Discussion on Integration of Welding Coordinator in Welding Quality System of KEPIC(Korea Electric Power Industry code)

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1. Introduction

Korea Electric Power Industry Code (KEPIC) has been developed on the basis of referring to the prevailing U.S. codes and standards which had been applied to the electric power facilities in Korea.

KEPIC has been applied to the construction of Ulchin Nuclear Units 5&6 since 1997 as per the endorsement of Ministry of Science and Technology, and is being completely applied to the construction of Shin-Kori and Shin-Wolsung Nuclear Power Plants (NPPs) in Korea and of Barakah NPPs in UAE.

In the technical and administrative requirements, KEA has been performing betterment studies to 'integration of welding coordinator in welding quality system of KEPIC'.

The welding quality system of KEPIC-MQW 'Welding Qualification' referencing ASME BPVC Sec.IX, Part QW requires welding procedures and performance qualification of welder or welding operator excluding welding coordinator. It means that there is potential possibility of any problem in process of welding on nuclear power plants or shop in absence of an welding coordinator who can resolve welding troubles. Therefore, the integration of welding coordinators in the welding quality system of KEPIC can improve welding quality and enhance safety of construction and management of power plants.

The introduction of welding coordinator requirement would put economic problems on manufactures for new employment and subsequent management works (eg. training) and field problems making authorized nuclear inspectors to be confused on inspection work scopes.

Those predictable problems are expected to be minimized or eliminated through public hearings and/or seminars with regulatory body, the owner, and manufacturers and, most significantly, cooperation with related KEPIC committees.

2. Introduction to KEPIC

2.1 Generals

The definition of KEPIC is 'a set of integrated standards applicable to the whole phases of design, manufacturing, installation, operation, testing, inspection and maintenance of electric power facilities and components so as to ensure their safety and reliability'.

Technical requirements, in compliance with related national rules such as Electric Utility Act, Atomic Energy Act, Building Act, and Framework Act on Fire Services, have been developed by the adaptation of foreign reference standards applied to electric power facilities in Korea. They are identical to the reference standards except for some editorial changes such as the use of KEPIC's own categorizing & numbering system. In case of absence of proper foreign reference standards, they have been developed on the basis of advanced domestic technologies.

Administrative requirements have been developed based on ASME BPVC Sec.III NCA "General Requirements" and modified to be suitable for the industrial circumstances and situation in Korea. They have established KEPIC's own Certification System for nuclear safety-related items including nuclear certification, authorized inspection, RPE, etc. They have adopted the ISO 9000 quality system and the authorized inspection system for non-nuclear safety related and thermal power items.

Application Scopes of KEPIC are overall electric industry fields such as nuclear power plants, thermal power plants, transmission·transformation·distribution facilities and whole phases of nuclear power plants including design, manufacturing, installation, operation, testing, inspection, maintenance, etc.

2.2 History of KEPIC

A feasibility study was conducted in 1987 for developing program of Korean codes and standards for power plant materials and components at the request of the government and with the support of Korea Electric Power Corporation (KEPCO). As the result of this feasibility study, it was recommended to be entitled Korea Electric Power Industry Code and the following guideline was adopted.

- The scope should cover the safety- and reliability-related materials and components, and select the localized items or imminently localizing items.
- The items on nuclear safety-related systems should be referred to codes and standards applied in Young-Gwang Nuclear Units 3/4 which was the first nuclear power plant of system standardization in Korea.
- The non-nuclear safety-related systems of a nuclear unit should be used in common with those of fossil power facilities.
- The technical requirements are to be identical to those of referenced codes and standards.
- The administrative requirements are to be modified to be suitable to Korean system among the selected codes and standards.

- The regulations associated with the electric and power facilities shall be harmonized with the structure of KEPIC when those are published.
- The procurement specifications for materials and components are to be revised to correspond with KEPIC requirements.
- It is preferred that KEPIC is published and utilized as those of or for the existing electric- and power-related societies or associations.

The development of KEPIC started under above guidelines in 1992. Being the responsible organization for developing and managing KEPIC, Korea Electric Association (KEA) published its first edition in 1995, while the following editions in year 2000, 2005, and 2010 not only adding new standards but also modifying other standards to fit into our industrial circumstances.

2.3 KEPIC development organizations

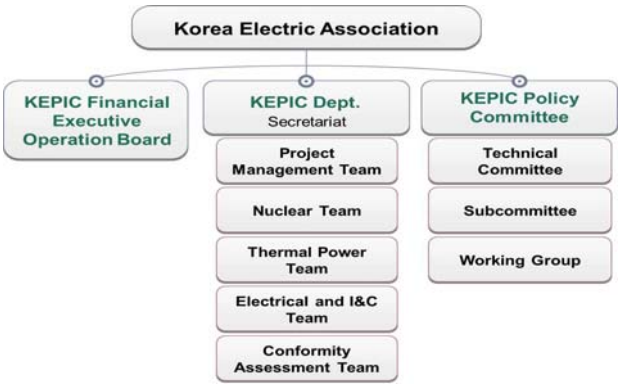

Fig. 1. Scheme of KEPIC development organizations

The KEPIC department of KEA is the secretariat of KEPIC. The KEPIC financial executive operation board funds the management budget of KEPIC, which consists of 25 electric power industry organizations including Ministry of Trade, Industry & Energy (MOTIE), KEPCO, etc.

2.4 Structure of KEPIC

KEPIC consists of seven parts which are named quality assurance, mechanical, electrical, structural, nuclear, fire protection, and environmental. Environmental standards have been developed on the basis of technical specifications and reports of domestic research & development organizations such as KEPCO Research Institute while other parts' standards are based on foreign codes & standards such as ASME, IEEE, ACI, RCC, ANS, NFPA, etc.

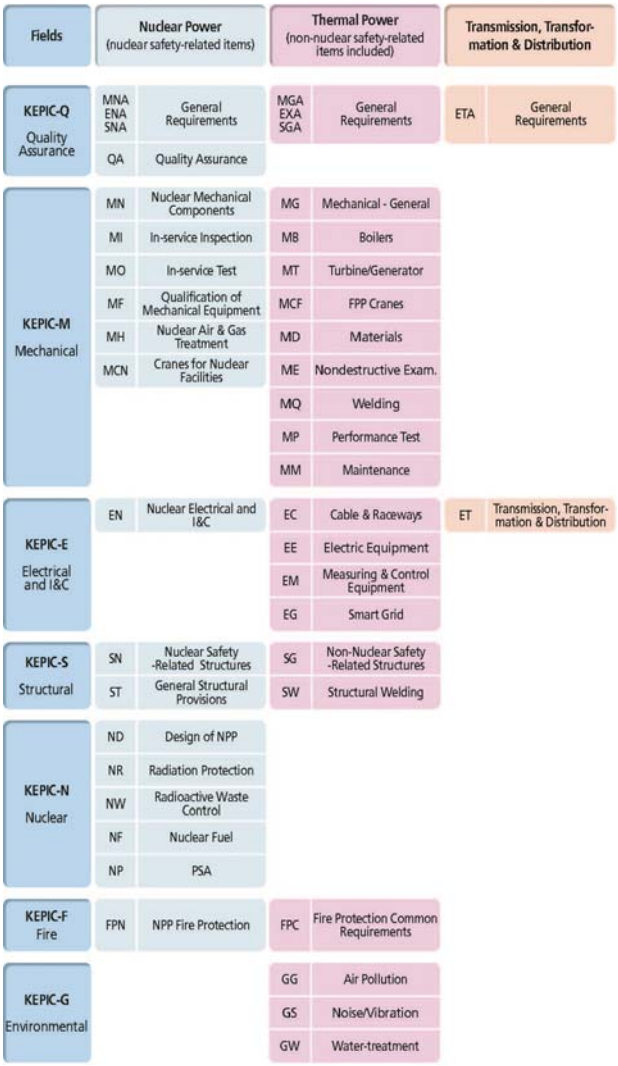

Fig. 2. Illustration of KEPIC structure

Table I: Reference standards of KEPIC

Part	Subpart	Reference Standards
KEPIC-Q (Quality Assurance)	QAP: Nuclear Quality Assurance	ASME NQA-1
	QAI : Authorized Inspection	ASME QAI-1
	QAR : Registered Professional Engineer	ASME Sec.III. App.XXIII
KEPIC-M (Mecha-nical)	MN : Nuclear Mechanical Components	ASME Sec.III. Div.1
	MG : Non-nuclear Mechanical Components	ASME Sec.VIII, HEI, API
	MC : Cranes	ASME NOG-1, CMAA 70
	MH : Nuclear Air & Gas Treatment	ASME AG-1
	MD : Materials	ASME Sec.II
	ME : Non-destructive Examination	ASME Sec.V
	MW: Welding & Brazing Qualification	ASME Sec.IX
	MI : In-service Inspection	ASME Sec.XI

	MO : In-service Testing	ASME OM
	MF : Qualification of Mechanical Equipment	ASME QME-1
	MB : Power Boilers	ASME Sec.I
	MT : Turbine & Generators	Manufacturer's Spec., ASME PTC 6
	MP : Performance Test	ASME PTC
	MM : Maintenance	ASME PCC
KEPIC-E (Electrical)	EN : Class 1E Equipment	IEEE, ANSI, ISA, etc.
	EM: Measuring & Control Equipment	IEEE, ISA, IEC, etc.
	EE : Electric Equipment	NEMA, IEC, ANSI, etc.
	EC : Cables & Raceways	ASTM, NEMA, IEEE, etc.
	ET : Transmission, Transformation and Distribution	IEC, IEEE, etc.
KEPIC-S (Structu-ral)	SN : Nuclear Structures	ASME Sec.III, ACI 349, etc.
	SG : Non-nuclear Structures	ACI 318, AISC, etc.
	ST : Extra-Provisions for Structures	ASCE 4, 7
	SW: Structural Welding	AWS D1.1, D1.3
KEPIC-N (Nuclear)	NF : Nuclear Fuels	RCC-C, ASTM, etc.
	ND : Design of Nuclear Power Plants	ANS 51.1, etc.
	NR : Radiation Protection Design	ANS 6.4, etc.
	NW : Radioactive Waste Control	ANS 55.1, etc.
	NP : Probabilistic Safety Assessment	ASME RA-S, ANS 58.21
KEPIC-F (Fire)	FP: Fire Protection	NFPA 801, 803, 804, 805, etc.
KEPIC-G (Environ-mental)	GG : Air Pollution	None
	GS : Noise/Vibration	None
	GW : Water-treatment	None

2.5. Committees

KEPIC committees have a KEPIC Policy Committee, 8 technical committees, and 34 subcommittees. Special committees and project committees can be organized if required. Working groups support KEPIC draft review tasks of subcommittees. Each committee is composed of chairman, vice-chairman, members, and a secretary.

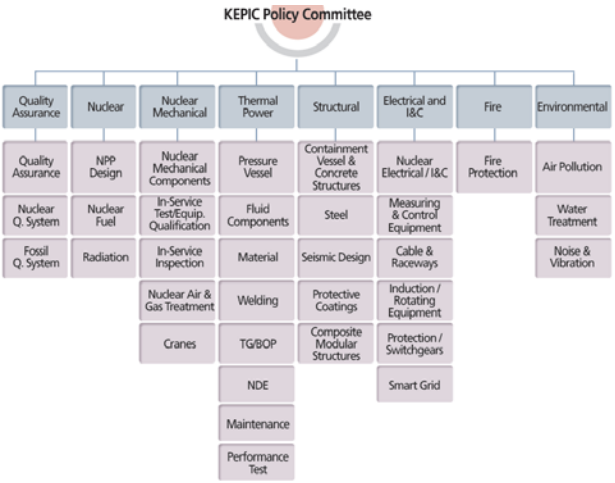

Fig. 3. Structure of KEPIC committees

2.6 Development and issuance

KEPIC development procedure has six steps: drafts are prepared by working groups or secretaries; reviewed by subcommittees and relevant industry organizations; reviewed and approved by technical committees; and reported to the policy committee.

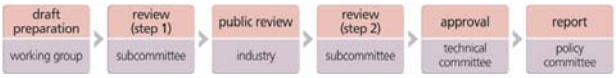

Fig. 4. KEPIC development procedures

Every five years, a revised and updated KEPIC Edition is published that incorporates all addenda issued during the last 5 years, including the newly developed codes and standards.

Addenda are published annually from 1996. Especially, in 2006 and 2008, two addenda were issued as 1st and 2nd in a year narrowing issuance gap between reference standards and KEPIC. Addenda reflect and/or incorporate the followings:

- Changes in reference codes and standards,
- Feedbacks and comments from industrial applications,
- Requirements to be revised according to the result of the KEPIC inquiry and reply system,
- Other changes for improvements.

KEPIC 2010 edition and its addenda issued as bilingual (Korean-English) version. Especially, safety-related standards of KEPIC 2000 edition were re-issued as bilingual version for adaptation to Barakah nuclear power plants in UAE in 2009.

Table II: KEPIC editions publication status

Part	2000 Ed.		2005 Ed.		2010 Ed.	
	No. of Std.	Pages	No. of Std.	Pages	No. of Std.	Pages
Quality Assurance [Q]	3	241	3	383	3	433
Mechanical [M]	51	8,336	56	10,489	74	26,286

Electrical and I&C [E]	216	7,377	240	8,967	184	17,979
Structural [S]	12	2,022	13	3,000	14	6,491
Nuclear [N]	2	204	21	1,345	39	3,832
Fire Protection [F]	3	281	6	456	16	3,222
Environmental [G]	-	-	-	-	8	832
Total	287	18,481	339	24,640	338	59,819

2.7 Endorsement by korean government

The Ministry of Science and Technology, previous Korean regulatory body, endorsed the 1995 edition of KEPIC to be used as applicable standards for the construction of new nuclear power plants by the Ministerial Notices in 1996. Therefore, KEPIC has been applied to the construction of the Ulchin Nuclear Units 5&6 since 1997. And then KEPIC is being completely applied to the construction of Shin-Kori and Shin-Wolsung Nuclear Power Plants (NPPs) in Korea and of Barakah NPPs in UAE.

Table III: Endorsement of KEPIC by Government's Notices

Regulatory Body	Notice No.	Notice Title	Applicable KEPIC
Nuclear Safety and Security Commission	2012-13	Guidelines for Application of Korea Electric Power Industry Code (KEPIC) as Technical Standards of Nuclear Reactor Facilities	Endorsement of KEPIC 2000 edition and yearly addenda, KEPIC 2005 edition and 2006 1st and 2nd addenda, and MFA/ENA 2007 addenda
	2012-17	Detailed Requirements for Quality Assurance of Nuclear Reactor Facilities	Adoption of KEPIC-QAP
	2012-9	Regulation on Safety Classification and Applicable Codes and Standards for Nuclear Reactor Facilities	Adoption of KEPIC-MN, EN, SN
	2012-14	Standards for Safety Valves and Relief Valves of Nuclear Reactor Facilities	Adoption of KEPIC-MD, MN
	2012-10	Regulation on In-Service Inspection of Nuclear Reactor Facilities	Adoption of KEPIC-MI
	2012-23	Regulation on In-Service Test of Safety-related Pumps and Valves	Adoption of KEPIC-MO
	2012-25	Guidelines on Application of Technical Standards for Assessment of Continued Operation of Nuclear Reactor Facilities	Adoption of KEPIC-MO
Ministry of Trade, Industry & Energy	2006-65	Electro-technical Regulations	Substitutive Application of KEPIC for Thermal Power Plants

2.8 Nuclear certification program

2.8.1 Introduction to KEPIC (Nuclear) certification program

The KEPIC certification program is a system that the qualified organizations and personnel by KEA (Korea Electric Association) 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 nuclear power plants.

The 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 were 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.

2.8.2 Scopes of KEPIC certification program

A. Organization Certification
- plant owner & designer, manufacturer, installer & constructor, material organization, and service organization,
- authorized inspection agency (AIA),
- pressure relief device testing laboratory,
- equipment qualification (EQ) testing organization.

B. Personnel Qualification
- authorized nuclear inspector/supervisor,
- registered professional engineer (RPE).

Fig. 5. Diagram of KEPIC Certification Program

2.8.3 Certification of quality assurance system

KEPIC certification system, being similar to ASME's N-type certificate system for pressure equipment (KEPIC-MN), has been extended to class 1E electrical and I&C items (KEPIC-EN), seismic category I reinforced concrete and steel structure (KEPIC-SN), and HVAC (KEPIC-MH). Nuclear safety-related

organizations should obtain KEPIC Certificate from KEA in accordance with general requirements of each nuclear standard.

Table IV: Certification organization and work scope

Field	Applicable KEPIC	Organizations	Work Scope
Mechanical	KEPIC-MN	owner, manufacturer, installer, material organization, service organization	Activities for Class 1, 2, 3, MC, and CS components
Electrical and I&C	KEPIC-EN	owner, manufacturer, installer, EQ testing organization	Activities for Class 1E equipment
Structural	KEPIC-SN	owner, designer, auxiliary item manufacturer, constructor, material org., service organization	Activities for Seismic Category Ⅰ structures or equipment
HVAC	KEPIC-MH	manufacturer, installer	Safety class air cleaning unit/air conditioning unit and components

2.8.4 Certification for authorized inspection agency/authorized inspector

The pressure equipment manufacturer and installer shall be inspected by an authorized inspector who is employed by the Authorized Inspection Agency (AIA). It is necessary for Authorized Inspector and Authorized Inspector Supervisor to take the training program and pass the qualifying examination. And then AIA makes application for their registration to KEA. Scopes are KEPIC-MNX, MIX, SNB, MGB, MGE, MBB.

2.8.5 Qualification for registered professional engineer (RPE)

RPE reviews the nuclear pressure equipment's design documents, such as the design specifications and design reports, and certifies those documents with an RPE stamping of acceptance. The person who intends to be qualified as a KEPIC RPE must possess the appropriate national technical qualification certificate and must be equipped with enough code knowledge and experiences. Scopes are KEPIC-MNX, SNB.

2.8.6 Certification for a pressure relief device testing laboratory

KEA certifies testing laboratories and designated organizations which perform the relieving capacity test and also certify the capacity in accordance with KEPIC-MNX, KEPIC-MGB, and KEPIC-MBB.

3. Integration of welding coordinator in welding quality system of KEPIC

3.1. Background

Welding quality system of KEPIC-MQW 'Welding Qualification' referencing ASME BPVC Sec.IX, Part QW requires welding procedures and performance qualification of welder or welding operator excluding welding coordinator. There is potential possibility of any problem in process of welding on nuclear power plants or shop in absence of an welding coordinator who can resolve welding troubles. Integration of welding coordinators in the welding quality system of KEPIC would help improve welding quality and enhance safety of construction and management of power plants.

3.2 Revision draft of KEPIC-MQW

A revision draft for KEPIC-MQW 'Welding Qualification' has been prepared by an working group through survey on domestic and international status of welding quality system (AWS, ASME, ISO, EN codes & standards) and investigation on qualification status of welders and/or welding operators in KEPIC certificate holders.

The revision draft of KEPIC-MQW could be summarized that a general requirement that all welding operations shall be performed under the control and supervision of one or more welding coordinators (mandatory requirement) is added, "KS B ISO 14731 , Welding coordinator – tasks and responsibilities", 2001 for tasks & responsibilities of welding coordinators is called, KS B ISO 3834-5 , Quality requirements for fusion welding of metallic materials – Part 5: Documents with which is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, ISO 3834-3, or ISO 3834-4", 2006 for training & qualification of welding coordinators is called, and roles of 'representative of manufacturer or contractor' are replaced with them of 'welding coordinator'.

Table V: Revision draft of KEPIC-MQW

Article	MQW 2010 ed.	Revision draft
Article Ⅰ Welding General Requirements QW-100 General	KEPIC-MQ relates to the qualification of welders, welding operators, brazers, and brazing operators, and the procedures that they employ in welding and brazing according to this Code and the Construction Code. It is divided into two parts: Part QW gives requirements for welding and Part QB contains requirements for brazing. The Construction Code may specify different requirements than those specified by this Code. Such requirements take precedence over those of this Code, and the	KEPIC-MQ relates to the qualification of welders, welding operators, brazers, and brazing operators, and the procedures that they employ in welding and brazing according to this Code and the Construction Code. It is divided into two parts: Part QW gives requirements for welding and Part QB contains requirements for brazing. The Construction Code may specify different requirements than those specified by this Code. Such requirements take precedence over those of this Code, and the

	manufacturer or contractor shall comply with them.	manufacturer or contractor shall comply with them. All welding tasks performed by the manufacturer or contractor in accordance with this Code shall be performed under supervision and control of welding coordinators. The manufacturer or contractor shall designate one or more qualified welding coordinators.
Article Ⅲ Welding Performance Qualifications QW-300 General QW-300.3	(b) The welders or welding operators used to produce such weldments shall be tested under the full supervision and control of the manufacturer, contractor, assembler, or installer during the production of these test weldments. It is not permissible for the manufacturer, contractor, assembler, or installer to have the welding performed by another organization. It is permissible, however, to subcontract any or all of the work of preparation of test materials for welding and subsequent work on the preparation of test specimens from the completed weldments, performance of nondestructive examination and mechanical tests, provided the manufacturer, contractor, assembler, or installer accepts full responsibility for any such work.	(b) The welders or welding operators used to produce such weldments shall be tested under the full supervision and control of the welding coordinator of the manufacturer, contractor, assembler, or installer during the production of these test weldments. The welding coordinator is responsible for welding tasks and have to be proven welding knowledge and capability through training and experiences. Responsibilities and tasks of the welding coordinator are stated in KS B ISO 14731. Guidelines for training and qualification of the welding coordinator are stated in annex A of KS B ISO 3834-5. It is not permissible for the manufacturer, contractor, assembler, or installer to have the welding performed by another organization. It is permissible, however, to subcontract any or all of the work of preparation of test materials for welding and subsequent work on the preparation of test specimens from the completed weldments, performance of nondestructive examination and mechanical tests, provided the manufacturer, contractor, assembler, or installer and their welding coordinators accepts full responsibility for any such work.
Article Ⅲ Welding Performance Qualifications QW-300 General	When simultaneous qualifications are conducted, each participating organization shall be represented during welding of test coupons by an employee who is responsible for welder performance qualification. Each participating	When simultaneous qualifications are conducted, each participating organization shall be represented during welding of test coupons by an welding coordinator who is responsible for welder performance qualification.
QW-300.2	organization's representative shall positively identify each welder or welding operator who is being tested. Each organizational representative shall also verify marking of the test coupon with the welder's or welding operator's identification, and marking of the top of the test coupon when the orientation must be known in order to remove test specimens.	Each participating organization's welding coordinator shall positively identify each welder or welding operator who is being tested. Each organization's welding coordinator shall also verify marking of the test coupon with the welder's or welding operator's identification, and marking of the top of the test coupon when the orientation must be known in order to remove test specimens.

4. Results

The revision draft was reviewed and discussed with personnel in nuclear industry by holding three workshop and public hearings from 2011 to 2012 and by having a presentation in 2014 KEPIC-Week.

Industrial consensus on need for integration of welding coordinators in welding quality system of KEPIC was performed by reasons that it would improve welding quality, guarantee welding reliability, advance expertise, and help export to abroad. However, economic problems on manufacturers for new employment and subsequent management works, for example training, are predicted. Therefore, introduction in stages for minimizing industrial impact regarding manufacturer's scale and permission of utilizing external welding coordinator for small scale manufacturers are required. A new draft version of KEPIC-MQW (if possible, appendices of MQW) including requirements and directives for solving these economic problems is needed. Also, more discussion with KEPIC committees in charge of administrative codes as KEPIC-MNA, 'General Requirements of Nuclear Mechanical' is required.

5. Future Works

A joint committee between KEPIC subcommittee on welding and subcommittee on nuclear quality system should be held to discuss adding new requirements for welding coordinator to KEPIC-MNA. And the final revision draft of KEPIC-MQW and, if needed, of KEPIC-MNA would be prepared. Of course, additional opinion of regulatory body, NPP owner, manufacturers, etc. through public hearings will be gathered. And concurrently, a plan for training programs of welding coordinators should be developed.

ACKNOWLEDGMENTS

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