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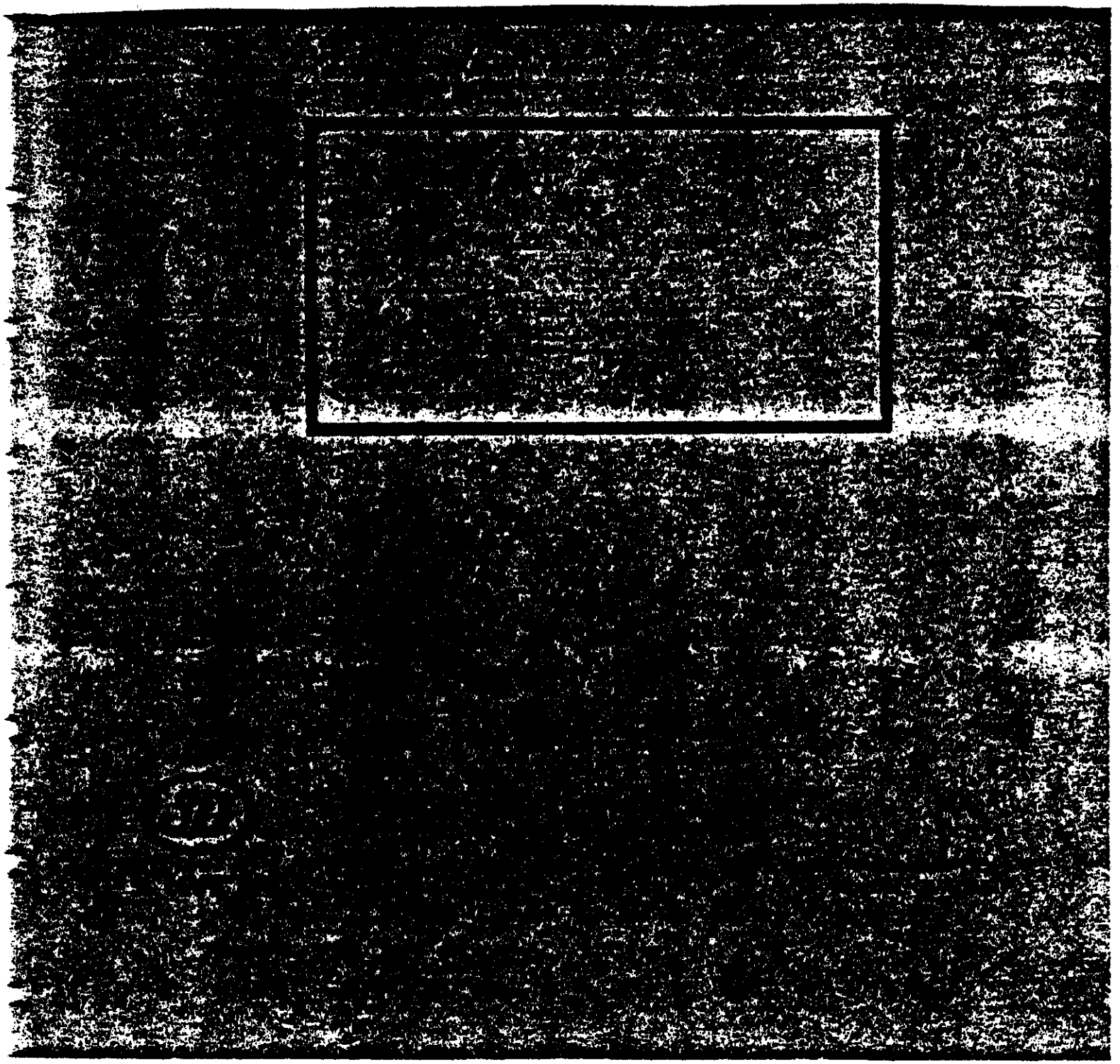

UPDATE REVIEW OF SAFETY ASPECTS
OF
NUCLEAR POWER PROGRAM
IN
REPUBLIC OF KOREA

By

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Prepared for
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TABLE OF CONTENTS

		Page
I.	EXECUTIVE SUMMARY	1
II.	INTRODUCTION	9
III.	REGULATORY ASPECTS	11
IV.	OPERATIONAL SAFETY	25
V.	OTHER COMMENTS	32
	APPENDIX I - LIST OF MEETINGS AND PERSONS VISITED	36
	APPENDIX II - CHANGES IN REGULATORY FRAMEWORK	38
	APPENDIX III - DEVELOPMENT OF KOREAN NUCLEAR CODES AND STANDARDS AND ACQUISITION AND DISSEMINATION OF NUCLEAR SAFETY INFORMATION	44
	APPENDIX IV - KEPCO Organization and Manpower DEVELOPMENT PROGRAMS	50
	APPENDIX V - STATUS OF NUCLEAR POWER PROGRAM IN KOREA AND KORI-1 UPGRADING AND WASTE RELEASE	61
	APPENDIX VI - ACTIVITIES OF DEADUK ENGINEERING CENTER	66

I. EXECUTIVE SUMMARY

A. Introduction

In June 1980, a "Review of Safety Aspects of Nuclear Power Program in Republic of Korea" was conducted (SLI-8012). This report is an Update Review on the same topic but with special emphasis on the regulatory aspects and operational safety of nuclear power plants. The work was carried out for the World Bank/UNDP and included a visit to Korea from April 6 to April 14, 1982.

B. Principal Conclusions

1. As recommended in 1980, it is essential and urgent that there exist in the Republic of Korea a strong, independent, and competent nuclear regulatory function as well as associated Korean safety laws, regulations, criteria, codes and standards. Even though some positive actions have been taken in recent months, the organization and the relevant documentation to control safety are still far from being in place in Korea. Top priority and adequate resources should be given to this effort. Detailed recommendations to help achieve the desired objective are given in Section III of this Update Report and the principal recommendations are summarized in Section C below.

2. Progress in operational safety at Kori-1 in the past two years has been limited. It is important to recognize that, by contrast to oil and coal power plants, operating nuclear power plants require continued upgrading in personnel training, equipment, and operational safety bases. Special funds must be provided and applied to satisfy such a need. Detailed recommendations to help increase operational safety are given in Section IV and the principal recommendations are summarized in Section D below.

3. At the present time, third party independent quality and safety audits and inspections are minimal in the Republic of Korea. The development of Korean criteria to conduct such audits and inspections should be assigned a high priority by the Quality Assurance Department of the Nuclear Safety Center. When such criteria are ready, consideration should be given to have the Korean nuclear industry carry out its own independent safety and quality audits and inspections. More details on this topic are furnished in Section IV of this report and are summarized in Section E below.

4. An integrated and complete Korean nuclear power safety program is not available. For example, the infrastructure and plans (beyond storage) for radioactive waste disposal are not yet defined; similarly, an integrated manpower development program, patterned after the KEPCO plan, does not exist to meet the needs of the regulatory and Korean equipment and services suppliers; finally, alternatives to cope with the safety of the back end of the fuel cycle (spent fuel storage, reprocessing, thermal recycle, breeder) must be formulated. Coordination and co-operation among the various ministries and organizations involved will help reach that objective, as discussed in Section IV of this report and Section E below.

C. Regulatory Aspects

1. Several important and desirable changes have been made in Korea nuclear regulatory aspects:

   a) A revision of the Atomic Energy Law was passed on April 1, 1982. The revision provides for an expanded coverage of nuclear activities (i.e. licensing of component manufacturing and nuclear material handling personnel and an expansion of regulatory inspections to cover construction,

architect-engineer, transportation, non-destructive testing and waste disposal firms). The law now requires the submittal of an environmental report and it strengthens the regulatory authority by making it legal and providing for civil penalties. The revision to the Atomic Energy Law is a substantial step forward in safety but, due to its very recent passage, its true impact remains to be assessed.

b) A Nuclear Safety Center (NSC) was created at the Korea Advanced Energy Institute (KAERI). NSC is being charged with carrying out the evaluation of all safety analysis reports and the audit and inspection of Korean Nuclear facilities to be regulated under the revision of the Atomic Energy Law. The formation of the Nuclear Safety Center is expected to be most beneficial to safety by providing a strong and capable technical team to assess and audit nuclear safety in the Republic of Korea.

c) NSC has set out to generate the necessary set of regulations, criteria, codes and standards to enact the new Atomic Energy law. When issued, they should provide the necessary legal and technical framework to enhance and control Korean nuclear safety. The adequacy of the proposed safety regulations and requirements could not be assessed because they are not yet available.

2. The Republic of Korea has a unique opportunity to put together an efficient and workable set of nuclear regulatory requirements. The following are recommendations which might help to achieve that objective:

a) Announcement and support from the highest level in Korean government when issuing the new Korean safety regulations that safety and quality are just as essential as meeting schedule requirements .(See Recommendation III.1).

b) Providing an adequate number of competent personnel to develop the necessary regulations and to carry out the required safety analyses, audits and inspections. The increased functions assigned to NSC will require more personnel. In addition, the present NSC team should be augmented with personnel experienced in the design, construction, and operation of nuclear power plants. (See Recommendation III.2).

c) Putting increased priority on formulating the regulatory and safety requirements for operating plants and plants under construction. The sooner these are defined, the less difficult they will be to backfit. In generating such requirements, a backfit policy should be developed which is based upon balancing the cost of implementation versus safety risk reduction. (See Recommendation III.3).

d) Issuance of regulations, criteria, codes and standards only at the rate that they can be enforced by the regulatory authorities or absorbed by those being regulated. Sufficient time should be taken to generate such regulations and to tailor them to the Korean situation. Considerable details should not be included to avoid the need to continuously change or upgrade them. (See Recommendation III.4).

e) Increasing the qualification and capability of the regulatory personnel at the Atomic Energy Bureau (AEB) to insure appropriate legal implementation of nuclear safety. (See Recommendation III.5).

f) Developing a clear scope and set of responsibilities for the regulatory personnel at AEB and for those at NSC. The working relationships and authorities between the two organizations must be defined to avoid inadequate coverage or overlap. An organization structure in which AEB issues

the licenses and carries out the inspection and enforcement and NSC carries the technical safety evaluation work may be advisable. (See Recommendation III.6).

g) Considering the use of an Advisory Group reporting to the Director, Nuclear Safety Center. This Advisory Group should not review specific licensing applications but rather it should deal with important policy decisions (e.g. backfit rule) or key generic issues (e.g. formulation and review of a Korean type TMI Action Plan). (See Recommendation III.7).

h) Encouraging future plant design standardization and its application by reducing the licensing schedule and review work when standard designs are utilized in applications. (See Recommendation III.8).

i) Acquiring probabilistic risk assessment capability and employing it to guide some of the regulatory decision process. (See Recommendation III.9).

D. Operational Safety

1. Some progress has been madein Kori-1 operational safety but it is limited. An important improvement is in the area of site emergency procedures where an agreement for cooperation with US NRC has been completed including the conduct of joint site emergency drills.

2. It is recommended that increased funds be made available to support operational plant safety including:

a) Operator qualifications should be increased by requiring added technical education and providing basic understanding courses in heat transfer, fluid flow and transient behavior of pressurized water reactor power plants. (See Recommendation IV.1).

b) The Kori-1 training simulator should be modified to include primary coolant boiling or flashing. (See Recommendation IV.2).

c) Symptom oriented emergency operating procedures should be developed for Kori-1 and subsequent plants. (See Recommendation IV.3).

d) Necessary design changes should be implemented in Kori-1 and all other plants to respond to the TMI-2 accident. As a minimum, a sub-cooling meter, a capability to detect stuck open relief valves, and reactor vents should be provided at Kori-1. (See Recommendation IV.4).

e) The delivery of a simulator for Units 7 & 8 should be accelerated and operator training on power plants and non-Korean simulators increased until that time. (See Recommendation IV.5).

f) An integrated spare parts program should be put in place, including the availability of emergency funds to procure essential foreign components not available in Korea. (See Recommendtion IV.6).

E. Others

1. While a detailed review of quality assurance was not performed, several quality assurance problems were noted during the review including insufficient management attention, lack of proper mental attitude towards quality assurance, inadequate number and

qualifications of personnel to carry out the necessary quality assurance audits and inspections. Consideration should be given to have the industry formulate its own independent quality assurance inspection program based upon criteria formulated by NSC. Such a program could include the development of top management workshops and training classes for quality assurance inspectors. It is important that in developing the program, emphasis be placed not upon extra paper generation but upon discovering inadequacies in implementing design and construc tion and upon finding operating deficiencies. (See Recommendation V.1).

2. As pointed out in the 1980 review, availability of manpower resources and, in particular, experienced and qualified personnel continues to be a critical safety issue in carrying out the proposed Korean nuclear program. KEPCO has done a good job but the government should take any action it can to direct experienced personnel and to enroll the best university graduates into the nuclear regulatory and other Korean nuclear programs. (See Recommendation V.2).

3. It is understood that studies will be initiated shortly to develop a national radioactive waste plan. It is recommended that an infrastructure be defined in Korea to carry out such radioactive waste disposal. Consideration should be given to having a special governmental organization handle radioactive wastes and recover its costs of development and operations from charges to users for disposal of waste. (See Recommendation V.3).

4. An integrated nuclear Korean plan is still lacking. There are plans for many segments of the nuclear program, but they are not integrated. Increased coordination would be useful and could avoid the development of animosity between the various organizations involved in nuclear development. (See Recommendation V.4).

In summary, positive actions have been taken on the regulatory front with the revision of the Atomic Energy Law and the formation of the Nuclear Safety Center. A carefully thoughout plan and prioritized plan should be developed to enact the regulatory framework. It should be coupled with the application of adequate and qualified resources to provide an efficient and workable Korean regulatory system. In the area of operational safety, improved operator training and qualifications, upgrading of plant designs and training facilities are essential. Increased emphasis on quality assurance at all levels and increased independent quality and safety audits and inspections are needed. An overall integrated nuclear power plan could be helpful as well as acceleration of decisions with respect to radioactive waste disposal. Implementation of the many suggestions contained herein as well as the utilization of other safety world experts could assist in attaining a safe and high quality nuclear power program in the Republic of Korea.

II. INTRODUCTION

From April 6 to April 14, 1982, the writer had the opportunity to rereview the nuclear power program in the Republic of Korea. This review was conducted for the World Bank/UNDP and its purpose was to update the work carried out in June 1980 and reported in "Review of Safety Aspects of Nuclear Power Program in Republic of Korea" (SLI-8012). The study was oriented to pay special attention to

- regulatory aspects including infrastructure, laws, regulations, criteria, codes and standards
- operational safety including operator training and design changes and support functions to improve power plant operation
- progress in manpower availability and qualifications, quality assurance, and radioactive waste disposal programs.

These topices were singled out for reexamination because, as pointed out in 1980, the regulatory aspects and manpower development programs needed the most attention. Also, operational safety is becoming more and more important with the number of operating plants expected shortly to jump from one to three. Finally, as the number of plants under construction and operation increases, quality assurance and radioactive waste disposal deserve more attention.

During the review, meetings were held with members of the Economic Planning Board (EPB), the Atomic Energy Bureau (AEB), and the Nuclear Safety Center (NSC) of the Korea Advanced Energy Institute (KAERI) of the Ministry of Science and Technology (MOST). Discussions were also held with members of the Korea Electric Power Company (KEPCO) and the Nuclear Division of the Ministry of Energy & Resources (MER). A visit was made to the Kori site and it included tours of the Kori-2 plant and the Kori Training Simulator. A list of meetings and principal persons visited are shown in Appendix I.

Power generation growth continues at a good although slightly reduced rate compared to the 1980 forecast. Nuclear power generation plans are relatively unchanged and, as a matter of fact, its overall contribution to predicted total power production has increased. Nuclear power is projected to account for 27.1 percent power generation by 1986 and 41.5 per cent by 1991. Corresponding forecast in 1980 were 24.0 per cent in 1986 and 34.3 percent in 1991 respectively. Information on the composition of power generation and status of Korean nuclear power plants is contained in Appendix V.. Because of the minimal changes to the nuclear plans since 1980, the safe design, construction, and operation of nuclear power plants in the Republic of Korea is even more important today than in 1980.

The principal findings of this Update Review are presented in the Executive Summary under Section I. More detailed recommendations and discussions are given in Sections III, IV, and V. Section III deals with the regulatory aspects. Section IV covers operational safety and Section V provides other pertinent comments. It should be recognized that the findings presented herein were developed after only two weeks work and that the opportunity did not always exist to examine details.

This report could not have been possible without the help and cooperation of all the persons listed in Appendix I. The Korean's hospitality and their willingness to make information available are acknowledged gratefully.

III. REGULATORY ASPECTS

BACKGROUND

The Korean nuclear regulatory framework has undergone substantial change since 1980. Most changes have been made in recent months and they are summarized in Appendix II. They include:

- an Amendment of the Atomic Energy Law, affirmed by the National Assembly on April 1, 1982
- a reorganization of the Atomic Energy Bureau (AEB) at MOST, effective November 27, 1981
- the establishment of the Nuclear Safety Center (NSC) at KAERI in early 1982.

The original Atomic Energy Law passed in 1958 consisted of 35 articles and was complemented by several presidential decrees. The Amendment of the Atomic Energy Law consists of 12 chapters and 122 articles. It legalizes the previous presidential decrees and expands regulatory control to many areas not previously covered. In particular, in Chapter 5, the law provides control of nuclear component manufacturing, construction, architect-engineer, and Non Destructive Testing (NDT) firms. etc. Chapter 6 deals with licensing and inspection of nuclear fuel cycle facilities and materials. Control of nuclear material transportation and waste disposal is covered in Chapter 8. Finally, penal provisions are spelled out in Chapter 12. A summary of the major features of the Amendment in Appendix II indicates that the new law will require the mandatory submittal of an environmental impact analysis report and will provide direction to the training programs for nuclear facility personnel. The revision of the Atomic Energy Law is quite responsive to many of the regulatory deficiencies noted during the 1980 review. However, how responsive it will be actually, will depend in fact upon how it is implemented.

In November 1981, the old Atomic Energy Bureau and the Nuclear Regulatory Board were merged into a single organization, the present Atomic Energy Bureau (AEB) at MOST. There are 6 Divisions in AEB and the following divisions are of particular significance to the regulatory process:

- Nuclear Reactor Licensing Division
- Nuclear Reactor Inspection Division
- Nuclear Standard Division
- Radiation Safety Division (responsible for personnel exposure, waste management systems and environmental matters)
- Nuclear Policy Division (safeguards is among its responsibilities)

It is important to realize that the AEB reorganization did not upgrade the regulatory personnel capability or increase the number of personnel assigned to regulatory matters.

The Nuclear Safety Center (NSC) was established to codify the Amendment to the Atomic Energy Law by generating regulations, safety codes and standards. It is also expected to carry out the necessary safety evaluations and to audit and inspect nuclear facilities. The organization of the Nuclear Safety Center is still changing with recent decisions being made to add the Safety Engineering Department to NSC and to split the Site and Environment Department into a Civil and Structural Department and an Environmental Department. The remaining departments are Nuclear Safety Standards, Reactor Systems, Instrumentation and Control, Safety Analysis, Radiation Protection, and Quality Assurance Departments. The formation of NSC should bring strong and technically competent people to review the safety of Korea nuclear facilities. This should produce a substantial improvement over the circumstances prevailing in 1980.

All the legal and organizational changes enacted in recent months should help strengthen the regulatory framework in Korea. The task is, however, the same as in 1980, i.e. to implement the necessary regulations and requirements. In the following paragraphs a series of recommendations are made to help achieve that status and to avoid some of the regulatory pitfalls which have occurred in the United States.

Recommendation III.1

When issuing the new safety regulations, the highest level in Korean government should announce and insist that safety and quality are just as important as meeting schedule requirements.

Basis for Recommendation III.1

1. Schedule performance has been very good on Korean nuclear power plants. The Wolsung and Kori-2 units are relatively on schedule and this pattern of holding schedules is characteristic of most Korean construction projects. Such achievements can be traced to the emphasis being put on schedule by the government and the top management of its industries.

2. While the importance of safety and quality is recognized in the Korean nuclear program, it is not apparent that schedule sometimes does not take precedence over safety and quality. In a few instances, the impression was gathered that safety and quality personnel were pressured organizationally not to extend schedules; in a few other cases, there was an attitude that the required detailed safety analyses and quality assurance documentation were a nuisance and unnecessary. Government and management's commitment to the full safety program and Quality Assurance System must be as genuine as to satisfying schedules. Increased use of independent audits as discussed in Section IV could help rectify any problem that might exist but the people in

the safety and quality assurance organizations should be encouraged and directed by government and industry leaders to be as dedicated in their field as project personnel are about schedules.

Recommendation III.2

An adequate number of competent personnel needs to be assigned to NSC to assure adequate safety reviews, Korean nuclear codes and standards generation, and audits and inspections. The increased responsibility assigned to NSC will require more personnel than presently at hand. In particular, the present staff assigned to NSC should be augmented with personnel experienced in the design, construction, and operation of nuclear power plants.

Basis for Recommendation III.2

1. The immediate workload assigned to NSC cannot be handled with the available manpower. For example, the Reactor Systems Department has a staff of 13 and it was assessed that a staff of 25 is needed to handle the on-going reviews and that the number may have to grow to 50 in the future. Similarly, the Site and Environment Department has a total staff of 6, the Quality Assurance Department and the Radiation Protection Department a staff of 7 each. All three of the latter Departments felt they would need more personnel to carry out their duties. There is no question that prioritization of the work at NSC would help lower the staff needs. Still, it is important to recognize that the new Atomic Energy Law requires the licensing of many more firms and the development of an entire new set of safety codes and regulations. Increased resources will be needed compared to the past if the job is to be done well and rapidly.

2. A total manpower limitation at KAERI is making it difficult to grow the NSC staff. Temporary loan employees from the nuclear industry to NSC could help in this regard.

3. The present staff of NSC appears quite capable and should strengthen the caliber of regulatory technical reviews. To increase their staff, the NSC managers are proposing to acquire university graduates and train them. While this approach may be the only one possible, there is a serious danger that it will lead to not having enough NSC staff members with design, construction, and operation experience. The KAERI members of NSC have a strong analytical and development background and means must be found to add people oriented towards design, construction, and operation. A rotation program of personnel between KAERI and KEPCO and construction and nuclear component manufacturers could be of benefit to all parties, i.e. KAERI would acquire practical engineers while KEPCO and others would benefit from strong analytical engineers who understand plant behavior and transients. If such a rotation cannot be implemented, having NSC members attend simulator training in Korea or the USA and take USNRC field assignments might help.

Recommendation III.3

The programs and efforts at NSC should be prioritized. Tentatively, the order of priority should be operating plants, next plants under construction and finally new orders. Such a sequencing would minimize any backfit burden to plants under construction and operation and would permit the earliest practical testing of new codes and regulations.

Basis for Recommendation III.3

1. The programs outlined in Appendix III combined with other safety functions assigned to NSC are extensive and they cannot be implemented all at the same time. Prioritization of the work efforts at NSC is essential. It is suggested that first priority be given to operating plants and that guides for operators and operational quality assurance as well as the formulation of a

Korean TMI Action plan be considered first. The reasons are as follows:

- operational safety needs improvement as discussed in Section IV

- any design changes to be backfitted should be defined as early as possible to ease the burden of implementation

- operating plants will give the best opportunity to test the practicality and adequacy of new Korean safety requirements.

The next priority should be assigned to plants under construction and it should be followed by new plants.

2. When new codes and regulations are issued, the question always arises of how they should be backfitted to plants under construction and operation. A Korean backfit policy should be developed which recognizes the implementation backfit costs versus the safety risk reduction they might produce.

3. The urgency to develop codes and standards for future orders may be decreasing. The recent drop in electric power consumption may allow more time before it is necessary to order units 11 and 12 and 13 and 14. Such a delay, if justifiable, could be very helpful in providing time to develop an orderly set of Korean safety codes and regulations.

4. Except for significant safety risk areas it might be wise to exempt plants under construction from new Korean codes and standards. All such plants were ordered to satisfy the safety requirements and codes prevailing in the selling country at the time of purchase and they were judged adequate at that time.

Recommendation III.4

The NSC and AEB program to issue regulations, criteria, codes, and standards should be carefully planned. It is important that such safety requirements be generated only as fast as they can be assimulated by those being regulated and those doing the regulating.

Basis for Recommendation III.4

1. A comprehensive and aggressive program to develop Korean nuclear codes and standards and acquire and disseminate nuclear safety information has been formulated by the Nuclear Safety Standards Department of NSC. This plan is outlined in Appendix III and it includes:

    - the development of Korean safety guides for siting, evironmental review, design, operation and quality assurance of nuclear power plants,
    - the preparation of drafts for enforcement regulations and codifying the new Atomic Energy Law
    - the development of a nuclear safety information center to accumulate and distribute safety literature and nuclear reactor operating data
    - the initiation of special projects, including the definition of a Korean TMI Action Plan and a study to define licensing criteria for Korean manufacturers of safety related components.

2. The present schedule calls for regulations to be issued by the end of June 1982 and for regulatory guides to be released by the end of 1982. This appears to be a very ambitious schedule, especially when it is recognized that the regulations and guides will be reviewed by a working committee and an executive

committee with members from the involved government and industry organizations. It is true that the proposed safety guides listed in Table 1 are to be derived from available IAEA and US NRC safety guides. Still a more deliberate plan is recommended for the following reasons:

- a too rapid imposition of regulations and standards can only lead to industry being over whelmed and to inadequate enforcement by the regulatory authorities. It could give this essential program a bad reputation.

- additional time could be used to formulate and prioritize an integrated plan and to tailor it to Korean needs. In particular, attention should be paid to the degree of details provided in codes and standards to reduce the need to change or upgrade them.

- important safety requirements should be defined and spelled out as clearly as possible. This is all the more important because many of the IAEA guides are rather broad in their contents due to the many compromises and reviews necessary before their issuance.

3. A suggested priority list could be:

- codification of the new law

- Korean TMI Action Plan for Kori-1, including upgrade of operator requirements

- Korean TMI Action Plan for plants under construction

- Backfit policy

- Setting criteria for new sites
- General safety criteria
- Safety System Requirements
- Korean Codes and Standards

Recommendation III.5

The capability and qualifications of the regulatory personnel at AEB continue to require upgrading.

Basis for Recommendation III.5

1. The number of people assigned to nuclear regulatory duties has not changed in spite of the reorganization of AEB. Some improvements in capability is noticeable due to training of a selected number of AEB regulators at USNRC. This program should be enlarged and accelerated. Assignment of an increased number of regulators to power plants could also help.

2. The qualifications of the regulatory personnel should be improved. For example, the resident inspectors of Kori-1 appear eager and willing to do their job but their experience on design, construction, and operation of power plants is quite limited. This situation encourages their transmitting information to Seoul rather than having confidence to take action at the site. It is true that AEB will now get technical support from NSC, but it is still important for AEB personnel to understand the requirements and findings to be generated by NSC. In particular, resident inspectors should be capable to identify problems and to follow through on corrective actions.

3. The problem of low salaries at AEB continues to make it difficult to attract and retain qualified personnel. Some means of assigning an increased number of graduates from the best technical colleges to AEB and some method to assure that they will stay in civil service there for more than a few years must be found. It is most important that the enforcers be capable and knowledgable if the administration of safety regulations is to be carried out in an equitable and responsible way.

Recommendation III.6

A detailed memorandum of understanding should be developed between AEB and NSC. The memorandum should spell the responsibilities of the two organizations, how they intend to work together and how information will flow from one organization to the other. Particular attention should be paid to avoid duplication, as for example, in audits and inspections.

Basis for Recommendation III.6

1. There is not a full written understanding of the responsibilities of AEB and NSC, besides the broad concept that NSC will provide the technical basis and AEB the legal enforcement of nuclear regulations. The scope and the specific responsibilities of AEB and NSC need to be clarified. Flow charting of how the work is to be transferred from one organization to the other is most important to avoid problems.

2. Because of manpower shortage, it is important that any overlap of responsibilities be avoided. In particular audits and inspections need to be scheduled jointly to avoid unncessary duplications.

3. It is most important that excellent communications prevail between AEB and NSC and that the flow of information from one organization to the other be complete and documented to avoid misunderstanding in carrying out their safety duties.

4. It is suggested that AEB responsibilities be patterned after the Inspection and Enforcement of USNRC while NSC should play the role of the Regulatory Branch NRR at USNRC. Responsibility for audits and inspections should be assigned to AEB and they can call for NSC participation. Also, it appears that the NSC organization may be overly segmented which might make overall coordination of safety evaluations difficult.

Recommendation III.7

It is suggested that an Advisory Group be formed reporting to the Director, Nuclear Safety Center. This Advisory Group should be concerned with overall safety strategies and key generic safety issues.

Basis for Recommendation III.7

1. An Advisory Committee for Reactor Safety (ACRS) existed in the previous Korean regulatory structure. This Committee was charged with the review of each licensing application. Its members were carrying out their advisory function over and above their normal duties. As reported in 1980, the work of the ACRS was slow and not always responsive to schedule needs. In the proposed new regulatory structure, no ACRS is proposed on the premise that its functions are to be performed by NSC.

2. The writer agrees that an ACRS is not needed to look at each specific license but an Advisory Group could still be helpful in dealing with difficult generic licensing issues. For example, the Advisory Group could review any backfit policy generated by the Standards Department of NSC. Similarly the Advisory Group could advise on the overall plan for Korean codes and Standards, or again the Korean TMI type Action Plan.

3. It is recommended that the suggested Advisory Group reports to the Director, Nuclear Safety Center and that its membership

include a limited number of outside representatives from government, industry and university with no conflict of interest.

Recommendation III.8

Future plant design standardization should be encouraged and a simplified safety review and a shortened licensing schedule be offered to applications employing standard designs.

Basis for Recommendation III.8

1. Korean nuclear power plants have considerable variations in design. The changes are due to past purchasing decisions being dominated by costs and financing terms. To-date about 5 different models have been used for the ten ordered plants. Such variations in plant design cannot help but put pressure on a difficult manpower situation. Design standardization in the future could help alleviate the difficult manpower situation in the regulatory functions and nuclear industry.

2. Design standardization will work only if industry perceives that it will, in fact, lead to a simplified review and a shortened schedule by the regulators. Also, design standardization will be effective only if regulatory requirements are defined clearly and kept stable. Because both of these objectives are very desirable, a Korean plan to achieve design standardization should be developed. As a minimum, nuclear components to be manufactured in Korea should be standardized.

Recommendation III.9

The acquisition and application of probalilistic risk assessment methods should be considered.

Basis for Recommendation III.9

1. The use of probabilistic risk assessment methods is growing rapidly in the United States and in other countries. Such methods are being employed more and more by the US NRC to guide its development of licensing requirements. A guide for draft probabilistic risk assessment procedures was issued in September 1981 and it is still being upgraded.

2. Probabilistic risk assessments should be viewed as a structured methodology with which one can assign priorities or make choices on critical safety issues. Its limitation in terms of handling common cause failures and human involvement must be recognized. Probabilistic risk evaluation also requires substantial resources and they should be applied judiciously. The long term outlook is still for increased use of probabilistic risk assessments in all countries and a plan to develop such capability in Korea in the long term would be desirable.

TABLE 1. Provisional List of Safety Guide

Subject	Title	References
Siting	1. Earthquakes and associated topics in relation to NPP siting	IAEA S.G 50-SG-S1
	2. Seismic analysis and testing of NPP	" " "-S2
	3. Site selection and evaluation for NPP with respect to population distribution	" " "-S4
		U.S. R.G Div.4
Design	1. Safety functions and component classification for BWR, PWR and PTR	IAEA S.G 5G-SG-D1
	2. Fire protection in NPP	" 50-SG-D2
	3. Protection systems and related features in NPP	" " D3
	4. Protection against internally generated missiles and their secondary effects in NPP	" " D4
	5. Instrumentation and control of NPP	" " D8
	6. Design aspects of radiological protection for operational	" " D9
	Fuel handling and storage systems in NPP	" " D10
Operation	1. Staffing of NPP and recruitment, training and authorization of operating personnel	" " 01
	2. In-service inspection for NPP	" " 02
	3. Operational limits and conditions for NPP	" " 03
	4. Radiological protection during operation of NPP	" " 05
	5. Preparedness of the operating organization for emergencies	" " 06
Quality Assurance	1. Preparation of the quality assurance programme for NPP	" " QA1
	2. Quality assurance auditing for NPP	" " QA10

IV. OPERATIONAL SAFETY

Background

Kori-1 is still the only operating nuclear power plant in the Republic of Korea. Kori-1 reached commercial operation on April 29, 1978 and achieved capacity and availability factors of 46 and 64.8 percent during the remainder of 1978. Its capacity factor increased to 61.3 percent in 1979 and 67.4 percent in 1980. The corresponding availability factors were 74.8 and 79.5 percent respectively. In 1981, the performance of Kori-1 was not as good and it achieved a reduced capacity factor of 56.3 percent. Even at that level, Kori-1 matches the average capacity factor of 56 percent attained by all U.S. nuclear power plants in 1981.

In the coming year, both Kori-2 and Wolsung-1 will start power operations. This means that the number of operational plants will triple and the issue of operational safety will deserve all the more attention. In the review report of 1980, the importance of operational safety was stressed particularly in view of the role played by operators in the TMI-2 accident. Several recommendations were made at that time and in a letter dated January 15, 1981, to the Export-Import Bank of the United States, Nack Chung Sung, vice president of KEPCO promised to implement most of the suggestions in that original report. During the most recent visit, it was disappointing to discover that most of the recommendations were still not in place. The primary reason for this delay appears to be that, in contrast to new power plant projects, it is difficult to get funds and approval to support operating plant changes. The approval process is tedious and foreign funds are especially difficult to get. It is most important that KEPCO management and controlling Korean government bodies realize that nuclear power plants require continued upgrading in both equipment and personnel to achieve safety and high capacity factors. It is strongly urged that funds (and in particular foreign exchange funds) be provided for the operational safety of nuclear power plants considerably above those budgeted for oil or coal fired plants. Inadequate funds can only lead to

~~increased plant maintenance and contamination, and less than desirable~~ performance from safety systems and personnel. Several recommendations are made again about operational safety and most of them duplicate items suggested in the 1980 report.

In the area of emergency planning, satisfactory progress has been made at Kori-1. An emergency internal plant drill was conducted and a cooperative agreement is being signed with USNRC. A joint drill with participation of USNRC is being planned and it will involve all the appropriate local authorities later this year. For that reason, no recommendation is made herein on this subject.

Recommendation IV.1

Plant operator qualifications need to be increased by requiring added technical education and basic understanding courses in heat transfer, fluid flow, and transient plant behavior.

Basis for Recommendation IV.1

1. This recommendation was made in 1980 and progress has been limited to-date. The same basic operator education program is being pursued. The standard ANS-3.1, 1981, Selection, Qualification and Training of Personnel for Nuclear Power Plants provides details on specific operator upgrading being implemented in the USA and it could be used to define corresponding necessary Korean improvement.

2. Basic understanding courses in heat transfer, fluid flow, and transient plant behavior remain at the early planning stage, and have not been introduced. The Kori training staff has been occupied fully in satisfying KEPCO needs for new or retrained operators.

3. The transfer of Kori-1 operators to Kori-2 will lead to a reduction of average operator experience, which makes it all the more important that new operators assigned to Kori-1 and Kori-2 be well qualified.

4. A substantial portion of operator training time is spent understanding the English language. This is necessary because the technical specifications and some of the plant procedures are still in English. The use of Korean might free the operator to get into more technical understanding of plant behavior.

Recommendation IV.2

The Kori training simulator should be modified to include primary coolant boiling or flashing.

Basis for Recommendation IV.2

1. Without this correction, the Kori training simulator cannot train operators to cope with small breaks, stuck open relief valves, or tube generator steam rupture. Such events account for a dominant portion of the safety risks projected at Kori-1 and Kori-2.

2. Similar changes have been made to all U. S. training simulators for over 18 months. Since the Kori-1 simulator duplicates the Surry-1 simulator, it should be possible to rapidly acquire the necessary change from the Surry-1 simulator.

Recommendation IV.3

Symptom oriented emergency operating procedures should be developed and used in operating training.

Basis for Recommendation IV.3

1. The TMI-2 accident revealed that present operating procedures may not be able to mitigate the consequences of a broad range of initiating events and multiple equipment failures. New emergency procedures are being developed in the USA. They rely upon defining symptoms for entering the emergency conditions and the diagnostic actions to be taken to determined the appropriate course of action. The new procedures have been found to be much superior to the old ones. USNRC NUREG-0799 provides draft criteria for the preparation of such symptom oriented emergency procedures.

2. KEPCO is a member of the Westinghouse TMI Owners Group and is receiving information about this program as well as many others related to the U.S. TMI Action Plan.

3. A set of new emergency procedures developed for Surry-1 was available at the Kori training simulator and its application to train Kori operators has been attempted. It has met with little success and the reasons could be that:

   - the new emergency procedures could not be used because the Kori training simulator does not represent well such events (see Recommendation IV.2) due to lack of boiling simulation.

   - the qualification of Kori operators are not adequate to grasp the new procedures.

   - the new emergency procedures are too complex and need revisions.

~~Whatever the reason, it should be corrected because a symptom oriented set~~ of emergency procedures will help increase the chances of avoiding serious fuel damage.

Recommendations IV.4

A Korean TMI type action plan and associated design changes should be defined and implemented on a specified schedule.

Basis for Recommendation IV.4

1. Minimal design changes have been made to Kori-1 since the TMI-2 accident. They include a change in the signal initiating coolant injection and the addition of hydrogen recombiners during the forthcoming outage. A detailed and specific KOREAN TMI Action Plan is under consideration by the Nuclear Safety Center (see Appendix III) but it has not been developed yet even though three years have elapsed since the accident.

2. Several design changes have been implemented in U. S. plants and as a minimum it is suggested that reactor vents, a means to detect stuck open relief valves, and a subcooling meter be considered for early introduction in the Korean plants. It should be noted that all the above changes are included in a list of planned changes at Kori-1 (see last page of Appendix V).

Recommendation IV.5

An integrated training simulator program should be developed and, in particular, the delivery of a simulator for Units 7 & 8 should be accelerated.

Basis for Recommendation IV.5

1. A similar recommendation was made in 1980 and a definitive program is still not in place. The present plans call for no training simulator at Wolsung and the purchase of a simulator for Units 7 & 8 and another one for Units 9 & 10.

2. Units 5, 6, 7, and 8 are quite similar and it would have been beneficial to order the simulator for Units 7 & 8 early enough to use it for the training of operators for Units 5 & 6. Unfortunately, the delivery of the simulator for Units 7 & 8 can no longer meet the startup schedule of Units 5 & 6. However, it is still recommended that the delivery of the simulator for Units 7 & 8 be accelerated as much as possible to help in any potential retraining of operators for Units 5 & 6.

3. The differences between the control room design of Kori 5 & 6 are even much larger than those existing between the Kori-1 plant and the present Kori simulator. For that reason, increased training of operators at power plants or U. S. simulators comparable to Kori 5 & 6 is recommended.

Recommendation IV.6

A complete and integrated spare parts program should be developed to support Kori-1 and subsequent units' operations. The program needs to recognize the distance between Korea and many of its spare parts and service suppliers. A special and limited fund to cover emergency needs of foreign service and parts could help reduce outage times which call for non-domestic involvement.

Basis for Recommendation IV.6

1. Recommendation IV.6 is worded exactly alike to the recommendation made in 1980 and the reasons are still the same

"• there are many critical parts in Kori-1 and the subsequent units which will require foreign supply and service until domestic localization can handle all needs. The situation has contributed to extending some of the outages at Kori-1 due to lack of spare parts and time to get foreign assistance

• a complete and integrated spare parts program needs to be formulated for the Korean nuclear units. Because of distance between suppliers and Korea, stockpile of spare parts may have to be above normal. Also, emergency procedures which will make it easy to acquire foreign service and spare parts might assist in coping with such outages. A limited emergency fund which requires a very limited number of approvals might be advisable . . ..."

2. Another way to help the spare parts situation is to make as many of the components in Korea. The localization program, however, cannot satisfy all such needs and the suggested spare parts program should be implemented until that time.

Recommendation V. 1

Quality assurance improvements are needed in the Korean nuclear program, especially in terms of third party independent and qualified inspections.

Basis for Recommendation V.1

1. The staffs of quality assurance personnel at the Atomic Energy Bureau and the Nuclear Safety Center (NSC) are very small and many of the engineers are not qualified inspectors. Independent Korean third party inspections are quite limited in number and content.

2. KEPCO has attempted to fill this gap through their Quality Assurance organization and through their Nuclear Review Board at Seoul. However, both organizations could be subject to pressure to meet schedules and they are not large enough to perform a comprehensive third party audit check.

3. It is suggested that overall independent operation and construction audits be carried out. The operation independent reviews could be patterned after those being performed by INPO in the USA. INPO is implementing a similar program for the construction phase of nuclear power plants. The NSC could acquire the criteria and techniques employed by INPO and modify them to suit Korean conditions. Because it will take considerable time to staff the regulatory groups to carry out such audits themselves, consideration should be given to have the industry put in place its own independent quality assurance program based upon a set of modified INPO criteria generated by NSC. NSC personnel could participate in such audits.

4. In carrying out such third party reviews it is important that they do not lead to just paper generation. It should involve plant and construction site visits, interviews, check lists... etc., to discover potential and real problems.

5. As noted before, management attention and support of this program and quality assurance in general is essential to plant safety. Lack of proper mental attitude was reported to be present in a few cases. Top management work shops about quality information could be developed and implemented by NSC. Similarly, training classes for inspectors could be offered by NSC. Note that INPO in the USA is formulating such plans.

Recommendation V. 2

Korean nuclear manpower development is still a key issue especially for other organizations than KEPCO.

Basis for Recommendation V. 2

1. The nuclear power program is on the same schedule as in 1980 and manpower needs will have to grow as rapidly as projected then. Overall personnel experience is decreasing due to rapid growth.

2. KEPCO has done a good job of meeting their needs as shown in Appendix IV. A comprehensive program has been put in place and it is important that it be continued.

3. A similar comprehensive program needs to be developed for NSC and AEB and it should be patterned after the program shown in Appendix IV.

4. Rotation of personnel for a limited period of time between the various nuclear organizations in Korea could be very helpful. For example, KEPCO has personnel experienced in design and construction but lacks personnel knowledgeable in plant transients. The reverse is true at NSC. An interchange could be

beneficial to both parties. If such interchange of personnel cannot be done, at least AEB and NSC should be allowed to be trained on KEPCO simulators and to utilize other available KEPCO courses.

5. The Korean government should take whatever action it can to direct a sufficient number of good college graduates to AEB, NSC, and KEPCO and to find incentives to keep them there. Reliable and safe performance of nuclear plants is of utmost importance to Korean economic growth and good personnel is one of the key elements to success of the Korean nuclear program.

Recommendation V.3

Progress on radioactive waste disposal should be accelerated.

Basis for Recommendation V.3

1. Development of waste disposal methods has been assigned to the Daeduch Engineering Center (see Appendix VI). Also, the formulation of a Korean radioactive waste disposal plan is being initiated. The program still needs to be accelerated due to its slow start and the long time necessary to implement it safely and appropriately.

2. Responsibility assignment for waste disposal and an infrastructure (e.g. defining organizations responsible for disposal, transportation) should be decided early in the program. Consideration should be given to having one single governmental organization in charge of all aspects of waste disposal except regulations. Such an arrangement will simplify interfaces and could accelerate the implementation of the overall program.

3. A continued source of funding is needed for this program and the concept of charging users for development and utilization of the disposal facilities will insure that radioactive waste disposal receives the necessary attention.

Recommendation V.4

A total integrated and cooperative Korean nuclear power program is needed.

Basis for Recommendation V.4

1. A total coordinated program is still lacking. In addition to the waste disposal issue noted above, the following areas need integrated attention

   - long term resolution of the back end of the fuel cycle (i.e. storage, reprocessing and disposal of spent fuel)
   - formation and staffing of an organization with systems design and plant performance and safety predictions capability
   - a plant decontamination plan

2. Potential areas of inadequate coordination are developing, including

   - the new KEPCO organization shown in Appendix IV disperses their nuclear functions through the entire organization. This can be expected to produce coordination problems. In the USA, all utilities are going in the opposite direction and are integrating their nuclear organization to match the previous KEPCO nuclear organization structure.
   - the relations between the Ministry of Energy and Resources (MER) and the Ministry of Science and Technology (MOST) are becoming strained. This might be due to the fact that MOST does the nuclear research and development as well as the regulatory function. A separate regulatory function might resolve this problem. Similarly, the role of the Atomic Energy Commission at MOST needs to be reexamined.

APPENDIX I - LIST OF MEETINGS AND PERSONS VISITED

April 6, 1982 - Arrival in Seoul

April 7, 1982 - Schedule Discussion (Tae Yon Kim, Director, and Kim Sung-Jin, Assistant Director, Infrastructure Planning Division, Bureau of Economic Planning).

April 7, 1982 - Atomic Energy Bureau discussions (Bak-Kwang Kang, Director-General, Atomic Energy Bureau; Won Mo Park, Director Nuclear Policy Division; Cheong-Won Cho, Assistant Director, Nuclear Policy Division; Jae Choon Lim, Director, Nuclear Reactor Inspection Division; Byong Do Kim, Director, Radiation Safety Division).

April 8, 1982 - Nuclear Safety Center Discussions (Sanghoon Lee, General Manager, Nuclear Safety Standards Department; Chae-Shik Rho, General Manager, Site and Environment Department; Yun-Peel Lee, General Manager, Quality Assurance Department; also General Manager of Radiation Protection Department, and Manager of Safety engineering Department and representatives from Reactor Systems, Instrumentation and Control, Safety Analysis Departments)

April 8, 1982 - Ministry of Energy & Resources Discussions (Se-Jon Kim, Director, Nuclear Power Division; Jang Hee Hong, Manager, Nuclear Safety Analysis & Licensing Section, Nuclear Power Generating Department, Korea Electric Power Company).

April 9, 1982 - Visit to Kori Site (Sang-Kee Park, Deputy General Manager, Nuclear Power Generation Department, KEPCO; Plant Manager and Assistant Plant Manager, Kori Site and Plant Superintendent, Kori-2, and Manager, Kori Simulator Training Center, KEPCO; Jae-Ock Chang, Chief Resident Officer at Kori Site, and Jae Dong Ko, Ministry of Science & Technology).

April 12, 1982 - KEPCO Discussions (Chang Tong Choi, General Manager, Nuclear Power Generation Department; Sang-Kee Park, Deputy General Manager, Nuclear Power Generation Department; Chong Hun Rieh, General Manager, Nuclear Power Construction Department; E. K. Lee, Manager, Nuclear Fuel office; Hai Chang Lee, Manager, Nuclear Power Planning Department; also Manager, Quality Assurance; Chairman, KEPCO Nuclear Review Board, and members of Nuclear Safety Analysis & Licensing Section).

April 13, 1982 - AEC and AEB Discussions (Yong-Kyu Lim and Byoung Whie Lee, Commissioners, Atomic Energy Commission and Staff members of AEB).

April 14, 1982 - Summary presentation of findings to Bureau of Economic Planning (Tae-Yon Kim and Sung-Jin Kim).

APPENDIX II - CHANGES IN REGULATORY FRAMEWORK

Amendment of the Atomic Energy Law of the Republic of Korea

A. Current Legal System

1) The Atomic Energy Law (Art. 35, 1958)

- Atomic Energy Commission
- R&D Promotion
- Control of Nuclear Material and Facility
- Radiation Hazards Protection

2) The Presidential Decrees of the Republic of Korea

- Licensing and Inspection of Nuclear Reactors
- Establishement of Exclusion Areas
- Technical Standards for Nuclear Reactors
- Licensing and Inspection of Fissionable Material and Production Facilities
- Regulation of Radioisotope and Radiation Hazards
- Reactor Operater and Radioisotope Handling Personnel Licensing

B. Revision of the Atomic Energy Law (122 Art, 1982)

1) Progress

Aug - Oct, 81	- Complete consultation with concerned Ministries and Agencies
Nov. 81	- Cabinet approval, President's approval
Dec. 81	- Deliberation by Science and Economy Committee of National Assembly

- Submitted to the Legal Committee of the National Assembly

Mar. 82 ; - Expected the Approval by National Assembly

2) Contents of the new law

Chap 1. General provisions
Chap 2. Atomic Energy Commission
Chap 3. R&D promotion
Chap 4. Licensing and Inspection of Nuclear Reactors
- Power reacter construction
- power reactor operation
- other reactors
Chap 5. Control of Nuclear Component Manufacturing firms, Construction firms, NDT firms, etc.
Chap 6. Licensing and Inspection of Nuclear Fuel Cycle
- facilities
- nuclear materials
Chap 7. Regulation on radic-isotopes
Chap 8. Control of Nuclear Material Transportation and waste Disposal
Chap 9. Nuclear personnel licensing
Chap 10. Radiation hazards protection
Chap 11. Miscellaneous
Chap 12. Penal provisions

3) Major features of the amendment.

a) Expansion of licensing areas to include
- component manufacturing firms
b) Expansion of inspection areas to include
- construction firms
- transportation firms

- waste disposal firms
- A/E Co.
- NDT firms

c) Expansion of personnel licensing to include

- nuclear material handling personnel

d) Environmental protection

- mandatory submission of environmental impact evaluation report

e) Delegation of regulatory authority to civil organization allowed

f) Direction of training programs for nuclear facility personnel

g) Strengthening of penal provisions

h) Strengthening of regulatory authority by spelling out in the law instead of decrees.

Reorganization of MOST/AEB

The Atomic Energy Bureau and the Nuclear Regulatory Bureau were merged into one and became the present Atomic Energy Bureau following the reorganization of the MOST in November 1981. The Atomic Energy Bureau is now responsible for the promotion of nuclear R&D and safety regulation of all nuclear facilities and materials in Korea.

There are 6 Divisions in the Atomic Energy Bureau, namely:

A. Nuclear Policy Division — Won Mo Park
   - nuclear policy planning
   - safeguards and international cooperation

B. Nuclear R&D Division — Sang Hoon Choi
   - R&D project management
   - manpower development
   - support R&D organization

C. Nuclear Standard Division — Young Sung Hahn
   - enactment of law and decree
   - codes and standards development
   - regulatory guide development

D. Nuclear Reactor Licensing Division — Uk Jong You

E. Nuclear Reactor Inspection Division — Jae Choon Lim

F. Radiation Safety Division — Byoung Do Kim

Nuclear Safety Center

A. Background

To fulfill succesfully an ambitious nuclear power programme in Korea, it is more imperative than ever to secure nuclear safety.

The Nuclear Safety Center is established to carry out evaluation and assessment of all safety analysis reports submitted by applicants and inspection and audit of nuclear facilities to support Government's safety regulation. It will also develop codes and standards suitable to Korea circumstances.

B. Functions

1). Development of Nuclear Safety Codes, Regulations and Standards

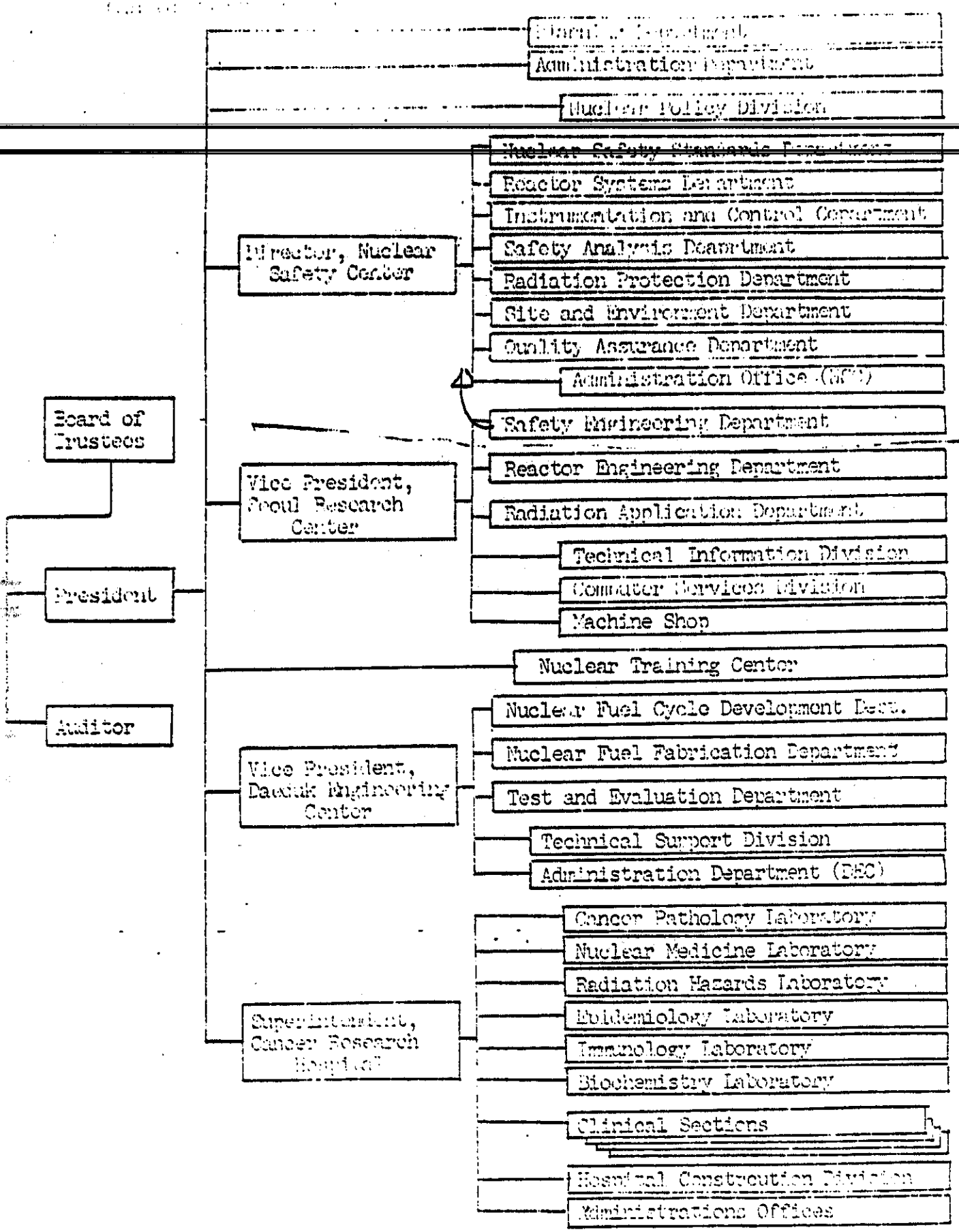
- a) Codes and Regulations
- b) Standards

2). Review of Safety for:

- a) Construction and Operation of Power Plants
- b) Fuel Cycle Facilities
- c) Components Production Facilities of Power Plants

3). Inspection

- a) Construction and Operation of Power Plants
- b) Fuel Cycle Facilities and Transportation and Storage of Fuel
- c) Radioactive Waste Treatment Facilities


Board of Trustees
President
Auditor
Director, Nuclear Safety Center
Vice President, Seoul Research Center
Vice President, Daeduk Engineering Center
Superintendent, Cancer Research Hospital
Nuclear Policy Division
Reactor Systems Department
Instrumentation and Control Department
Safety Analysis Department
Radiation Protection Department
Site and Environment Department
Quality Assurance Department
Safety Engineering Department
Reactor Engineering Department
Radiation Application Department
Technical Information Division
Machine Shop
Nuclear Training Center
Nuclear Fuel Cycle Development Dept.
Nuclear Fuel Fabrication Department
Test and Evaluation Department
Technical Support Division
Administration Department (DEC)
Cancer Pathology Laboratory
Nuclear Medicine Laboratory
Radiation Hazards Laboratory
Epidemiology Laboratory
Immunology Laboratory
Biochemistry Laboratory
Clinical Sections
Hospital Construction Division
Administrations Offices

APPENDIX III

Development of Korean Nuclear Codes and Standards and Acquisition and Dissemination of Nuclear Safety Information

April 8, 1982

Nuclear Safety Standards Department

Nuclear Safety Center

I. Development of Domestic Safety Guides

1) Guides for Siting and Environmental Review

- o Site Geology and Earthquake
- o Aseismic Analysis and Test
- o Population Distribution Evaluation
- o Environmental Review and Environmental Impact Assessment

2) Guides for Safety Design

- o Classification of Safety Function and Safety Level of Components
- o Design of Reactor Protection System
- o Design of Fire Protection System
- o Design of Instrumentation and Control System
- o Design of Radiation Protection System
- o Design of Fuel Storage and Handling Facilities
- o Design of Protection System Against Missiles in Containment

3) Guides for Operation

- o Rights and Qualification of Operating Personnel
- o In-Service Inspection Procedure
- o Operational Condition and Limits
- o Radiation Protection Planning
- o Emergency Planning

4) Guides for Quality Assurance

- o Quality Assurance Program and Records
- o Quality Assurance Audits

II. Coordination in Regulation

1) .Review of Safety Analysis Reports

2) Operation of Task Force Team

3) International Cooperation

- o Korea - U.S
- o Korea - France
- o Korea - West Germany
- o Korea - Canada
- o U.S.NRC

4) Formulation of Long-Range Plan for Nuclear Safety Center

III. Preparation of Drafts for Enforcement Regulation and Ordinance of Atomic Energy Law

V. Nuclear Safety Information Activities

1) Operation of Nuclear Safety Information System

- Acquisition of safety-related literatures especially nuclear codes and standards
- Acquisition and evaluation of nuclear accident and failure data
- Information exchange of non-commercial literatures
- Analysis and dissemination of safety information to Nuclear Safety Center staffs and Korean nuclear circle

2) Operation of Nuclear Failure Data Bank

- Utilization of licensee Event Reports of U.S.NRC
- Preparation of reporting of domestic operating information
- Operation of domestic event data bank

3) Operation of Information Room for Domestic Nuclear Power Plants

- In operation : Kori Unit 1
- In completion stage : Kori Unit 2 and Wolsung Unit 3
- Under Construction : KNU Nos. 5 - 10

VI. Investigation Projects

1. Review of Action Plan Implementation after TMI Accident
   - Survey of the materials related to TMI-Accident issued from U.S. NRC and other countries (France, Germany, Japan, etc.)
   - Modification of those materials to be appropriate to Korea Nuclear Power Plants (e.g. addition or deletion of some requirements, change of implementation schedule and qualification criteria, etc.) after review and analysis of them.

2. Preparation of Manufacturing Permit Criteria for the Nuclear Safety-related items
   - In order to assure safety of nuclear power plant, the Government decreed on December 29, 1980, that every local manufacturer who plans to manufacture the safety-related items shall obtain a manufacturing permit from the Ministry of Science and Technology. This study is a work to make the Government's permit criteria (draft) for the manufacturers of the safety-related items, legally based on the Atomic Energy Law.

     The permit criterion is prepared as a guideline for the Ministry officials who will review technical capability and quality assurance program of the applicants.

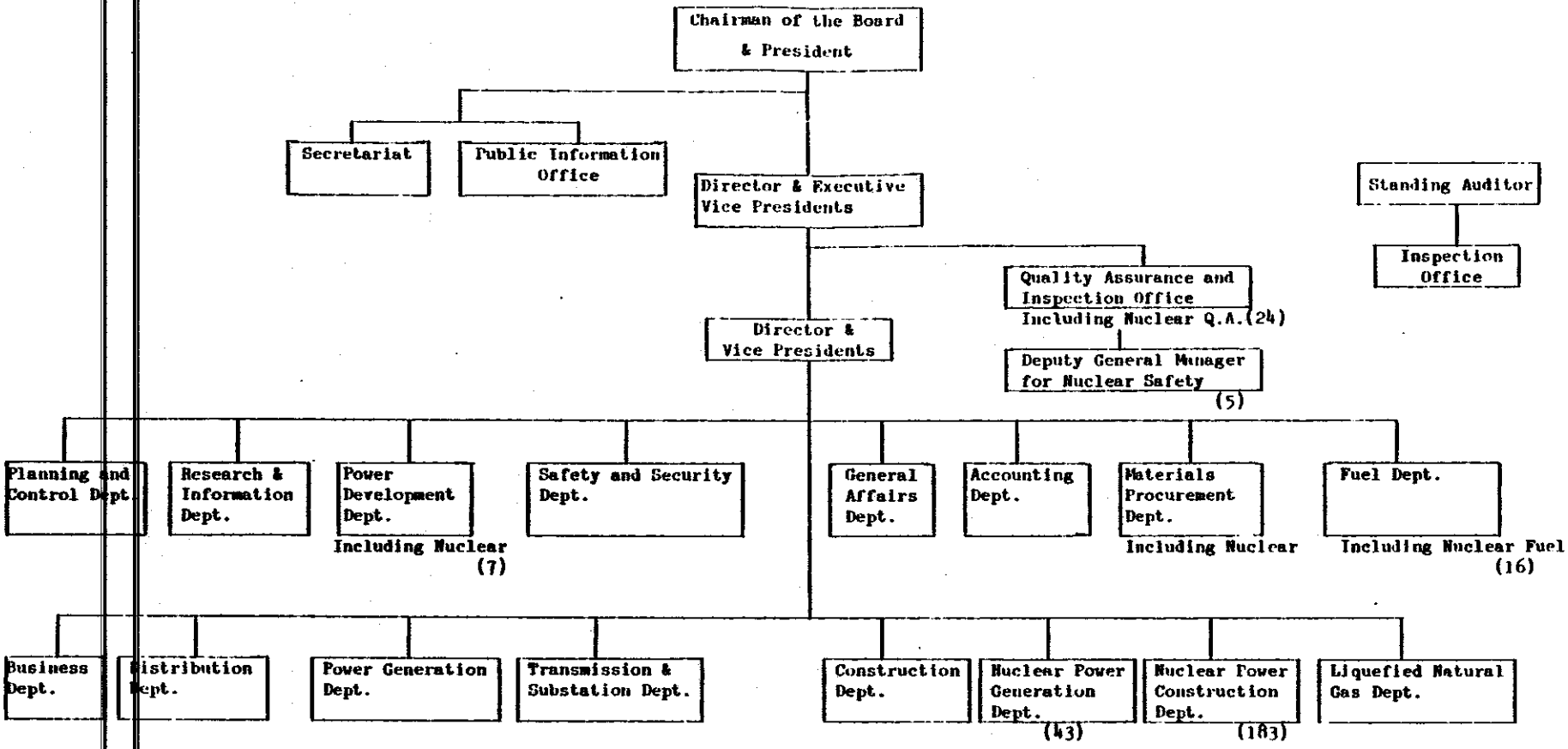
3. Site Differential Settlement Investigation

4. Preparation of Korean Seismic Risk Map

APPENDIX IV

KEPCO Organization and Manpower Development Programs

1. KEPCO ORGANIZATION CHART



(__) - Nuclear Personnel assigned to function.

2. KEPCO Nuclear Manpower Program

A. Long-Term Technical Man Power Requirement

Classification / Year	Yearly Requirement			Yealy Increase	Loss	Recruitment
	Construction	Operation	Total Technical			
1980	706	467	1173			
1981	835	760	1595	422	80	502
1982	950	850	1800	205	90	295
1983	1115	1080	2195	395	110	505
1984	1260	1330	2590	395	130	525
1985	1185	1650	2835	245	140	385
1986	1315	1810	3125	290	155	445
1987	1325	2040	3365	240	170	410
1988	1385	2290	3675	310	180	490
1989	1455	2610	4065	390	200	590
1990	1680	2930	4610	545	230	775
1991	1800	3250	5050	440	250	690

Remarks : 1. Yearly Status is as of the end of each year.

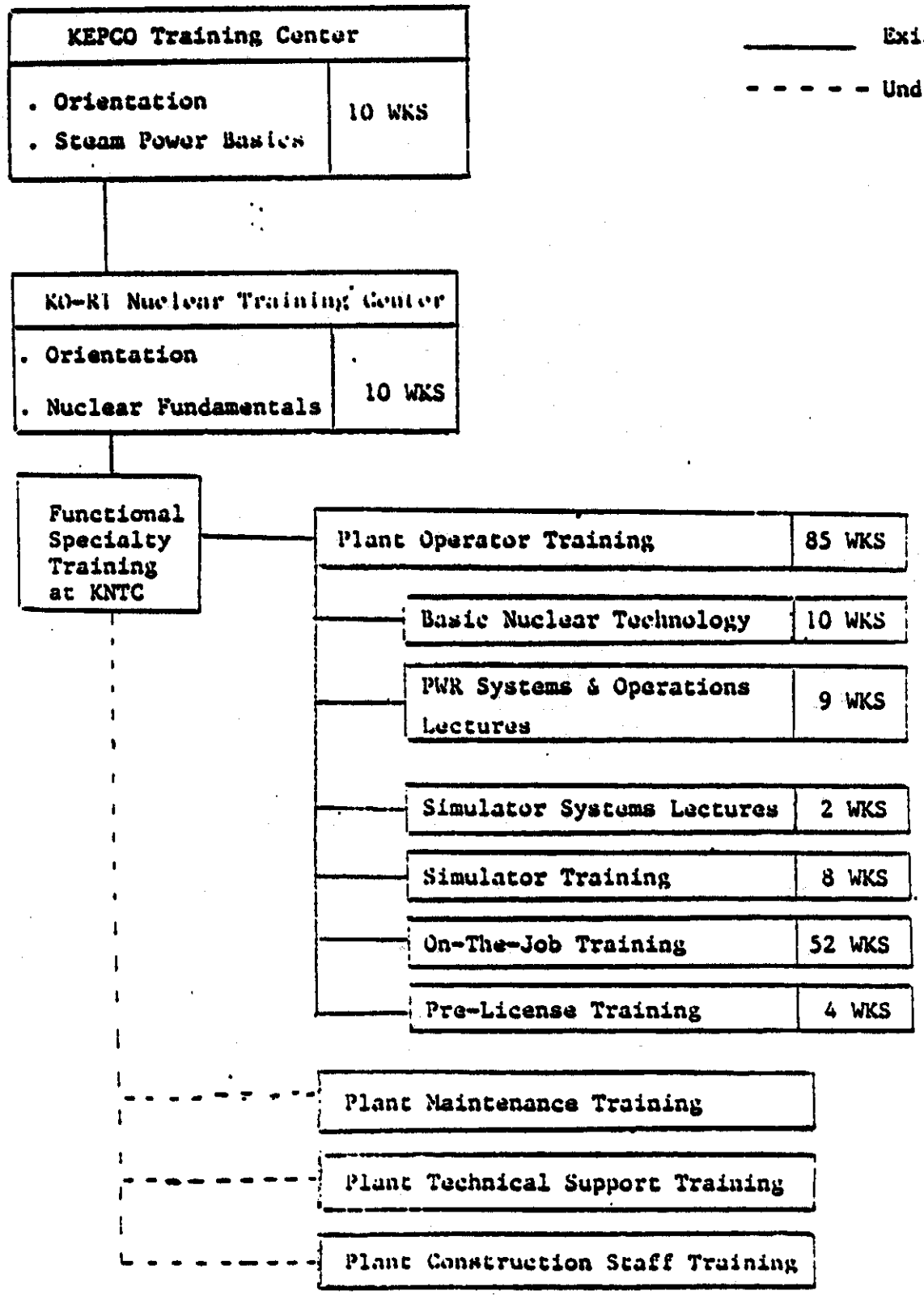
2. Recruitment is to be done one year prior to actual requirment to allow training in advance.

3. A loss of 5% per year is assumed

4. Implementation of two units as a single project is assumed.

B. Training Program

1. Training Program for New Recruits



2. Overseas Training Program

Classification	Discipline	Duration (month)
Training at Manufacturer	NSSS, T/G Operation and engineering	4 - 24
Training at A/E's Office	All Disciplines	8 - 24
Training by IAEA	Academic courses and some speciality areas	1 - 18
Graduate Course	KEPCO arrange MS course by direct contact with universities in mechanical, electrical, nuclear engineering and business administration	24
Miscellaneous	Case by case arrangement for planning, contracting and other special areas	6 - 12
Training through Technical Cooperation Agreement with Foreign Utilities	Case by case arrangement planning, various technical and special areas	1 - 18

3. Status of Overseas Trained Personnel

As of Dec. 31, 1981

Classification \ Year	70	71	72	73	74	75	76	77	78	79	80	81	Total
Operation Group	-	-	-	19	5	-	6	-	-	35	3	14	82
Plant Technical Group	1	1	3	16	2	3	7	8	20	36	6	2	105
Design & Construction Group	-	-	3	4	1	1	5	9	34	12	3	25	97
Others	15	3	2	4	-	4	5	9	6	2	6	7	63
Total	16	4	8	43	8	8	23	26	60	85	18	48	347

4. Overseas Training Status

As of Dec. 31 1981

Organization / Classification	W	B	Burns & Roe	SWRI (South West Research Inst.)	MIT	Remarks
Training Course	KNU #5&6 Operator	KNU #7&8 Planning & Construction	LMFBR	Pre-Service Inspection	Nuclear Engineer (Graduate Course)	
Training Duration (Months)	2-12	6-12	30	8	24	
Number of Trainees	16	25	4	2	1	Total 48

D. Recruiting Sources

- o Graduate
- o Under graduate (Open employment)
  - Schorship Student
  - R.O.T.C.
- o Technical college (Open employment)
- o Su-Do Technical High School

E. Simulators

1. We are now operating one simulator for operator training and its specification as follow ;

   o General Outlines

   - Monufacturer : EAI (Electronic Associates Incoporated, USA)
   - Reactor Type : Surry #1 Copy (Virginia Electric Co., USA) 3 Loop, 810 MW, PWR ,(Westinghouse)
   - Cost : US $3.5 Millions (About 2 Billion Won)
   - Completion year : 79. 7. 4

- No. of Malfunction : 250

- Training Capacity : 24 Person/29 Week

2 We will purchase simulators for KNU #5&6, #7&8 and #9&10 in near future.

3. Build-Up of KNE Engineering Capability

A. Basic Policy

- Local engineering capability is to be developed through KNE
- KEPCO holds majority share of KNE (about 94%)
- KEPCO gives contractual requirements to foreign A/E so that a reasonable level of KNE participation can be assured.
- Gradual expansion of KNE participation in the project engineering.
- A joint engineering firm of KNE and Bechtel is under negotiation to expedite the transfer of technology.

B. KNE Participation Program

Unit No.	KNE Participation	Remarks
Nuclear #2 Nuclear #3	. Design for site facilities . Participation in construction management	
Nuclear #5 & 6	. Participation in Off-shore engineering : 8.5% . Participation in On-shore services : Preliminary estimation is 30.4%	17 KNE engineers are resident in Norwalk, Ca. as of Dec. 1981
Nuclear #7 & 8	. Participation in Off-shore engineering : 15% . Participation in On-shore services : preliminary estimation is 32.0%	43 KNE engineers are resident in Norwalk, Ca. as of Dec. 1981
Nuclear #9 & 10	. Participation in Off-shore engineering : 16.5% . Participation in On-shore services : Under discussion	11 KNE engineers are resident in Paris, France. Total of 30 KNE engineers are to be dispatched.

C. KNE Technical Man-Power Status

as of December 31, 1981

Classification / Grade	'78	'81	Increase(times)
Project Manager	0	1	
Project Engineer Assistant P.E	2	20	10
Supervisor	12	28	2.3
Group Leader	24	50	2
Senior Engineer	33	98	3
Engineer/ Designer	79	249	3.2
Total	150	446	3

- Technical Cooperation Agreements
  - Personnel exchange program with Taiwan Power Co., R.O.C
  - Personnel exchange program with Kyushu Power Co., Japan
  - Technical cooperation agreement with Comision Nacional de Energia Atomica of Argentina
  - Technical Cooperation agreement with Ontario Hydro, Canada
  - Technical Cooperation agreement with EPDC, Japan

It is our policy to expand cooperative relationships with foreign utility companies and similar organizations.

APPENDIX V

STATUS
OF
NUCLEAR POWER PROGRAM
IN
KOREA
AND
KORI-1 UPGRADING AND WASTE RELEASE

January 1982

NUCLEAR POWER PLANNING DEPARTMENT
KOREA ELECTRIC POWER CORPORATION

1. Composition of Power Generation Facilities

Sources \ Year		Dec. '81	'86	'91
Hydro	MW	802	1,282	1,665
	%	8.1	7.3	6.2
Pumped Storage	MW	400	1,000	1,600
	%	4.1	5.7	5.9
Oil	MW	7,321	6,153	5,003
	%	74.4	35.0	18.3
Coal	MW	725	2,970	4,970
	%	7.4	16.9	18.4
Gas (LNG)	MW	-	1,400	2,550
	%	-	8.0	9.5
Nuclear	MW	587	4,766	11,216
	%	6.0	27.1	41.5
Total	MW	9,835	17,571	27,004

2. Nuclear Power Program

Item / Plant Name	Site	Capacity (MWe Gross)	Reactor Type	Scheduled Operation	Status	Suppliers & A/E
Nuclear Unit No. 1	Ko-Ri	587	PWR	Apr. 78	In Operation	NSSS, Fuel : W T/G : GEC A/E : GAI
Nuclear Unit No. 2	Ko-Ri	650	PWR	Dec. 83	Under Construction	NSSS, Fuel : W T/G : GEC A/E : GAI
Nuclear Unit No. 3	Wolsung	678	PHWR	Apr. 83	"	NSSS, Fuel : AECL T/G : HPL/CAP A/E : CANATOM CO.
Nuclear Units No. 5 & 6	Ko-Ri	950	PWR	Sep. 84 Sep. 85	"	NSSS, Fuel : W T/G : GEC A/E : BECHTEL
Nuclear Units No. 7 & 8	Yeong-gwang	950	PWR	Mar. 86 Mar. 87	"	NSSS, Fuel : W T/G : W A/E : BECHTEL
Nuclear Units No. 9 & 10	Uljin	950	PWR	Mar. 88 Mar. 89	"	NSSS, Fuel : FRAMATOME,COGEMA T/G : Alsthom Atlantique A/E(Consultant) : EBASCO
Nuclear Units No. 11 & 12	Not Decided	900 Class	Not Decided	Dec. 89 Dec. 90	Under Planning	Not Decided
Nuclear Units No. 13 & 14	"	"	"	Mar. 91 Dec. 91	"	"

Radioactive Waste Release from Kori-4

Classification \ Year	Annual release limit	1978	1979	1980	1981
Gas(Ci)	11,800	below 1	19.34	198.6	211.54
Liquid(Ci)	140	4.62	12.4	6.49	0.26
Solid(Drum)	-	542	694	799	1768

Plant Upgrading and Post TMI Actions at Kori-1

Completed

- Expansion of Demineralized Water System Capacity
- Increase of Spent Fuel Storage Capacity
- Installation of Closed Circuit TV System
- Replacement of Potential Leaky Valves in Primary System
- Installation of Automatic Condenser Tube Cleaning Facilities
- Addition of a New Interlock to trip the Containment Sump Pump on High Level of Waste Holdup Tank
- Installation of Locking System and Status Indicating Panel for Manual Valves of Safety Systems
- Establishment of an Independent Organization at Head Office for Safety Review, Audit and Inspection on Plant Safety Activities
- Strengthening of Operator Training Utilizing Simulator
- Performance of Radiation General Emergency Dill and Upgrading of Emergency Plan
- Upgrade of Plant Computer Software for Subcooling Indication
- Reinforcement of Public Information on Nuclear Safety through Seminars, Pamplets and Mass-Media

APPENDIX VI

ACTIVITIES

OF

DEADUK ENGINEERING CENTER

KOREA ADVANCED ENERGY RESEARCH INSTITUTE

MARCH 1982

- Participating in Westinghouse Owner's Group for Joint Resolution of TMI Related Problems, Generic Engineering, Licensing, and Operational Matters.

Under Progress

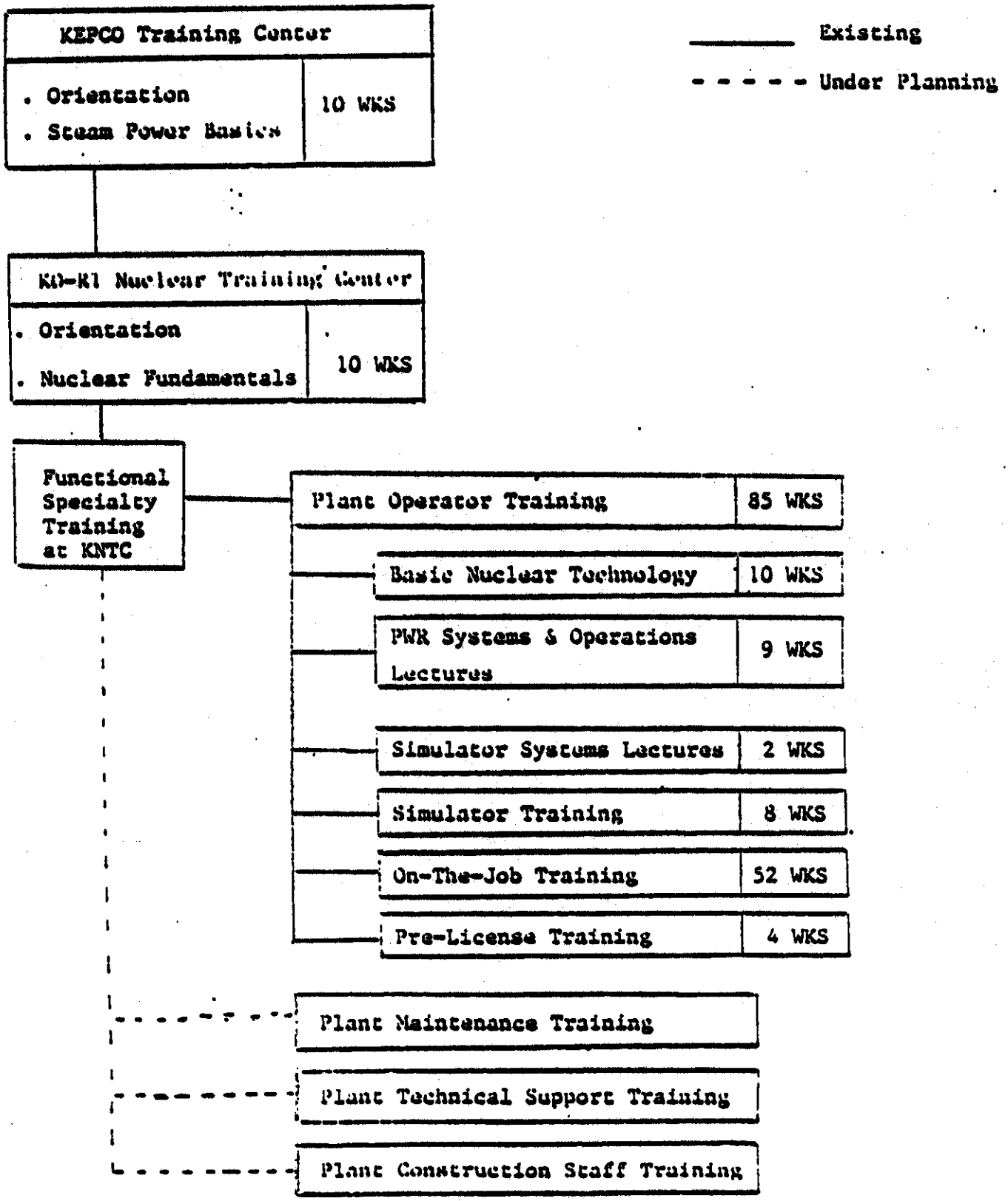
- Expansion of Liquid Radwaste Disposal system capacity
- Installation of Condensate Polishing Plant
- Installation of Hydrogen Recombiners

Planned

- Installation of Reactor Vessel Water Level Indicator
- Installation of Reactor Head Vent System
- Installation of Containment Monitoring System
- Installation of Wide Range Radiation Monitor
- Installation of Pressurizer Safety Valve Position Indicator
- Installation of Core Subcooling Monitor

B. Training Program

1. Training Program for New Recruits



1. BRIEF HISTORY

*	Feb. 1, 1975	Established as the Daeduk Branch of the Korea Atomic Energy Research Institute (old KAERI)
*	Dec. 1, 1976	Separated from the old KAERI to become an independent institute-the Korea Nuclear Fuel Development Institute(KNFDI).
*	Apr. 4, 1978	Moved from SEOUL to the present Daeduk Science Town.
*	Dec. 22, 1980	Consolidated with the old KAERI and became the Daeduk Engineering Center of the Korea Advanced Energy Research Institute(new KAERI).

2. MISSION

Daeduk Engineering Center is the national R & D center for nuclear fuel cycle technology and related subjects, including test and evaluations of nuclear fuels and components.

Immediate and near-term objectives are:

a. Development of nuclear fuel fabrication technology as well as other front-end nuclear fuel cycle technologies, except enrichment
b. Development of post irradiation examination(PIE)
c. Development of low and medium radwaste treatment technology

Long term goals are:

To develop technological basis for back-end fuel cycle technologies and proliferation resistant enrichment technology through laboratory scale fundamental research and/or to follow-up of published literature with special attention to avoid any NPT infringement.

Other missions would include performing feasibility studies on nuclear fuel cycle policy development.

3. WORKSCOPE

The Center's R & D programs are focused on the research and development of nuclear fuel cycle technology. It may be summarized as the following areas.

- Uranium ore processing and conversion technology
- Nuclear fuel design and fabrication
- Fuel performance evaluation technology
- Radwaste treatment and disposal
- Chemical analysis
- Radiological safety and nuclear safeguards

4. POLICY

The research and development projects of the Center are carried out for the sole purpose of peaceful use of nuclear energy under the safeguards aspect acceptable to the bilateral and multilateral(e.g. NPT) agreements.

5. CURRENT ACTIVITIES

In order to achieve the supply assurance of nuclear fuel for Korea's on-goning nuclear power programme, emphasis is placed on the development of immediatly needed nuclear fuel cycle technologies, such as uranium ore refining, conversion, fabrication, radwaste treatment and post-irradiation examination.

a. URANIUM ORE REFINING

Uranium ore refining pilot plant, with the capacity of 150Kg ore/hour, was constructed in March 1982. Particular stress is laid on crushing and grinding, solid-liquid separation, leaching, solvent extraction and precipitation works using low grade Korean uranium ore.

b. URANIUM CONVERSION

Uranium conversion plant, with the maximum capacity of 200 MTU/year was also completed in March 1982. In this conversion process, yellow cake is used as starting material instead of UF_6 in order to manufacture the ceramic grade UO_2-power. Emphasis is placed on the dissolution, purification, and calcination and reduction.

c. NUCLEAR FUEL MANUFACTURING

The R & D for nuclear fuel manufacturing technology such as fuel design, fuel fabrication and QA/QC, have been performed since 1978. The nuclear fuel fabrication research facility was completed at the end of 1978, in which fabrication technology development from UO_2 to fuel assembly are on-going. The following facilities are playing an important to develop necessary nuclear fuel fabrication technology.

- UO_2 pellet sintering facilities
- Fuel rod fabrication facilities
- Fuel component machine shop
- Fuel assembling facilities

d. OTHERS

1) POST-IRRADIATION EXAMINATION

The post irradiation examination(PIE) facility is expected to be completed by 1983. This facility will provide PIE services for Korean nuclear power reactor fuels as well as fuel experiment related to the reactor safety, fuel design and fabrication. The activities to be performed by these facilities include;

- Visual examination and metrology of PWR fuel assembly in pool-water
- Non-destructive test of fuel rod
  * Eddy current test
  * X-ray radiography
  * Gamma scanning
- Fission gas collection and analysis from fuel rod
- Metallographic structure test by means of optical macro-and micro-scopes
- Sectional gamma scanning
- R & D on PIE

2) RADWASTE TREATMENT

The radwaste treatment facility, which will have about $5000m^3$/year medium level liquid waste treatment,

will be completed by the end of 1984. This facility also can treat medium level solid waste. Following are main activities using the facility.

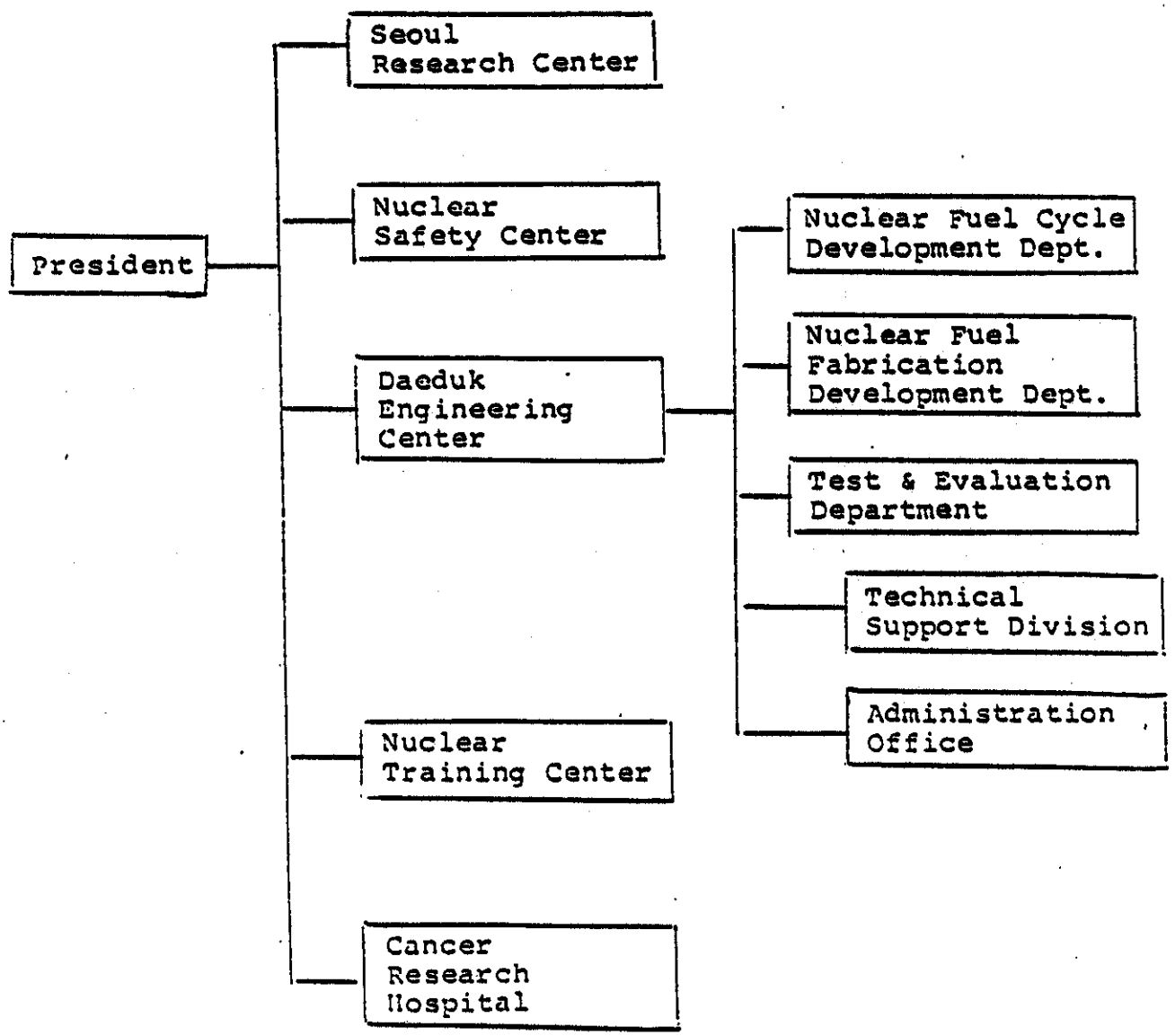
- Liquid waste evaporation and bituminization
- Solid waste volume reduction(Cementation)
- Equipment decontamination
- Laundry
- Solid waste storage

3) CHEMICAL ANALYSIS

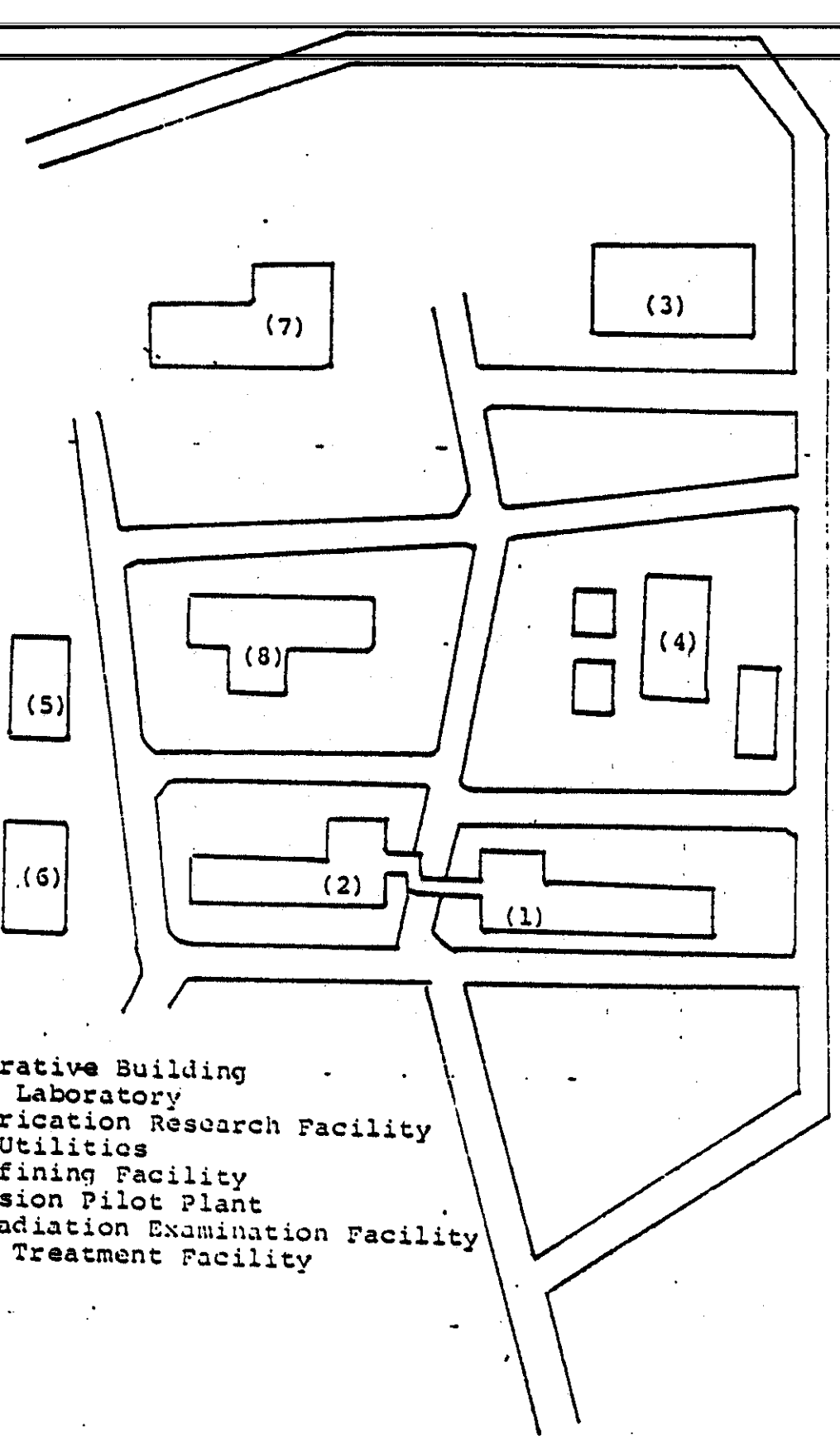
All chemical analysis are being performed in the following fields.

- Raw material analysis
- Chemical analysis for process control
- End product specification analysis
- Nuclear material safeguards analysis

6. ORGANIZATION



7. LAYOUT OF THE CENTER



(1) Administrative Building
(2) Research Laboratory
(3) Fuel Fabrication Research Facility
(4) General Utilities
(5) U ore Refining Facility
(6) U Conversion Pilot Plant
(7) Post-Irradiation Examination Facility
(8) Radwaste Treatment Facility

8. OTHERS

Establishment of a PWR Fuel Fabrication Company

It is estimated that by 1990 the local requirement of PWR fuel for reloading will surpass 200 tons per year. Therefore, the Center performed a feasibility study for the establishment of a commercial PWR fuel fabrication plant in Korea. Based on the study, the Center recommended the ROK Government to form a Korean Nuclear Fuel Corporation to produce locally needed reload PWR fuel by 1988 with an annual capacity of 200 tons/yr.
In 1981, the Korean Government approved a plan to form a joint venture company by KAERI and KEPCO with the participation of a foreign company as the joint venture partner who will supply the necessary fuel fabrication technology and related software technologies such as nuclear fuel design, in-core management and safety analysis. The foreign company will be requested to secure necessary credits from foreign bank(s) and will be allowed to participate in the joint venture with an investment of up to 49%.
KAERI, KEPCO, MOST, MOER, and EPB have been working closely to implement the plan since December 1981, and it is expected that the Government will select the foreign partner by late 1982 and will approve the establishment of a new company by early next year.

KOREA ELECTRIC COMPANY

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TELEX NO: KELECCO K24287, K28350
YEO EUI DO P. O. BOX 40
(TEL) 783-2445

1-791, YEO EUI DO-DONG, YOUNG DEUNG PO-KU,
SEOUL, KOREA

Dr. Charles E. Houston
Vice President, Asia Division
Export-Import Bank of the United States
811 Vermont Avenue N.W.Washington D.C.20571
U.S.A.

January 15, 1981

Subject : Dr. Levy's Recommendations

Dear Sir :

It is my great pleasure to advise you of our position on Dr. Levy's Recommendations contained in the report titled, "Review of Safety Aspects of Nuclear Power program in the Republic of Korea."

Please note that the discussions are limited to those specific recommendations related directly to our company,KECO.

Please feel free to ask if you have any queries on the contents of the enclosed KECO's position.

Very truly yours,

Sung, Nack Chung
Director & Excutive
Vice president

Enclosures
CC : S. Levy

KECO's Position on Dr.Levy's Recommendations

Recommendation	KECO's Position
III.4 Until such time as the Korean regulatory process is finalized, standardized, and codified nuclear power plant designs should be acquired from foreign countries with very strong requlatory programs, and the purchase order should specify a domestic reference plant in that foreign country to identify the safety level to be implemented.	Our government as well as our company follow U.S. NRC regulatory codes and standards strictly in the implementation of Korean nuclear power program and therefore we are pretty sure that an acceptable level of safety has been achieved. Although we consider it is not always necessary to specify a reference plant in the supplier's country on the above basis it would be usefull to provide an adequate level of safety on a certain case. This approach has been utilized for our initial nuclear program, Kori 1 and Wolsung 1. For subsequent units, a reference plant in a third country has been specified because of specific reasons. There was no updated 2-loop plant to reference in the U.S.A at the time of Kori 2 contract. For unit 5&6 and

Recommendation	KECO's Position
	7&8, there was no suitable reference plant other than the plant in a third country which is specified presently for the specific architecture engineer selected. However, the latest order for Nuclear 9&10 specified a reference plant in the supplier's country and this approach will be followed as far as possible in the future too.
IV.1 Increased and, in particular, experienced manpower development is essential to supply near-term requirements. Experienced manpower development could be helped by increased rotating assignments at KAERI, reactor plant sites, and at foreign vendors. Acquisition instead of domestic development of high technology computational methods might reduce the demands of specialized personnel.	As an electric utility company, KECO has implemented a manpower training program to be self-sufficient to run nuclear power plants ever since the beginning of nuclear power program. We have acquired high technology computational methods from the States such as 'RETRAN' 'CITATION' and etc, with the required training for their use from Energy Incoperated and NUS etc. This program will be going on to develop our own technical capability. Also, we will utilize KAERI and Korea Nuclear Engineering (KNE) for a certain part of the safety and transient analyses which is required to implement design changes in operating plants.

Recommendation	KECO's Position
IV.2 Operator qualifications and training programs need upgrading. The following improvements are recommended :	We quite agree with the recommendation and we are reviewing the training program to incorporate the lessons learned after TMI.
Increased qualifications to insure physical understanding of plant behavior and response during abnomal events.	The majority of KECO shift supervisors(SRO) and a good portion of operators are college graduates. For high school graduates, more theoretical training will be given to enhance physical understanding of system transients.
Reduced number of opportunities to pass operator examinations Juxtapose to Unit 2 and the Simulator	KECO has a plan to evaluate the existing training programs and training facilities in January 1981 by Westinghouse training experts. Following the Westinghouse experts evaluations, KECO will take appropriate actions to upgrade the training programs and facilities if required. Tests and examinations programs will be also re-evaluated, and upgraded. KECO has already upgraded the existing simulator by increasing the computer memory capacity to enhance the operator training more effectively.

Recommendation	KECO's Position
	As for software programs, we are planning to upgrade Kori simulator to enable simulation of multiple failures, operator errors, saturated conditions and natural circulation.
Additional training on power plants due to substantial differences in Kori simulator from actual Korean plant designs.	In order to maximize the training effects, KECO training center performs substantial on-the-job training at the plant after the simulator training. For the future simulators, identical design to the actual plants will be provided as far as practicable.
Early decision on the acquisition of a Wolsung simulator, if no simulator is provided, extended operator training in Canada is necessary to approach the Canadian level requirements for operators.	KECO's policy for simulator is to install at least one simulator for each site. Based on this policy, a simulator is installed in Kori site and another simulator is being planned at Yeong Kwang site for Nuclear units 7 and 8. We are also contacting

	Recommendation	KECO's Position
		Framatome for units 9 and 10 simulator. However, we do not consider the acquisition of a Wolsung simulator at the moment because no additional CANDU Plant is planned. The operators are now under on-site training after the training course including simulator for the extended period in Canada. Further training will be carried out at the plant during various commissioning tests until plant operation. Operators will be sent to Canada for simulator training for requalification as required.
•	Development of a long-term simulator and training program for future units (units 7 and 8 and beyond)	Refer to the above response for a long-term simulator program. Also, a long-term training program will be reevaluated to provide the appropriate training for future units.
IV.3	A complete and integrated spare parts program should be developed to support Kori-1 and subsequent units' operation.	The first step to develop a spare parts program already has been taken with the consultation of Korea Nuclear Engineering Co (KNE) with the scheduled completion of

Recommendation	KECO's Position
The program needs to recognize the distance between Korea and many of its spare parts and services suppliers.	early this year. Based on the result of this, we will continue to develop a complete and integrated spare parts program. In addition, it is under processing to make a contract with the Kori 1 suppliers for emergency services and spare parts. Also, the Korea Heavy Industry Inc.(KHI) which was formed by the recent unification of nuclear equipment and component manufacturers will be fully utilized to supply required spare parts with flexibility. We will expand our efforts in this area in cooperation with government authorities concerned.
IV.4 A disposal plan must be developed for low activity waste generated during nuclear power plant generation. Regualtions, disposal sites, transportation methods have to be in place soon to cope with an inadvertent surge in low activity production and the filling up of low activity storage space at the reactor sites.	Low level radwaste stroage facility is provided at the site with 10 years storage capacity. Recognizing the urgency of the national policy regarding the disposal of radioactive waste, this subject is already being discussed to set regulations, disposal sites and transportation methods. We completed an initial study for a proposed solution for the final disposal by a service

Recommendation	KECO's Position
	contract with KAERI in 1980. We will take further action to resolve this matter.
V.1 Under the very ambitious long-term nuclear program being proposed, availability of manpower resources and, in particular, experienced manpower could become the most important single issue to the continued safety of the Korean nuclear power program. It is probable that too much is being planned to be accomplished on too many fronts. Prioritization of some elements of the program and more realistic goals and extended schedules might enhance the chances of satisfying the manpower needs.	Realizing the importance of this issue, KECO has established a long-term manpower recruiting and training program. Under this program, KECO is operating a technical high school to recruit enough technicians. This school produces 600 graduates in a year and, in order to maintain qualified engineers, a certain ratio of the high school graduates (about 10 percent) will be sent to an engineering college. For this program, KECO has already made an agreement with Ulsan university. KECO is also providing scholarships to prospective college students throughout the country to recruit them after graduation in parallel with general recruitment of college graduates.

	Recommendation	KECO's Position
V.3	As Korea moves to become totally self-sufficient in nuclear power, it will need capability to design and analyze power plants and reload fuel. The present infrasturcture does not appear to provide for such capability or assign such responsibility. A production oriented organization will have to be designated with time to support totally based Korean Power Plant project reload fuel and plant operations.	KAERI combined with KNFDI will be responsible for a certain portion of nuclear design, particularly safety evaluation of reload fuel as a fuel manfacturer. The combining of these two organization will help to develop such an engineering capability. The responsibility for architect engineering still rests onto KNE.