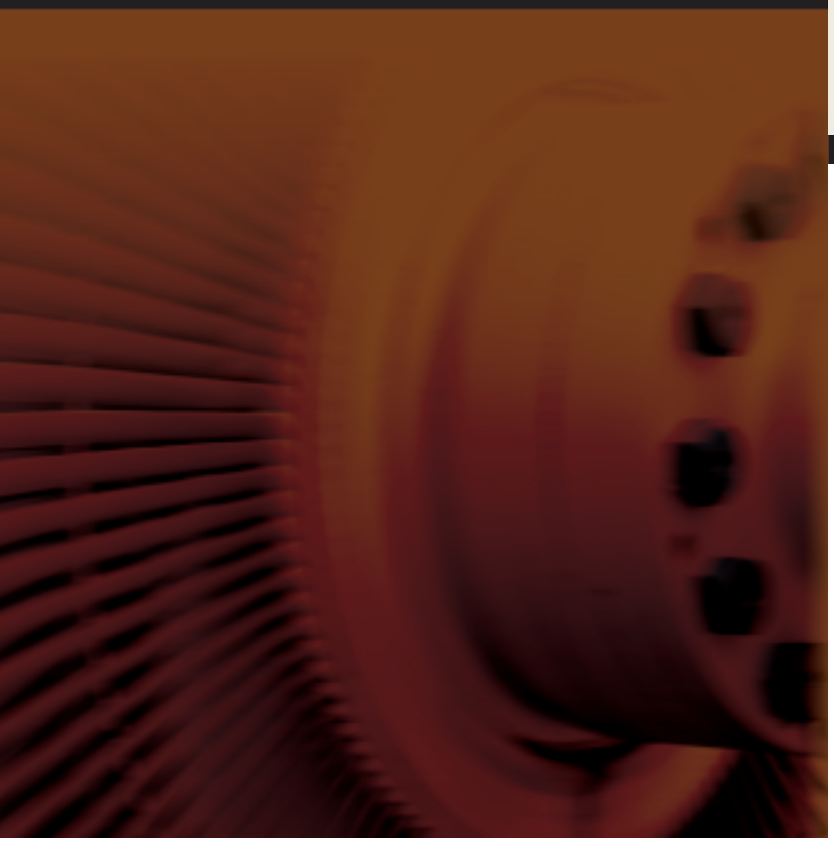

Critical Operations Power Systems:

THE GENERATOR IN YOUR BACKYARD

By Michael A. Anthony, P.E.

The subject of electric power security opens onto a minefield of sensitivities about boundaries and budgets, risk, and civil readiness. Some see power security as a business investment; others see it as an expense. Everyone agrees that power security is a classic public good that challenges traditional payback methods. But what role does government have in determining how much we should pay for power security, and who should pay for it? If one out of every six dollars spent on power equipment is spent on the secondary, backup systems[1], doesn't a more attractive alternative lie in allocating scarce capital to make the primary system more reliable?

It is onto this minefield where new requirements for "critical operations power systems" (COPS) will appear in the 2008 National Electric Code. Article 585 is the work of a new NEC technical panel, Panel 20, and this work will appear in Chapter 5 of the NEC—the Special Occupancy chapter—where installation requirements for healthcare facilities, places of assembly, also appear. The implications of this article of the NEC should be considered in programming emergency and standby power sources.

During threats to the campus and/or host city, local leadership (e.g., mayor, university president, county executive, civil

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defense experts, etc.) may need to meet in one or more Designated Critical Operations Areas (DCOAs). First responders and other emergency personnel may also need to assemble and communicate at one or more facilities equipped to carry out the rescue and recovery functions of government. Mutual aid agreements between the university and the city should be clarified with respect to critical operations power supply.

For higher education facility managers, noteworthy features of Article 585 are as follows:

a) A COPS is a system within a facility, "*classed by municipal, state, federal, or other codes, by any governmental agency, having jurisdiction or by facility engineering documentation establishing the necessity for such a system.*" The DCOA will be an area within a facility or site designated as requiring critical operations power.
b) Risk assessment for the DCOA shall be conducted and documented. Threats—both naturally occurring and human made—shall be identified. Mitigation strategies shall be developed and be part of the documentation. This documentation shall be submitted to the authority having jurisdiction (usually the electrical inspector or fire marshal) to demonstrate conformity.
c) Physical security of the DCOA shall be accomplished with several prescriptive requirements: flood plain protection of feeders, enhanced fire ratings of the building envelope, and signaling conduit. Site selection of the DCOA should limit access to qualified personnel as well as assure the safety of the fuel and water supply.
d) The normal source of power shall have a backup source. Storage batteries, fuel cells or generator sets qualify as backup sources. The source shall be capable of running 72 hours without refueling. There must be an exterior plug to provide power from a mobile generator while the first generator is being serviced. Water supply shall be available for cooling generators.
e) The DCOA shall be commissioned for service and tested periodically according to *NFPA 110, Standard for Emergency and Standby Power Systems, NFPA 1600-2004, Standard on Disaster/Emergency Management and Business Continuity Programs,* provides additional guidance concerning risk assessment and hazard analysis. There are numerous references to related codes and standards that govern life safety, healthcare facilities, and maintenance.

The foregoing summary is based upon the written record of Panel 20 work so far. The complete record of Article 585 development is accessible at: www.nfpa.org/assets/files/PDF/ROP/NEC2008Article550-647.pdf.

To develop the first draft of Article 585, NFPA (the National Fire Protection Association) selected representatives from industry and government—code veterans that know how to write code that is enforceable but satisfies the competing technological requirements of stability and dynamism. Keep in mind that the final draft of Article 585 may be affected by public comments during the December 2006 meetings and at the NFPA Standards Council meeting in May 2007.

Many believe that it is better to have an imperfect Article 585 now than a perfect Article 585 later. Consensus documents like the National Electric Code achieve their credibility by being hammered upon in a public forum. In the code business there is no writing—only rewriting. Article 585 will elicit many of the same passions that have animated recent technical discussions over flash hazard and overcurrent selectivity. Such code controversies expose the divide between the people who want the NEC to be general (performance based) and those who want the NEC to be specific (prescriptive).

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Perspective

Power reliability and power security are often used interchangeably and have become the focus of an expanding intellectual history involving the combined—but not always harmonious—efforts of code writers. Putting together a new NEC panel to craft Article 585 is part of a wider effort by the NFPA to focus its 200-odd standards workgroups to meet the government's need for improved power security standards, not the least of which is the Department of Homeland Security (DHS). That is why you see the NFPA documents referenced so liberally in government regulations (those promulgated by OSHA are another example). Consensus standards developed in the private sector are closer to industry action and are quick to be adopted as law. Government needs the dynamism of private industry.

The NFPA, with its tradition of high-level relationships in the federal government, has been involved in power security issues for the better part of its hundred-year history. Only recently has its work been so closely linked to national security. NFPA involvement ensures that relatively newer organizations (such as the North American Electric Reliability Council and various state public service commissions) do not reinvent the wheel in effort to respond to DHS requirements for power security at the building premises level[2]. In its announcement at the October 2005 Standards Council meeting the NFPA explained the effort of new Panel 20.

> *Recent terrorist events and natural disasters, including the World Trade Center attack, the 2005 hurricane season, most notably Hurricane Katrina, have brought to light the need to assess the adequacy of current requirements in the National Electric Code relating to electrical infrastructure protection and reliability.*

Interdependent systems that support electricity supply are not perfect and institutional mechanisms to support reliability, security, and survivability need to strengthen at the building premises level. If we start work on the critical power systems at the building premises level, then we will have taken a significant step in the direction of a more distributed

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power generation regime. Distributed generation (DG) is widely accepted as the platform for improved power system economy and security.

The Loyal Opposition

The public record of the work of Panel 20 tracks agreement on core issues (that much could be borrowed from military logistics, for example). There was then discussion that ran the other way:

- Some panel members asserted that the requirements of Article 585 are subjective, difficult to enforce for a particular installation, and may not be needed for all critical operations power systems.
- Which governmental agency will actually class such systems? Did Panel 20 contemplate that any electrical engineer can class a system as a COPS?
- Article 585 seems to have gone outside the long-standing NEC committee charter, *"to minimize the risk of electricity as a source of shock and as a potential ignition source of fires and explosions."*
- The highly technical debate over overcurrent selectivity in NEC Articles 700 and 701 appears again in Article 585. There is a material conflict between the IBC—which requires conformity to NFPA 110 (where selectivity is not required) and NEC (where selectivity is required). A design engineer cannot do both.
- The original draft of Article 585 permitted a separate utility service as a redundant power source. This allowance was eventually withdrawn. The panel stated in its substantiation: *"The Panel agreed that a utility supplied second service to the building or facility does not meet the expectations for continuity of operations during the events Article 585 is designed to handle."*[3]

The loyal opposition suggested that Article 585 be issued as information in a "Recommended Practice" or as an optional system. Two annexes were added to provide guidance on signaling and quantitative methods for analyzing reliability. Additional references and fine print notes reach deep into management and operation practice.

Recommendations

Most electrical engineers are able to tell you how to wire a generator; fewer are able to tell you if you need one at all. Existing NEC articles on emergency, standby, and legally required standby power remain silent on the "if" side of the engine-generator question; there are other ways of generating emergency power other than with combustion engines (batteries, fuel cells, and photovoltaics, for example). Even now, the existing NEC articles 700, 701, and 702 only say: "This is how you wire the emergency power source generator once the electrical and telecommunications engineer, Fire Marshall, Architect, elevator engineer, ADA office, and the electrical inspector have all agreed an engine-generator set is necessary to meet the requirements of the life safety and building code "Not even, *NFPA Standard 110—Standard for Emergency and Standby Power Sources* will explicitly tell you that an engine-set is required. The decision is made by implication, based upon the performance requirements for life safety.

The 2008 NEC will be available for public use as early as October 2007. Some actions items might be:

1. Determine if you already have a *documented* designated critical operations area. You probably have

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one or more of these but they may not be documented as such. Few have heard of the "facility engineering documentation" cited in Article 585, but it is likely you will know it when you see it. Assess what processes are already in place identify the DCOA(s).

2. Review mutual aid agreements with the emergency authorities in your host city, if any. Determine if honoring a mutual aid agreement will require additional generation on either or both sides of the agreement. Search for ways to share emergency power resources.
3. Review existing protocols for power emergencies with the local utility. While investor-owned utilities are typically governed by another code—the National Electric Safety Code—they all have knowledgeable people available to help their customers conform to the NEC. Reliability data from the utility may be required in the COPS documentation anyway.
4. Plan generator sets with an eye toward meeting the requirements of the Life Safety Code and Article 585 simultaneously. It is less expensive to install generator sets when conformity to the Life Safety Code puts them in the first cost of a new building. Since Article 585 covers COPS in portions of buildings as well as in dedicated free-standing buildings, consider strategic sizing of generators and COPS rooms for a future DCOA. There is risk in overreacting to what some have called the "doom boom" in Homeland Security, but codevelopment (and cofinancing) of generator facilities spreads the risk and uses capital more efficiently.
5. Consider application of methods that emerged from the Total Quality Management movement such as Quality Function Deployment (QFD). Reference to this approach appears in Article 585 as a non-mandatory suggestion. QFD is a flexible and comprehensive group decision-making technique used in product or service development, brand marketing, and product management. QFD can help an organization focus on the critical characteristics of a new or existing product or service from the separate viewpoints of the customer market segments, company, or technology-development needs. The results of the technique yield transparent and visible graphs and matrices that can be reused for future DCOAs.

Conclusion

Victor Hugo once said that there is nothing more powerful than an idea whose time has come. With all the talk in recent years about distributed generation, there has been nothing to give impetus to the resolution of complicated site-specific bar-

Q1. What are examples of facilities that may require a COPS (critical operations power system)? Central station service facilities, communication centers, emergency evacuation centers, fuel supply pumping stations, hospitals, water and sewer treatment facilities, police, fire and civil defense facilities, radio repeater operations.

Q2. What will Article 585 conformity cost us? Most certainly it will mean more investment in redundant power systems for COPS. Spare transformers may be part of a mission survivability plan. It is noteworthy that in September 2006 the U.S. Federal Energy Regulatory Commission permitted public utilities to recover the cost of spare transformers dedicated for power security. It remains to be seen whether a case can be made to the various government agencies that expenses related to Article 585 conformity can be similarly recoverable by colleges and universities.

Q3. Shouldn't campus power security be circumspect? Article 585 requires a risk assessment for critical power operations power systems including identifying the hazards, their likelihood of occurrence and the vulnerability of the electrical system to those hazards. Although the panel did not address the issue of who gets access to the COPS information my personal belief is that these assessments should be distributed on a need-to-know basis. Most state public service commissions make publicly-owned utility reliability data public[4]. Some method must be developed to meet the competing requirements for access to reliability information and the physical security of the primary power delivery network.

riers to DG such as: community acceptance, utility easement, fuel supply and containment, emissions, etc. One of the reasons Edison's model of the neighborhood generation facility failed 100 years ago was that Westinghouse's remote generating stations were located farther away from population centers. While the bulk transmission grid had an economy of scale that allowed U.S. manufacturing industries to prosper during the middle part of the last century necessarily caused us to rely on a single source of (distant) power.

Now communities, colleges, and universities are looking for ways to afford DG while they lament the complexity of siting the generating facility, getting fuel and cooling water to it, etc. College and university planners have the same lament. Even the publicly traded companies that have the term "distributed" in their corporate names are in the business of selling products—not solutions for difficult site specific barriers to DG.

Using the necessity for redundant power sources in designated critical operations areas, new NEC Article 585 may stimulate distributed generation (or at least raise the level of the discussion), and thereby strengthen the networks that provide power during normal operation. A different economy of scale may emerge from all of this which will drive down the cost of solving site-specific problems that must be considered whenever new generation facilities are built.

Three code cycles from now we may look back to see that we have engineered ourselves back to the neighborhood power system of Edison's original conception.

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