

韓國의 非破壞 檢查現況

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Nondestructive Testing Activities in the Republic of Korea

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ABSTRACT

Nondestructive testing activities in Korea are summarized. Present activities and the future direction in NDT programs are presented. Korean NDT personnel qualification system is also presented. Training program, NDT services, and activities of professional societies also explained.

1. INTRODUCTION

Nondestructive testing (NDT) became a magic word in Korea as power plants and heavy & chemical industry developed under four successive five-year economic development plans since 1962. At the moment, nine NDT companies offer services, and over fifty firms routinely use NDT techniques for their products. Our conservative estimate is that the work volume will increase five times of the current rate during the next five years.

During the early '60s, the Korea Advanced Energy Research Institute (KAERI) conducted research on radiography and training of NDT personnel who later become the leaders of the NDT industry in Korea. The NDT Technical Qualification Act was promulgated by the ROK Government in 1978 as major plants were designed and constructed by domestic engineering firms.

To meet the ever increasing demands for NDT expertise, the Korea Institute of Machinery & Metals (KIMM) at Changwon Industrial Complex in Kyungsang - nam do, the Korea Standard Research Insti-

tute (K-SRI) at Dae Deog Dan Ji in Chung nam, the Korea Advanced Institute of Science & Technology (KAIST) in Seoul, and universities are all contributing to development of NDT technology in Korea.

The local chapter of the American Society for Nondestructive Testing (ASNT) and the Korean Society for Nondestructive Testing (KSNT) were established in 1978 and 1979 respectively.

2. RESEARCH AND DEVELOPMENT

Research on nondestructive testing (radiography) was initiated at KAERI by a small group of physicists and engineers in the early 1960's. The main purpose of the research was to investigate casting techniques and to detect defects in the 6th century bronze statue of buddha of the Silla Dynasty(1). The research was sponsored jointly by the Korean Government and the Asian Foundation as part of an ancient craft preservation program.

With the technique and skills acquired through the research, KAERI undertook training of NDT technicians for heavy and chemical plants being constructed under the 1st five year economic development plan. At the same time, KAERI published a guide book(2) on the industrial use of radiography. During the late 60's, an attempt was made to develop radiography equipments(3) at KAERI. This led to the commercial use of the equipment in the late 70's(4,5). From the late 60's to mid-70's, NDT related research was conducted primarily at Korean Universities. NDT research at KAERI was very limited due to the prime emphasis on nuclear power technology. Primary research emphasis was placed on the safety of the Korea Nuclear Unit No. 1 (Kori-1). In 1979, KAERI established a NDT Group to undertake basic research as well as inservice inspection of nuclear power plants. The Group, with the help of Southwest Research Institute of the USA, successfully completed the first inservice inspection of Kori-1. To this point in our nuclear power plant program most Pre-service and Inservice inspection was carried out under contract to foreign firms.

However, KAERI have now developed expertise in this field and they will become our main agency for this work in the future. For other industrial applications the expertise has been developed by KIMM, K-SRI and KAIST as well as KAERI. Those organizations will serve as the major of technical excellence for the Korean power industry and furnish a broad spectrum of technology, such as NDT, quality assurance quality control, management information system, applied mechanics, corrosion, welding, training and continuing research in these areas.

Currently KAERI is acquiring and assimilating NDT technology from abroad. However, in the near future we hope to initiate our research and development programs suitable to Korean environment.

3. PERSONNEL QUALIFICATION AND TRAINING

In December of 1973, the ROK Government promulgated the National Technical Qualification Act(7) which establishes a system of testing engineers and craftsmen whose technical capabilities have reached certain levels. Beginning in January 1975, the ROK Government has started to enforce the qualification tests according to the Act, which covers 758 specific titles as shown in Table 1.

The Act was modified in 1978 to include NDT technical qualifications in the field of production control. There are three levels; First Grade NDT Engineer, First Grade NDT Technician, and Second Grade NDT Technician. The qualifications and contents of the examination in various grades are given in Tables 2 and 3 respectively. The Korean system is compared with the U.S. system in Table 4 utilizing the same format as Mr. T.E. Goldfinch's(8).

The tests are administered once a year by the Korea Vocational Training & Management Agency, and certificates are issued by the ROK Government to those who pass the examination. The cumulative total of the certificates granted are 578 (Table 5).

Two to three NDT training sessions were offered annually at KAERI's Nuclear Training Center. Three courses lasting Four weeks and Eight days each are offered, one for General course in NDT, Specialized course in RT, and UT. The curriculums are shown in Tables 6.

The numbers of NDT trainees from 1977 to 1982 are listed in Table 7.

The Korean Society for Nondestructive Testing, the Korea Atomic Industrial Forum (KAIF), the Korean Society for Mechanical Engineers (KSME) and the Korean Society for Naval Architecture and Marine Engineering each help one or two weeks seminar on NDT technology during 1982 and received favorable responses from local industry.

4. NDT SERVICES

Stringent quality control requirements for power plants and heavy & chemical plants industry led industrial management to recognize the importance of NDT. At the moment over seventy private firms routinely use NDT for their products, and nine firms offer NDT services. The services cover 1) defense industry/precision tool industry, 2) petrochemical plant construction and subsequent maintenance, 3) pressure vessel fabrication, 4) transportation industry, 5) power plant construction and maintenance, 6) aircraft manufacturing, and 7) shipbuilding. The major equipment the the number of technical personnel of the NDT service companies are listed in Table 8. The total number of NDT service company technical personnel as of July 1982 was 557. This is over 4 times of the March 1978 number 157(9). The equipment has also more than quadrupled during the last three years. During the next three years it is anticipated the work load of the NDT firms will increase more than five times.

5. PROFESSIONAL SOCIETIES

In March of 1979, the local chapter of the ASNT was formed to promote technical information exchanges among its members residing in Korea. Currently the local chapter has 54 members and holds quarterly meetings to exchange views and technical information on NDT. A plan is being formulated to institute ASNT Level III Certification Program in Korea coming November in 1982.

The KSNT was organized in March 1980 to promote national as well as international cooperation in NDT. Publication of the society journal and establishment of an international division in the Society is planned to cope with the ever increasing demand for such activity.

6. REFERENCES

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- 4) C.K. Hwang, "Co-60 Radiography Unit", KAERI/204;RR-73/79, 1979.
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- 7) T.E. Goldfinch, "A Comparison of NDT Personnel Qualification Schemes in the Pacific Area", Treatises on the Pan Pacific Symposium on Non-destructive Testing, Korea Atomic Industrial Forum, April 1978, pp.15-21.
- 8) Byoung Whie Lee, "Present Status and Prospects of Nondestructive Testing in Korea", Treatises on the Pan Pacific Symposium on Non-destructive Testing, Korea Atomic Industrial Forum, April 1978, pp.40.1 - 40. 13.
- 9) H. Lee and N. Ho, "Nondestructive Testing Activities in the Republic of Korea", J. of KSNT Vol. 1, No. 1, 1981, pp. 45-59.

Table 1. National Technical Qualification Titles by Fields and Classes

Technical Fields	Engineering Group			Craft Group				Total
	Prof. Engr.	Class I Engr.	Class II Engr.	M Craftman	Class I Craftman	Class II Craftman	Ass. Craftman	
1. Machine	9	9	8	18	42	42	33	161
2. Metal	5	1	1	10	14	14	12	57
3. Chemical Engineering	9	4	3	9	15	16	12	68
4. Electricity	4	2	3	3	7	6	8	33
5. Electronics	4	2	2	1	3	3	2	17
6. Communication	1	3	3	1	4	9	5	26
7. Shipbuilding	4	2	1	4	6	6	4	27
8. Aviation	3	1	1					5
9. Civil Engineering	10	1	1	7	9	9	6	43
10. Architecture	3	3	1	8	16	16	15	62
11. Textile	5	2	2	6	10	10	9	44
12. Mining	3	1	1	3	6	7	6	27
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	22	130
Total	91	62	51	89	162	169	134	758

Table 2. Qualification for an Examination in Various Grade

Grades	Qualification
1st Grade NDT Engr.	<ol style="list-style-type: none"> 1. No less than 2 years NDT experience with 1st grade NDT technicians certificate. 2. Accredited college (Four years after high school) graduates or equivalent. 3. No less than 2 years experience in NDT after graduating from junior college or technical vocational school.
1st Grade NDT Tech.	<ol style="list-style-type: none"> 1. No less than 3 years NDT experience with NDT second grade technicians certificate. 2. Junior college or technical vocational school education or equivalent. 3. International Technical Olympic Medalist. 4. Graduates of first grade technician educational institutes or equivalent training courses. 5. No less than 4 years NDT experience after high school graduation. 6. No less than 6 years NDT experience.
2nd Grade NDT Tech.	<ol style="list-style-type: none"> 1. Assistance technician. 2. 2 years education in technical high school or equivalent. 3. Non-technical high school education or equivalent. 4. 1800 hours training as specified by the Vocational Training Act.

Table 3. Contents of NDT Examination

A. First Grade NDT Engineer

	Written Exam.	Practical Exam.
RT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. RT Theory 3. Industrial Standards of RT and its Application 4. Welding Technology 5. Basic Metallurgy 6. Radiation Safety, Atomic Acts and Regulations 	<ol style="list-style-type: none"> 1. Film Interpretation 2. Practice of RT
UI	<ol style="list-style-type: none"> 1. General Theory of NDT 2. UT Theory 3. Usage of Standard Test Block 4. Industrial Standards of UT and its Application 5. Welding Technology 6. Basic Metallurgy 	<ol style="list-style-type: none"> 1. Practice of UT
MT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. MT Theory 3. Industrial Standards of MT and its Application 4. Welding Technology 5. Basic Metallurgy 6. MT Equipment 	<ol style="list-style-type: none"> 1. Practice of MT
PT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. PT Theory 3. Industrial Standards of PT and its Application 4. Welding Technology 5. Basic Metallurgy 6. PT Equipment 	<ol style="list-style-type: none"> 1. Practice of PT
ET	<ol style="list-style-type: none"> 1. General Theory of NDT 2. ET Theory 3. Industrial Standards of ET and its Application 4. Welding Technology 5. Basic Metallurgy 6. ET Equipment 	<ol style="list-style-type: none"> 1. Practice of ET

B. First Grade NDT Technician

	Written Exam.	– Table 3 continued –
RT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. RT Theory 3. Industrial Standards of RT and its Application 4. Welding Technology 5. Radiation Safety, Atomic Acts and Regulations 	<ol style="list-style-type: none"> 1. Film Interpretation 2. Practice of RT
UT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. UT Theory 3. Industrial Standards of UT and its Application 4. Welding Technology 5. UT Equipment 	<ol style="list-style-type: none"> 1. Practice of UT
MT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. MT Theory 3. Industrial Standards of MT and its Application 4. Welding Technology 5. MT Equipment 	<ol style="list-style-type: none"> 1. Practice of MT
PT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. PT Theory 3. Industrial Standards of PT and its Application 4. Welding Technology 5. PT Equipment 	<ol style="list-style-type: none"> 1. Practice of PT
ET	<ol style="list-style-type: none"> 1. General Theory of NDT 2. ET Theory 3. Industrial Standards of ET and its Application 4. Welding Technology 5. ET Equipment 	<ol style="list-style-type: none"> 1. Practice of ET

C. Second Grade NDT Technician

	Written Exam.	– Table 3 continued –
RT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. Testing Principles of RT 3. RT Equipment 	<ol style="list-style-type: none"> 1. Practice of RT
UT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. Testing Principle of UT 3. UT Equipment 	<ol style="list-style-type: none"> 1. Practice of UT
MT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. Testing Principle of MT 3. MT Equipment 	<ol style="list-style-type: none"> 1. Practice of MT
PT	<ol style="list-style-type: none"> 1. General Theory of NDT 2. Testing Principle of PT 3. PT Equipment 	<ol style="list-style-type: none"> 1. Practice of PT
ET	<ol style="list-style-type: none"> 1. General Theory of NDT 2. Testing Principle of ET 3. ET Equipment 	<ol style="list-style-type: none"> 1. Practice of ET

Table 4. Comparison of Personnel Qualification Schemes of the USA and the Republic of Korea

	U. S. A.	Korea
1. No. of NDT Methods Presently Covered	7	5
2. Level of Qualification	Generally 3 levels for each method of which levels I & II are operational levels.	Generally 3 levels for each method of which Grade I & II are operational levels. Engineer Grade I Corresponds to level III.
3. Application	General (specific examination conducted according to products or candidate employer)	Not Specific to one type of product.
4. Issue of Certificate	Issued by employer to employee (Not transferable)	Issued to candidate by ROK Government.
5. Validity and Renewability	Maximum 5 years for all levels. Renewal on basis of examination or continuing employment.	Valid Indefinitely.
6. Consistency of Marking	Can not be assessed since examinations linked to specific requirements of employers.	Examinations are centrally administered through the Korea Technical Qualification and Testing Agency.
7. Independence	Certification must be by employer although outside agencies conduct level III examinations.	ROK Government
8. Composition of Approval Procedure	<ol style="list-style-type: none"> 1. General written exam. 2. Specific written exam. 3. Practical written exam. 4. Specific requirements of employer. 	<ol style="list-style-type: none"> 1. General written exam. 2. Specific written exam. 3. Practical written exam. 4. Practical exam.
9. Education	Linked to training and experience and is related to American education system.	Linked to Korean education system.
10. Training and Experience	Specific terms of training recommended for level I & II. Experience requirements are related to level and rating.	Linked with extent of prior education.
11. Health	Annual eye test mandatory	No requirement
12. Appeals Procedure	Not specific	No appeal

Table 5. Numbers of Certificates Issued

		1st Grade NDT Eng.					1st Grade NDT Tech.					2nd Grade NDT Tech.				
		RT	UT	MT	PT	ET	RT	UT	MT	PT	ET	RT	UT	MT	PT	ET
'78	Issued	64					38					73				
'79	Issued	36					55					55				
'80	Issued	30					33					68				
'81	Issued	27					12					72				
'82	Issued	15														
Total (578)		172					135					268				

Table 6. Curriculum for Training-Courses in Non-Destructive Testing

A. General Course in Non-Destructive Testing (4 weeks)

	Curriculum	Hour
Lecture	Radiation Safety Management	5
	Welding Techniques	14
	Metallurgy and Material Science	14
	Quality Assurance	3
	Outline of Non-destructive Testing	4
	Atomic Energy Laws and Regulations	4
	Ultrasonic Testing	20
	Magnetic Particle Testing	7
	Liquid Penetrant Testing	4
	Radiographic Testing	20
	Eddy Current Testing	3
	RI Production and Application	2
	Special Lecture	1
	Neutron Radiography	2
Experiment	Radiographic Testing	21
	Ultrasonic Testing	21
	Magnetic Particle Testing	21
	Liquid Penetrant Testing	21
	Eddy Current Testing	21
Others	Videotape show and Others	13

B. Specialized Course in Radiographic Testing (8 days)

Lecture	Introduction of Radiographic Testing	4
	Welding Technology	3
	Metal Materials	3
	Classification of Flaws	2
	Codes and Standards	10
Experiment	Radiographic Technique	14
	Preparation of Report	3
	Film Reading and Evaluation	7
Others	Videotape Show and Others	5

Table 8. NDT Company List

Name	Address	Major Equipment	No. of Tech. Staff
Samyong NDT Co., Ltd. Chairman S.S. Choi	58-18, 1Ka, Shinmoon-Ro, Chongro-Ku, Seoul. Sin-A Bldg. 4th Fl. Tel. 722-2168-9 722-8597-8	60KVA x 4mA x 1set, 140KVP x 5mA x 1set 200KVP x 8mA x 1set, 200KVP x 5mA x 4sets 250KVP x 5mA x 3sets, 260KVP x 5mA x 2sets 300KVP x 5mA x 2sets, Ir-192: 50Ci x 5sets, 5Ci x 6sets, 30Ci X 10sets UT: Flaw Detector x 5sets, Thickness Meter x 2 sets MT: Prod 4000Amps x 2 sets, Prod 1000Amp x 2 sets Yoke x 6sets	127
Hanyang Advanced Insp. Co., Ltd. President W.M. Chae	143-15, Nonhyun-dong Kangnam-Ku, Seoul Kunil Bldg 3rd Fl. Tel. 556-7873-5	200KVP x 6mA x 1sets, 250KVP x 5mA x 1set 260KVP x 5mA x 2 sets, 300KVP x 5mA x 3 sets Ir-192: 35Ci x 8sets, 11Ci x 1set 50Ci x 2sets, 100Ci x 4 sets UT: Flaw Detector x 2sets, Thickness Meter x 2sets MT: Yoke x 4sets	36
Hankuk Insp. & Development Co. President K.W. Lee	146-1, Ssanglim-dong Choong-Ku, Seoul Samkwang Bldg 5th Fl. Tel. 260-2155-7 267-7246	200KVP x 5mA x 2sets, 250KVP x 5mA x 3sets 260KVP x 5mA x 1set, 300KVP x 5mA x 2sets Ir-192: 30Ci x 8sets, 50Ci x 3sets UT: Flaw Detector x 2sets, Thickness Meter x 1set MT: Prod 1200Amps x 1set, Yoke x 2sets	96
Booil Industrial Testing Co., Ltd. President S.K. Kim	94-2, 1Ka Hoehyan-dong Choong-Ku, Seoul Jinyang Bldg 3rd Fl. Tel.: 778-5582 752-7422	200KVP x 8mA x 1set, 250KVP x 5mA x 2sets 300KVP x 5mA x 1set Ir-192: 15Ci x 1set, 10Ci x 1set UT: Flaw Detector x 1set MT: Yoke x 4 sets	12

Name	Address	Major Equipment	No. of Tech. Staff
Hankuk Industrial Testing Co. President H.K. Ji	53-17, 1Ka, Wonhyo-Ro, Yongsan-Ku, Seoul. Wonhyo Bldg. 5th Fl. Tel.: 712-3194 712-3156	130KVP x 5mA x 1set, 160KVP x 5mA x 1set 200KVP x 5mA x 2sets, 200KVP x 6mA x 2sets 220KVP x 8mA x 2sets, 250KVP x 5mA x 4sets 250KVP x 8mA x 1set, 260KVP x 5mA x 3sets 300KVP x 5mA x 5sets, 300KVP x 6mA x 2sets Ir-192: 50Ci x 3sets, 30Ci x 5sets 15Ci x 5sets, UT: Flaw Detector x 2sets Thickness Meter x 1set MT: Prod 3000Amps x 1sets, Yoke x 2sets ET: 1 unit	82
Yuyang Atomic Industrial Co. Ltd. President S.J. Kim	36-6, Nonhyun-dong Kangnam-Ku, Seoul. Seojin Bldg. 2nd Fl. Tel.: 555-6256 555-9731	160KVP x 5mA x 1set, 180KVP x 5mA x 1set 200KVP x 8mA x 1set, 200KVP x 5mA x 1set 250KVP x 5mA x 2sets, 250KVP x 6mA x 2sets 250KVP x 8mA x 1set, 260KVP x 5mA x 3sets 300KVP x 5mA x 2sets, 300KVP x 6mA x 2sets Ir-192: 100Ci x 1set, 35Ci x 16 sets 50Ci x 2sets, 30Ci x 10sets 15Ci x 2sets Co-60 5Ci x 2sets Ut: Flaw Detector x 3sets Thickness Meter x 1set MT: Prod 1500Amps x 4sets, Prod 2000Amps x 1set Yoke x 8sets ET: 1 unit	110

Name	Address	Major Equipment	No. of Tech. Staff
<p>Kuksan Engineering. Co., Ltd. President Y.H. Baik</p>	<p>2-35, 2Ka, Hangang-Ro Yongsan-Ku, Seoul Tel.: 792-7042-8 793-23377-8</p>	<p>160KVP x 5mA x 1set, 200KVP x 5mA x 3sets 250KVP x 5mA x 4sets, 260KVP x 5mA x 1set 300KVP x 5mA x 4sets. Ir-192: 50Ci x 2sets, 30Ci x 6sets 20Ci x 1set. 10Ci x 4sets UT: Flaw Detector x 3sets Thickness Meter x 1set MT: Prod 6000Amps x 6sets ET: 1 unit</p>	<p>61</p>
<p>Korea Industrial Testing Co., Ltd. President Y.H. Song</p>	<p>14-5, Kalwol-dong Yongsan-Ku, Seoul Sung-A Bldg. 3rd Fl. Tel.: 792-3718</p>	<p>160KVP x 5mA x 2sets, 180KVP x 5mA x 1set 200KVP x 5mA x 1 set, Ir-192: 20Ci x 1set, 15Ci x 3sets Co-60: 20Ci x 1set UT: Flaw Detector x 1set MT: Yoke x 2sets</p>	<p>15</p>
<p>Energy Management Corp.</p>	<p>98-5, Woonni-dong Chongro-Ku, Seoul Tel.: 613-3812 764-4825</p>	<p>160KVP x 4mA x 1set, 250KVP x 5mA x 3sets 300KVP x 5mA x 2sets, Ir-192: 15Ci x 4sets.</p>	<p>16</p>