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Introduction to 2018 Revision of KEPIC Non-Destructive Examination Requirements

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1. Introduction

KEPIC (Korea Electric Power Industry Code) is a technology standard developed according to the domestic industry that specifies the methods and procedures for the design, manufacturing, installation/construction, operation, maintenance and testing/examination to ensure the quality of facilities used for the electric power industry (for both nuclear power plants and thermal power plants). KEPIC continuously maintains and reflects the changes in domestic and overseas technology, develops new standards for industry, publishes addenda with revised matters every year, and publishes edition every five years.

KEPIC is fully applied to the 10 units of Korean nuclear power plants constructed after Shin Kori Unit #1. Meanwhile, other 16 units of nuclear power plants in operation, which were constructed with overseas standards applied, are now replaced to KEPIC. KEPIC is also expanding its application to thermal power fields such as 1,000MWe USC thermal power plants.

KEPIC is electric power industry standard that conforms to the needs of all users from operators, designers, installers, inspectors, and etc. as much as possible to ensure the safety and reliability of nuclear and thermal power plants.

2. KEPIC

2.1 Generals

KEPIC is developed by adopting US standards, such as ASME, IEEE and etc., as the reference standards, which are representative De facto standards, in order to enhance the safety and economics, to accumulate design and manufacturing technologies and to retain national competitiveness through standardization of domestic power facilities.

2.2 Structure of KEPIC

KEPIC is classified into quality assurance, machinery, nuclear power, electricity, structure, and fire that are referencing international standards. The field of environment has been developed on its own due to the lack of reference standards.

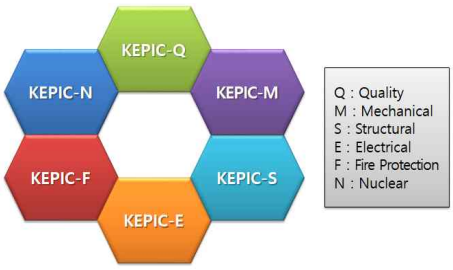

Fig. 1 Structure of KEPIC

- Administrative Requirements : Modified(MOD) the reference standards to conform to the domestic situation and developed according to the domestic industrial environments and situations, referring to domestic and international technical standards.
- Technical Requirements : Developed identical (IDT) to reference standards and modified (MOD) it by reflecting the technology by steps. In the field of mechanical and electrical measurement have been developed in correspondence with item numbers and numbering system of reference standards, which are ASME and IEEE.

The KEPIC edition is published every five years (applying the revisions and new standards for all addenda issued for the previous edition), and changes of reference standards, the revised opinions by industry experience, and other improvements are issued annually as addenda.

2.3 KEPIC Committee

The KEPIC Committee consists of 36 subcommittees and 11 technical committees, including a working group for drafting changes of reference standards. The committee consists of a policy committee that approves the final approval. Each committee consists of a chairman, a vice chairman, members and a secretary . It is possible to set up and operate a special committee if necessary.

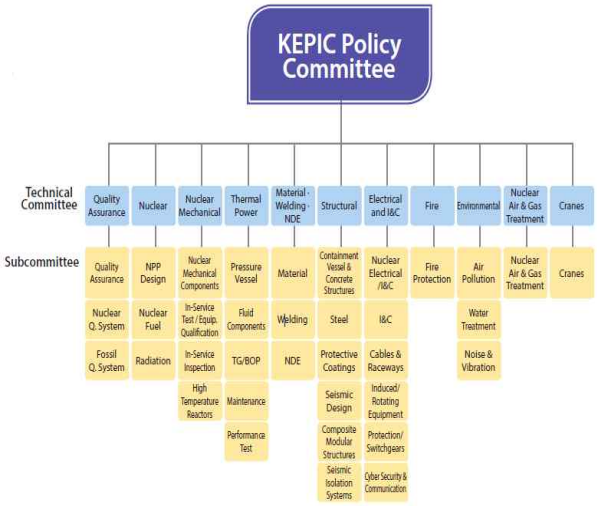

Fig.2 Structure of KEPIC Committees

2.4 KEPIC Certification Program

KEPIC certification program is a system that the qualified organizations certified by KEA in accordance with KEPIC requirements perform their appropriate code activities for nuclear safety-related items so as to achieve the safety and reliability

goals of electric power facilities, especially NPPs.

KEPIC certification program has been established by referring and modifying certification programs of foreign codes and standards which had previously been applied to domestic industries. Main characteristics of the program distinguished with that of foreign codes and standards are as follows:

- Correcting the problem that unauthorized foreign certification programs in Korea had been applied.
- Easy acquisition of certificates and related information through the program operated by domestic certification and accreditation body
- Economizing costs needed for acquisition and holding of one or more foreign certificates.

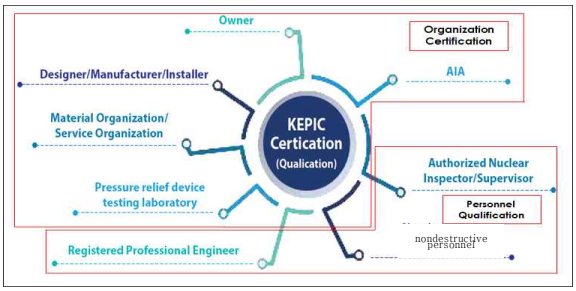

Fig.3 Scope of KEPIC Certification Program

3. KEPIC-MEN Non-Destructive Examination

3.1 Development Policy

The NDE (Non-Destructive examination) technology is applied to manufacturing/construction of facilities and then furnishes preventive maintenance to optimize the operation of power plants and to ensure structural integrity. It is a technology used for diagnosis and prediction of failures. KEPIC-MEN is a technical standard for NDE methods and procedures adopting the ASME Boiler and Pressure Vessel Code, Section V as reference standard.

The degree of compliance with the reference standard in accordance with ISO/IEC Guide 21 is "MOD" due to the following reasons;

- Configuration and numbering system is equivalent but some articles are not adopted,
- Requirements for qualification of NDE personnel are developed into KEPIC's own standard with reference to qualification in the current National Technical Qualifications Act,
- NDE Organization Qualification Requirement (ASTM E-543) is not adopted.

3.2 Scope

KEPIC-MEN provides requirements for NDE methods and qualification of NDE personnel. NDE methods are used to detect surface and internal imperfections of materials, welds, parts, and mechanical & stuructural components. NDE methods prescribed by KEPIC-MEN are specified as 7 methos; Radiographic Examination (RT), Ultrasonic Examination (UT), Liquid Penetrant Examination (PT), Magnetic Particle Examination (MT), Eddy Current Examination (ECT), Visual Examination (VT), Leak Testing and Acoustic Emission Examination (LT).

The requirements for qualification of NDE personnel provides qualification recognition requirements for those which the NDE qualification has been acquired by the Human Resources Development Service of Korea under the National Qualified Qualification Act or those who are qualified for evaluation at the same level that who want to perform nondestructive examination of power plants.

Table.2 Comparison between KEPIC-NDE and ASME Sec.V

Sec.	ASME	KEPIC	Title
Sub. A	Article 1	MEN A1	General Requirements
	Article 2	MEN A2	Radiographic Examination
	Article 4	MEN A4	Ultrasonic Examination Methods for Welds
	Article 5	MEN A5	Ultrasonic Examination Methods for Materials
	Article 6	MEN A6	Liquid Penetrant Examination
	Article 7	MEN A7	Magnetic Particle Examination
	Article 8	MEN A8	Eddy Current Examination
	Article 9	MEN A9	Visual Examination
	Article 10	MEN A10	Leak Testing
	Article 11	Not adopted	Acoustic Emission Examination of Fiber-Reinforced Plastic
	Article 12	MEN A12	Acoustic Emission Examination of Metallic Vessels During Pressure Test
	Article 13	MEN A13	Continuous Acoustic Emission Monitoring
	Article 14	MEN A14	Examination System Qualification
	Article 15	MEN A15	Alternating Current Field Measurement Technique (ACFMT)
	Article 16	MEN A16	Magnetic Flux Leakage (MFL) Examination
	Article 17	MEN A17	Remote Field Testing (RFT) Examination Method
	Article 18	MEN A18	Acoustic Pulse Reflectometry(APR) Examination
	Article 19	MEN A19	Guided Wave Examination Method for Piping
Sub. B	Article 22	MEN B22	Radiographic Standards
	Article 23	MEN B23	Ultrasonic Standards
	Article 24	MEN B24	Liquid Penetrant Standards
	Article 25	MEN B25	Magnetic Particle Standards
	Article 26	MEN B26	Eddy Current Standards
	Article 29	MEN B29	Acoustic Emission Standards
	Article 30	Not adopted	Terminology for Nondestructive Examinations Standard
	Article 31	MEN B31	Alternating Current Field Measurement Standards
	Article 32	Not adopted	Remote Field Testing Standard
	Article 33	MEN B33	Guided Wave Standreds

3.3 Qualification of NDE Personnel

The NDE is an important process that is classified as a special process in the processes of manufacturing, constructing, and repairing power generation facilities. Therefore, KEPIC-MEN has established the qualification system of NDE personnel based on the National Technical Qualification Act and that of ASME Sec. V. Also in order to supplement for the characteristics of the electric power industry, with reference to the ASNT SNT-TC-1 applied in the existing electric power industry and the ISO 9712 established as the international standard, the criteria for qualification of NDE personnel qualification was established.

Table.3 Qualification Requirement of NDE Personnel

Level	Qualification Requirement
I	Obtain qualification to be assessed as equivalent to Non-destructive inspection “Craftsman” by the National Qualifications Act.
II	Obtain qualification to be assessed as equivalent to Non-destructive inspection “Industrial Engineer” by the National Qualifications Act.
III	At least one year of experience in the field of testing after obtain qualification to be assessed as equivalent to Non-destructive inspection “Engineer” by the National Qualifications Act.

4. Revisions of KEPIC-MEN 2018 Addendum

4.1 Direction

The KEPIC-MEN 2018 addendum has reflected the changes of the reference standard such as addition/deletion of technical requirements, sentence correction, and edit of equations and figures of ASME BPVC Sec.V 2017 edition as well as the review results of KEPIC Subcommittee on NDE for translation and typo errors. In particular, Article 33 Guided Wave Standards was newly applied to reflect the request for adoption from industry.

4.2 Major Revisions of KEPIC-MEN 2018 addendum

4.2.1 MEN A2 : Radiographic Examination

▪ Mandatory Appendix VII : Radiographic Examination of Metallic Castings

- IX-260 CALIBRATION

All Digital Detector Systems require, after readout, a software-based calibration to determine the under performing pixel map in accordance with manufacturer’s guidelines. Calibration software shall be capable of correcting the nonuniformities.

- IX-263 BEAM WIDTH

When a change in motion of the source, detector, travel speed, or any combination of these occurs, the beam width shall be controlled by a metal diaphragm such as lead. The diaphragm for the energy selected shall be at least 10 half value layers thick.

Table.4 Revisions Summary of KEPIC-MEN 2018 Add.

Article	Revision Summary
MEN A2 Mandatory Appendix IX	IX-260 CALIBRATION - Digital Detector System Calibration requirement added.
	IX-263 BEAM WIDTH - a decision method of beam width added.
MEN A4	T-453 SCANNING TECHNIQUES - manual scanning, nonautomated scanning, semiautomated scanning, and automated scanning added.
MEN B22 SE-1165	1.3 Scope - range selection requirement of nominal focal spot dimension added.
MEN B23 SE-273	2.2 ASNT Documents - Reference standard ANSI/ASNT CP-189 Standard for Qualification and Certification of Nondesctructive Testing Personnel added.
	2.3 ISO Standard - ISO 9712 Non-destructive Testing - Reference standard Qualification and Certification of NDT Personnel added.
	6.5 Surface Preparation & 6.6 Reporting Criteria/Acceptance Criteria & 6.7 Reexamination of Repaired/Reworked Items Newly added
B-29 SE-2075	- Standard Practice for Verifying the Consistency of AE-Sensor Response Using an Acrylic Rod newly added.
B-33 SE-2775 SE-2929	- Standard Practice for Guided Wave Testing of Above Ground Steel Pipework Using Piezoelectric Effect Transduction newly added. - Standard Practice for Guided Wave Testing of Above Ground Steel Piping With Magnetostrictive Transduction newly added.

4.2.2 MEN A4 : Ultrasonic Examination Methods for Welds

- IX-260 CALIBRATION

Examination may be performed by one of the following techniques:

(a) manual scanning using no scanner equipment

(b) nonautomated scanning using nonautomated scanner(s)

(c) semiautomated scanning using semiautomated scanner(s)

(d) automated scanning using automated scanner(s)

4.2.3 MEN B22 : Radiographic Standards

▪ SE-1165 : Standard Test Method for Measurement of Focal Spots of Industrial X-Ray Tubes by Pinhole Imaging

- 1. Scope : Susparagraph (1.3) added

This standard specifies a method for the measurement of focal spot dimensions from 50 μm up to several mm of X-ray sources up to 1000 kV tube voltage. Smaller focal spots should be measured using EN 12543-5 using the projection of an edge.

4.2.4 MEN B23 Ultrasonic Standards

▪ SE-273 : Standard Practice for Ultrasonic Testing of the

Weld Zone of Welded Pipe and Tubing
- 2.2 ASNT Documents
Recommended Practice SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing
ANSI/ASNT CP-189 Standard for Qualification and Certification of Nondesctructive Testing Personnel
- 2.3 ISO Standard
ISO 9712 Non-destructive Testing-Qualification and Certification of NDT Personnel
- Susparagraph (6.5), (6.6), (6.7) added
6.5 Surface Preparation
The pre-examination surface preparation criteria shall be in accordance with paragraph 1.2 unless otherwise specified.
6.6 Reporting Criteria/Acceptance Criteria
Since acceptance criteria are not specified in this standard, they shall be specified in the contractual agreement.
6.7 Reexamination of Repaired/Reworked Items
Reexamination of repaired/reworked items is not addressed in this standard and if required shall be specified in the contractual agreement.

4.2.5 MEN B29 : Acoustic Emission Standards

SE-2075 Standard Practice for Verifying The Consistency Of AE-Sensor Response Using Acrylic Rod is newly added, which is used for routinely checking the sensitivity of acoustic emission (AE) sensors and is intended to provide a reliable, precisely specified way of comparing a set of sensors, or telling whether an individual sensor's sensitivity has degraded during its service life, or both.

4.2.6 MEN B33 : Guided Wave Standreds

SE-2775 Standard Practice for Guided Wave Testing of Above Ground Steel Pipework Using Piezoelectric Effect Transduction is newly added, which provides a procedure for the use of guided wave testing (GWT), also previously known as long range ultrasonic testing (LRUT) or guided wave ultrasonic testing (GWUT).

And SE-2929 Standard Practice for Guided Wave Testing of Above Ground Steel Piping With Magnetostrictive Transduction is newly added, which provides a guide for the use of waves generated using magnetostrictive transduction technology for guided wave testing (GWT) welded tubulars.

5. Future Development Plan

KEPIC-MEN will be annually revised through technical review of KEPIC Subcommittee on NDE for translation errors of previously published editions and addenda, irrespective of revision of ASME Sec.V and, of course, will be biennially revised by adopting the changes of future ASME Sec.V editions to be revised.

KEPIC Subcommittee of NDE is preparing to review the result of a domestic R&D project developing PAUT technology for replacing RT method now applying to nuclear power plant equipments. The PAUT method would be issued as a KEPIC Code Case if KEPIC Subcommittee of NDE and KEPIC Technical Commiittee on Materials/Welding/NDE approve the suitability of adopting the PAUT method as new method of KEPIC-MEN.

KEPIC Subcommittee on NDE will review the ASME ANDE-1 2015 providing new requirements of nondestructive examination and quality control central qualification and certification program and the Subcommittee will determine whether developt a new KEPIC standard adopting ASME ANDE-1 or not.

Table.4 Development plan of KEPIC-MEN

Revision Activities				Issue Year
Review of KEPIC-MEN irrespective of revision of ASME Sec.V	Stage 1	MEN A1	-	2019
		MEN A4	MEN B23	
		MEN A5		
	Stage 2	MEN A2	MEN B22	2020
		MEN A8	MEN B26	
		MEN A6	MEN B24	
	Stage 3	MEN A7	MEN B25	2021
		MEN A9	-	
		MEN A10	-	
		MEN A12	MEN B29	
		MEN A13	-	
ASME Sec.V 2019				2020
PAUT Method from R&D Project				2024 (assumed)

REFERENCES

[1] KEPIC MEN (2015 Edition, 2018 Addenda).
[2] ASME Boiler and Pressure Vessel Code, Section V(2017 Addenda).
[3] Brochure of KEPIC Electric Power Industry Code, Korea Electric Association, 2018