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The National Electrical Code® (NEC®) and the National Electrical Safety Code® (NESC®)

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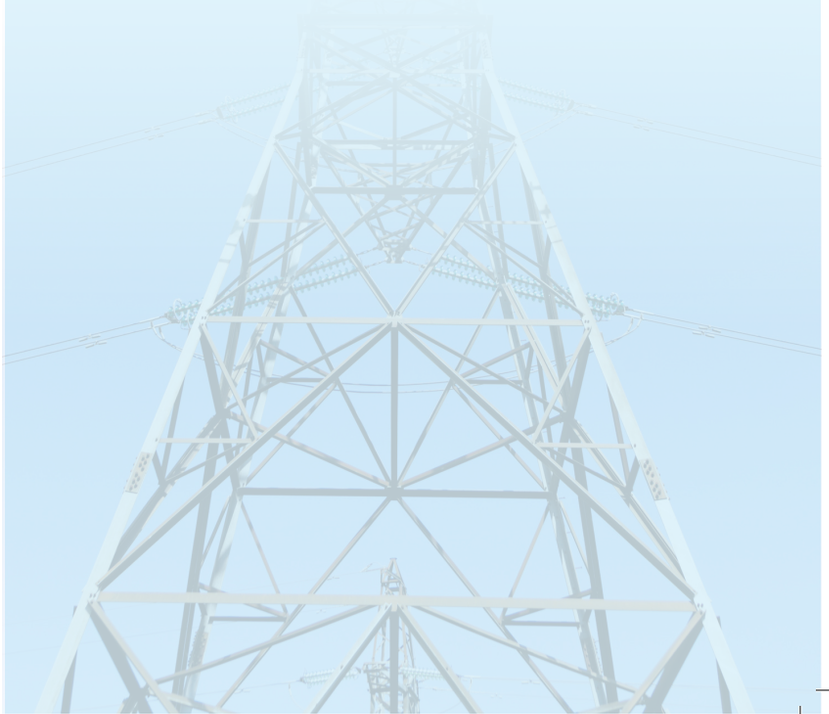
Contents

"Change is the law of life, and those who look only to the past or present are certain to miss the future."

-- John F. Kennedy



Introduction

In the history of the world, the harnessing of electricity ranks right up there with the discovery of fire. As a technology that touches nearly every aspect of our modern life, it's hard to imagine how things would be without electricity.

For most people, electricity is a 'given' with very predictable properties—it's convenient, reliable, and safe to use. Of course, the end-to-end electrical system that many now take for granted didn't just 'happen', but came about from years of effort by many participants.

After decades of relative stability, our industry stands at the beginning of an exciting new era in electrical generation, transmission, and consumption—a time that will bring all of our diverse stakeholders together to meet the challenges of new technology while safeguarding the public trust

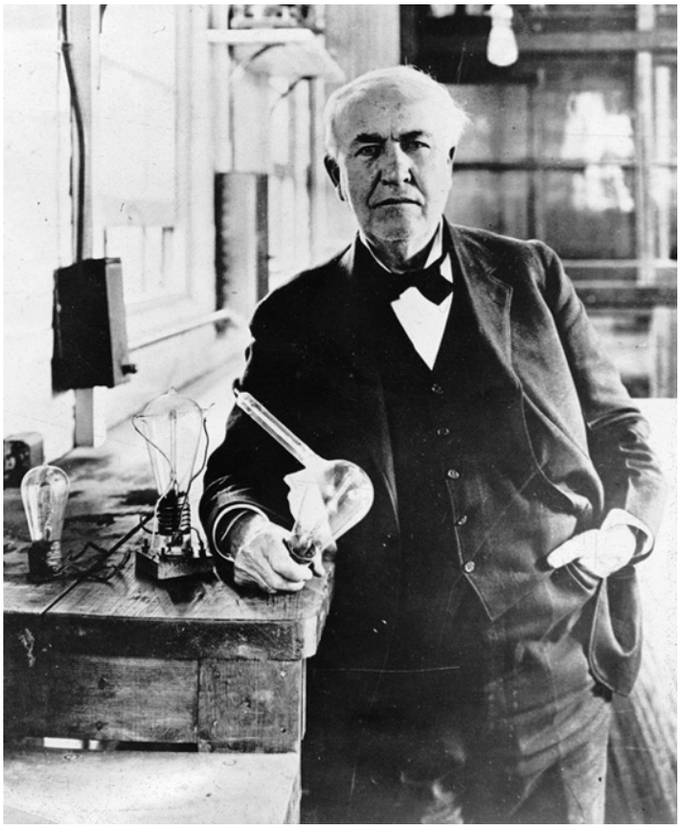
The 'Wild West' Electrification of America

Compared with the use of fire that stretches back thousands of years, our relationship with electricity is a very recent development. The arrival of the commercial era of electricity in the U.S. is generally marked by Thomas Edison's invention of the incandescent light bulb in 1880, followed by the first centralized power generation facility coming on line in 1882 [1], [2].

Despite the fact that its initial output was only 100 kW, the arrival of Manhattan's Pearl Street Station heralded the beginning of America's electrification. In addition to grabbing coast-to-coast headlines that emphasized the wonders of electricity, a near-fatal worker accident at the facility shortly after opening also signaled a growing awareness of the potential dangers of electricity [3], [4].

Public uncertainty around electrical safety would only grow over the next decade as industry heavyweights like George Westinghouse, Nikola Tesla, and Edison himself squared off around the merits of direct current (dc) vs. alternating current (ac) power generation. Heavily invested in the dc approach, Edison reportedly took to electrocuting animals with alternating current to advance his argument with local jurisdictions and state legislatures that dc-producing facilities were inherently safer for workers as well as the public-at-large [4].

While the debate was raging over the best approach for power generation, the situation was just as unsettled on the transmission, distribution, and consumption side of things. By 1888, more than 200 central generation facilities had come on line in the U.S., with essentially no generally agreed-upon engineering and operational standards for getting electricity to those who would use it. Early that same year, a series of headline-grabbing worker electrocutions further fueled public concern, particularly given the root cause findings of haphazard wiring coupled with the lack of any meaningful oversight and enforcement [5], [6].



Order from Chaos

The early consumption of electricity was largely limited to commercial undertakings and wealthy individuals, with installation practices showing a high degree of variation and personal interpretation.

From the jurisdictional standpoint, the huge state-by-state differences in oversight over the rapidly expanding number of generation facilities led to the formation in 1889 of the National Association of Regulatory Utility Commissioners (NARUC), whose membership would grow to represent all U.S. Public Utility Commissions.

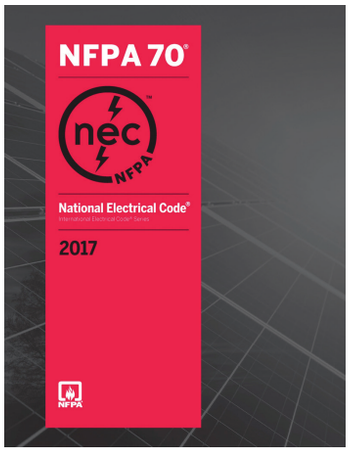
National Association of Regulatory Utility Commissioners

For the young industry's electrical workers, safety was a very personal concern, and led to the formation in 1891 of the safety-focused organization that would become the International Brotherhood of Electrical Workers (IBEW).

The Chicago World's Fair of 1893 proved to be another key event in the emergence of a coherent approach to electrical safety. The Fair's impressive Palace of Electricity was nearly a 'no-go', given significant concerns that the insurance underwriters had about the electrical and fire safety of the exhibition. The day was saved, however, when a young electrical engineer, William Merrill, conducted a rigorous assessment of the exhibit's infrastructure and electrical devices and made the necessary wiring changes to help ensure public safety. Convinced of the need and importance for standardized testing of electrical products, Merrill went on to establish the Underwriters' Electrical Bureau the following year, which was then renamed as Underwriters Laboratories (UL) in 1900 [7].

Underwriters Laboratories

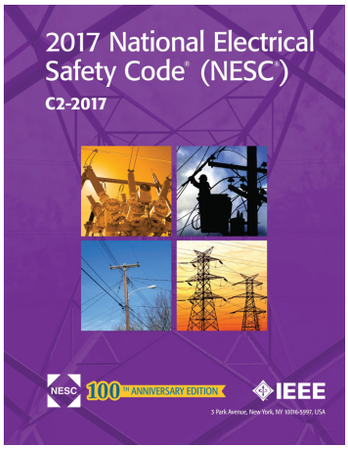
By 1896, there were at least five separate—and often conflicting—approaches that offered formal rules for electrical and fire suppression installations. In a landmark effort that underscores the power of individuals collaborating toward a common goal, representatives from all of the major interests came together in that year to develop a single uniform electrical code. A year later, their collective efforts bore fruit with the release of the very first edition of the National Electrical Code® (NEC®) [8].



For the first several years, the code was developed by the Underwriters National Electric Association for the National Board of Fire Underwriters, and in 1911, the National Fire Protection Association (NFPA), became the sponsor of the NEC.

The release of the first NEC represented a huge step forward toward a common nationwide approach for the installation of electrical wiring and equipment in residential, commercial, and industrial environments—essentially the 'load' side of the end-to-end electrical infrastructure. Somewhat conspicuously, the other key parts of the equation—generation, transmission, and distribution—still lacked a similar uniform standard.

The absence of agreed-upon practices for the safe installation, operation, and maintenance of the 'line' side persisted until 1913, when the National Bureau of Standards undertook the development of the National Electrical Safety Code (NESC), which was first published two years later.



The approach that was taken for the NESC incorporated many of the precedents established by the NFPA, including the emphasis on including all interested parties in the development and updating of rules and standards. From the very first editions of the NEC and NESC, this insistence on the importance of 'inclusion' has ensured that all industry participants—among them the UL, IBEW, NARUC, the National Electrical Contractors Association (NECA), and International Association of Electrical Inspectors (IAEI)—continue to have the opportunity to contribute their particular expertise and perspectives to both Codes.

The Future is Now

The century that has elapsed since the initial editions of the NEC and NESC has seen the incorporation of hundreds of modifications to both Codes to address a range of changes in the industry—from the introduction of new technologies like ground-fault circuit interrupter (GFCI) and arc-fault circuit interrupter (AFCI) protection, to enhanced rules around grounding-bonding and overhead wind loadings.

In an acknowledgement that both Codes would need mutual adjustment to keep pace with changing technology and practices, rules have periodically moved from one Code to the other, such as the transfer of premises wiring systems content from the NESC to the NEC in 1940. Recognition of each Code's particular focus has also given rise to cross-referencing, such as in the NEC's Section 399.10 informational note reference to the NESC for outdoor overhead conductors.

Relatively speaking, our first hundred years with electricity were marked by gradual changes in technology that the NEC and NESC were able to fairly easily address—from the push for rural electrification and arrival of large-scale hydro-electric generation in the 1930s, through the first nuclear and geothermal generation facilities coming on-line in the late 1950s [9], [10].

The pace of change began to quicken on the heels of the Public Utility Regulatory Policies Act (PURPA) of 1978, which in part promoted greater production from renewable energy sources, as well as the use of power from non-utility producers.

In fact, the 1980s saw several dramatic developments—among them Southern California Edison's utilization of a 13.8 MW solar facility, and the installation of domestic wind turbine farms capable of producing an impressive 1,700 MW of total capacity. As would be expected, these technological developments also brought new stakeholders to the NEC and NESC, such as the Solar Energy Industries Association (SEIA) and American Wind Energy Association (AWEA) [11].

The rate of technological innovation showed no signs of slowing over the last thirty-some years, with the photovoltaic (PV) industry delivering a steady stream of power production efficiencies, and entirely new technologies like Smart Grid and Advanced Metering Infrastructure (AMI) seeing initial commercial deployments [12].

In addition to changes in the technology itself, the energy access and ownership models of power generation have also been experiencing rapid and significant shifts.

Driven largely by consumption, economics, and changes in the national energy policy, the predominance of centralized power generation has been challenged by the emergence of Distributed Energy Resource (DER) systems, where power is typically generated through renewable sources at the edges of the traditional electrical grid [13].

Compared with a typical 500 MW coal-fired facility that produces output consumed by a wide range of residential and commercial customers, DER systems usually produce power in the up-to 10 MW range and are often privately owned and dedicated for local use by universities, hospitals, and individual communities. These DER systems, when combined with new energy-storage technologies like advanced lithium-ion batteries and electric vehicle charging stations, become microgrids (also referred to as intentionally islanded electrical systems) that can operate in complete isolation from the nationwide transmission and distribution grid [14].

As both Codes move to include the appropriate rules to address these new technologies, many of our traditional understandings of the industry need to be reassessed, with frequently asked questions like "where exactly is the service point?" and "what really constitutes a utility?".

Those of us hoping 'to catch our breath' in the face of this non-stop change are unlikely to get much relief. According to a recent energy study by global consultancy Deloitte, the velocity of innovation shows little likelihood of slowing, and in fact, is actually accelerating [15].

Opportunities for All

Many economists would characterize the electrical industry as being in a state of disruption, and there's no question that our current circumstances feel uncomfortable at times with many questions being asked and few clear answers.

As a counterbalance to that unsettled feeling, the economists would also tell us that it's a pretty safe bet that this disruption will create new markets and financial opportunities for those participants that engage —rather than resist—the change.

The earlier JFK quote on embracing the future captures the thought well, as does the challenge put forth by Deloitte senior partner Gregory Aliff in a recent report on the future of the energy industry [16]:

"… Disruptive innovation, by its very nature, gives birth to new business models.

The question… do today's electric-sector participants have the capacity and the will to transition to new business models in order to participate in the coming transformation?"

For each of us in every part of the industry—contractors, workers, inspectors, equipment manufacturers, listing agencies, utilities, and regulators—the answer must be a resounding 'yes'.

Going Forward

Although much work lies ahead in successfully meeting these challenges, we also have a rich history of teamwork and cooperation that traces back to the earliest days of the industry. The fact is—more times than not—we have been successful in working together to achieve individual goals while also meeting our common commitment to the highest standards of electrical safety for our people and the general public.

Recently, many leaders across multiple NEC and NESC stakeholder organizations were asked how to best proceed in 'engaging the challenge'. With a strong consensus, a proposed near-term action plan has taken shape.

At the heart of the proposal is a renewed commitment to open communication and cooperation across all stakeholders, as well as the need for tight alignment between both Codes. In our fast-moving times, all of the leaders also agreed that greater general awareness and education around our collective industry challenges is a 'clear must'.

As a first tangible step, the formation of a standing 'Cross-Code Correlating Committee' has been proposed, to be composed of leaders from the major stakeholder groups. In addition to jointly participating in the key NEC and NESC sessions and summits, the development of a roadmap to address the 'overlaps and intersects' between the two codes will be a clear priority.

While none of the leaders are under the illusion that the journey ahead will be easy, all were clear that this is a "unique zone of opportunity that demands a better approach."

To ensure success, the mindset that all of us will need for the journey ahead was simply stated by Jim Pauley, President and Chief Executive Officer of the NFPA: "As we jointly tackle our collective issues and challenges, I have absolutely no doubt that we will prevail as long as all participants are guided by what is best for the public safety that we all serve."

Jim Pauley, President and Chief Executive Officer of the NFPA

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