Comparison of Domestic and International Equipment Qualification Certification Systems and Feasibility of a Joint Certification Program

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1. Introduction

Equipment Oualification (EO) for nuclear power plants ensures that safety-related equipment (SRE) reliably performs required safety functions under normal operation and accident conditions [1]. In Korea, the necessity for a robust national oversight system emerged following the 2013 nuclear test-report falsification incident, prompting the revision of the Nuclear Safety Act in 2015. Subsequently, the Korea Foundation of Nuclear Safety (KoFONS) was designated as the official Equipment Qualification Management Agency (EQMA), managing Equipment Qualification Testing Entities (EQTEs) through the Equipment Oualification Accreditation Program (EQAP) [2].

Currently, approximately 30–40% of safety-related equipment installed in Korean nuclear power plants is qualified by overseas testing entities [3]. However, these foreign entities are not legally required to obtain KoFONS accreditation, raising concerns about the reliability and fairness of their verification processes [3]. Possible management methods for overseas entities include direct oversight through KoFONS accreditation or indirect management utilizing equivalent foreign certification programs [4].

Meanwhile, the IEEE Conformity Assessment Program (ICAP) operates as an industry-driven, voluntary certification system evaluating nuclear equipment compliance with internationally recognized standards such as IEC/IEEE 60780-323 (Environmental Qualification) and IEEE 344 (Seismic Qualification) [5]. KoFONS accreditation, while mandatory for Korean regulatory compliance, lacks international recognition, whereas IEEE ICAP certification enjoys broad global acceptance but is not legally enforced. This disparity underscores the need for an internationally recognized joint certification system [6].

In response, KoFONS and IEEE signed a General Cooperation Agreement on May 22, 2022, to explore joint certification approaches [6]. Furthermore, an amendment proposed on November 18, 2024, introduced a dual-logo certification system integrating IEEE ICAP certification within KoFONS's national framework [7]. This paper compares domestic (KoFONS) and international (IEEE ICAP) EQ certification systems and assesses the feasibility and potential impact of implementing a joint certification program.

2. Comparison of KoFONS and IEEE ICAP Certification Systems

KoFONS and IEEE ICAP employ distinct approaches to equipment qualification certification. KoFONS accredits EQ testing entities responsible for performing equipment qualification in compliance with KoFONS's Regulation on Accreditation and Management of Equipment Qualification Testing Entities. In contrast, IEEE ICAP certifies individual equipment based on international nuclear safety standards. Although both systems reference similar technical standards, KoFONS

Aspect	KoFONS Accreditation (Korea)	IEEE ICAP Certification (International)
Governance	Public agency under NSSC	Industry-driven voluntary certification
Scope of Certification	Accreditation of EQTEs	Certification of equipment (products)
Technical Standards	KEPIC (based on IEEE and IEC)	IEC/IEEE 60780-323, IEEE 344
Certification Process	Application \rightarrow Document Review \rightarrow On-Site	Lab Authorization \rightarrow Testing \rightarrow Review \rightarrow
	Audit \rightarrow Accreditation	Certification
Environmental	Thermal, radiation, humidity, LOCA, MSLB,	IEC/IEEE 60780-323 environmental conditions
Qualification	Flame tests and analysis etc.	
Seismic Qualification	Shake table tests, structural analysis	IEEE 344 seismic standards
EMI/EMC Qualification	Included	Included (aligned with nuclear standards)
Active Mechanical EQ	Pump & valve performance tests	Not explicitly covered

Table I: Comparison of KoFONS and IEEE ICAP Certification Systems

emphasizes institutional accreditation, while IEEE ICAP focuses primarily on product certification [8].

Certification scopes also differ. **KoFONS** accreditation covers comprehensive qualification testing, qualification, including environmental seismic qualification, electromagnetic interference(EMI/EMC) qualification, active mechanical equipment qualification. IEEE ICAP mainly certifies Class 1E electrical and instrumentation control systems, explicitly addressing environmental and seismic qualification according to IEC/IEEE 60780-323 and IEEE 344, respectively. However, mechanical equipment performance testing is not explicitly included in IEEE ICAP certification [8].

3. Challenges and Implications for Joint Certification

Implementing a joint certification program requires overcoming key challenges related to the differences between KoFONS and IEEE ICAP methodologies. Firstly, harmonizing environmental and seismic qualification categories is essential, as KoFONS currently classifies qualification based on specific tests, whereas IEEE ICAP classifies qualification based on environmental conditions [4]. Standardizing these qualification approaches will ensure consistency in evaluation across both systems.

Additionally, IEEE ICAP may need to incorporate mechanical equipment performance testing-such as pump and valve testing-or formally accept KoFONS accreditation results. The EMI/EMC testing procedures present the most feasible area for immediate mutual recognition, given their existing similarity in standards and evaluation methodologies. A pilot joint certification project could further validate the feasibility of a combined certification process for selected equipment categories, facilitating technical and regulatory alignment.

4. Feasibility and Expected Benefits of Joint Certification

The proposed 2024 amendment to the KoFONS-IEEE Cooperation Agreement suggests integrating IEEE ICAP certification into KoFONS's domestic accreditation framework. This integration would allow products certified under IEEE standards to automatically receive KoFONS recognition without redundant testing [4].

The anticipated benefits of joint certification include enhancing the reliability of performance verification for nuclear equipment manufactured overseas, expanding domestic safety-related equipment manufacturers' access to international nuclear markets, elevating the global credibility of domestic qualification entities, and establishing a world-class nuclear equipment qualification management platform. Strategically, the KoFONS-IEEE joint certification initiative has the potential to enhance Korea's position as a leader in global nuclear equipment qualification, improving the reliability of overseas equipment verification and elevating domestic equipment qualification testing entities' international competitiveness.

5. Conclusion and Policy Recommendations

This study demonstrates that KoFONS accreditation and IEEE ICAP certification systems are complementary, and their integration through a joint certification framework is both feasible and beneficial. Aligning technical standards, certification processes, and regulatory acceptance can significantly enhance international credibility, efficiency, and safety in nuclear equipment qualification.

To successfully implement the joint certification framework, this study recommends

(1) Establishing a formal Mutual Recognition Agreement (MRA) to enable reciprocal acceptance of certifications

(2) Conducting pilot joint certification projects to validate operational feasibility and technical compatibility

(3) Harmonizing certification standards and test procedures to ensure global consistency

(4) Enhancing stakeholder collaboration-including regulators, manufacturers, and operators-to refine and sustain the certification framework

By adopting these measures, KoFONS and IEEE ICAP can create an internationally recognized, unified certification system that ensures the reliability and safety of nuclear equipment worldwide, thereby contributing substantially to global nuclear safety and market expansion.

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