Application Status of Korean Equipment Qualification Accreditation Program

Hanna Cho*, Hyung Jin Shim
Nuclear Eng. Dept., Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea
Corresponding author: elina05@gmail.com

1. Introduction

In September 2012, Korea Hydro & Nuclear Power (KHNP) started conducting self-investigation for unqualified items used in nuclear power plants (NPPs). [1] In November 2012, KHNP reported to Nuclear Safety and Security Commission (NSSC) that 7,682 components had been supplied with fabricated quality verification documents (QVDs) past ten years. [1, 2] Then NSSC formed the regulator-public joint investigation team to conduct complete enumeration investigations of quality verification documents as well as test reports of nuclear grade items. In 2015, the NSSC announced that the number of counterfeited test reports was 2,134 (0.7%) out of 289,983 testing reports during past ten years. [2]

In addition to falsifications in the QVDs and the test reports, it is found in May 2013 that the equipment qualification (EQ) report of control cables supplied to Shin-Kori 1 & 2 and Shin-Wolsong 1 & 2 were falsified by the equipment qualification testing entities (EQTEs). This serious falsification leaded to shutdowns of Shin-Kori 2 and Shin-Wolsong 1 and delays of NPP constructions.

After numerous discussions on the document forgery, NSSC's capability for EQ management was enforced by designating a committed agency following Article 15-4 of Nuclear Safety Act. The work scope of the EQ management agency defined in Article 25-3 of Enforcement Decree of Nuclear Safety Act is (a) accreditation of EQTEs, (b) follow-up management of EQTEs, (c) surveys for operational status of EQTEs, (d) supports for the enhancement of EQ capabilities of EQTEs. In Dec. 2014, NSSC assigned Korea Foundation of Nuclear Safety (KoFONS) as the EQ management agency.

For the management of EQTEs, KoFONS established the EQ accreditation program (EQAP), which started in 2015. We introduce the EQAP and its application status for past five years.

2 Equipment Qualification Accreditation Program

2.1 EQAP System

The aim of EQAP is managing the EQTEs in Korea. The EQTE includes manufacturer performing self-qualification. In the EQAP, the EQ tests and analyses provided by the EQTEs are managed into 16 types which can be categorized into 4 fields; environmental, seismic, electromagnetic and active mechanical equipment qualifications. Table I shows the 16 qualification types of 13 tests and 3 analyses and the corresponding technical standards. [11]

Table I: Qualification Type and Method

Category	Qualification Type and Method	Technical Standards
Environmental Qualification	Thermal Aging (T*), Thermal Aging (A*), Thermal cycle (T), Temperature & Humidity (T), Radiation Aging (T), Radiation Aging (A), Vibration Aging (T), LOCA (T), Line Break (T), Flame (T)	KEPIC END1100, KEPIC END3700 KEPIC END3830, KEPIC END3810, etc.
Electromagnetic Qualification	Electromagnetic Interference (T), Electromagnetic Susceptibility (T)	Reg.Guide 1.180, MIL46, Reg.Guide 1.180, MIL461
Seismic Qualification	Seismic (T), Seismic (A)	KEPIC END2000
Active Mechanical Equipment Qualification	Pump Performance (T), Valve Performance (T)	KEPIC MF

* T: test, A: analysis

The accreditation process comprises application, audit and EQ commission's decision phases. After KoFONS receives an application for EQ accreditation from an EQTE, the EQ audit team conducts the document review and a site visit including interviews with EQ professionals and executives. During the audit process, auditors evaluate 4 key elements; (1) human resource, (2) testing and/or analysis facilities, (3) QA program and (4) test and/or analysis procedure. The auditors can figure out nonconformity items. Then after the EQTE applicant corrects the nonconformity, the EQ audit team could evaluate the corrections. Then the EQ Committee deliberates the accreditation issuance of the EQTE candidate.

In the process of EQAP, key requirements are following four; (1) Human Resource, (2) Testing QA Program, (3) QA Program and Technical Program for EQ activity.

Human resources in the EQTE classified QA manager, technical manager, tester, QA inspector. After human resource appraisal, workers resister EQ professionals.

Testing facilities are appraised essential equipment's capability for each fields and scope. In EQAP, according to qualification type and method, each EQ field has a criteria for their testing or analysis. For example, Thermal Aging Test

QA Program should follow KEPIC QAP-1(2005) and there are 18 items, such as organizations, documentations. KEPIC QAP-1 is similar with ASME

NQA-1. The audit team appraises the compliance of QA Program. The audit team concentrates on the prevention of forgery**.**

The safety-related equipment which is installed in NPPs must be qualified following designated standards such as KEPIC MF, KEPIC END. The audit team appraises the compliance of EQTE's EQ testing procedure, program and reports following standards.

Fig. 1. Accreditation Key Requirement

After accreditation, the EQTE is subjected to annual regular inspection. The inspection audit team reviews EQ activities. When forgery items are found, the EQ accreditation can be cancel.

2.2 Characteristics of the EQAP

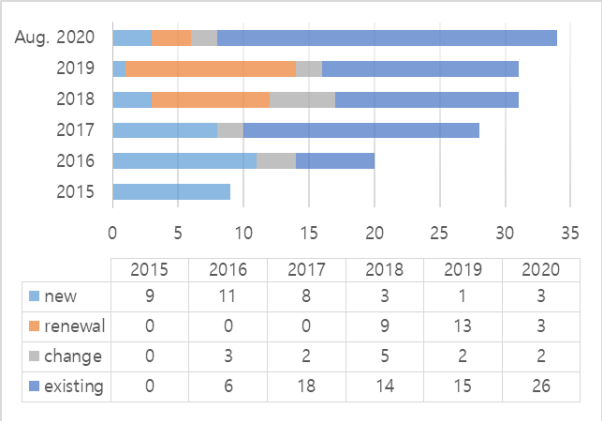
Comparison with EQ management system between Korea, U.S. and Europe is summarized in Table II. Most of Korean EQTEs have industry certifications like KEPIC, but if they supplied safety-related equipment to NPPs, they must have the EQ accreditation. Even if there is the EQ accreditation, they must be inspected by KINS. But in U.S. or Europe, a certification or an accreditation are not mandatory for EQTE. In U.S and Europe, vendor inspection by regulator is indirectly done when the regulator inspects manufacturers. Environmental qualification and seismic qualification are in common range of EQ, but only in Korea, electromagnetic qualification and active mechanical equipment qualification are in EQ area. [9]

Table II: Comparison of EQ management System

Items \ Country	Korea	U.S	Europe
Accreditation	- KoFONS	-	-
Testing Lab. Certification (not mandatory)	- KEPIC	- ISO/IEC 17025	- ISO/IEC 17025
Vendor Inspection	- KINS	- Indirect way (by NRC) e.g, NUPIC Audit Program.	- Regulator or Indirect way
Code & Standard (mainly used)	-KEPIC EN, MF (very similar with IEEE)	-IEEE-323, 344	-IEEE-323, 344,
Qualification Fields	Environmental, Seismic, Electromagnetic, Active Mechanical	Environmental, Seismic	Environmental, Seismic

3. Operational Experience

EQAP runs after 2015. At Aug. 2020, 34 organizations have EQ accreditations. Accreditation validity period is 3 years. So, after 2018, the applications for accreditation renewal are on progress.



	2015	2016	2017	2018	2019	2020
new	9	11	8	3	1	3
renewal	0	0	0	9	13	3
change	0	3	2	5	2	2
existing	0	6	18	14	15	26

Fig. 2. Accreditation Status of number of EQTEs

25 EQTEs have accreditation for seismic analysis. In other fields, the number of EQTEs having accreditation is less than 8. The number of testing for LOCA, Line Break, Valve and Pump Performance is 2 and for Flame test is 1.

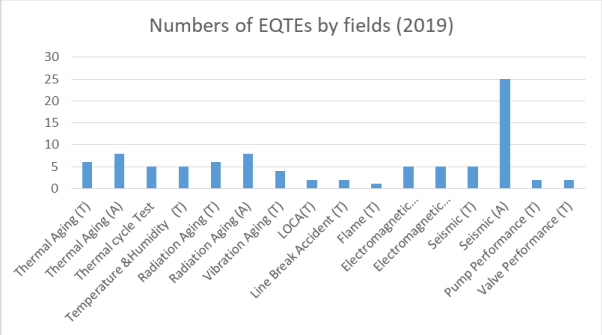


Fig. 3. Number of accredited EQTEs by qualification fields

The first regular inspection is done 1 year after accreditation and the regular inspection program was started in 2016. Table III and Fig.4 show the total number of non-conformance cases in the regular inspection.

Total number of nonconformance cases is 262 from 2016 to 2019. And there was 1 case for cancellation of accreditation at 2019 but it is not because of EQ activities.

From 2016 to 2019, total number of non-conformance cases increases and the total number of EQTEs also increases. The average cases per EQTEs is the largest at the first year of regular inspection, and the second year, the average case is reduced and is rising after 2017. From the first year, through the annual mandatory training, the cases are sharing and it reduced

the number of nonconformance cases. After 2017, the number of cases per EQTEs is stable.

About 55% of the nonconformance cases are related to QA Program. Most cases are related to noncompliance with QA manual. For example, EQ document (procedure, program, report) and testing conditions is not follow the registered QA Program. In test facilities area (21%), calibration and examination in use are common issue. In Human Resource part (16%), most cases are related to insufficient qualification management of EQ personnel, such as skipped annual training or re-evaluation. [10]

Table III: Number of non-conformance cases in the regular inspection [10]

	2016	2017	2018	2019
(A) No. of non-conformance cases	44	54	73	91
(B) No. of EQTE	9	20	26	29
(A) / (B)	4.89	2.70	2.81	3.14

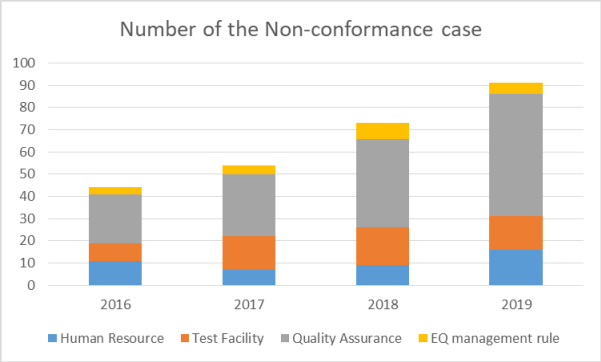


Fig. 3. Number of the non-conformance cases in the regular inspection [10]

4. Conclusions

This paper overviews the Korean Equipment Qualification Accreditation Program which is a follow-up action for prevention of nuclear fraudulent. The accreditation process audit for the system and the prevention of fraudulent. For the regular inspection, all EQ documents are managed. When conducting complete enumeration investigations of EQR in 2017, there is no fabricated EQR. [2]

REFERENCES

[1] 민병주, 2013, 원전 부품_품질 및 기기검증 안전성 강화를 위한 정책 제언, National Assembly of Korea
[2] 외국업체 품질서류 불일치 조사 중간결과, 2017. 8, 원자력안전위원회
[3] KEPIC END 1100, "Qualifying Class 1E Equipment for Nuclear Power Generating Stations", 2010, KEPIC
[4] KEPIC END 2000, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations", 2010, KEPIC
[5] IEEE-323, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations", 1974, IEEE
[6] IEEE-344, "IEEE Standard for Seismic Qualification of Equipment for Nuclear Power Generating Stations", 2013, IEEE
[7] KEPIC MF, "Qualification of Mechanical Equipment", KEPIC
[8] KEPIC QAP, Nuclear Quality Assurance Standard, 2005, KEPIC
[9] Equipment qualification information system, http://www.kofons.or.kr/eqis, 한국원자력안전재단
[10] 원전기기 성능검증 관리기반구축 사업결과보고서, 2016-2019, 한국원자력안전재단
[11] 성능검증기관의 인증 및 관리에 관한 규정, 2019, 한국원자력안전재단