NRC STANDARDS FORUM

IEEE Certification for Nuclear Qualified Electrical Equipment

Thomas Koshy, Vice Chairman

Nuclear Power Engineering Committee

Agenda

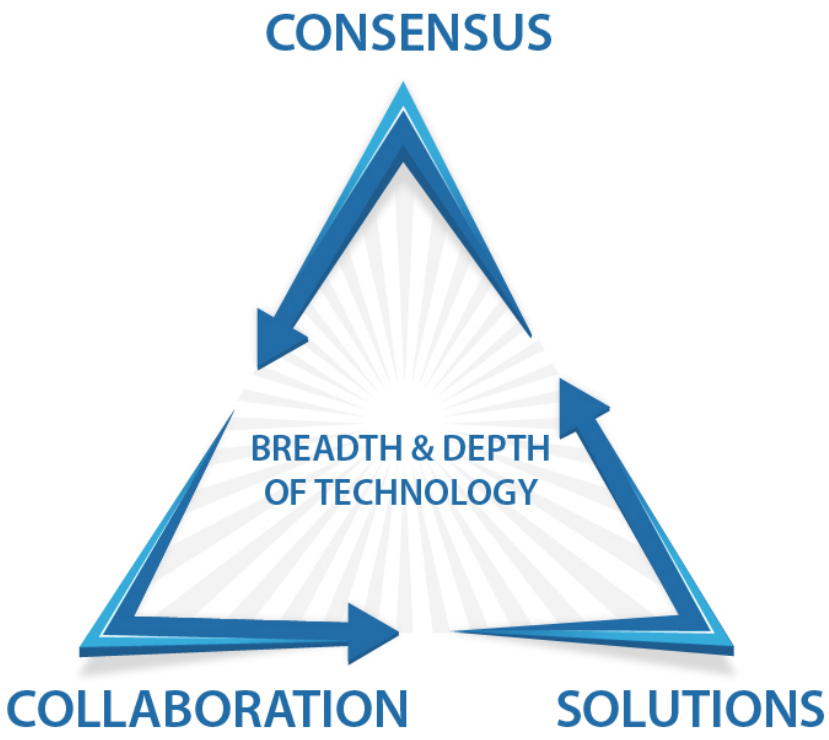
- IEEE Conformity Assessment Program (ICAP) - Certification
- International Collaboration
- Standards for Current Nuclear Power Operating Fleet
- Standards for Future Reactors

IEEE-SA Rigorous Standards Process

IEEE STANDARDS ASSOCIATION

- Consensus
- Due Process
- Openness
- Right of Appeal
- Balance

The widely respected IEEE-SA standards-development process produces results that reflect the collective, consensus view of participants and enables industry to achieve specific objectives and solutions



Benefits of IEEE Conformity Assessment Program (ICAP) -- Certification

- Mitigate the uncertainties 1E electrical equipment procurement.
- Cost savings on source verification and audits
- Limit fraudulent product issues
- Independent assessment on compliance to the standard and in turn to the regulatory requirements

Industry Issues

- Counterfeit, Fraudulent & Sub-Standard parts
  - USNRC Notice 2008-04
    - Plant Hatch – Counterfeit Stator Water cooling stop check valves
    - CPSC recalls counterfeit circuit breakers labeled "Square D"
  - CNSC in February 2014 acknowledged increased occurrence of CFSI and the proactive measures they were putting in place
  - In 2012 Executive Director of IEA indicates that countries should be vigilant and well resourced to take appropriate decisions
- Investigations conducted in 2012 concludes that:
  - More than 8000 parts found in the past decade
  - Impacted 11 nuclear power units
  - Doctoring of test reports, false certificates and misrepresented test data

Impact

- Time delays
  - Construction delays
  - Shutdowns from faulty equipment
- Added expenditure from independent Quality Assurance Audits, inspection & verifications
- Potential loss of public trust

Goals of NPEC Conformity Program

- Class 1E devices used by end users in nuclear power facilities should conform to IEEE 323 standard
- Class 1E device conformity should be certified
- Conformance should be assessed by third party authorized independent experts and/or authorized test laboratories
- Certified devices may bear an IEEE certification logo and listed on a public registry managed by IEEE

Major Stakeholders

- **Utility & Plant owner Benefits**
  - Ability to leverage a common, shared resource for certification and testing
  - Expanded base of compliant suppliers
  - Interoperability to minimize risks of deployment choices
  - Lower occurrence of fraudulent and non-compliant products
- **Vendors**
  - Expanded potential national and global market
  - Reduced burden for utility required testing
- **Regulatory Agencies & Local governments**
- **Plant designers and engineers**
- **EQ testing facilities**
- **Insurers**

SEAMLESS INTEGRATION BETWEEN IEEE CERTIFICATION PROGRAM PARTICIPANTS

IEEE Process

Accredited Labs

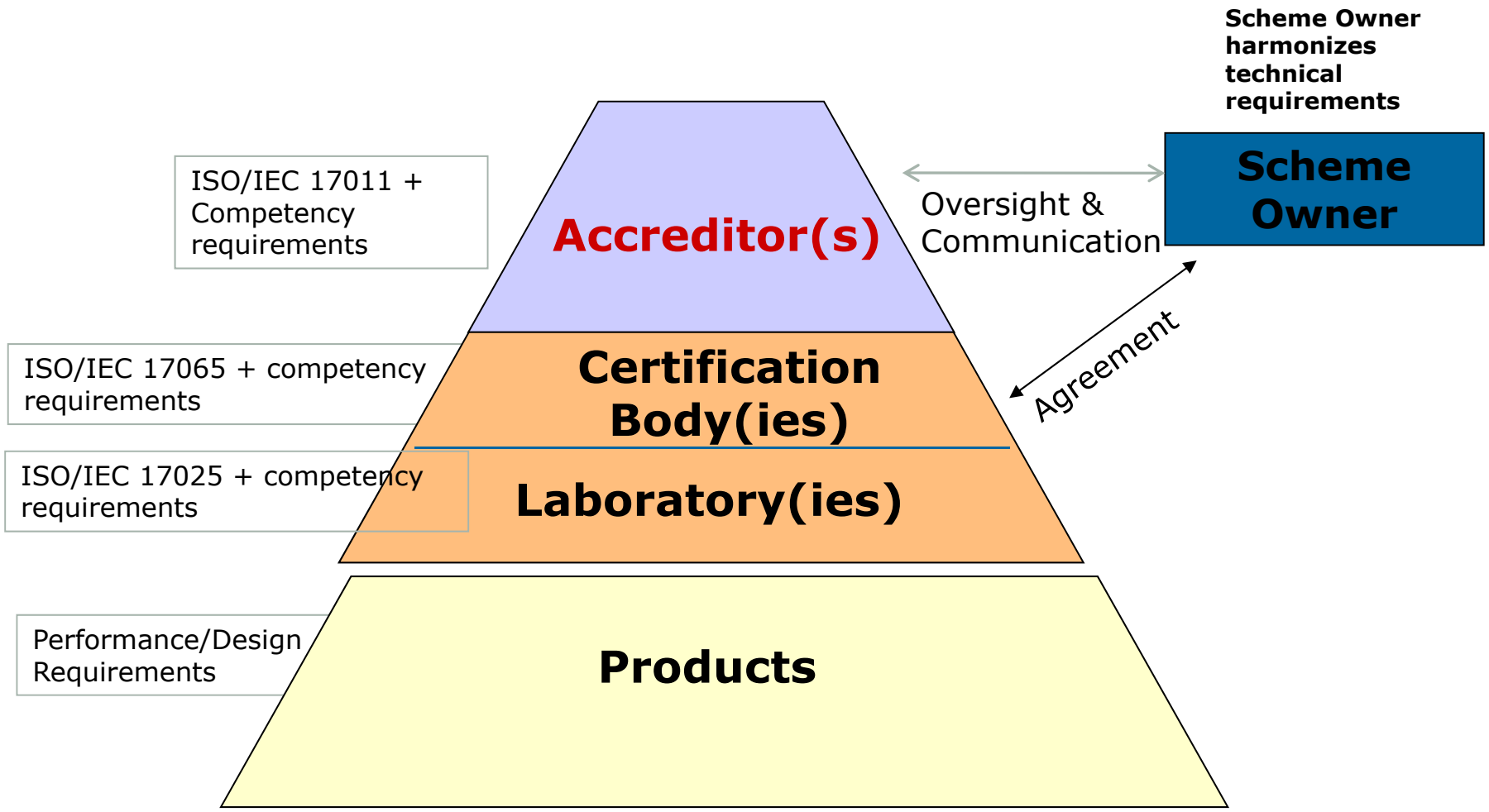
Certified Products

Nuclear Power Plants

NPEC Conformity Assessment Steering Committee

- ICAP Committee of invited subject matter experts from utilities, regulators, manufacturers, testing laboratories and independent consultants
  - Formed in October 2014
- Chaired by Jonathan Cornelius (Tyco) and John White (Past SC2 Chair)
- Participation from North America, China and Europe
- Developing Lab auditing and qualification process
- Developing Equipment certification process
- Developing test report template
- Determining requalification and re-testing frequencies

Conformity Assessment
Certification Scheme – Single Scheme



Courtesy of G.Gillerman @ NIST

Lab Accreditation – Planned Process

- All IEEE Approved testing facilities will be:
  - Audited for their technical competence and quality systems
    - Utilizing ISO/IEC 17025 standard and relevant IEEE NPEC stds.
  - Qualified to one of THREE categories
    - Category 1 – Lab can perform testing independently
    - Category 2 – Lab can perform testing after IEEE approval of test plan
    - Category 3 – Lab can perform testing under IEEE witness
  - Audited every 3 years
  - Published and listed on the IEEE Certification Program website

Lab Accreditation – Planned Process

- Three labs have been identified as pioneer labs
  - Curtiss Wright, Kinetrics & NTS
  - MoUs were signed in 2015
  - Planning for IEEE audits in Q3/4 2016
- IEEE Audit Checklist
  - Encompasses NUPIC, NQA-1, NAIC, 10 CFR 50 Appendix B requirements
  - Assessment of laboratory quality systems based on ISO/IEC 17025
- Audit Process
  - Documentation audit - conducted before onsite
  - IEEE will assemble audit team – composed of QA & technical experts
  - To assess lab's technical competence to test to IEEE stds

Audit Scope

- **IEEE 323**
  - Aging
    - Pressure and temperature profile
    - Relative humidity
    - Thermal Aging
    - Thermal Cycling
    - Radiation environment *
    - Non-seismic vibration
    - Operating cycles
    - Mechanical Cycling
    - Electrical loading and transients
    - Qualified Life
  - Design Basis Accidents
  - Condensation, chemical spray, and submergence
  - EMI/RFI and power surges
  - Flammability (where applicable)*
- **IEEE 344 – Seismic**
  - Seismic operating basis earthquake (OBE)
  - Seismic Safe Shutdown Event (SSE)

Product Certification – Planned Process

- All Certified Devices:
  - Shall be tested at an IEEE Approved testing lab
  - Have test reports that are reviewed by an IEEE technical reviewers prior to certification
  - All manufacturers undergoing certification shall sign the IEEE certification agreement
  - Shall undergo periodic evaluation to ensure compliance
  - Shall be published and listed on the IEEE Certified Products Registry
  - Will utilize the IEEE Certification Logo on the product and marketing materials
  - Unique, traceable certification number will be provided by IEEE

Product Certification – Grandfathering

- Product must be available for sale
- Report must be in IEEE format and reviewed by IEEE Technical reviewers
- Equipment used to perform testing must have been calibrated with NIST certification or equivalent
- Product has to be previously qualified by:
  - An IEEE accredited lab or their predecessors or
  - An original equipment manufacturer (OEM) with a qualified product, can submit product as an accredited vendor for IEEE certification under their QA program.
    - Any manufacturing changes (including locations) must be addressed;
    - Change in materials must be identified and addressed
    - NRC Part 21 notices (including sub-components must be reviewed and addressed
    - Design changes evaluated (changes in parts and sub-components) and determined not to impact qualification
    - Change in owners
    - Changes in form, fit and function must be evaluated

Product Certification Grandfathering

- Test anomalies must be IEEE reviewed and disposition concurred with
- Radiation certificates must be provided
- Test samples must be specifically identified, including part numbers of what was tested e.g. auxiliary switch, auxiliary contacts, etc.
- IEEE registry to differentiate grandfathered vs. newly tested product.

ONE COMMON PLATFORM

REPRESENTATIVE "PROCESS SPECIFIC" ADAPTABILITY

DIGITAL REFERENCE + DATA ENTRY + EQUIPMENT DETAILS + TRENDING + SCHEDULING + INTEGRATION

IEEE ICAP CLEARINGHOUSE

Specific Attributes

- List of Accredited Labs
- Listing of Certified Products
- Equipment Types
- Product Verification
- Test Report Validation
- Accreditation Requests
- Grandfathering Requirements

IEEE ACCREDITED LABS

Specific Attributes

- Test Specification
- Test Plans
- Test Reports
- Specific References
- Specific Certified Products
- IEEE Standards Met
- Certification Level
- Authorized Personnel

IEEE CERTIFIED PRODUCTS

Specific Attributes

- Manufacturer Listings
- Certified Products Available
- Vendor Test Reports
- IEEE Standards Met
- Test Report Summary

IEEE CERTIFIED TEST REPORT

Specific Attributes

- Standardized Qualification Evaluation
- Status and Revision History
- Test & Calibration Details
- Qualified Life Calculator
- Activation Energy Calculation
- Maintenance Requirements
- Direct Package Update

EQ PACKAGE Plant Data

Specific Attributes

- Site Specific Data
- Integrated with ICAP Test Report
- EQ Maintenance Manual
- Qualified Life Extension
- Site Specific References

IEEE Certification Mark

- Suggested Certification Mark for Class 1E product certification

IEEE

Certified™

FILE # / Category

NPEC XXXXX

Other reading materials

- Proposed IEEE Conformity Assessment Program White Paper available
  - http://www.techstreet.com/ieee/products/1904401
- EnergyBiz Article
  - http://community.energycentral.com/community/energy-biz/new-standard-simplifies-process-qualifying-nuclear-safety-equipment
- Recent Press Releases
  - http://standards.ieee.org/news/2016/iec_ieee_60780_323.html
  - http://standards.ieee.org/news/2015/nuclear_mous.html

International Collaboration - International Electro-technical Commission (IEC)

Joint Standards Issued

Standard	Year	Title
62582-1	2011	Nuclear power plants - Instrumentation and control important to safety - Electrical equipment condition monitoring methods - Part 1: General
62582-2	2011	Nuclear power plants - Instrumentation and control important to safety - Electrical equipment condition monitoring methods - Part 2: Indenter modulus
62582-3	2012	Nuclear Power Plants - Instrumentation and control important to safety - Electrical equipment condition monitoring methods - Part 3: Elongation at break
62582-4	2011	Nuclear power plants - Instrumentation and control important to safety - Electrical equipment condition monitoring methods - Part 4: Oxidation induction techniques
P60780-323	2016	Qualification of Electrical Equipment Important to Safety for Nuclear Facilities REGULATORY GUIDE 1.89 - to be revised

Joint Standards with IEC Under Development

Project	Type	Title
IEEE-344	Revision	Seismic Qualification of 1E Equipment
IEEE-1082	Revision	Human Action Reliability Analysis for Nuclear Power Generating Stations. THE NEW REVISION WILL BE ADOPTED BY IEC
P62582-5	New	Nuclear Power Plants - Instrumentation and control important to safety - Electrical equipment condition monitoring methods Part 5: Optical time domain reflectometry

International/ National Collaborations

- IEEE membership collaboration in NPEC with Japan, Germany, China, India, Sweden, etc.
- Joint Committee with ANS
- Nuclear Energy Institute Participation
- EPRI
- Nuclear Utility Group on Equipment Qualification

NRC Utilization of IEEE Standards

- Incorporated into Regulations
- Endorsed through Regulatory Guides
- Referenced in Standard Review Plan for license applications / amendments

Areas of Standards Endorsed Through Regulatory Guides

- Battery, sizing, maintenance
- Electrical Control Systems (Analogue & Digital)
- Class 1E Electrical Power System
- Primary Guidance for Environmental Qualification and various daughter standards for qualifying electrical equipment
- Seismic Qualification
- Human Factors (*in process*)
- Post Accident Monitoring

IEEE Standards Incorporated into Regulation by NRC

Standard	Edition	Title	CFR Location
IEEE 279	NDG	Criteria for Protection Systems for Nuclear Generating Stations	10 CFR 50.55a(h)(2)
IEEE 603	1991	Standard Criteria for Safety Systems for Nuclear Power Generating Stations	10 CFR 50.55a(h)(2)
IEEE 603	1991	Standard Criteria for Safety Systems for Nuclear Power Generating Systems	10 CFR 50.55a(h)(3)
IEEE 803	1983	Recommended Practice for Unique Identification in Power Plants and Related Facilities	10 CFR 50.73(b)(2)(ii)(F)(1)

Concepts Considered for Future Reactors

- **Approach for Fault Tolerance**
  - Consideration of Three Safety Trains (n+2)
  - Channels and divisions contained within fire zone (zone of influence) with two instrument channels in a Division
  - Power supplies contained within divisional zone (DC power, inverter, Emergency Diesel Generator)
  - Process signals shared for logic cabinets only through fiber optic cables without any metal sheathing

Concepts Considered for Future Reactors

- Ideal Separation for fire, electrical, and train independence
- Worst failure takes out only one electrical train and two instrument channels and it is contained in a fire zone
- Use of qualified optical cables between divisions/channels to prevent propagation of energy or any other deleterious effects

Contacts

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IEEE Conformity Assessment Program

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