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EDUCATION

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EDUCATION

FEATURED STORIES

IN THIS ISSUE

BUILDING A STANDARDS-READY WORKFORCE: THE ROLE OF THE ANSI COMMITTEE ON EDUCATION

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USNC TMC Member

The Standardization ecosystem is changing at a very fast rate due to the need to develop standards faster for emerging technologies, proliferation of standards setting organizations (SDOs, consortia, forums etc.), politicization of standards development process, the geopolitical environment (specifically with the impact of deregulation and trade), digitalization of standards processes, loss of standard experts to retirements, and other reasons. The only way to ensure that we can move swiftly through these developments in the world of standards is by being effective in our role as standards professionals via continuous learning and preparing the next generation to not only be aware of standards, but equipped to lead with them. Therefore, standards education must be a top priority for a sustainable standards system. To be effective in standards engagement efforts, U.S. experts and delegates must be well-prepared and equipped with the right skillsets according to the range of roles USNC TAG members play within the IEC TCs/SCs/WGs/PCs—such as convenor, chair, secretary, expert, editor etc.

ANSI COMMITTEE ON EDUCATION (COE) – ADVANCING STANDARDS EDUCATION

The ANSI CoE is the body overseeing all of ANSI's initiatives related to standards and conformity assessment education. With over 70 members representing academia, industry, government, and SDOs, the committee is a dynamic forum for collaboration and innovation on standards education initiatives. Its overarching goal is to ensure that individuals—students, educators, and professionals alike—are knowledgeable about standards and conformity assessment, and understand their impact on business, technology, safety, and global trade. Its mission is clear: to promote the integration of standards into education and professional development, raise awareness of the strategic importance of standards across disciplines, develop

educational materials and to support the U.S. Standards Strategy through outreach and training. The key activities of ANSI CoE include:

- **Annual Student Paper Competitions:** ANSI's paper competition invites high school and post-secondary students to submit original papers on a specific topic related to standards and conformity assessment—for example, "How Do Standards Mitigate Disaster?" or "Imagine a World without Standards." The competition supports ANSI's long-term effort to raise awareness among students of the significance of standards and conformance in nearly every aspect of business, industry, and society. The committee's annual student paper competition continues to be a cornerstone of its outreach.
- **University Outreach:** Recognizing the importance of academic partnerships, the CoE has hosted hybrid meetings at universities. These events feature interactive activities for students and provide an opportunity to learn from standard professionals directly. ANSI provides guest speakers from the standardization community upon professors' request based on their needs. A new graduate who is familiar with the standards relevant to their industry and how the standards system works is a strategic asset to their future employer. The objective is to raise awareness and impact of standards across all disciplines.
- **Standard Simulations:** ANSI CoE often partners with sponsor organizations to host standards simulation exercises where individual students and/or emerging professionals (fewer than eight years in standards) participate in the "development" of a standard. These events offer a hands-on introduction to the actual standards development process. The participants acquire a feeling for the stakes in standardization, gain insight into standards-related interests and strategies (their own, those of others, the common interest), and experience the relevance of procedures in standards processes. The committee is also trying to develop an in-house standards simulation so we don't have to rely on organization sponsorships to host these impactful and valuable activity for students and emerging professionals.

SUPPORTING EMERGING PROFESSIONALS FOR SUCCESSION PLANNING

In addition to standards education activities, we need to support our emerging professionals to ensure successful succession planning—which requires a structured and inclusive approach that ensures leadership continuity and cultivates future expertise. Organizations should begin by identifying key leadership roles in standard committees and mapping the competencies required for each. Once these roles are defined, it's essential to proactively engage individuals who show potential and interest in leadership. This process should prioritize diversity in technical expertise, geography, and stakeholder representation. Contingency planning is also critical to manage unexpected transitions and maintain momentum in ongoing work programs.

To foster leadership readiness, organizations should invest in mentoring, training, and outreach. Pairing experienced leaders with emerging professionals facilitates knowledge transfer and builds confidence—like in the USNC Mentorship Program. Training programs—ranging from technical workshops to leadership development courses—should be cataloged and made accessible, especially through online platforms to accommodate global participation such as the ANSI Education Page. Outreach initiatives and formal calls for expressions of interest can help attract new talent and broaden the pool of future leaders. Recognizing contributions and maintaining succession planning as a regular agenda item in leadership discussions

reinforces a culture of growth, inclusion, and continuity. These practices, when consistently applied, help build a resilient and engaged community of future leaders.

INTEGRATING STANDARDS INTO CURRICULUM TO PREPARE THE NEXT GENERATION OF STANDARDS LEADERS

A workforce fluent in standards is essential to U.S. competitiveness. It ensures that professionals can effectively participate in standards development, navigate the changing landscape of standardization, and drive innovation. The ANSI CoE is actively collaborating with academia and other relevant stakeholders and identifying how to best integrate standards into curriculum. At the 2024 ANSI CoE roundtable with academia, we heard a need to address barriers to integration (lack of faculty awareness, lack of incentives to faculty to integrate standards into curriculum, mapping teaching competencies to standards); value of context-based standards education such as standards for cybersecurity, privacy, artificial intelligence etc.; lectures from invited standards experts; and the ability to offer standards education content into flexible modalities (such as incorporating them into senior design/capstone projects, byte size trainings on targeted topics, etc.).

The ANSI Committee on Education plays a pivotal role in shaping the workforce of tomorrow. Collaboration between educators, industry, and standards bodies will be essential in crafting curricula that reflect real-world needs and anticipate future trends. As the Chair of the ANSI Committee on Education and a standards professional, I've seen first-hand the transformative power of standards education. It equips individuals with the tools to lead, collaborate, and innovate in a complex global environment, and it ensures that the U.S. remains a leader in shaping the standards that define our future.

USNC PROFESSIONAL MENTORING PROGRAM

The USNC's Professional Mentoring Program offers emerging standards and conformity assessment professionals the unique opportunity to engage in a one-on-one mentoring relationship with an experienced member of the USNC community. Unlike traditional training, this program offers a personalized partnership where mentors provide guidance to help protégés achieve their individual goals—whether that means stepping into leadership roles, better contributing as experts, or advancing within U.S. and international programs.

Those who have completed the mentoring program state that it helped foster their professional growth and maintain their engagement, and gave them the tools they needed for a successful future as USNC leaders.

The program will take place from October 2025 through July 2026. To participate, please complete and submit the USNC Mentoring Program application to Mackenzie Connors (maconnors@ansi.org).

The deadline for applications is **17 September 2025.**

USNC/IEC TRAINING & EDUCATION

New to USNC? The USNC provides education and training resources for electrotechnical standardization and conformity assessment.

We encourage you to take advantage of our training opportunities available now on the USNC webpage!

- » USNC Constituent Training Modules
- » USNC Effective IEC Participation Webinar
- » USNC & IEC Conformity Assessment 101
- » Why IEC Standards Work Is Important to My Company
- » Benefits of Standards Work for Emerging Professionals

ICYMI: IEC Effective Participation Webinar

On Tuesday August 19, USNC colleagues took part in a webinar on effective participation in the IEC. The presentation focused on a brief history of the USNC and IEC, how to prepare for international meetings such as the IEC General Meeting, responsibilities after meetings, an overview of technical positions, guidelines for voting, and hot topics. The following USNC members presented:

Muhammad Ali: Sr. Standards Strategy and Policy Leader, HP Inc.

Walter Zoller: Manager, Global Product Standards and Regulation/Technology and Innovation, Rockwell Automation

Valara Davis: International Standards Manager, ULSE

View the webinar recording here.

Stay Tuned: The USNC will be hosting an Emerging Professionals Workshop in October!

Elevate your career in standards and conformity assessment at the American National Standards Institute's second-annual Emerging Professional Workshop! Held in conjunction with ANSI's Innovation Summit, join us from October 21st–23rd, 2025 in Bethesda, Maryland, for a multi-day event designed to prime emerging standards professionals for success.

Individuals with fewer than eight years of experience in standards/conformity assessment are invited to network with industry leaders at the ANSI Summit, gain insights into the standards development and conformity assessment processes, and attend invaluable trainings to advance your career and the work of your organization. Space is limited, so mark your calendars and stay tuned for further details on how to apply. Together, let's shape the future of international standards and conformity assessment!

Looking for more? IEC Academy & Capacity Building hosts frequent webinars. You can access past webinar recordings and register for upcoming webinars here.

IEC Online Standards Development (OSD) Resources

New to using OSD? We've got you covered. Check out our resources and training materials here.

SUPPORTING STANDARDS LITERACY IN POST-SECONDARY EDUCATION

Julia Koppernaes, Manager of Academic Engagement - CSA Standards

Jennifer Teague, Vice President of Research and Education - CSA Standards

Standards impart a wide range of benefits, from enhanced safety to reduced environmental impact. They help provide credibility to products in the marketplace and they help innovators compete on a level playing field. Standards and codes are often hiding in plain sight. Though they represent a key, often daily, resource for many professions, many post-secondary students spend their academic career without engaging with standards content. As such, they often lack a true understanding of what standards are, where to find the ones they need, and how to apply them.

Engaging students in foundational training on standards can yield many important returns. Enhanced awareness can lead to greater use and application of standards and may lead to future participation in the standards development process. This awareness can also drive benefits to the institution, creating opportunities for knowledge translation of research findings into standards; improved achievement of learning outcomes, particularly for applied courses such as senior capstone courses; and more holistic approaches to the commercialization of institutional innovations.

The widespread lack of explicit, standards-based education in post-secondary institutions represents a lost opportunity to inform future professionals and innovators of the role of standards in their field; the role that they can play in the products, services and processes they develop; and more generally of the fundamental importance of the standards system in supporting a safe, sustainable, healthy world. A strong understanding of standards— including what they are, how to find them, and how and when to use them— should therefore be a fundamental component of higher education, providing essential knowledge and skills to the workforce of tomorrow.

CSA Group has embarked on a journey to develop foundational educational modules to support standards literacy in post-secondary institutions. The project began with interviews with post-secondary instructors at universities and colleges across Canada, mainly in the field of engineering. The questions sought to determine the need for or interest in standards-based training, the depth of information required, how the material would support current learning objectives within their courses,

and the appropriate format to achieve the goals. The investigation yielded a design framework outlining key topics to address standards basics, i.e., foundations, delivered in short, asynchronous modules that would allow instructors to incorporate the material into their course in a flexible manner.

The project then led to the development of four core standards literacy modules where post-secondary students and faculty members can learn about the importance, application, and involvement of standards in day-to-day life. The modules are framed around a case example, featuring engineering students who have designed a product and are attempting to bring it to market, but have not considered standards in their design. The modules are available at no cost, can be completed in 10 to 15 minutes in an asynchronous manner, and have knowledge checks throughout to reinforce learning. A *Facilitators' Guide* is also available to support instructors incorporate the material in their courses.

The four foundational modules in the Standards Literacy series are available in both English and French:

1. **Standards: Why Care?** - Defines standards, the benefits of applying them, and the risks of not applying them.
2. **Standards: How Do I Find What I Need?** - Guides students on how to identify and locate relevant standards and their key sections.
3. **Standards: How Do I Apply Them?** - Teaches when the best time to identify and refer to applicable standards is and how to apply them.
4. **Standards: How Do I Get Involved?** - Provides information on how students can engage with the standards community, contribute to standardization efforts, and benefit from involvement.

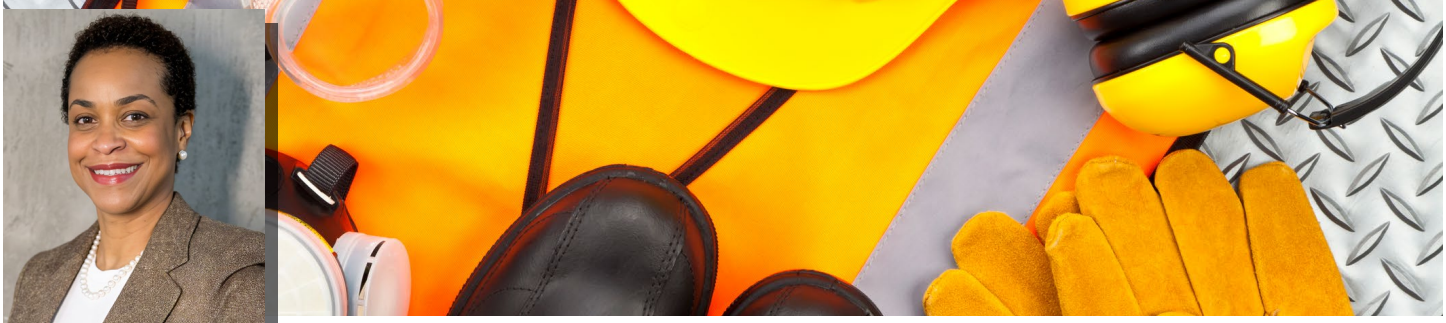
These core modules have since been successfully piloted in a first-year engineering program at a Canadian university. Three years since the initial launch, many students are now returning to the content to support their senior-level courses. Student and instructor feedback on the courses has also been leveraged to inform the development of new modules, including a new case example focused on accessibility—where students can explore how standards serve as a tool in navigating day-to-day complexities—and a *Learn More Series*—which delves deeper into topics of who develops standards, how standards are developed, and the global ecosystem. The accessibility case example is available now, and the *Learn More Series* will launch by the end of August 2025.

While the foundational modules follow an engineering case example, all the modules are designed to be relevant to any field of study and have been designed with input from students with a variety of backgrounds. The modules are also standards development organization (SDO) agnostic, featuring SDOs at the national and international level.

We invite you to explore these resources and share the links with those who might benefit from their content. As we continue towards our goal of supporting standards-based education in flexible, accessible and practical ways, feedback is greatly appreciated. CSA's Manager of Academic Engagement, Julia Koppernaes (julia.koppernaes@csagroup.org), is happy to discuss this project with all from the standards and post-secondary circles.

STANDARDS ACADEMY: A NEW WAY TO BRING UL SAFETY STANDARDS TO COLLEGE CLASSROOMS

Bethany King Walkes, Ph.D., Standards Academy Manager - UL Research Institutes



UL Standards & Engagement, a global leader in the development of safety standards, collaborates closely with UL Research Institutes' Office of Research Experiences & Education to inspire and educate the next generation of standards professionals.

Together, our organizations aim to increase awareness of the critical role that standards development plays in building a safer, more sustainable world.

REAL-WORLD SAFETY STANDARDS EDUCATION

This partnership led to the creation of Standards Academy, which was developed together with standards development experts and engineers at ULSE, in collaboration with OREE's education experts.

Launching soon, the goal of Standards Academy is to support the next generation of early career professionals in understanding the value of safety standards to ensure a safer world. The free, interactive online platform is designed for undergraduate students to learn more about what safety standards are, why they matter, and how safety standards are used to mitigate safety risks and hazards.

WHY IS THIS IMPORTANT?

58% of employers expect new hires to have a knowledge of safety standards at the time of hire, according to a 2010 study by Harding and McPherson. But, only 15% of standards professionals were exposed to safety standards in college, based on findings from the 2022 UL Standards & Engagement Next Generation Stakeholder Survey.

With this new knowledge of safety standards gained from Standards Academy, students will be able to increase their efficacy of standards implementation in engineering design.

Standards Academy utilizes an interrupted case study approach, where students will:

» Learn about safety standards and how they apply to real-world scenarios

» Grow their knowledge of safety hazards and risks addressed by safety standards

» Gain understanding of the standards development process, the role of UL Standards & Engagement's technical committees, and see how consensus drives the outcome of a standard

» Have an opportunity to offer feedback that influences standards development

The case studies:

» Help students engage in active learning

» Encourage thought-provoking questions and collaborative problem-solving

» Lead to engaging classroom conversations

» Showcase standards professionals in action

Current case study themes include:

» Sustainability

» Electrification

» Fire safety

» Mechanical safety

» Electrical safety

» Human and environmental health, climate adaptation

A COLLABORATIVE BEGINNING

The development of Standards Academy first began in 2022 as UL Research Institutes and UL Standards & Engagement partnered closely to develop this unique platform.

The partnership began with ULRI's Office of Research Experiences & Education, which provides educational expertise in STEM to educators and students across the entire education continuum, along with programs that promote access to equitable opportunities and workforce development in safety science.

Alongside UL Standards & Engagement, a world-renowned leader in safety standards with more than 1,700 standards developed, OREE's education experts began to explore the issue of safety standards exposure in college and university curriculums.

OREE took part in a nationwide university listening tour in 2022, engaging engineering faculty and administrators from 10 participating universities to understand the current state of undergraduate standards education. Based on those findings, OREE began building the content for Standards Academy.

The case studies were written in partnership with OREE's education experts and subject matter experts across ULSE, including engineers and standards experts, bringing together diverse sets of knowledge, expertise, and experiences to bring Standards Academy to life.

Dozens of new case studies are currently in the works, along with supplemental case study resources, including videos and interactives.

A MEETING OF MINDS

In March 2025, OREE partnered with the Colorado School of Mines to host the Standards Education Summit in Golden, Colorado — bringing together experts from UL Standards & Engagement, UL Research Institutes, and award winners from the National Institutes of Standards and Technology Standards Coordination Office Curricula Development Cooperative Agreement Program. This summit convened experts across industry and higher education to share their curriculum practices that promote postsecondary standards education, and to increase collaboration and communication in the standards development field.

Together, attendees:

» Learned more from postsecondary faculty on successfully developing and implementing standards education curriculum in existing engineering courses

» Highlighted curriculum programs that already exist

» Enhanced the development of standards education programming for undergraduate students

» Discussed how to collaborate more and broaden participation in standards development and standardization

The discussions at the summit contributed directly to the development of resources on Standards Academy, with learnings incorporated into the case study approach.

The interrupted case study approach includes:

» A problem: why is there a need for a standard?

» Approach: how the technical committees are formed and their work

» Solution: the publication of the standard

» Interruptions: pause points to reflect on a question or prompt from the content

THE FUTURE OF STANDARDS EDUCATION

Standards Academy is formatted to ensure that students reading the case studies aren't lost in theory or hypotheticals—they're engrossed in real-world situations that are relevant to their lives. Within each case study, students learn about the role that technical committee members and stakeholders play in the consensus process and are invited to take part in the standards development process themselves.

Empowering young adults with autonomy enables them to shape their own futures and take charge of their lives. Involving young people in the standards development process can bring valuable change, driven by their fresh perspectives and sharp insight into the world they live in.

We're excited to help be a part of that positive change. For all the latest on the launch of Standards Academy, visit ULRI's Office of Research Experiences & Education webpage or sign up for email updates from OREE and Standards Academy.

DECISION DEPOT

This column provides easy access to recent decisions that have been made regarding IEC and USNC policies and procedures that directly affect our members. Click the link below to access the recent decisions.

See the Decision Lists below for decisions made at the following meetings: SMB meeting 183 held on 2025-06-13 in Geneva (CH); and IEC Board meeting held in July 2025.

SMB/8440/DL

IB/498/DL

BRIDGING THE BATTERY ENGINEERING SKILLS GAP IN HIGHER EDUCATION: THE BATTERY BOOM AND THE SKILLS GAP

Abhineet Nigam, Senior Battery Engineer - WHOOP, Inc.
USNC TAG IEC TC 21

From smartphones to electric vehicles (EVs) and grid storage, batteries are everywhere, and the market is booming. Global demand for lithium-ion batteries is expected to increase sixfold by 2030, with over 1,000 GWh of annual production and more than 40 new battery plants projected in the U.S. alone.[1] Talking about the EV sector alone, the U.S. is on track to have over 26 million electric vehicles on the road by 2030.[2] This explosive growth has created an equally urgent demand for engineers who understand battery technology. Yet industry surveys reveal a "significant" skills gap: over 80% of companies report difficulty finding qualified battery engineers.[3] In particular, "green-collar" roles, technicians, assemblers, and system engineers for batteries are in short supply.[4] Without a workforce fluent in battery systems, the clean-energy transition could be stifled by talent shortages.

Why is it so hard to find "battery generalists?" Part of the problem is how we educate engineers. Today's university programs excel at producing specialists, electrical engineers, chemical engineers, materials scientists, mechanical engineers, etc., each expert is a slice of the battery puzzle. But a battery is the puzzle in itself: a complex system of electrochemistry, materials, electronics, and software all in one box. As a result, companies need engineers who can understand the working of the battery end-to-end, yet such broad training is rare in academia. A recent workforce assessment by the Center for Automotive Research found critical skills gaps in electrochemistry, battery chemistry, battery management systems, systems design, manufacturing, and safety—essentially every facet of battery engineering.[5] General engineering roles (the kind that span multiple disciplines) were in the shortest supply, even more than specialized battery roles. In short, universities aren't graduating enough "Swiss Army knife" battery engineers to meet industry needs.

1 BatteryTech Online
2 Center for Automotive Research (Li-Bridge Battery Workforce report)
3 BatteryTech Online
4 Ibid.
5 USNC Current (ANSI) archives

SPECIALISTS VS. GENERALISTS: A GAP IN ACADEMIA

Most engineering students learn about batteries only in passing. For specialists, on the other hand, a chemist might study novel battery materials but never delve into battery management electronics. An electrical engineer might design battery chargers but know little about cathode chemistry. Each discipline addresses a piece of the battery equation, but rarely the whole. Battery technology is inherently multidisciplinary. In the words of one program director at Norwegian Battery Coast, "a successful battery engineer must simultaneously be a chemist, an electrical engineer, a physicist, a data scientist, a mechanical engineer, and an entrepreneur."[6] That's a tall order, and it highlights why a siloed educational approach leaves future battery engineers with blind spots.

Take, for example, the divide between making a battery cell and building a battery pack. Producing battery cells is primarily a chemical process, whereas assembling those cells into a pack is a mechanical and electrical process.[7]

Bridging such diverse knowledge areas from the nano-scale chemistry inside a cell to the system-level engineering of a large pack is challenging in a traditional curriculum. It's no wonder that new graduates often lack either the deep electrochemical insight or the practical pack integration skills that battery employers seek. The result is a talent gap: companies must invest heavily in on-the-job training to turn a single-discipline engineer into a full-fledged battery systems engineer. This gap is evident in the low enrollment for emerging battery training programs; for example, a recent pilot program in Michigan offering battery technician scholarships attracted only 220 students, despite a goal of 2,000 trainees by 2026.[8] Clearly, more needs to be done to interest and prepare the next generation of battery experts.

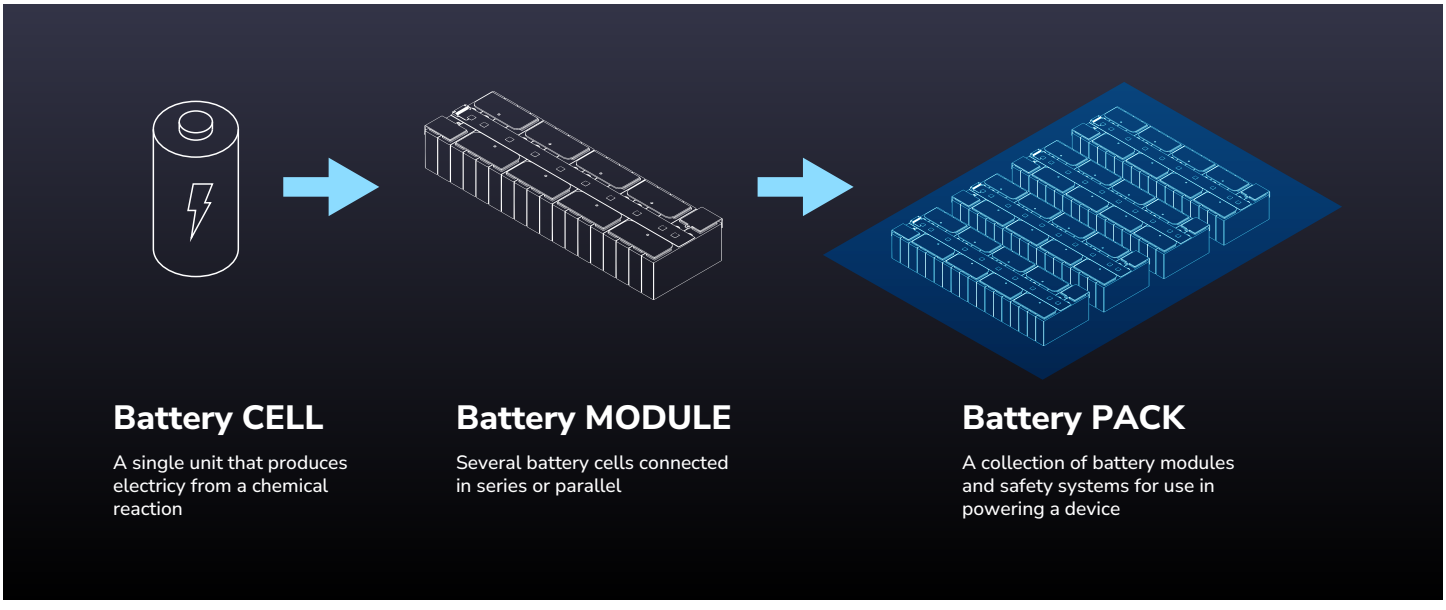
Government and industry are starting to respond. The U.S. Department of Energy's new Battery Workforce Challenge is launching regional training hubs and collegiate competitions to boost battery education and hands-on skills.[9] Universities and professional societies are rolling out certificate programs in battery technology.

6 University program materials (RWTH Aachen, University of Agder, IFP School)

7 UL research

8 BatteryTech Online

9 Ibid.



Design adapted from graphic by Automotive Cells Co.

A few pioneering schools abroad have even created dedicated battery engineering degrees for instance, RWTH Aachen in Germany will debut a Master's in Battery Systems Engineering covering the entire battery value chain, from modeling and cell chemistry to recycling.[10] These efforts, however, are still the exception. For most engineering students today, there is no clear roadmap to become an expert on battery systems. It's time to change that.

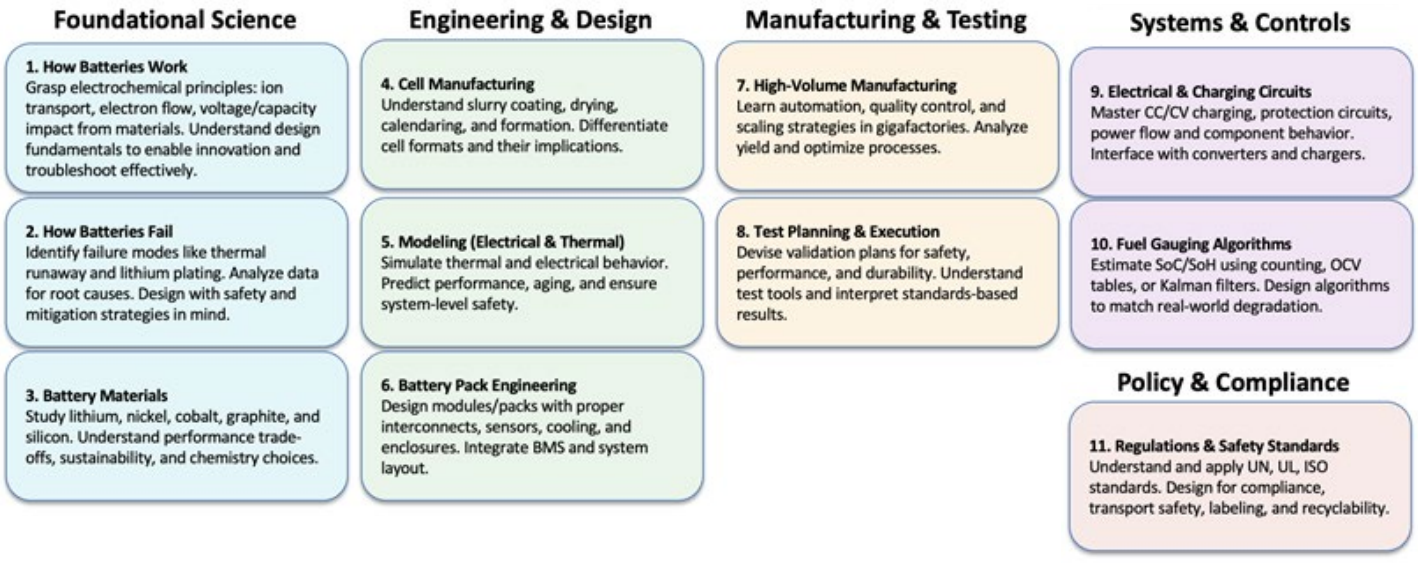
TOWARD A HOLISTIC BATTERY ENGINEERING CURRICULUM

How can universities close this skills gap? The answer may lie in reimagining curricula to blend disciplines and emphasize systems thinking. Instead of siloing students in traditional majors, a battery engineering curriculum would pull from chemical, electrical, and mechanical engineering and, crucially, teach students to integrate those perspectives into a more cross-functional approach. Imagine a program where classroom theory is continually reinforced by hands-on battery projects and industry experience.

10 University of Wisconsin-Madison InterPro course descriptions

This holistic approach breaks the traditional academic silos. For instance, students might begin with core fundamentals in electrochemistry and thermodynamics (to understand how batteries work and why they fail) alongside introductory circuits and programming (laying the groundwork for BMS and algorithms). Materials science modules would cover battery-specific topics like cathode/anode chemistry and separator properties, paired with laboratory sessions where students build and test coin cells. In parallel, a practical course on "Battery Pack Fundamentals" could have students assemble a small battery pack from cells, learning about wiring, sensing, and safety interlocks as they go.

As the curriculum progresses, more specialized courses would layer on. A semester on *Battery Modeling and Control* might teach equivalent-circuit modeling of cells and thermal models of packs, with projects using software tools to simulate performance and design a basic battery management algorithm. As the integration of AI in battery development progresses, including modules on the application of AI in the industry can also be included. A *Battery Manufacturing and Scale-up* course could cover how cells are mass-produced perhaps even



A conceptual diagram of the broad skill areas a battery systems engineer must span from fundamental electrochemistry and materials science to pack assembly, electronics, thermal management, manufacturing, testing, and regulatory compliance.

in partnership with a battery factory for real-world insight, and require students to analyze yield and quality control data. Importantly, a *Battery Testing and Safety* course would delve into standards and test methods: students would devise test plans to qualify a battery for, say, UL or UN safety tests, and maybe even run abuse tests in a controlled lab setting.

Crucially, the program should culminate in an interdisciplinary capstone project. For example, student teams might be tasked with designing a complete battery system for a specific application for an electric vehicle battery module, or a consumer electronic battery system starting from cell selection, designing the physical module with thermal and battery management systems, and planning out the manufacturing and testing strategy. Along the way, they would have to consider regulatory requirements and perhaps even cost analysis and environmental impact. Such a capstone brings together all core competencies in a realistic context. It also mirrors how industry projects work, with cross-functional teams iterating between chemistry, hardware, software, and compliance.

Of course, no single engineer will be an equal expert in all aspects. The goal of a generalist curriculum isn't to replace specialists, but to produce engineers who can speak everyone's language. A graduate of this program should be able to walk into a meeting with a battery cell chemist, a mechanical pack designer, and an algorithms engineer and understand each of their concerns, facilitating integration. In industry, this integrative role is extremely valuable. It's the systems engineer or technical lead who ensures that the battery as a whole will meet its requirements.

There are encouraging signs that academia is moving in this direction. The University of Wisconsin-Madison, for example, now offers a professional course series in *Batteries and Electrification* that covers everything from battery chemistry to pack design to safety and degradation.[11] In Europe, the University of Agder in Norway launched an interdisciplinary battery engineering program explicitly to blend chemistry, engineering, and hands-on industry experience.[12] Still, to truly fill the generalist gap, more mainstream universities and engineering departments will need to adapt. This might mean creating new minors or certificate programs in battery technology that students in traditional majors can opt into involving closer collaboration with industry, inviting battery experts as adjunct professors, setting up internship pipelines with battery manufacturers, or co-developing curricula to meet current industry standards. The payoff for students could be significant: they would graduate not just with theory, but with tangible experience (say, having cycled their own built battery cells in a lab, or written code for a battery fuel gauge on a microcontroller). For industry, the payoff is a pipeline of engineers ready to hit the ground running on day one, fluent in the lingua franca of batteries.

Breaking down silos between disciplines that currently exist in the battery discipline and building a new kind of curriculum one that produces T-shaped engineers (broad across the top in many areas, with depth in one or two) tailored to battery systems. As the world leans increasingly on batteries to enable a clean energy future, investing in such education will be critical. We need engineers who can look at a battery and see both the forest and the trees: the intricate chemistry of each cell and the big-picture architecture of the system. By training more of these generalists, universities can empower the next generation of battery innovators to lead us into a fully electrified era, safely, efficiently, and sustainably. It's a tall order for any single degree program, but as battery technology becomes ever more central to engineering, it's a necessary evolution. The sooner we align our educational programs with this multidisciplinary reality, the faster we can charge forward to that future.

11 Boston University

12 University program materials (RWTH Aachen, University of Agder, IFP School)

CREATING CAREER PATHWAYS BY INTEGRATING ACADEMIC DEGREES AND INDUSTRY CERTIFICATIONS

Karen Elzey, Associate Executive Director of Operations - Workcred

A persistent challenge for employers is identifying job candidates with the necessary knowledge, skills, and abilities for available jobs. Simultaneously, post-secondary education institutions are under increasing pressure to ensure that their graduates possess the skills valued by employers and have positive job outcomes. One strategy to achieve the goal of better aligning college programs with the skills in demand by employers is to integrate industry certifications into academic degree programs. Industry certifications can be integrated into academic degrees in various disciplines including information technology, cybersecurity, healthcare, manufacturing, logistics, and business. By combining two different types of credentials, which have different purposes, into one academic program, students gain both a broad-based education and occupationally-specific skills. And in fact, community colleges are leading this effort.

At Kirkwood Community College in Kirkwood, Iowa, the faculty developed the computer support specialist (CSS) pathway in which students earn the CompTIA A+ certification, AWS Cloud Practitioner certification, and a CSS Associate of Applied Science (AAS) degree. This pathway combines customer service skills with a variety of IT knowledge that includes hardware, software, networking, and programming, as well as durable skills such as problem solving and analytical thinking. To ensure that the pathway included the skills local employers need, faculty worked closely with an advisory board they created made up of industry representatives who represent both large and small employers, and span a broad array of roles, including technical, supervisory, and human resources/administrative roles. Students take the included certification exams at the end of their first academic year, which provides opportunities for students to get a job in IT, while continuing to pursue their CSS degree.

With a focus on behavioral health, the Community College of Aurora in Aurora, Colorado integrated certifications and certificates in AAS degrees that allow students to advance from paraprofessionals to careers that require a bachelor's degree. The behavioral health pathway consists of five microcredentials that are offered as credit-bearing certificates and stack into

two AAS degrees in behavioral health—one with an emphasis on mental health and social work and the other with a focus on addictions and addiction recovery. Students who earn the Addiction Recovery Assistant microcredential in the pathway will have completed the educational requirements for the Certified Addiction Technician certification. And, students who continue on the pathway to earn an AAS degree in mental health and social work or addiction recovery fulfill the educational prerequisites for the Registered Behavior Technician® and the Certified Peer and Family Support Specialist certifications. Learners who want to pursue further education can continue to earn a bachelor of science degree in either mental health and wellness or addiction recovery.

The value of including certifications in career pathways is that they attest to an individual's ability to perform a set of skills applicable to a professional setting and are awarded by organizations separate from higher education institutions, such as nonprofit organizations, professional associations, industry or trade organizations, and businesses. According to Credential Engine, there are 7,000 industry-recognized certifications offered across industry sectors.[1] Yet, only a subset meet the definition of high-quality certifications, which are based on a third-party assessment and are time-limited, renewable, and revocable.[2]

Furthermore, some certifications are accredited either by the ANSI National Accreditation Board (ANAB) or the National Commission for Certifying Agencies (NCCA), though each uses a different voluntary standard that they assess against. ANAB uses ANSI/ISO/IEC: 17024:2012, *Conformity assessment – General requirements for bodies operating certification of persons*, which is a national and international standard that sets the bar for quality certification programs.[3] And NCCA uses the 2021 *Standards for the Accreditation of Certification Programs*.[4] Even though a minority of certifications are accredited, it is a mark of distinction for the certification bodies.

In conclusion, these pathways complement the broad-based knowledge and executive function skills from completing a degree with opportunities for students to demonstrate that they have occupationally validated knowledge and skills through the certification exams. As employers transition from hiring based on credentials to hiring based on skills, the integration of certifications into degree programs will help students more effectively articulate and demonstrate the skills that they possess, and lead to more positive career opportunities.

1 *Counting U.S. Postsecondary and Secondary Credentials* (Credential Engine, 2022), https://credentialengine.org/wp-content/uploads/2023/01/Final-CountingCredentials_2022.pdf.

2 Good, Larry, Evelyn Ganzglass, Stephen Crawford, Kyle Albert, Roy Swift, Karen Elzey, and Isabel Cardenas-Navia, *Understanding Certifications* (2020), https://www.workcred.org/Documents/Understanding-Certifications-Report-Dec-2020.pdf.

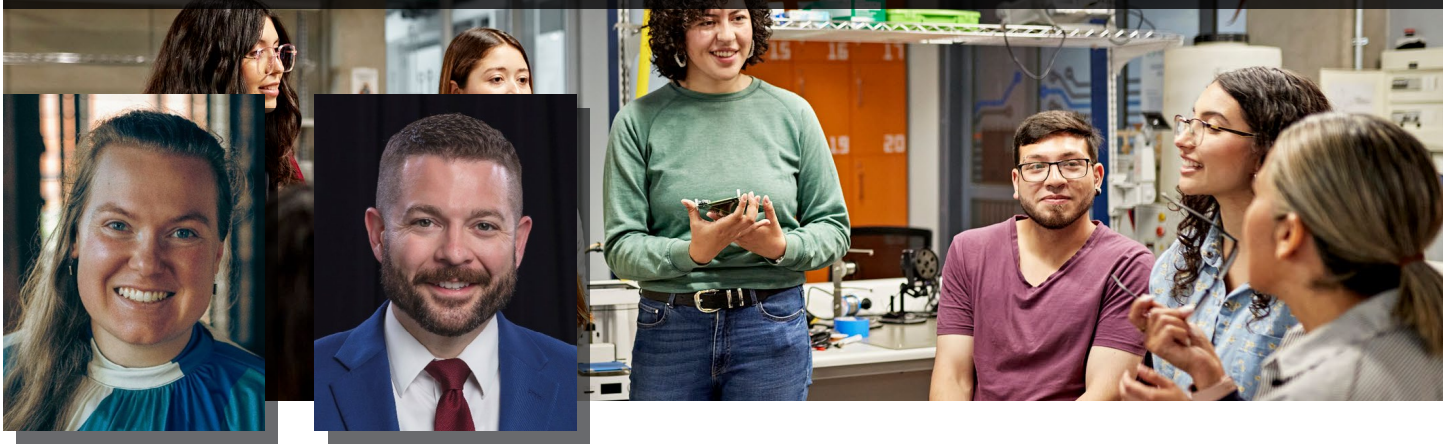
3 For more information about the ANSI/ISO/IEC 17024 standard requirements, see https://anab.ansi.org/accreditation/personnel-certification/?srsltid=AfmBOor2rf9tIZJNQMiiZz-2paaOWKCRI9snVegXn_zGG2U79oIMBWsK- and https://www.iso.org/standard/52993.html.

4 Institute for Credentialing Excellence, National Commission for Certifying Agencies, *Standards for the Accreditation of Certification Programs* (October 2021).

EMPOWERING THE NEXT GENERATION: ADVANCING TECHNICAL STANDARDS EDUCATION THROUGH THE TECHNICAL STANDARDS IN ENGINEERING PROGRAM

Amy Kurr, Program Manager - TSE Lead

Jimmy Landmesser, Jr., Program Manager - TSE Lead



Despite their essential role in engineering practice, the integration of technical standards into formal engineering education remains a challenge for many programs and educators. From design specifications to regulatory compliance, standards are deeply embedded in the work engineers do—yet many graduates enter the workforce with limited exposure to how they're developed, interpreted, or applied. This disconnect poses real challenges for new professionals and employers alike.

To help bridge this education-industry gap, the Technical Standards in Engineering (TSE) Program was developed as a free modular, adaptable curriculum that introduces students to the purpose, use, and global landscape of technical standards. Designed as a collaborative effort among engineers, researchers, and librarians, the program provides foundational, instructor-ready content that can be integrated into existing courses or used as standalone learning modules. It emphasizes both conceptual understanding and practical skills—such as reading a standard, evaluating its relevance to a project, and understanding how it fits within regulatory and legal frameworks.

Increased collaboration between academia, industry, and standards development organizations (SDOs) has resulted in much progress. However, major standards education challenges remain. These include the limited availability of engineering librarians with standards expertise, the wide diversity and volume of standards and SDOs globally, and the need to align with accreditation outcomes (such as ABET in the United States). Many free educational resources exist, especially online, but educators find them tough to integrate and adapt to existing courses. Furthermore, faculty who wish to personally customize or develop such content face significant time and resource demands. These hurdles are not easily addressed at the individual or institutional level, which is why centralized flexible tools like the TSE Program are critical.

The TSE Program has gone through two international reviews and is currently preparing for its formal release in 2026 on Canvas Commons. The team is actively seeking volunteer reviewers from diverse backgrounds—including students, faculty, industry professionals, government agencies, and standards organizations—to

participate in the third review. Reviewers are asked to contribute 12 hours over 3–4 months to complete the course and provide feedback on each learning module.

By working together across sectors and disciplines, we can prepare the next generation of engineers to use standards not just competently—but confidently and creatively—in solving the challenges of tomorrow.

LEARN MORE

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Fall 2025 Content Review Interest Survey: tinyurl.com/Fall2025TSEreviewer

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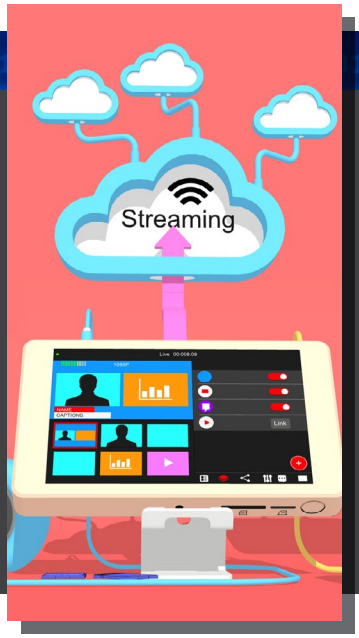
THANK YOU TO OUR AUGUST 2025 USNC MANAGEMENT MEETING HOST, EATON CORPORATION!

Powering Business Worldwide

On August 11–14, the three USNC policy committees (USNC Council, Technical Management Committee and the Conformity Assessment Policy Coordinating Committee) met in Warrendale, PA at the Eaton Corporation facilities for four days of fruitful meetings. Thank you to Eaton Corporation for hosting us!



ANSI MEMBERSHIP WEBINARS

Membership in ANSI is the key to unlocking the benefits and opportunities that standardization can provide. Standardization and conformity assessment activities lead to lower costs by reducing redundancy, minimizing errors, and reducing time to market, resulting in enhanced profitability.

These interactive 30-minute webinars—held on the first Friday of each month and free of charge—are hosted live and provide an overview of ANSI's activities, as well as information on how to take full advantage of ANSI membership. A Q&A session encourages active dialogue between all participants.

For more details, visit our website!

JUST PUBLISHED

Check out the latest and greatest recently published standards by the IEC. A complete list of recently published documents can be found here. Here's just one (of many!) we think you'll find interesting:

IEC 61000-4-23:2016+AMD1:2025 CSV- ELECTROMAGNETIC COMPATIBILITY (EMC) - PART 4-23: TESTING AND MEASUREMENT TECHNIQUES - TEST METHODS FOR PROTECTIVE DEVICES FOR HEMP AND OTHER RADIATED DISTURBANCES

IEC 61000-4-23:2016+AMD1:2025 CSV provides a protective devices test method for HEMP and other radiated disturbances. It is primarily intended for HEMP testing but can be applied to other externally generated radiated disturbances where appropriate. It provides a brief description of the most important concepts for testing of shielding elements. For each test, the following basic information is provided:

- Theoretical foundation of the test (the test concepts);
- Test set-up including outside-to-in and inside-to-out measurements;
- Required equipment;
- Test procedures;
- Data processing.

This international standard does not provide information on requirements for specific levels for testing. Due to the available space, a transmitting antenna position outside the barrier has mainly been suggested. However, nowadays, many EMP protection facilities in practical use do not actually have enough space available outside the electromagnetic barrier due to physical constraints such as concrete walls or soil to allow the method described in IEC 61000-4-23:2000 (edition 1) to be applied correctly. From experience many facilities have available space for a 1m separation or less only. Therefore, in many practical cases it is not possible to measure shielding effectiveness according to the test method of previous documents.

The constructors for EMP protection facilities are also unwilling to build facilities with extra space for measurements with the transmitting antenna outside the barrier due to the great expense and inefficiency of the operational working area for new or existing buildings. This document provides additionally a method that allows the transmitting antenna to be placed inside the enclosure and the receiving antenna outside the barrier ('inside-to-out' method). Annex F includes test set-up and procedure examples. This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) updates to the shielding effectiveness (SE) test method in Clause 5;

b) a new Annex F describing methods for testing 'inside-to-out' has been added.

Developed by TC 77/SC 77C High power transient phenomena

A UNANIMOUS VOTE IN SUPPORT OF U.S. PLUG-IN SOLAR INNOVATION

Achim Ginsberg-Klemmt, Principal Investigator - GismoPower LLC
USNC TAG IEC TC 64

"The United States National Committee supports much of the proposed document except for those requirements found in 751.550.101, specifically 751.550.101.1 and 751.550.101.2. This phrasing in 751.550.101 does not allow for the use of plug-in solar systems and could prevent new technologies from being implemented. Germany has supported VDE V 0126-95 safe connection methods which are compatible with national systems based on IEC 60884-1. Strategic Energy Europe reports that Germany has hit 1 million plug-in solar devices (https://strategicenergy.eu/renewable-energy-germany-solar-devices/). This IEC standard should not prevent innovative solutions from being implemented."

Not long ago, to be exact on July 30th 2024, the New York Times published an article with the title: "Germans Combat Climate Change from their Balconies."

This well-researched article highlights the phenomenal growth of "Plug-In Solar" across the Atlantic and poses a pressing question: Why are U.S. electrical codes and standards still lagging so far behind?

One passionate lawmaker in Salt Lake City read the article and thought, "Why don't we have this here in the U.S.?" Indeed. Why don't we?

That lawmaker wasn't an attorney. He wasn't an electrical engineer. And he wasn't a Democrat either. But Dr. Raymond Ward, armed with both an M.D. and a Ph.D., was curious enough to dig deeper and spoke in support of accessible plug-in solar solutions in a recent YouTube interview published by the nonprofit organization BrightSaver.org.

Apparently, he didn't find any compelling reason *not* to allow plug-in solar in the U.S. So, he drafted H.B. 340, the "Solar Power Amendments", Utah's now-legendary law legalizing "Plug-In Solar." The bill sparked excitement, surprise, and yes, some safety concerns nationwide.

"But what about the exposed prongs when you unplug the solar panel?"

We'll get to that obvious question.

In October 2024, another solar trailblazer took a historic step toward making "Plug-In Solar" a U.S. reality. Oglala Lakota Chief Henry Red Cloud, at Pine Ridge, South Dakota, received the first utility-approved grid interconnection for a plug-in solar system in the nation. Using a standard 240V/50A NEMA connector, his 5kW MEGA portable solar carport was approved by Lacreek Electric. It's been running smoothly, even through South Dakota's harsh, snowy winter.

Utah's H.B. 340 had to pass four rounds of voting. In an era where bipartisan consensus is rare, the bill passed unanimously—every single time. On May 7, 2025, "Plug-In Solar" for portable generation devices under 1,200 watts officially became law in the great state of Utah.

Hurrah! But here comes the fine print: All "Portable Solar Generation Devices" must also be UL-listed and NEC compliant.

Fortunately, the Department of Energy anticipated this hurdle. Back in 2023, DOE awarded a generous SBIR Phase II grant to GismoPower, the company behind Chief Red Cloud's MEGA, to develop a new UL standard for "Plug-In Solar – Made in USA."

Although there was initial skepticism at Underwriters Laboratories (UL) about incorporating Utah's technology definition of "Portable Solar Generation Devices" into the ongoing New & Innovative (N&I) standard creation process, pragmatism ultimately prevailed. UL engineers, including lead engineer Tim Zgonena, embraced a forward-looking, "Yes, we can do this" attitude.

Yet progress remains slow. Outdated assumptions, entrenched mindsets, and decisions made by appointed code-making panels at the National Fire Protection Association (NFPA), keepers of the U.S. National Electrical Code (NEC), continue to hinder innovation.

This is where education, the core mission of this edition, must play a crucial role. Unfortunately, the NEC's long update cycles mean that even the most urgent improvements may take years to be reflected in the code.

Thankfully, forward-thinking members of the U.S. National Committee's Technical Advisory Group 64 (USNC TAG64), including Secretary Casey Granata and Technical Advisor Thomas Domitrovich, understand the power of code language and the profound effects it can have, both positive and negative.

In recent meetings of IEC Technical Committee 64, pre-vote discussions brought up concerns like this:

"The main reason that the text 'dedicated coupling system' is used is because there were no product standards for plug-in balcony PV. It is understood that incorporated technology would see the failure of the mains/utility supply and switch off the output from the panel within a 'safe time.' What is not clear is if, for example, two panels were plugged into an extension lead and there was a failure of the mains/utility supply, would both panels switch off or would one see the other and assume that the mains/utility supply was healthy? The discussions we had led to the understanding that the plug for the extension with two panels connected (even three or four) would remain live when withdrawn from the socket-outlet."

It shouldn't be difficult to determine that product standards for "Plug-In Balcony PV" systems already exist or are currently under development. At a minimum, safety expert committees should be expected to familiarize themselves with the well-established "anti-islanding" requirements that have been embedded in PV inverter standards globally for over a decade.

While the direction of the 2026 U.S. National Electrical Code remains uncertain, particularly regarding barriers outlined in Lawrence Berkeley National Laboratory's recent publication Barriers to Balcony Solar and Plug-In Distributed Energy Resources in the United States,"it appears that our USNC TAG 64 committee has submitted a well-considered comment to help guide IEC 60364-7-751 in a more constructive direction.

COMBINATION OF EXPLOSION PROTECTION METHODS FOR ENHANCED SAFETY IN EXPLOSIVE ENVIRONMENTS

Anil V. Bhalerao, R&D Manager—Test & Certifications - Valmet (Gas Chromatography Systems MAXUM LLC)
Member of USNC TAG TC31, SC 31G

In the current Fourth Industrial Revolution (Industry 4.0), there will be a fundamental change in the way we live, work, and relate to one another. As industry embraces digitalization, remote monitoring, and artificial intelligence with smart technologies, the need for hybrid protection methods is expected to grow significantly in upcoming years. Modular automation systems, smart control systems, remote monitoring solutions, product predictive maintenance to avoid downtime, use of smart sensors, wireless sensors, edge computing, and product application environments will increase the demand for innovative and hybrid combinations of Ex techniques to assure safety without sacrificing performance.

Protection for products used in explosive/hazardous environments is not just a regulatory requirement, it is a foundation of operational safety in these environments where flammable gases, vapors, or dust may be present during normal operation.

Individual protection methods like flameproof enclosures or intrinsic safety are well established Ex protection techniques, and combining one or more Ex protection techniques can offer more enhanced safety, flexibility, and performance.

This article provides an overview of how integrated approaches to explosion protection are developing and how they align with international standards such as IEC 60079 and NEC/CEC.

WHY COMBINE EX PROTECTION METHODS?

The individual Ex protection method has its strengths and limitations, and by combining them, engineers can:

- Increase safety for complex systems.
- Customize protection to specific components or zones.
- Significantly improve maintainability and diagnostics.
- Adopt certification requirements across global markets.

HAZARDOUS AREA CLASSIFICATIONS:

Hazardous Areas are classified depending on the risk of an explosive substance being present. The classification is defined differently depending on the region and standards used.

North America and Canada use both Class, Division and Class, Zone based systems whereas regions working with IECEx or ATEX use a Zone classification.

Class, Division	AEx Zone	ATEX/IECEx	Definition
Class I, Div 1	Class I, Zone 0	Zone 0	Presence of an explosive gas atmosphere continuously, frequently or for extended periods
	Class I, Zone 1	Zone 1	Occasional presence of an explosive gas atmosphere under normal operation
Class I, Div 2	Class I, Zone 2	Zone 2	An explosive gas atmosphere is unlikely to occur in normal operation and if it does, disperses quickly
Class II, Div 1	Zone 20	Zone 20	Presence of an explosive cloud of dust in the air continuously, frequently or for extended periods
	Zone 21	Zone 21	Occasional presence of an explosive cloud of dust in air under normal operation
Class II, Div 2	Zone 22	Zone 22	An explosive cloud of dust in air is unlikely to occur in normal operation and if it does, disperses quickly
Class III, Div 1	-	-	Ignitable fibers and flyings present continuously or under normal operation
Class III, Div 2	-	-	The presence of ignitable fibers and flyings are not likely to be under normal operation

Even substances that are not typically flammable like grain or sugar can explode when in dust form at high enough concentrations.

PROTECTION CONCEPTS IECEX AND ATEX:

Table 1 below lists the types of protection methods and basic concepts of protection according to ATEX and IECEx standards for electrical equipment to operate or install in hazardous areas for flammable gases and dust.

EN/IEC 60079-0: *Equipment - General Requirements* applies in accordance with applicable standards for type of protection.

Type of Protection	EN/IEC Standard	Ex Symbol	Protection Concept
Flameproof Enclosure	EN/IEC 60079-1	Ex d / da / db / dc	Explosion containment, prevention of flame transmission
Pressurized enclosure	EN/IEC 60079-2	Ex p / pxb / pyb / pzc	Exclusion of Ex-atmosphere
Powder filling (Quartz/ Sand)	EN/IEC 60079-5	Ex q / qb / qc	Prevention of explosion diffusion
Liquid immersion	EN/IEC 60079-6	Ex o / ob / oc	Exclusion of Ex-atmosphere
Increased Safety	EN/IEC 60079-7	Ex e / eb / ec	No arcs, sparks or hot surfaces, enclosure IP54 or better
Intrinsic Safety	EN/IEC 60079-11	Ex i / ia / ib / ic	Limitation of spark energy and surface temperature
Pressurized enclosure/ ventilation	EN/IEC 60079-13	p/v	Exclusion of Ex-atmosphere / dilution
Non-Sparking	EN/IEC 60079-15	Ex nA / nC / nR	Enclosure IP54 or better (nA) No arcs, sparks, or hot surfaces, (nC) Explosion containment, prevention of flame transmission, (nR)Exclusion of Ex-atmosphere for a limited period,
Encapsulation	EN/IEC 60079-18	Ex m / ma / mb / mc	Exclusion of Ex-atmosphere
Intrinsic system	EN/IEC 60079-25	i	Limitation of spark energy and surface temperature
Equipment with protection level (EPL) Ga	EN/IEC 60079-26		Double protection concept
Inherently safe optical radiation	EN/IEC 60079-28	Ex op is / op sh / op pr	Limitation of radiation energy
Protection by enclosure	EN/IEC 60079-31	ta / tb / tc	Exclusion of dust
Special protection	IEC 60079-33	Ex sa / sb /sc	Specific measures

COMMON EX PROTECTION COMBINATIONS IN PRACTICE

FLAMEPROOF ENCLOSURE AND INCREASED SAFETY (EX D + EX E)

A flameproof (Ex d) enclosure houses sparking components like contactors, while an increased safety (Ex e) terminal box ensures safe wiring connections. This combination is common in motor starters and control panels.

INTRINSIC SAFETY AND INCREASED SAFETY (EX I + EX E)

An intrinsically safe circuit (Ex i) installed within increased safety enclosures (Ex e) to protect low-energy instrumentation in Zone 1 areas like sensors and transmitters.

PRESSURIZED ENCLOSURE AND INCREASED SAFETY (EX P + EX E)

A pressurized enclosure (Ex p) maintains a protective atmosphere, while Ex e terminals provide safe connections. This is ideal for control systems in Zone 2 where a pressurized/purged instrument cabinet contains process controller, power supply, I/O cards, and other equipment that are connected to field instruments using Ex e terminals for power and signal within the cabinet. It is very cost effective compared to Ex d protection type.

INTRINSIC SAFETY AND ENCAPSULATION (EX I + EX M)

With this combination of Ex protection methods, a sensitive electronic circuit that is intrinsically safe is encapsulated (Ex m) to keep it away from Ex atmospheres. Intrinsic safety limits the energy, while encapsulation physically isolates components from the Ex atmosphere.

STANDARDS AND CERTIFICATION

While Combining two or more Ex protection methods provides benefits, a engineers must pay careful attention to the EN/IEC 60079 series of standards, which outlines general and specific requirements for equipment used in explosive atmospheres.

In the U.S., the National Electrical Code (NEC) Article 500–506 provides parallel guidance, with Class/Division classifications and acceptable protection techniques.

For certification of combined protection methods, certification bodies may require:

- Overall system-level testing
- Documentation of interfaces between two or more protection methods.
- Maintenance procedures for the equipment.
- Zone classification alignment

Design and Engineering Considerations

- Temperature (T) Classification: Ensure the combined system meets the required T-rating.
- Ingress Protection (IP): Maintain IP ratings across all interfaces of equipment.
- Safe Maintenance Access: Design for safe inspection and repair procedures for the equipment.
- Fault Diagnostics: Design safe fault detection without compromising protection.

CONCLUSION

The combination of explosion protection methods in product design is not just a technical challenge, it is an opportunity to enhance safety, reliability, and global compliance of products. By understanding the strengths of each method and integrating them thoughtfully, engineers can build systems that are both robust and adaptable to the evolving demands of hazardous environments.

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EMC: THE HIDDEN FORCE POWERING OUR CONNECTED LIVES

Thelina Smith, Founder & Principal Consultant - Quality Catalyst
USNC Young and Emerging Professionals Committee member

Congratulations to our USNC Don Heirman Award Program recipient, Thelina Smith!

In today's hyper-connected world, our lives unfold through an ecosystem of electronic devices working in perfect synchronization—from medical devices in hospitals to wireless gadgets at home. Behind this seamless experience is a critical yet often underappreciated foundation: Electromagnetic Compatibility (EMC)—the discipline that ensures technologies can coexist safely and reliably. As someone whose career bridges biomedical engineering, quality, compliance, and international standards, I've come to understand EMC not just as a technical safeguard, but as the invisible infrastructure that underpins trust, safety, and innovation in our modern lives.

EMC IN EVERYDAY INTERACTIONS

This becomes most apparent in our everyday routines. From the moment we wake up and check our smartwatches to when we set our phones to charge at night, we interact with dozens of electronic devices. These devices send and receive electromagnetic signals that, without proper regulation, could interfere with one another. EMC ensures these interactions are smooth and safe.

Imagine making a mobile payment on a crowded subway platform, streaming music through wireless earbuds, and sending messages simultaneously. EMC is what prevents these overlapping signals from turning into a digital traffic jam. EMC failures don't just result in frustrating glitches—they can lead to system failures, data corruption, and in some cases, safety risks. In an environment filled with wireless chargers, Bluetooth connections, and AI-driven assistants, EMC is the unseen force maintaining balance.

In these everyday moments, EMC acts as the hidden infrastructure that ensures not only convenience, but the overall safety and stability of our increasingly connected world.

THE CRITIAL ROLE OF EMC IN HEALTHCARE

Healthcare settings powerfully demonstrate how essential this invisible protection is to safety and reliability. My background in biomedical engineering has given me firsthand insight into how even minor electromagnetic interference can jeopardize lives. In hospitals, precision and reliability are non-negotiable.

Consider a scenario where a patient's infusion pump, if exposed to interference from a nearby mobile device, delivers the incorrect dose. Or imagine an ECG machine providing a distorted reading because of an unshielded cable. In MRI suites, where magnetic fields are extremely strong, strict EMC protocols are critical to maintaining both diagnostic accuracy and patient safety.

From pacemakers to ventilators, these devices must undergo rigorous EMC testing to comply with international standards such as IEC 60601-1-2. These standards ensure that life-saving equipment operates reliably, even in environments saturated with electromagnetic signals. In healthcare, EMC is not a luxury—it's a life-preserving necessity.

EMC IN SMART HOMES AND CONNECTED CITIES

As we continue building smarter homes and cities, EMC takes on even greater significance. Our homes now include connected thermostats, EV chargers, wearable health monitors, and voice-activated assistants—all operating within the same electromagnetic environment. Without EMC controls, your electric vehicle charger might disrupt your Wi-Fi, or your neighbor's solar inverter could interfere with your smartwatch's heart rate monitor.

In urban settings, where thousands of devices interact in close quarters, a lack of EMC resilience can disrupt emergency communication systems, destabilize smart grids, or compromise smart infrastructure performance. EMC is the key to ensuring that technological interconnectivity does not come at the cost of reliability and safety. It allows us to build smart systems that are not only innovative but also dependable.

EMC AS A PILLAR OF COMPLIANCE, TRADE, AND TRUST

While EMC safeguards user experience, its role in regulatory and trade ecosystems is equally critical. Beyond technical design, Electromagnetic Compatibility (EMC) plays a central role in regulatory compliance and risk management. In my work in quality systems and compliance, I've seen firsthand how EMC requirements shape product development timelines, regulatory approvals, and international market readiness.

It is critical to ensure that products meet EMC standards before entering the market. Regulatory agencies such as the FDA enforce EMC requirements, guided by standards developed by international bodies like the IEC and ISO. Neglecting EMC considerations can result in product recalls, loss of certifications, and restricted market access. More importantly, such oversights can erode public trust and compromise user safety.

In an increasingly interconnected global marketplace, EMC compliance facilitates cross-border trade by ensuring consistent device performance across diverse environments. Strong Quality Infrastructure (QI)—including conformity assessment, accreditation, and metrology—ensures that EMC requirements are met reliably and transparently around the world.

Through Quality Infrastructure systems, EMC evolves from a behind-the-scenes process to a foundational component of global trust. It ensures that what works in one country will also function safely and predictably in another. By investing in QI, organizations and governments not only meet today's regulatory demands—they also strengthen their capacity to support the technologies of the future.

LOOKING AHEAD: EMC FOR AI, SUSTAINABILITY, AND CIRCULAR INNOVATION

Building on EMC's foundational role in compliance and trade, its relevance continues to grow as we look toward a future shaped by AI, digital infrastructure, and sustainable development.

As AI and digital systems become increasingly embedded into everyday life, EMC will continue to rise in importance. AI tools rely on real-time data streams, edge computing, and sensor inputs that are highly sensitive to even minor electromagnetic disruptions. Interference in these systems can result in delayed decisions, inaccurate outputs, or compromised safety—particularly in high-impact sectors such as agriculture, transportation, and emergency response.

At the same time, EMC is becoming a key enabler of sustainability. As industries and governments adopt circular economy models aligned with the UN Sustainable Development Goals (SDGs), the lifecycle of electronic products is being extended through reuse, refurbishment, remanufacturing, and redistribution. These practices support global priorities related to responsible consumption (SDG 12), climate action (SDG 13), and resilient infrastructure (SDG 9).

However, for these circular models to be scalable and safe, the ongoing electromagnetic performance of reused or repurposed devices must be rigorously revalidated. Devices repurposed from multiple sources—or deployed in new electromagnetic environments—may not behave as expected without proper EMC safeguards. This makes EMC not just a box to check, but a strategic requirement for environmental integrity and technical reliability.

EMC IS A CRITICAL BRIDGE BETWEEN SUSTAINABILITY AND SAFETY

To support this shift globally, it is essential to strengthen and harmonize Quality Infrastructure systems, especially in regions where testing capacity, accreditation frameworks, or regulatory oversight may be emerging. When EMC is embedded into circular economy frameworks, it ensures that environmental sustainability and technological integrity go hand in hand—fostering long-term trust, safety, and resilience across borders.

I believe EMC will be a defining pillar of digital sustainability and equity in the years ahead. Its role in enabling trustworthy AI, expanding sustainable trade, and protecting environmental health cannot be overstated.

CONCLUSION: EMC IS TRUST IN THE DIGITAL AGE

Electromagnetic Compatibility may be invisible, but its impact is profound. From safeguarding patients in hospitals to ensuring smart homes and cities operate seamlessly, EMC is the silent enabler of modern life. It protects not just our devices, but our safety, privacy, and peace of mind.

As a young professional navigating the intersections of biomedical engineering, compliance, and business strategy, I see EMC as more than a checkbox in product development. It is a foundation of trust, safety, and innovation in an interconnected world.

As the world continues to digitize and decentralize, EMC will be essential not just for innovation—but for inclusion, equity, and sustainability. The next generation of leaders must champion EMC not only as engineers, but as stewards of trust in the digital age.

In building a future defined by innovation, equity, and sustainability, EMC will not just support progress—it will protect it.

United States National Committee of the IEC

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