

THE ROLE OF STANDARDS FOR NUCLEAR ENERGY

BUILDING THE PATH TO SUSTAINABILITY WITH TECHNOLOGY – BY DESIGN

*EMPOWERING THE DEVELOPMENT OF STANDARDS AND SOLUTIONS THAT HELP MAKE
TECHNOLOGY BETTER, SAFER AND MORE SUSTAINABLE FOR THE BENEFIT OF INDUSTRY,
SOCIETY, HUMANITY AND THE PLANET.*

MAIKE LUIKEN, PHD

NPSS SCHOOL ON NUCLEAR POWER FOR SUSTAINABLE DEVELOPMENT, HO CHI MINH CITY, SEPTEMBER 9, 2026

ABOUT THE IEEE SA

- Responsible for all IEEE standards programs and is the IEEE interface in standards-related matters
- Empowering the development of consensus-based **standards and solutions that can help make technology safer to use and more sustainable for the benefit of industry, society, humanity and the planet.**
- Creating **collaborative spaces that engage people with diverse backgrounds** who look to solve challenges and explore opportunities with emerging and evolving technologies

BEFORE I SHARE MY OPINION...

“At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE.”

IEEE-SA Standards Board Operation Manual

WHAT IS A STANDARD?

- A **technical standard** is an **established norm or requirement about technical systems**.
- A **formal standard** is a **technical document developed by consensus that establishes uniform engineering or technical criteria, methods, processes and practices**.
- **De facto standards** are a **custom, convention, company product, corporate standard, etc. which becomes generally accepted and dominant**.

IEEE SA
STANDARDS
ASSOCIATION

IEEE Standard for Ethernet

Amendment 5:
Physical Layers Specifications and
Management Parameters for
10 Mb/s Operation and
Associated Power Delivery over a
Single Balanced Pair of Conductors

IEEE Computer Society

Developed by the
LAN/MAN Standards Committee

IEEE Std 802.3cg™-2019
(Amendment to IEEE Std 802.3™-2018
as amended by IEEE Std 802.3ab™-2018,
IEEE Std 802.3bt™-2018, IEEE Std 802.3cd™-2018,
and IEEE Std 802.3cn™-2019)

IEEE



STANDARDS

WE ALSO NEED TO KNOW...

...what standards are not!

They are not a design guide

They are not an implementation plan

They may not have the best technology

STANDARDS DEVELOPMENT ORGANIZATIONS (SDOs)

Process of developing a standard is typically facilitated by a Standards Development Organization (SDO)

SDOs facilitate the process of developing, distributing and maintaining a standard (but NOT enforcing)

SDOs adhere to fair and equitable processes that ensure the highest quality outputs and reinforce the market relevance of standards

SDOs such as IEEE, International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), International Telecommunication Union (ITU) and others offer **time-tested, auditable platforms, rules, governance, methodologies, and services that objectively address the standards development lifecycle, and help facilitate the development, distribution and maintenance of standards**



STANDARDS IMPROVE QUALITY OF LIFE

Standards are integral to the mission of IEEE

- Deliver technology to the marketplace
- Benefit humanity



STANDARDS GROW MARKETS



- Drive innovation
- Create global markets
- Protect health and public safety for centuries

IMPORTANCE OF GLOBAL STANDARDS



Former Intel CEO Craig Barrett on the importance of global standards:

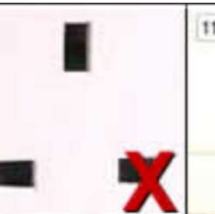
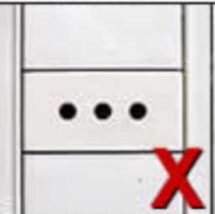
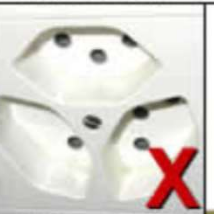
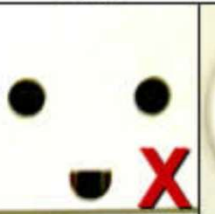
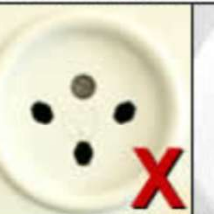
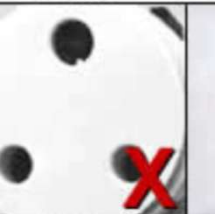
"When you have common interfaces and common protocols, everyone can **innovate** and **interoperate**. Companies can **build** their **businesses**, **consumers** can expand their **choices**, **technology** moves forward **faster**, and users get more **benefit**.."



"The world is getting smaller on a daily basis. Hardware, software and **content move independent of, and irrespective of, international boundaries**. As that increasingly happens, the need to have commonality and interoperability grows. **We need standards** so that the movie made in China or India plays in the equipment delivered in the United States, or the Web site in the United States plays on the computer in China."

Standards support users – global and / or local

➤ Local standards...

						
North America Grounded NEMA 5-15	Japan Non-grounded JIS C 8303	Europe German style CEE7/4 Schuko	Europe French style Schuko	Europe/Russia Non-grounded CEE7/16 Europlug	Great Britain Grounded BS-1363	Great Britain "Shaver socket" BS-4573
						
Australia/China Grounded AS-3112	Italy Grounded CEI 23-16	Switzerland Grounded SEV-1011	Denmark Grounded SRAE 1962/DB	Israel Grounded SI 32 (IS 16A-R)	India Grounded BS-546 "Small"	South Africa Grounded BS-546 "Large"

STANDARDS ARE PERVASIVE



```

end
end
WAIT_TO:
begin
  if(CRS)
    begin
      next_mod_148_3_state <= EARLY_RECEIVE;
    end
    if(plca_active && (curID == local_nodeID) && packetPending && (!CRS))
      begin
        next_mod_148_3_state <= COMMIT_STATE;
      end
      if((curID == local_nodeID) && (!packetPending) || (!plca_active) && (!CRS))
        begin
          next_mod_148_3_state <= YIELD;
        end
        if(to_timer_done && (curID != local_nodeID) && (!CRS))
          begin
            next_mod_148_3_state <= NEXT_TX OPPORTUNITY;
          end
        end
      end
    end
    EARLY_RECEIVE:
    begin
      if(!CRS && (local_nodeID != 0) && (rx_cmd != BEACON) && beacon_det_timer_done)
        begin
          next_mod_148_3_state <= RESYNC;
        end
        if(!CRS && (local_nodeID == 0))
          begin
            next_mod_148_3_state <= RECOVER;
          end
          if((local_nodeID != 0) && (!receiving) && ((rx_cmd == BEACON) || (!CRS) && beacon_det_timer_not_done)))
            begin
              next_mod_148_3_state <= SYNCING;
            end
            if(receiving && CRS)
              begin
                next_mod_148_3_state <= RECEIVE;
              end
            end
          end
        end
      end
    end
    COMMIT_STATE:
    begin
      if(TX_EN)
        begin
          next_mod_148_3_state <= TRANSMIT;
        end
        if(!TX_EN && (!packetPending))
          begin
            next_mod_148_3_state <= ABORT;
          end
        end
      end
    end
    YIELD:
    begin
      if(CRS && to_timer_not_done)
        begin
          next_mod_148_3_state <= EARLY_RECEIVE;
        end
        if(to_timer_done)
          begin
            next_mod_148_3_state <= NEXT_TX OPPORTUNITY;
          end
        end
      end
    end
    RECEIVE:
    begin
      if(CRS)
        begin
          next_mod_148_3_state <= NEXT_TX OPPORTUNITY;
        end
      end
    end
    TRANSMIT:
    begin

```

STANDARDS ARE EVERYWHERE



Over 100 standards for networking alone

Management RFC 1911 DNS (client) RFC 1912 Inet management Protocols RFC 2008 Link Aggregation RFC 2009 LACP Bridges RFC 2010 Priority RFC 2011 Multiple Spanning Trees RFC 2012 N classification by Protocol and RFC 2013 d Reconfiguration of Spanning RFC 2014 IEEE 802.3ad Link Aggregation Control Protocol (LACP) RFC 2015 IEEE 802.3af Power over Ethernet RFC 2016 IEEE 802.3x Flow Control RFC 2017 RFC 768 UDP RFC 2018 RFC 783 TFTP Protocol (revision 2) RFC 2019 RFC 792 ICMP RFC 2020 RFC 793 TCP RFC 2021 RFC 826 ARP RFC 2022 RFC 854 TELNET RFC 2023 RFC 868 Time Protocol RFC 2024 RFC 951 BOOTP RFC 2025 RFC 1058 RIPv1 RFC 2026 RFC 1350 TFTP Protocol (revision 2) RFC 2027 RFC 1519 CIDR RFC 2028 RFC 1542 BOOTP Extensions RFC 2029 RFC 2030 Simple Network Time Protocol (SNTP) v4 RFC 2030 RFC 2131 DHCP RFC 2031 RFC 2453 RIPv2 RFC 2032 RFC 2548 (MS-RAS-Vendor only) RFC 2033 RFC 3046 DHCP Relay Agent Information Option RFC 2034 RFC 3576 Ext to RADIUS (CoA only) RFC 2035 RFC 3768 VRRP RFC 2036 RFC 4675 RADIUS VLAN & Priority RFC 2037 UDLD (Uni-directional Link Detection) IP multicast RFC 2038 RFC 3376 IGMPv3 (host joins only) RFC 2039 RFC 3973 Draft 2 PIM Dense Mode RFC 2040 RFC 4601 Draft 10 PIM Sparse Mode	IPv6 RFC 1981 IPv6 Path MTU Discovery RFC 2375 IPv6 Multicast Address Assignments RFC 2460 IPv6 Specification RFC 2464 Transmission of IPv6 over Ethernet RFC 2710 Multicast Listener Discovery (MLD) for IPv6 RFC 2925 Definitions of Managed Objects for Remote Ping, Traceroute, and Lookup Operations (Ping only) RFC 3019 MLDv1 MIB RFC 3315 DHCPv6 (client and relay) RFC 3484 Default Address Selection for IPv6 RFC 3587 IPv6 Global Unicast Address Format RFC 3596 DNS Extension for IPv6 RFC 3810 MLDv2 (host joins only) RFC 4022 MIB for TCP RFC 4113 MIB for UDP RFC 4251 SSHv6 Architecture RFC 4252 SSHv6 Authentication RFC 4253 SSHv6 Transport Layer RFC 4254 SSHv6 Connection RFC 4291 IP Version 6 Addressing Architecture RFC 4293 MIB for IP RFC 4294 IPv6 Node Requirements RFC 4419 Key Exchange for SSH RFC 4443 ICMPv6 RFC 4541 IGMP & MLD Snooping Switch RFC 4861 IPv6 Neighbor Discovery RFC 4862 IPv6 Stateless Address Auto-configuration RFC 5095 Deprecation of Type 0 Routing Headers in IPv6 RFC 5340 OSPFv3 for IPv6 RFC 5453 Reserved IPv6 Interface Identifiers RFC 5722 Handling of Overlapping IPv6 Fragments MIBs RFC 1213 MIB II RFC 1493 Bridge MIB RFC 1724 RIPv2 MIB	RFC 1801 OSPFv2 MIB RFC 2021 RMONv2 MIB RFC 2096 IP Forwarding Table MIB RFC 2613 SMON MIB RFC 2618 RADIUS Client MIB RFC 2620 RADIUS Accounting MIB RFC 2665 EthernetLike-MIB RFC 2668 802.3 MAU MIB RFC 2674 802.1p and IEEE 802.1Q Bridge MIB RFC 2737 Entity MIB (Version 2) RFC 2787 VRRP MIB RFC 2863 The Interfaces Group MIB RFC 2925 Ping MIB Network management RFC 2819 IEEE 802.1AB Link Layer Discovery Protocol (LLDP) RFC 2819 Four groups of RMON: 1 (statistics), 2 (history), 3 (alarm) and 9 (events) RFC 3176 sFlow RFC 4113 ANSIS/TIA-1057 LLDP Media Endpoint Discovery (LLDP-MED) RFC 4291 SNMPv1/v2c/v3 RFC 4293 XRMON OSPF RFC 2328 OSPFv2 RFC 3101 OSPF NSSA RFC 5340 OSPFv3 for IPv6 QoS/CoS RFC 2474 DiffServ Precedence, including 8 queues/port RFC 2597 DiffServ Assured Forwarding (AF) RFC 2598 DiffServ Expedited Forwarding (EF) Security RFC 2819 IEEE 802.1X Port Based Network Access Control RFC 1492 TACACS+ RFC 2865 RADIUS (client only) RFC 2866 RADIUS Accounting RFC 2867 Secure Sockets Layer (SSL) RFC 2868 SSHv1/SSHv2 Secure Shell
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STANDARDS ARE INTEGRAL TO INDUSTRY

Heavy investments of:

- Money
- Personnel
- Time
- Expertise
- Intellectual Property



STANDARDS SUPPORT USERS

- **Customer Choice and Value**
- **Interoperability**
- **No vendor lock-in**



STANDARDS CAN DEFINE FUTURE DEVELOPMENTS

IEEE 802.11 originally conceived for linking cash registers
Today, society is benefiting from revolutionary mobile devices we couldn't have imagined a decade ago



STANDARDS SUPPORT INNOVATION

Innovation built on open standards:

- Open standards don't mean no innovation
- Innovation on how to implement the standards
- Innovation on how to process the information

“People often take the view that standardization is the enemy of creativity. But I think that standards help make creativity possible - by allowing for the establishment of an infrastructure, which then leads to enormous entrepreneurialism, creativity, and competitiveness.”

Vint Cerf, TCP/IP co-developer

<http://en.wikipedia.org/wiki/Vint_Cerf>

STANDARDS SUPPORT USERS - EVERYWHERE

Global standards...



Photo courtesy of Nepal Wireless

RECAP - WHAT ARE STANDARDS? WHY STANDARDS ARE IMPORTANT?

- Standards provide a consensus view of requirements or guidelines based on an industry technical area or need
- Standards establish common terminology and frameworks that ensure clarity in specifications and requirements.
- Standards lead to:
 - overall improved quality of installations
 - modularity.
 - ...
- Develop the framework from which design rules emerge.
- Standard designs form a baseline for performance
- Support product selection and procurement
- Support the development of regulations

IEEE SA PORTFOLIO OF PROGRAMS

Industry Connections

Pre-standardization work to explore and incubate new technology and its use

Standardization

Creating markets and protecting public safety through standards development

National Standards Adoption

Enabling widespread usage of IEEE standards

Membership

Getting connected to experts and resources and enabling advanced participation options

Conformity Assessment & Certification

Providing confidence and assurance and accelerating market adoption

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Assisting industry organizations in accelerating development and adoption of global standards

Learning & Development

Providing individuals and organizations with timely knowledge, resources and skills-training

Policy Engagement

Working with government bodies and policy makers on standards, policy & regulation matters

- IEEE Government Engagement Program on Standards (GEPS)
- IEEE SA Standards Fellowship Program

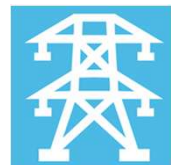
IEEE STANDARDS ASSOCIATION PRACTICES

Each **IEEE SA Practice** represents a **strategic epicenter** of stakeholders to address its **core questions**, i.e., meaningful problems, through foresight, planning, and growing relevant ecosystems within IEEE and with external stakeholders.



Connectivity & Telecom

- Rural Connectivity
- Consumer Connectivity
- Industrial Connectivity



Energy

- Smart Energy
- Electrification Solutions
- Energy Infrastructure



Foundational Technologies

- Industrial IoT
- Consumer Applications
- Infrastructure for Emerging Applications



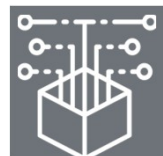
Healthcare & Life Sciences

- Clinical Health
- Pharmaceutical & Biotech
- Global Wellness



Mobility

- Safe Automated Mobility
- Sustainable Mobility
- Inclusive Integrated Mobility



New Frontiers & Emerging Spaces

- AI ethics & technology governance
- Age-appropriate design and children's data
- Planet Positive 2030, measurement, and accountability

IEEE STANDARDS ASSOCIATION ENERGY PRACTICE

Via its **Energy Practice**, IEEE Standard Association **works closely with IEEE societies and councils including the Power & Energy Society, Industry Application Society, Communications Society, and more** that have technical expertise for the energy practice, providing them the **platform to build consensus-based standards**.

See <https://standards.ieee.org/practices/energy/> for Upcoming Events, Standards & Projects, Products & Programs, and Industry Connections Activities



Smart Energy >

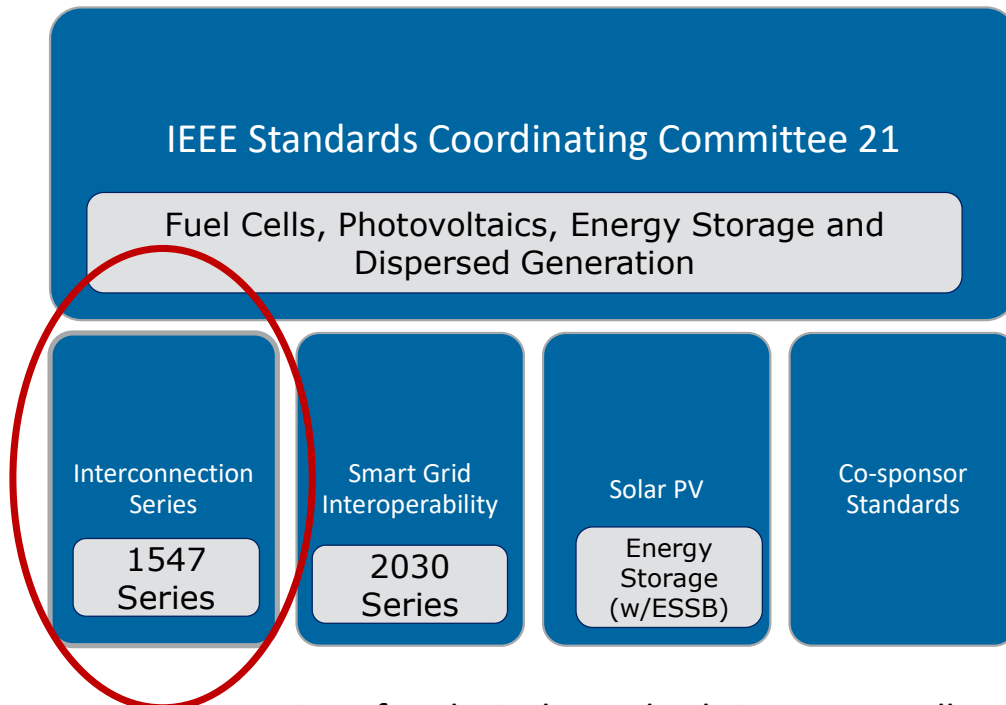


Electrification Solutions >



Energy Infrastructure >

IEEE SC21 OVERVIEW



Scope: The IEEE Standards Coordinating Committee 21 oversees the development of standards in the areas of fuel cells, photovoltaics, dispersed generation, and energy storage

Coordinates efforts in these fields among the various IEEE societies and other affected organizations

Ensures that all standards are consistent and properly reflect the views of all applicable disciplines.

Increases emphasis on communications interoperability and system control

Reviews and approves all standards in these sponsored areas

IEEE 1547 series of technical standards is a very well recognized series of standards for the interconnection of Distributed Energy Resources.

SUSTAINABLE ICT STANDARDS



HOMEABOUTBLOGEVENTSSTANDARDSSPOTLIGHTPODCASTSWEBINAR SERIESSearch

#SustainableICT

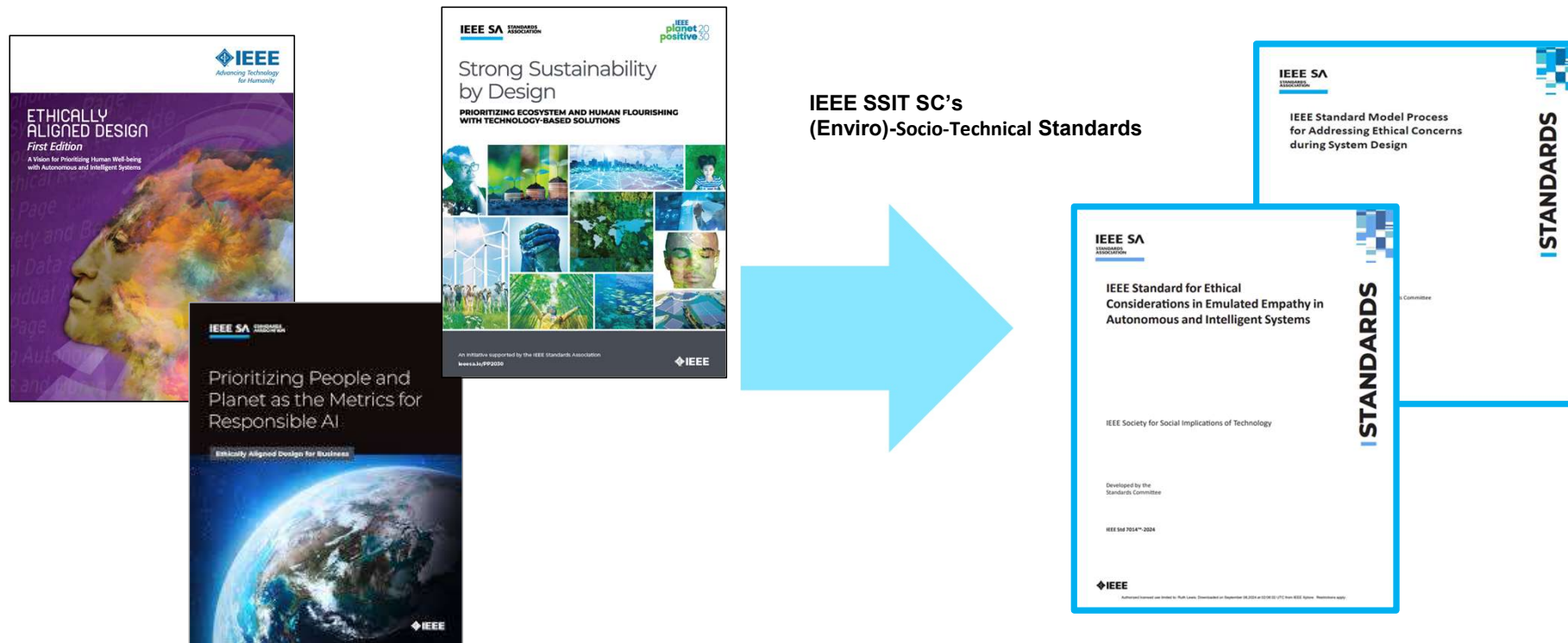


IEEE 1680 Series: a family of IEEE sustainability standards dealing with the assessment of environmental performance of electronic products

IEEE P1922.1™ - Standard for a method for calculating anticipated emissions caused by virtual machine migration and placement
IEEE 1922.2-2019™ - IEEE Standard for a Method to Calculate Near Real-Time Emissions of Information and Communication Technology Infrastructure
IEEE P1923.1™ - IEEE Standard for computation of energy efficiency upper bound for apparatus processing communication signal waveform
IEEE P1924.1™ - Recommended practice for developing energy efficient power-proportional digital architectures
IEEE P1925.1™ - Standard for Energy Efficient Dynamic Line Rate Transmission System
IEEE P1926.1™ - Standard for a Functional Architecture of Distributed Energy Efficient Big Data Processing
IEEE P1927.1™ - Standard for Services Provided by the Energy-efficient Orchestration and Management of Virtualized Distributed Data Centers Interconnected by a Virtualized Network
IEEE P1928.1™ - Standard for a Mechanism for Energy Efficient Virtual Machine Placement
IEEE P1929.1™ - An Architectural Framework for Energy Efficient Content Distribution

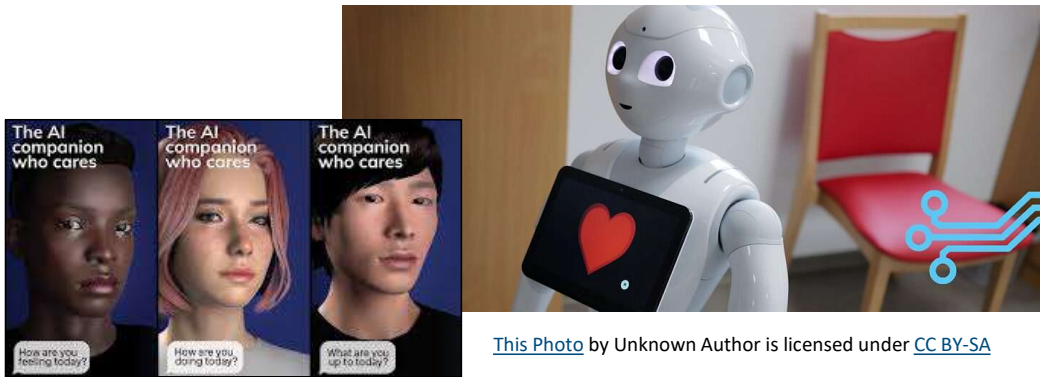
TECHNICAL STANDARDS – SOCIO-TECHNICAL STANDARDS

TECHNICAL STANDARDS INCORPORATING SUSTAINABILITY *BY DESIGN*



EXAMPLES OF IEEE SOCIO-TECHNICAL STANDARDS

IEEE 7014™-2024 Standard for Ethical Considerations in Emulated Empathy in Autonomous and Intelligent Systems



[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)

<https://replika.com/>

Provides guidance for the design and implementation of empathic AI systems that are prioritized to maximize human flourishing and protect users from bias, abuse, or exploitation.



IEEE P7017™ Recommended Practice for Design-Centered Human-Robot Interaction and Governance

Describes the 'compliance by design' in the area of human-robot interaction for socially assistive robots. Includes emotional, physical and religious robots.

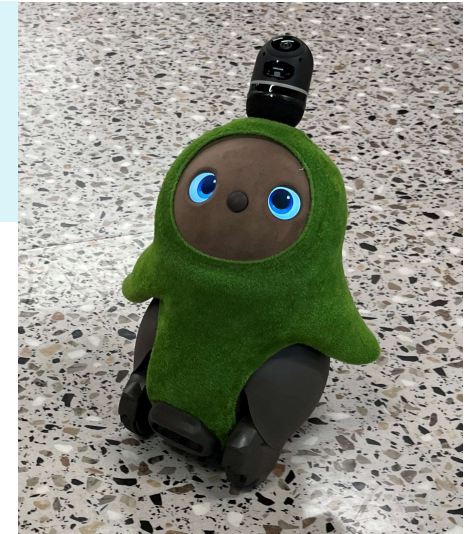


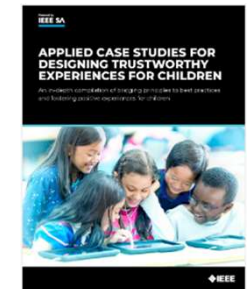
Photo by Ruth Lewis

DESIGNING TRUSTWORTHY ONLINE/CONNECTED ECOSYSTEMS FOR CHILDREN



In a world that is ever more connected, where online ecosystems take up ever more time, and where AI characters are made to appear like friends, how do we protect children from addiction and unrealistic expectations. *How can he help to **give children back their childhood**?*

- Societal pressure and political momentum is building with **UN resolutions, laws and regulations in UK, EU, Australia, Indonesia, US States**, and more ...
- IEEE Standards can provide the processes to enable meeting those requirements in practice
- **IEEE 2089™ family of standards, including Standard for Age-Appropriate Digital Services Framework, based on the 5Rights Principles for Children**
- IEEE Ethically Aligned Design, IEEE 7000™ family of standards around AI ethics and other AI governance work



In the News

IEEE age-appropriate design work with Indonesia leads to first-of-its-kind regulation >
Biometric Update



Blog Post

IEEE SA Works Towards Safer, Age-Appropriate Internet for Kids >
Jon Labrador & Moira S. Patterson |
Beyond Standards

[IEEE SA - Enabling Trustworthy Digital Experiences for Children](#)

IEEE SA PORTFOLIO OF PROGRAMS



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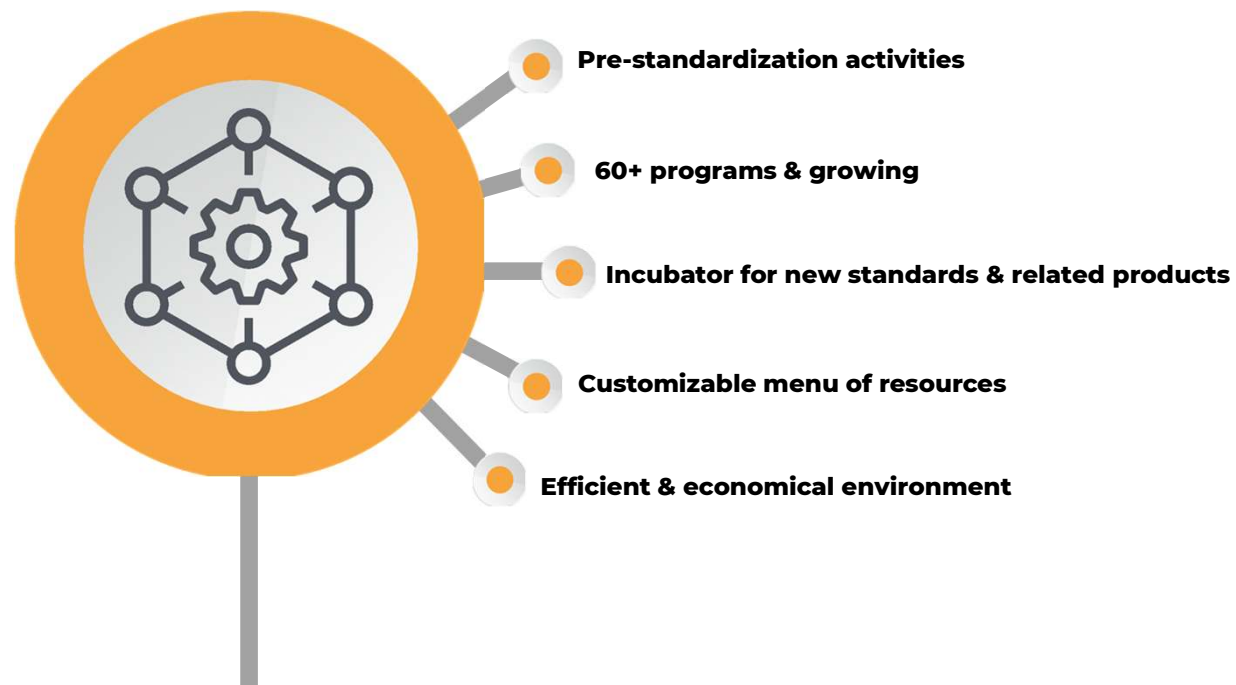
Providing individuals and organizations with timely knowledge, resources and skills-training

Policy Engagement

Working with government bodies and policy makers on standards, policy & regulation matters

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IEEE SA INDUSTRY CONNECTIONS



INDUSTRY CONNECTIONS ACTIVITIES

Current IC Activities Related to the Electric Power Grid

- Sustainable Maritime
- Data Centers – Standards Needs Analysis and Recommendations
- **Accelerating Deployment of Advanced Nuclear Power Generation**
- Electric Energy Resources Interconnection Standards Collaborative
- Green Hydrogen
- Low Carbon Building Electrical Technology
- Marine Carbon Dioxide Removal (mCDR)
- Open Data Center Initiative
- Supply Chain and Asset Traceability for Electric Grid (SCATE)

All Activities: <https://standards.ieee.org/practices/energy/industry-connections-activities/>

Industry Connections Activities are focused on incubating new or developing technologies that are being explored for future Standards Activity. Most of the IEEE SA Industry Connections Activities meet via web meetings.

RELATED STANDARDS DEVELOPMENT



FOR MORE INFORMATION, APPROVED STANDARDS SEE: [IEEE SA - SUSTAINABLE DEVELOPMENT](#)

- **P7800™** Recommended Practice for Addressing Sustainability, Environmental Stewardship and Climate Change Challenges in Professional Practice: <https://standards.ieee.org/ieee/7800/11039/>
- **P7801™** Recommended Practice for Technical Knowledge Commons Initiatives and Platforms: <https://standards.ieee.org/ieee/7801/11197/>
- **P7802™** Standard for Measurement and Verification of Reduction of Greenhouse Gases for Climate Action Projects and Solutions: <https://standards.ieee.org/ieee/7802/11238>
- **P7803™** Recommended Practice for Inclusive Sustainable Smart Cities: <https://standards.ieee.org/ieee/7803/11412/>
- **P3469™** Standard for an Environmental Liability Process Model for Accounting in Systems Engineering: <https://standards.ieee.org/ieee/3469/11608/>
- **P7100™** Standard for Measurement of Environmental Impact of Artificial Intelligence Systems: <https://standards.ieee.org/ieee/7100/11671/>

Raising the world's standards through collaboration: locally and globally

IEEE STANDARDS DEVELOPMENT - ADDRESSING SOCIETAL CHALLENGES

➤ AI Systems

Built practical approaches and solutions for **ethically aligned design and use** of AI technology and systems

➤ Cybersecurity

Addressing key and critical aspects of cybersecurity through **technical frameworks and standards**

➤ Age-Appropriate Design

Developing standards and establishing frameworks and processes for age-appropriate digital services and **protecting children's data**

➤ Sustainability & Climate Change – Energy Systems Transformation

Focused on **aligning technical innovation with sustainability and developing solutions** to help critical sustainability and climate change issues

➤ Next Generation Connectivity & Telecommunications

Exploring and putting into practice solutions for robust, responsible and affordable connectivity

➤ Digital Transformation and Governance

Exploring approaches and solutions to help **ensure safe, responsible and resilient digital transformation** with practical governance throughout the digital transformation journey



IEEE SA - WHAT WE DO



Adhere

to the World Trade Organization (WTO)
Principles for International
Standardization



Support

a framework of open participation
and diversity



Work

within the principles of: Direct Participation,
Due Process, Broad Consensus, Balance,
Transparency and Openness



Embrace

new ideas and technologies, and welcome
new communities of interests and work



Provide

time-proven and respected structures
and processes



Ignite

collaboration that crosses borders,
disciplines and markets

IEEE SA IEEE STANDARDS DEVELOPMENT PROCESS

Stages in the IEEE Standardization Process

Working with a framework of open participation and diversity, IEEE's unique, borderless standardization paradigm espouses competition and at the same time collaboration among a wide variety of stakeholders to create standards that drive innovation and national and global growth.

2. PROPOSAL

The group submits a proposal for a standard. If approved, the project moves forward and a Working Group is formed.

4. VOTING

A diverse group of individuals or entities with an interest in the standard votes to approve/disapprove the draft standard. Broad consensus must be obtained. If approved, the IEEE Standards Board votes on it.

1. IDEATION

A diverse group of expert individuals or organizations sees a need for a standard—e.g., to grow the market, ensure interoperability, spread adoption of a promising technology—and comes together to develop it.

3. DRAFTING

The Working Group makes agreements and compromises to create the standard with its technical specifications, often using existing technology/documentation contributed by one or more members of the group.

5. PUBLICATION and MAINTENANCE

Once the standard is approved, it is available for use around the world. Updates are made as needed during the lifetime of the standard.

IEEE SA STANDARDS DEVELOPMENT PROCESS PROTOCOLS

Protocols intended to ensure

➤ Consensus

e.g. 802.11 Standards require 75% approval through two sequential ballot series. Typically, 95% approval is achieved.

➤ Due process

Documented process. Checks and balances.

➤ Openness

Access to documents, meetings etc... is open to all (although fees may apply).

➤ Balance

Standards development process aims to satisfy the requirements of the majority, while protecting the rights of the minority

LET'S RECAP - THE ROLE AND IMPACT OF STANDARDS?

- Tailored Standards establish **interoperability**, simplify product development, and speed time-to-market as well as **scalability**
- Standards improve **safety and reliability** of the processes, materials, products, methods, and/or services people use every day; increasingly looking at standards for sustainability and ethical considerations
- Standards form the fundamental building blocks for product development by **establishing consistent protocols** that can be universally understood and adopted
- Standards make it easier to understand and **compare** competing products
- As standards are globally adopted and applied in many markets, they also help with **international trade**
- Standards fuel **innovation, the development and implementation of technologies** that influence and transform the way we live, work and communicate



LET'S REPEAT – THE IMPACT OF GLOBAL STANDARDS – IS HUGE



Ensure interoperability

Facilitates compatibility and seamless communications between different devices and systems, ensuring they work together



Reduce costs & increases efficiency

Streamlines development and production processes, reducing costs and increasing efficiency through standardized practices and protocols



Promote innovation

Provides a robust framework that encourages technological advancements and innovation by setting clear and consistent guidelines



Global market access

Enables products and services to meet international standards, facilitating entry into global markets and helping to ensure broader adoption



Enhance quality & reliability

Establishes high standards for performance, safety and reliability, leading to improved product quality and consumer trust



Support regulatory compliance

Assists in meeting regulatory requirements and achieving compliance with laws and regulations, reducing legal risks and fostering consumer protection

ASPECTS OF STANDARDS IN THE NUCLEAR INDUSTRY

STANDARDS FROM A NUCLEAR SAFETY PERSPECTIVE

Principles

Requirements

Guidance / codes

Licensing evidence

Standards are the technical and governance infrastructure that makes nuclear safety demonstrable, supply chains qualifiable, designs licensable, and SMR replication plausible.

WHY STANDARDS MATTER

Nuclear facilities are long-lived, high-consequence socio-technical systems. Their safety case depends on consistent interfaces among physics, engineering, software, people, organizations, emergency arrangements, supply chains, security and waste management. **Standards turn broad objectives into criteria that can be specified, verified, audited and improved.**

Protection	Translate radiation protection, confinement, heat removal and emergency preparedness into assessable requirements.
Licensing evidence	Create a common language and accepted methods for the regulator's independent review of a safety case.
Supply-chain qualification	Define material, fabrication, testing, traceability and quality expectations for safety-significant items.
Lifecycle integrity	Link construction, commissioning and operation to inspection, ageing management, repair, waste and decommissioning.
Digital resilience	Set expectations for safety-classified instrumentation and control (I&C);, software assurance, electrical systems and cybersecurity.
Trust and investability	Reduce avoidable uncertainty while preserving demonstrable public protection.

THE STANDARDS ECOSYSTEM – SAFETY STANDARDS

Safety Fundamentals articulate enduring principles.

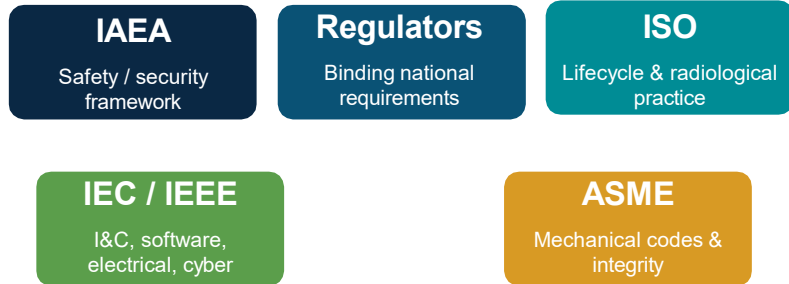
Safety Requirements state what must be achieved.

Safety Guides and consensus codes offer recommended approaches, detailed engineering rules and common practices.

National regulation and licences make applicable requirements enforceable for a particular jurisdiction and facility.

The IAEA (International Atomic Energy Agency) hierarchy includes SF-1, the General Safety Requirements series, Specific Safety Requirements, and Safety Guides. The IAEA framework covers safety throughout the facility lifetime; it is complemented—but not replaced—by nuclear security guidance and national safeguards obligations.

WHO DOES WHAT? – NO SINGLE BODY COVERS THE ENTIRE LIFECYCLE



ISO International Organization for Standardization

IEC International Electrotechnical Commission

ASME American Society of Mechanical Engineers

WENRA Western European Nuclear Regulators Association

IAEA	SF-1; GSR Parts 1–7; SSR-2/1 (Rev. 1), <i>Safety of Nuclear Power Plants: Design</i> ; SSR-2/2 on commissioning and operation; Safety Guides including SSG-39 on I&C;
ISO/TC 85	Peaceful nuclear applications, radiological protection, installations and reactor technologies; includes work through SC 2, SC 5 and SC 6.
IEC TC 45 / SC 45A	Nuclear I&C;, electrical power, software, safety classification and cybersecurity: IEC 61226, 61513, 60880, 62138, 62645, 62859 and related publications.
IEEE SA	Safety-system functional and design criteria, digital devices, testing and electrical/I&C; practice: IEEE 603, IEEE 7-4.3.2, IEEE 336, P63160.
ASME	BPVC Section III for construction of nuclear facility components; Section XI for in-service inspection, repair and replacement.
WENRA / regulators	Reference levels, harmonization dialogue and binding national requirements; WENRA’s safety objectives are considered a minimum expectation for SMRs.

SMRS CHANGE THE STANDARDS PROBLEM

SMR is not a single technology. It includes light-water designs, high-temperature gas-cooled reactors, liquid-metal-cooled fast reactors, molten-salt concepts, microreactors and other configurations. Their shared commercial proposition—repeatable modules, factory production and multi-unit sites—makes standards portability central to both safety and economics.

SMR promise	Standards implication
Factory manufacture and serial production	Requires repeatable quality records, design configuration control, module interfaces, inspection acceptance and regulator confidence in factory oversight.
Passive safety	Requires credible methods to characterize reliability, physical dependencies, environmental conditions and long-duration performance.
Multi-unit sites and shared control rooms	Requires analysis of common-cause events, staffing workload, shared systems, concurrent accidents and aggregated releases.
Higher digitalization / remote support	Requires integrated safety, software assurance, cybersecurity, human-factors and supply-chain controls.
International deployment	Requires alignment of codes, terminology, evidence formats and regulator expectations while retaining sovereign national decision-making.

HIGH-PRIORITY THEMES

Multi-module safety	Concurrent events, shared systems, aggregated releases, control-room workload, operator staffing, common-cause failures and shared emergency arrangements.
Passive-system assurance	Consensus methods for failure modes, reliability claims, model validation, degradation, environmental dependencies and long-duration heat removal.
Advanced technologies	Technology-specific methods for source terms, thermal hydraulics, fuel behavior, materials and confinement for non-water-cooled reactors.
Digital and cyber	Automation authority, AI-enabled diagnostics, remote access, patching, supplier software, safety-security integration and human-machine interfaces.
Manufacturing and interfaces	Factory inspection, digital traceability, transport and site integration, advanced manufacturing qualification and fleet configuration control.
Licensing evidence	Common safety-case templates, equivalence of codes, joint reviews and proportionate recognition of qualified evidence.

STANDARDS OPPORTUNITIES?

1. Passive safety

Passive features may reduce reliance on active equipment, but a credible safety case must address physical failure modes and dependencies—not simply label a system “passive.” The SMR Regulators’ Forum has highlighted the absence of a generally accepted methodology for assessing reliability of passive safety systems, even though national guidance may set quantitative expectations.

2. Multi-module operations

The conventional single-unit lens is inadequate when several reactor modules share control rooms, operators, heat sinks, water inventories, site services, maintenance resources or emergency arrangements. Standards should state how independence, redundancy, staffing and aggregated off-site consequences are demonstrated.

3. Digital systems, cybersecurity and AI

IEC 62645 provides a cybersecurity basis for nuclear I&C; and electrical systems, while IEC 62859 addresses coordination of safety and cybersecurity. Emerging SMR architectures require more implementation guidance on remote operation support, lifecycle patching, software supply-chain security, digital twins and AI/ML used for diagnostics or maintenance.

4. Novel fuel, materials and waste

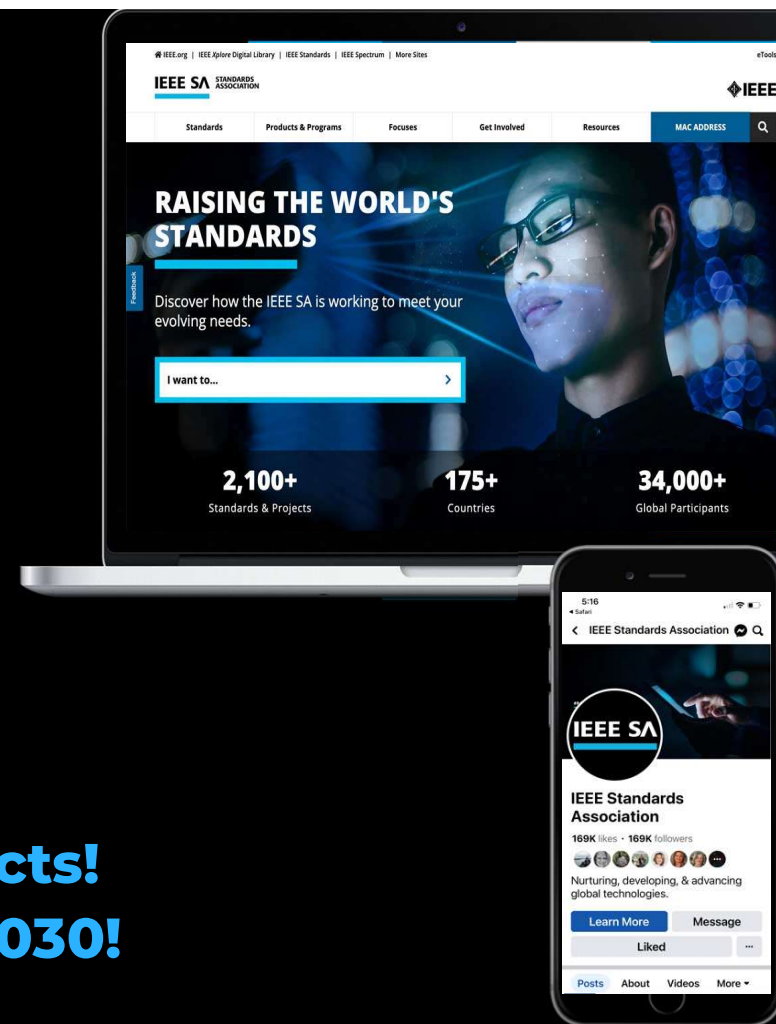
New fuel forms and coolants can alter qualification evidence, criticality assumptions, radionuclide behavior, waste characterization, transport and eventual disposal pathways. Lifecycle standards activity must begin early in design—not after the technology reaches deployment.



GETTING INVOLVED

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I am Committed to a Better World for All

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Education is the Catalyst of Sustainability
Interaction is the Catalyst of Innovation

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Sarnia-Lambton brings together Natural Beauty, Education, Industry and Agriculture on the shore of Lake Huron with easy access to the Canadian and US markets.



SELECTED SOURCES AND STANDARDS

1. International Atomic Energy Agency (IAEA), *Fundamental Safety Principles*, IAEA Safety Standards Series No. SF-1, Vienna.
2. IAEA, *Safety of Nuclear Power Plants: Design*, Specific Safety Requirements No. SSR-2/1 (Rev. 1), 2016.
3. IAEA, *Applicability of IAEA Safety Standards to Non-Water Cooled Reactors and Small Modular Reactors*, Safety Reports Series No. 123, 2023. The review examines lifetime applicability, areas of novelty, gaps and further considerations.
4. IAEA, General Safety Requirements series: GSR Part 1 (Rev. 1), GSR Part 2, GSR Part 3, GSR Part 4, GSR Part 5, GSR Part 6 and GSR Part 7.
5. International Electrotechnical Commission (IEC), IEC 61226; IEC 61513; IEC 60880; IEC 62138; IEC 62645:2019; IEC 62859:2016; and IEC TR 63335:2021.
6. IEEE Standards Association, IEEE 603-2018; IEEE 336-2020; IEEE P63160 (draft/project information).
7. ASME Boiler and Pressure Vessel Code, Section III, *Rules for Construction of Nuclear Facility Components*, and Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*.
8. ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, including the work of SC 2, SC 5 and SC 6.
9. Western European Nuclear Regulators Association (WENRA), work on safety objectives and applicability to SMRs.