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Status and Prospects of Nondestructive Testing and Evaluation in the Republic of Korea

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Abstract Past, present and future of nondestructive testing and evaluation(NDT&E) activities in Korea are reviewed. The current status and future direction in NDT&E research and development are presented. The newly revised edition of Korean NDT personnel qualification system is described. Other activities such as NDT&E training programs, NDT field services, and professional societies and international cooperation are also summarized. Founded in 1980, the Korean Society for Nondestructive Testing is now the center of domestic activities in NDT&E as well as the gateway to the international cooperation.

1. INTRODUCTION

Nondestructive testing and evaluation became a matter of great concern to the people of prudence in Korea as electric power plants and heavy industries were developed under the series of the five-year economic development plan starting from 1962. Since then the NDT work volume has been steadily increased due to the continued development of Korean industries such as the automobile and the shipbuilding industries as well as the petrochemical and the nuclear power plants. Currently, sixteen companies offer NDT field services and numerous firms routinely use more than on NDT&E techniques for either the quality control of their products or the safety and reliability of structures under operating conditions. As the majority of industrial plants were designed and constructed by domestic engineering firms, the NDT Personnel Qualification Act became effective in 1978.

During the early 1960s, the Korea Atomic

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Energy Research Institute(KAERI) initiated the research on radiography and the training of NDT personnel who later became the leaders of NDT activities in Korea. KAERI has greatly contributed to the early establishment of NDT&E research and development(R&D) activities during 1970s as well as 1980s. From mid-1970s through mid-1980s, other institutions also started to participate in NDT&E related activities either R&D or training and education or both. Just a few of them are Korea Research Institute of Standards and Science (KRISS, formerly Korea Standards Research Institute), Korea Institute of Machinery and Metals(KIMM), and Hanyang University.

The Korean Society for Nondestructive Testing(KSNT) was founded in 1980, which became the center of domestic activities in NDT&E related fields and the gateway to the international technical exchange. KSNT has also administered the ASNT Level III Examinations inside the Republic of Korea (ROK) under the auspices of the American Society for Nondestructive Testing(ASNT) since November, 1982.

2. RESEARCH AND DEVELOPMENT

Research and development on NDT&E in Korea was initiated by a small group of physicists and engineers at KAERI in the early 1960s. The main purpose of the research was to investigate the casting technology and to detect defects of the Buddhist statues of Shilla Dynasty manufactured in the 6th century[1]. The project was sponsored jointly by the ROK Government and the Asian Foundation as a part of the nationwide campaign for the preservation of nationally designated cultural assets.

With the techniques and experiences acquired through the research project, KAERI undertook the training of NDT technicians for the heavy and the chemical plants being constructed under the first Five-year Economic Development Plan. At the same time, KAERI published a guide book on the industrial use of radiography[2]. During the late 1960s, an attempt was made to develop radiography equipment at KAERI[3]. The commercialization and practical use of the equipment was realized in the late 1970s[4, 5].

NDT&E research activity at KAERI was actually very limited due to the heavy emphasis on nuclear power generation technology. In 1976, KAERI established an NDT & E Group to undertake basic research as well as in-service inspection of nuclear power plants. Primary emphasis was placed on the safety of the Kori Nuclear Power Plant Unit No. 1(Kori-1). The Group, with the help of Southwest Research Institute of the United States, successfully completed the first in-service inspection of Kori-1 by the end of 1970s.

Other institutions also started to participate in the R&D of various areas of NDT& E activities. NDT&E Groups were established at KIMM and KRISS in 1978 and 1980, respectively. The group at KPISS has devoted to acquiring and assimilating NDT & E technology from abroad and the development of instrumentation including NDT sensors such as UT−, ECT−, AE− sensors and EMAT. The group is also concerned about the standardization of various NDT&E technologies. On the other hand, the group at KIMM has concentrated on the practical applications of various NDT&E methods to the plant maintenance of petrochemical and other heavy industries. KIMM is located in the middle of Changwon Heavy Industrial Complex near the southern coast of Korean Peninsula.

From the early 1970s, a few area of NDT&E research were also conducted at universities, which included strain measurement at Hanyang University, ultrasonics and acoustic emission at Korea Advanced Institute of Science and Technology, Kukmin University, and Welding NDT at Seoul Polytechnic University.

3. PERSONNEL QUALIFICATION AND TRAINING

In December, 1973, the ROK Government legislated the National Technical Qualification Act[6] which established a system of producing certified engineers and craftsmen in various fields of specialization. From the beginning of 1975, the ROK Government started to enforce the qualification examinations based on the Act. Currently, it covers 624 specific titles as shown in Table 1.

In 1978, the Act was revised to include the NDT personnel qualifications for the industrial production control. This included four levels ; NDT Engineer Class I and Class II, NDT Craftsman Class I and Class II, Two more classes, namely the Professio nal NDT Engineer and the Master NDT

Table 1. National technical qualification titles by fields and classes

Technical Fields	Engineers			Craftsmen			Total
	Prof. Engr.	Cl. I Engr.	Cl. II Engr.	Master Craftsman	Cl. I Craftsman	Cl. II Craftsman	
1. Machine	9	9	8	18	42	42	128
2. Metal	5	1	1	10	14	14	45
3. Chemical Engineering	9	4	3	9	15	16	56
4. Electricity	4	2	3	3	7	6	25
5. Electronics	4	2	2	1	3	3	15
6. Communication	1	3	3	1	4	9	21
7. Shipbuilding	4	2	1	4	6	6	23
8. Aviation	3	1	1				5
9. Civil Engineering	10	1	1	7	9	9	37
10. Chemical	3	3	1	8	16	16	47
11. Textile	5	2	2	6	10	10	35
12. Mining	3	1	1	3	6	7	21
13. Information Processing	3	1	1				5
14. Energy	4	2	1				7
15. National Land Development	7	5	4				16
16. Ocean	1	1	1				3
17. Safety Management	5	8	6				19
18. Production Control	3	3	2				8
19. Applied Industries	8	11	9	19	30	31	108
Total	91	62	51	89	162	169	624

Craftsman, were added in 1984 and 1988, respectively. To cope with international qualification scheme, it was further revised 1992, that is, NDT Craftsman, NDT Engineer Class II, NDT Engineer Class I, respectively. We still retain Professional NDT Engineer, however. The minimum requirements for and the contents of examinations in various classes are summarized in Tables 2 and 3, respectively.

The examinations are offered more than once a year and administered by the Korea Vocational Training Management Association (KVTMA). Certificates are also issued by KVTMA to those who pass the examination. Currently six areas of NDT techniques are covered by the examination, namely, RT, UT, MT, PT, ET, and LT. The cumulative figures of the certificates granted as of 1991 are shown in Table 4.

Table 2. Requirements for the qualification examination

Classes	Minimum Requirements
Professional NDT Engineer	1) No less than 7years NDT experience with Engineer Class I certificates 2) No less than 9years NDT experience with Engineer Class II certificates 3) No less than 9years NDT experience with B.S. degree 4) No less than 11years NDT experience after graduated from junior colleges or technical vocational schools(2-year program) 5) No less than 20years NDT experience 6) Having equivalent certificates from foreign countries
NDT Engineer Class I	1) No less than 2years NDT experience with NDT Engineer Class II certificates 2) Graduates of accredited colleges with B.S. degree 3) No less than 2years NDT experience after graduated from junior colleges 4) Graduates of educational institutes for NDT Engineer Class I or equivalent training courses approved by Labor Department 5) No less than 10years NDT experience 6) Having equivalent certificates from foreign countries
NDT Engineer Class II	1) Graduates of junior colleges 2) NDT Craftsman 3) Graduates of educational institutes for NDT Engineer Class II or equivalent training courses approved by Labor Deparment 4) No less than 3years NDT experience with NDT Craftsman ceritificates 5) No less than 4years NDT experience after graduated from high school 6) No less than 7years NDT experience 7) Having equivalent certificates from foreign countries
NDT Craftsman	No limitation

Table 3. Contents of the qualification examination

	Written Examination	Practical Examination
RT	1. Principles of RT 2. RT techniques 3. Codes and standards 4. Radiation safety/Acts and regulations on atomic energy 5. Basic metallurgy 6. Fundamentals of welding	1. Testing skill 2. Equipment and instruments 3. Film processing and interpretation
UT	1. Principles of UT 2. UT techniques 3. Codes and standards 4. Basic metallurgy 5. Fundamentals of welding	1. Testing skill 2. Equipment and instruments 3. Interpretation and evaluation of test results
MT	1. Principles of MT 2. MT techniques 3. Codes and standards 4. Basic metallurgy 5. Fundamentals of welding	1. Testing skill 2. Equipment and instruments 3. Interpretation and evaluation of test results
PT	1. Principles of PT&LT 2. PT&LT techniques 3. Codes and standards 4. Basic metallurgy 5. Fundamentals of welding	1. Testing skill 2. Calibration of specimen 3. Interpretation and evaluation of test results
ET	1. Principles of ET 2. ET techniques 3. Codes and standards 4. Basic metallurgy 5. Fundamentals of welding	1. Testing skill 2. Calibration of specimen 3. Interpretation and evaluation of test results
LT	1. Principles of PT&LT 2. PT&LT techniques 3. Codes and standards 4. Basic metallurgy 5. Fundamentals of welding	1. Testing skill 2. Calibration of specimen 3. Interpretation and evaluation of test results

Several organizations offer different level of NDT training courses. The KSNT offers refreshers for ASNT Level III examinations annually. With the rapid development of Korean industries, the number of applicants and the certificates issued for ASNT Level III has been steadily increased as shown in Table 5. In addition, KSNT offers courses for each discipline of NDT including radiation safety for field workers.

An NDT training course of four-week long is offered annually at KAERI's Nuclear Training Center. The curriculum is summarized in Table 6. Besides the KSNT and

Table 4. National NDT PQ certificates issued during 1978－1991

Year Issued	Professional NDT Engineer	NDT Engineer Class I	NDT Engineer Class II	NDT Craftsman Class I	NDT Craftsman Class II
		RT UT MT PT ET LT	RT UT MT PT ET	RT UT MT PT ET LT	RT UT MT PT ET
78-83	－	(215)	－	(210)	(542)
84	4	20 18 4 10 2 -	5 8 3 3 1	42 7 14 4 1 -	65 53 20 18 -
85	3	30 14 11 14 2 -	9 2 2 2 -	18 18 10 7 - -	103 32 29 19 -
86	5	8 7 5 8 1 -	5 14 2 2 -	24 24 20 8 - -	80 22 30 19 4
87	6	20 8 5 3 0 -	2 4 5 3 -	18 10 10 7 1 -	191 40 28 30 3
88	2	7 2 3 9 3 2	6 7 7 6 -	16 5 9 13 - 1	99 10 31 40 4
89	4	8 49 2 7 1 1	14 6 5 11 1	11 9 20 7 1 -	189 23 33 20 4
90	2	39 2 12 9 - 1	3 4 11 7 -	11 5 12 19 6 1	225 17 29 29 3
91	4	19 1 9 11 1 -	10 4 4 1 -	16 8 12 8 - -	309 30 28 43 -

Table 5. ASNT Level III certificates issued during 1982－991

	R T	M T	U T	P T	E T	L T	N R T	Total
1982	29 (59)	26 (46)	20 (49)	11 (29)	1 (5)	0 (2)	1 (1)	88 (191)
1983	28 (40)	29 (45)	26 (42)	16 (44)	6(14)	1 (9)	2 (2)	108 (196)
1984	14 (23)	20 (29)	7 (22)	10 (24)	5(15)	0(10)	2 (5)	58 (128)
1985	11 (19)	9 (20)	6 (21)	1 (6)	1 (3)	0 (2)	1 (1)	29 (72)
1986	····· The examination was not offered in Korea ·····							
1987	26 (47)	30 (45)	29 (49)	10 (15)	5(12)	3 (4)	1 (1)	104 (173)
1988	21 (24)	24 (27)	11 (29)	9 (16)	1 (4)	2 (5)	1 (1)	69 (106)
1989	····· The examination was not offered in Korea ·····							
1990	11 (22)	20 (31)	20 (31)	2 (15)	5(19)	1 (3)	0 (0)	59 (121)
1991	28 (47)	24 (36)	11 (36)	16 (29)	3(19)	2 (6)	0 (2)	84 (175)
Total	168(281)	182(279)	130(279)	75(178)	27(91)	9(41)	8(13)	599(1162)

KAERI, other organizations offering one- or two-week long training courses include KRISS, the Korean Atomic Industrial Forum (KAIF), the Korean Society for Mechanical Engineer(KSME), and the Society of Naval Architects of Korea(SNAK).

As the regular educational programs in colleges or universities, however, NDT education has been carried out rather poorly. Due to its multi-disciplinary nature, NDT is included as a partial curriculum in various departments such as Applied Physics, Metallurgy, Mechanical and Nuclear Engineering.

4. NDT FIELD SERVICE ACTIVITIES

Stringent quality control requirements for the power plants and the heavy and chemical industries led for the top management to recognize the importance of NDT. Numerous firms routinely use more than one NDT techniques for either the quality control of their products or the safety and reliability of structures under operating conditions. Currently, sixteen companies offer NDT field service. Seven out of sixteen field service companies have been established within a year. The toal number of

Table 6. Curriculum for NDT training courses(4weeks)

Subjects	Hour
Introduction to NDT	3
Radiation Safety	3
Acts and Regulations on Atomic Energy	2
Metallurgy	7
Welding Technology	10
Visual Testing	6
Quality Assurance	2
Radiography	28
Ultrasonic Testing	28
Magnetic Particle Testing	9
Penetrant Testing	9
Eddy Current Testing	12
Codes and Standards	5
Examination and Quiz	3
Others	16
Totals	143

5. PROFESSIONAL SOCIETIES

The KSNT was founded in March, 1980 to promote the development and exchange of technical information on NDT both domestically and internationally. The society has grown steadily since then and the total number of members reached 954 including 94 corporate members as of September, 19 92. On the other hand, publication of papers in the Journal of KSNT has been stagnant until recently but started to increase rapidly in the last two years as can be seen in Table 7. The number of issues per year is increased from two to four in 1992 to cope with the ever increasing demand for such activities.

In March, 1979, the local chapter of the ASNT was installed to promote the technical exchanges among its members residing in Korea. The chapter became a catalyst in launching the KSNT then has been inactive for many years, however, for its role has been taken over by the KSNT. Very recently, the cooperation between the KSNT and the ASNT has become more practical since the agreement on the technical exchange was executed during the ASNT 50th Anniversary Fall Conference in September, 1991.

As a part of international cooperation activities between countries in the Far East

Table 7. Technical papers published in the journal of KSNT

Year / Theme	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91*	Total
UT	1	2	1	1	3	3	4	4	7	10	15	51
RT					1							1
ET					1		2	1		1	5	10
AE			1	2		3	1	1		2	5	15
Others	1	2	1		2	1	1	4	4	5	3	24
Total	2	4	3	3	7	7	8	10	11	18	28	101

* Figures include the papers appeared in the FENDT '91 Proceedings.

technical personnel of service companies reached a couple of thousand. The number of major equipments has also been increased more than ten times during the last decade. The NDT field services cover 1) defense industries/precision tool industries, 2) petrochemical plants construction and maintenance, 3) pressure vessel manufacturing, 4) power plants construction and maintenance, 5) transportation industries, 6) aerospace industries, and 7) shipbuilding industries.

Region, the agreement on the technical exchange between the KSNT and the Japanese Society for Nondestructive Inspection (JSNDI) was executed on June 1, 1990. This agreement provides the means when technical cooperation is needed in specific area such as information exchange, the exchange of visits of technical staffs, etc. As the first step of implementing the agreement, the First Far East Nondestructive Testing Conference and Exhibition(FENDT '91) was held on November 15-16, 1991 in Seoul, Korea. A similar agreement was also executed between the KSNT and the Republic of China Society for Nondestructive Testing(ROCSNDT) during FENDT '91.

References

1. Y. H. Kang, "Studies on Korean Antiques and Art Craft by Nondestructive Testing", Presented at the 2nd Annual Meeting on the Radioisotopes in the Physical Science and Industry, Tokyo, Japan, April, 1965.
2. K. Lee and W. K. Hwang, γ-ray Radiography by Ir^{192}, KAERI Report, 1968.
3. K. Lee and W. K. Hwang, Development of Radiography Equipment, KAERI Report, Vol. 2, 1967.
4. C. K. Hwang, Co^{60} Radiography Unit, KAERI/204 RR-73/79, 1979.
5. C. K. Hwang, Potable Radiography Unit, KAERI/392RR-125/80, 1980.
6. National Technical Qualification System, Ministry of Science and Technology, Republic of Korea, November, 1975.