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NONDESTRUCTIVE TESTING ACTIVITIES IN THE REPUBLIC OF KOREA

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ABSTRACT

Nondestructive testing activities in Korea are summarized. Past programs and the future direction in NDT research and development are presented. Korean NDT personnel qualification system is compared with the US system. Training program, NDT services, and professional societies are 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 starting in 1962. At the moment, nine NDT companies offer services, and over fifty firms routinely use NDT technology for their products. Our conservative estimate is that the work volume will increase five times the current rate during the next three 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 Nuclear Engineering Test and Evaluation Center (NETEC) is being constructed at KAERI. When it is completed in 1983, NETEC will be the center of excellence for NDT technology in Korea. NETEC will collect and dissiminate advanced NDT technology to local industries. The local chapter of the American Society for Nondestructive Testing (AS-

NT) 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 methods and to detect defects in the 6th century buddha art craft of the Silla Dynasty[1]*. The research was sponsored jointly by the Republic of Korea (ROK) Government and Asian Foundation as part of an ancient art 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 60ś, an attempt was made to develop radiography equipment[3] at KAERI. This led to the commercial use of the equipment in the late 70ś[4,5]. From the late 60s to mid−70ś, NDT related research was conducted primarily at Korean Universities. NDT research at KAERI was very limited due to the heavy emphasis on nuclear power technology. Primary research emphasis was placed on the safety of the Kori Nuclear Power Plant Unit No. 1(Kori-1). In 1976, 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. The NDT Group along with applied mechanics related Groups was instrumental in establishing KAERI's Nuclear Engineering Test and Evaluation Center (NETEC)[6].

NETEC is being constructed at KAERI in response to the nation's urgent need for ensuring safety and reliability of nuclear power plants, particularly when the goals of component localization and plant betterment capabilities are to be achieved. When it is completed in 1983 NETEC will undertake the following missions:

1) Development of specialized NDT capabilities to perform inservice inspection of nuclear power plants.
2) Performing qualification of nuclear grade components (safety related items) in order to ensure quality and reliability prior to installation.
3) Establishment of a national quality authorization program for locally produced nuclear grade components.

NETEC will serve as the center of technical excellence for the Korean power industry and furnish a broad spectrum of technology, such as NDT, quality assurance

* Numbers in the parenthesis designate references.

/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 will begin initiating our research and dvelopment programs suitable to Korean environment.

3. PERSONNEL QUALIFICATION AND TRAINING

In December of 1973, the ROK Government promulgated the National Technical Quafication Act[7] which establishes a system of testing engineers and craftmen whose technical capabilities have reached certain levels. Beginning in January 1975, the ROK Government started to enforce the qualification tests according to the Act. It 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 Technical Qualification Testing Agency (KTQTA), and certificates are issued by the ROK Government to those who pass the examination. The cumulative total of applicants and the certificates granted are 1730 and 452 respectively (Table 5)

Two to three NDT training sessions were offered annually at KAERI's Nuclear Training Center. Two courses lasting six weeks each are offered, one for supervisory personnel and the other for technicians. The curriculums are shown in Tables 6 and 7. The numbers of NDT trainees from 1977 to 1980 are listed in Table 8. The Korean Atomic Industrial Forum (KAIF), the Korean Society for Mechanical Engineers (KSME), and the Korean Society for Naval Architecture and Marine Engineering each held one or two weeks seminar on NDT technology during 1980 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 fifty 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 ma-

intenance, 6) aircraft manufacturing, and 7) shipbuilding.

The major equipment and the number of technical personnel of the NDT service companies are listed in Table 9. The total number of NDT service company technical personnel as of November 1980 was 374. This is over 2.3 times 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 early next year.

The KSNT was organized in March 1980 to promote domestic 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.

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9) 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.

Table 1. NATIONAL TECHNICAL QUALIFICATION TITLES BY FIELDS AND CLASSES

Technical Fields	Engineering Group			Craft Group				
	Prof. Engr.	Class I Engr.	Class II Engr.	M. Craft-man	Class I Craft-man	Class II Craft man	Ass. Craft-man	Total
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.	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.	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.	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	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	1. Film Interpretation 2. Practice of RT
UT	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	1. Practice of UT
MT	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	1. Practice of MT
PT	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	1. Practice of PT
ET	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	1. Practice of ET

B. FIRST GRADE NDT TECHNICIAN

—Table 3 continued—

	Written Exam.	Practical Exam.
RT	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	1. Film Interpretation 2. Practice of RT
UT	1. General Theory of NDT 2. UT Theory 3. Industrial Standards of UT and its Application 4. Welding Technology 5. UT Equipment	1. Practice of UT
MT	1. General Theory of NDT 2. MT Theory 3. Industrial Standards of MT and its Application 4. Welding Technology 5. MT Equipment	1. Practice of MT
PT	1. General Theory of NDT 2. PT Theory 3. Industrial Standards of PT and its Application 4. Welding Technology 5. PT Equipment	1. Practice of PT
ET	1. General Theory of NDT 2. ET Theory 3. Industrial Standards of ET and its Application 4. Welding Technology 5. ET Equipment	1. Practice of ET

C. SECOND GRADE NDT TECHNICIAN

—Table 3 continued—

	Written Exam.	Practical Exam.
RT	1. General Theory of NDT 2. Testing Principles of RT 3. RT Equipment	1. Practice of RT
UT	1. General Theory of NDT 2. Testing Principle of UT 3. UT Equipment	1. Practice of UT
MT	1. General Theory of NDT 2. Testing Principle of MT 3. MT Equipment	1. Practice of MT
PT	1. General Theory of NDT 2. Testing Principle of PT 3. PT Equipment	1. Pratice of PT
ET	1. General Theory of NDT 2. Testing Principle of ET 3. ET Equipment	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

— Table 4 continued —

	U. S. A.	Korea
8. Composition of Approval Procedure	1. General written exam. 2. Specific written exam. 3. Practical written exam. 4. Specific requirement of employer.	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 Pprocedure	Not specific	No appeal

Table 5. NUMBERS OF APPLICANTS AND CERTIFICATES ISSUED

		1st Grade NDT Engineer					1st Grade NDT Technician					2nd Grade NDT Technician				
		RT	UT	MT	PT	ET	RT	UT	MT	PT	ET	RT	UT	MT	PT	ET
'78	Application	259					110					250				
	Issued	64					38					73				
'79	Application	62	56	28		—	52	40	25		—	116	67	55		—
	Issued	24	4	8		—	29	18	8		—	30	14	11		—
'80	Application	53	36	14	7	—	120	43	25	15	2	192	41	38	24	—
	Issued	14	7	6	3	—	18	10	3	1	1	33	11	15	9	—

Cumulative Total Application : 1,730
Certificates Issued : 452

Table 6. CURRICULUM FOR NDT SUPERVISORY COURSE

Course	Hours
Radiation Safety	9
Welding Technology	12
Metallurgy	9
Quality Assurance	3
Nondestructive Testing	4
Ultrasonic Testing	24
Magnetic Particle Testing	12
Liquid Penetrant Testing	9
Radiographic Testing	27
Eddy Current Testing	9
Strain Gauges	3
Preservice Inspection of Nuclear Power Plant	3
Radioisotope Production & Application	4
Atomic Acts	4
Others	2
Experiments	54

Table 7. CURRICULUM FOR NDT TECHNITIAN COURSE

Course	Hours
Radiation Safety	9
Welding Technology	12
Nondestructive Testing	7
Metallurgy	9
Ultrasonic Testing	24
Magnetic Particle Testing	12
Liquid Penetrant Testing	12
Radiographic Testing	21
Eddy Current Testing	6
Inservice Inspection of Nuclear Power Plants	3
Atomic Acts	6
Others	7
Experiments	54

Table 8. NUMBERS OF NDT TRAINEES DURING 1977~1988

	77	78	79	80
Supervisory Course	47	87	50	49
Technician Course	-	29	15	17

Table 9. NDT COMPANY LIST

(Nov. 1, 1980)

Name	Address	Major Equipment	No. of Technical Staff
Korea Industrial Testing Co., Ltd.	14-5, Kalwol-Dong, Yongsan-ku, Seoul Tel. 792−3781	160KVP x 5mA x 2sets, 200KVP x 5mA x 1set Ir-192 : 30Ci x 8sets, 15Ci x 3sets UT : Flaw Detector x 1set MT : Yoke x 2sets	24
Kuksan Engineering Co., Ltd.	18-5, 1Ka, Hangang-Ro, Yongsan-Ku, Seoul Tel. 793−2377~8	160KVP x 5mA x 2sets, 200KVP x 5mA x 3sets 250KVP x 5mA x 3sets, 300KVP x 5mA x 3sets Ir-192 : 100Ci x 3sets, 50Ci x 4sets 35Ci x 11sets UT : Flaw Detector x 3sets Thickness Meter x 1set MT : Prod 6000 Amps x 6sets ET : 1 unit	68
Samyong NDT Co., Ltd.	53-17, 1Ka, Wohnhyo-Ro, Yongsan-Ku, Seoul Tel. 713−2350~2	60KVP x 4mA x 1set, 200KVP x 5mA x 4sets 200KVP x 8mA x 1set, 250KVP x 5mA x 4sets 260KVP x 5mA x 2sets, 300KVP x 5mA x 2sets Ir-192 : 200Ci x 1set, 100Ci x 5sets 50Ci x 2sets, 30Ci x 9sets Co-60 : 5Ci x 1sets UT : Flaw Detector x 5sets Thickness Meter x 2sets MT : Prod 4000Amps x 2sets, Prod 1000Amps x 2sets Yoke x 6sets	103

— Table 9 continued —

Name	Address	Major Equipment	No. of Technical Staff
Yuyang Atomic Industrial Co., Ltd.	62-3, Ducksan-Dong, Yongsan-Ku, Seoul Tel. 855—3251~5	160KVP x 5mA x 1set, 180KVP x 5mA x 1set 200KVP x 8mA x 1set, 250KVP x 5mA x 2sets 250KVP x 6mA x 2sets, 300KVP x 6mA x 2sets Ir-192 : 200Ci x 2sets, 100Ci x 2sets 35Ci x 16sets Co-60 : 5Ci x 1set UT : Flaw Detector x 3sets Thickness Meter x 1set MT : Prod 1500Amps x 4sets, Prod 2000Amps x 1set Yoke x 8sets ET : 1 unit	70
Booil Industrial Testing Co., Ltd.	94-2, 1Ka, Hoehyan-Dong, Choong-Ku, Seoul Tel. 778—5582	200KVP x 8mA x 1set, 300KVP x 5mA x 1set Ir-192 : 15Ci x 4sets, 30Ci x 7sets 35Ci x 2sets, 50Ci x 1set UT : Flaw Detector x 1set MT : Yoke x 4sets	25
Energy Management Corp.	88, Kyungwoon-Dong, Chongro-Ku, Seoul Tel. 612—2168	Ir-192 : 30Ci x 7sets	7
Hankuk Industrial Testing Co.	66-1, 2Ka, Hangang-Ro, Yongsan-Ku, Seoul Tel. 793—1564~6	130KVP x 5mA x 1set, 160KVP x 5mA x 1set 200KVP x 5mA x 4sets, 200KVP x 6mA x 2sets 250KVP x 5mA x 5sets, 300KVP x 5mA x 5sets Ir-192 : 50Ci x 3sets, 30Ci x 15sets 150Ci x 2sets Co-60 : 5Ci x 2sets	21

— Table 9 continued —

Name	Address	Major Equipment	No. of Technical Staff
Hankuk Industrial Testing Co. (continued)		UT : Flaw Detector x 2sets Thickness Meter x 1set MT : Prod 3000Amps x 1set, Yoke x 2sets ET : 1 unit	
Hankuk Inspection & Development Co.	56-85, 1Ka, Changchoong-Dong, Choong-Ku, Seoul Tel. 267—7246	200KVP x 5mA x 2sets, 250KVP x 5mA x 1set 300KVP x 5mA x 2sets Ir-192 : 35Ci x 7sets, 50Ci x 2sets UT : Flaw Detector x 2sets Thickness Meter x 1set MT : Prod 1200Amps x 1set, Yoke x 2sets	38
Korea Electric Technical Service Corp.	98-7, Woonni-Dong, Chongro-Ku, Seoul Tel. 763—3111~5	250KVP x 8mA x 3sets, 300KVP x 6mA x 2sets Ir-192 : 35Ci x 5sets, 100Ci x 2sets UT : Flaw Detector x 1set	18