KOREA RESEARCH REACTOR –1 & 2 DECOMMISSIONING PROJECT in KOREA

S.K. Park, U.S. Chung, K.J. Jung and J.H. Park
Korea Atomic Energy Research Institute
P.O. Box 105, Yuseong, Daejeon, 305-600, Korea
E-mail: skpark2@kaeri.re.kr

ABSTRACT

Korea Research Reactor 1 (KRR-1), the first research reactor in Korea, has been operated since 1962, and the second one, Korea Research Reactor 2 (KRR-2) since 1972. The operation of both of them was phased out in 1995 due to their lifetime and operation of the new and more powerful research reactor, HANARO (High-flux Advanced Neutron Application Reactor; 30MW). Both are TRIGA Pool type reactors in which the cores are small self-contained units sitting in tanks filled with cooling water. The KRR-1 is a TRIGA Mark II, which could operate at a level of up to 250 kW. The second one, the KRR-2 is a TRIGA Mark III, which could operate at a level of up to 2,000 kW.

The decontamination and decommissioning (D & D) project of these two research reactors, the first D & D project in Korea, was started in January 1997 and will be completed to stage 3 by 2008. The aim of this decommissioning program is to decommission the KRR-1 & 2 reactors and to decontaminate the residual building structures and the site to release them as unrestricted areas. KAERI (Korea Atomic Energy Research Institute) submitted the decommissioning plan and the environmental impact assessment reports to the Ministry of Science and Technology (MOST) for the license in December 1998, and was approved in November 2000.

In June 1998, All 299 rods of spent fuels from the two research reactors were safely transported to the US, according to the US originated fuel management policy. Therefore, this project doesn't include the handling of fuel and any potential criticality hazards.

Until now, the radioactivity measurement results of the contaminated area show that the radiation levels do not exceed more that 3 times the natural radiation level. The free release level of these areas is fixed 0.4 Bq/g (or Bq/cm^2) for β-γ emitters and 0.04 Bq/g (or Bq/cm^2) for α emitters. The occupational dose target was established at 15 mSv/y. This target was kept in establishing the ALARA strategy.

All the dismantled materials are classified by the 3 following categorises; non-contaminated, radioactive material lower than the free release level and material higher than this. The non-contaminated wastes will be disposed of like industrial waste. The second one will be temporarily stored on the site then disposed of after permission from the Ministry of Science and Technology. The radioactive wastes will be further volume reduced by decontamination by proper techniques such as chemical and ultrasonic washing, cutting, compacting etc., and putting them into a 4m^3 containers for temporary storage on the site. These will then be transported to the national LILW repository when it is operational, probably in 2008.

According to the decommissioning program, the practical D & D activities were started in August 2001 by decommissioning the radioisotope production facility, hot cells, equipment and experimental laboratories in the KRR-2. These objects are currently being decontaminated and dismantled. The two reactor halls, the reactor themselves and the auxiliary facilities will be dismantled starting in 2003.

INTRODUCTION

KRR-1 located in KAERI's Seoul site is an open pool and fixed core type reactor with a capacity of 250kW thermal. Graphite was used as a reflector. The construction was started in 1957. Its first criticality was reached in March 1962 (1). The total power was 3,700MWh during 36,000 operating hours until its shut down in January 1995. KRR-2 is an open pool and movable core type reactor with a capacity of 2,000kW thermal. Water was used as a reflector. Its first criticality was reached in May 1972. The total power was 69,000MWh during 55,000 operating hours until its shut down in December 1995 (2).

Fig. 1. Site view of the KRR-1 & 2 (□ : KRR-1, ⬚ : KRR-2)

Since the new research reactor, HANARO, in KAERI's Daejeon site began its operation and the two research reactors were shut down in 1995, the Korea Electric Power Cooperation (KEPCO) officially asked KAERI to restore the site and related estates after their decontamination and decommissioning as soon as possible. According to Article No. 31 of the Atomic Energy Act (responsibility of the decommissioning of nuclear facility), the operator, KAERI, is responsible for the decontamination and decommissioning of the two research reactors. KEPCO is actually using the remaining site and buildings as their training center.

A plan for the decontamination and decommissioning of the KRR-1 & 2 was reported to the 12th meeting of the Nuclear Development and Utilization Committee in March 1996. And the decommissioning project was then started in January 1997 (3).

In 1997, the first year of the project, work was performed in preparation for the decommissioning plan, the start of the environmental impact assessment and the setup of the licensing procedure.

At the end of 1998, Hyundai Engineering Company (HEC) was selected by open bid as the main contractor to do the decommissioning design and the preparation of the licensing documentation for the D&D of both reactors. British Nuclear Fuel plc (BNFL) was selected as the technical assisting partner of HEC for decommissioning design and plan. KAERI people implemented the environmental impact assessment work.

The decommissioning plan document including the environmental impact assessment was finished at the end of November 1998 and was submitted to the Ministry of Science and Technology (MOST) for licensing in December 1998 (4,5) and was approved in November 2000

after long consultation and debates.
Meanwhile, preparation work for the decommissioning has been carried out since 1998, such as the installation of radiation measuring and analysis equipment, a turn-style access gate which is equipped with an automatic individual radiation exposure recording system, hot and cold shower rooms for the workers, laundry equipment and installation of radioactive liquid waste treatment facilities, etc.
A tentative schedule of the D&D project for KRR-1 & 2 is shown in Fig. 2. This schedule was reviewed many times depending on the change of decommissioning strategy and the related R&D program.

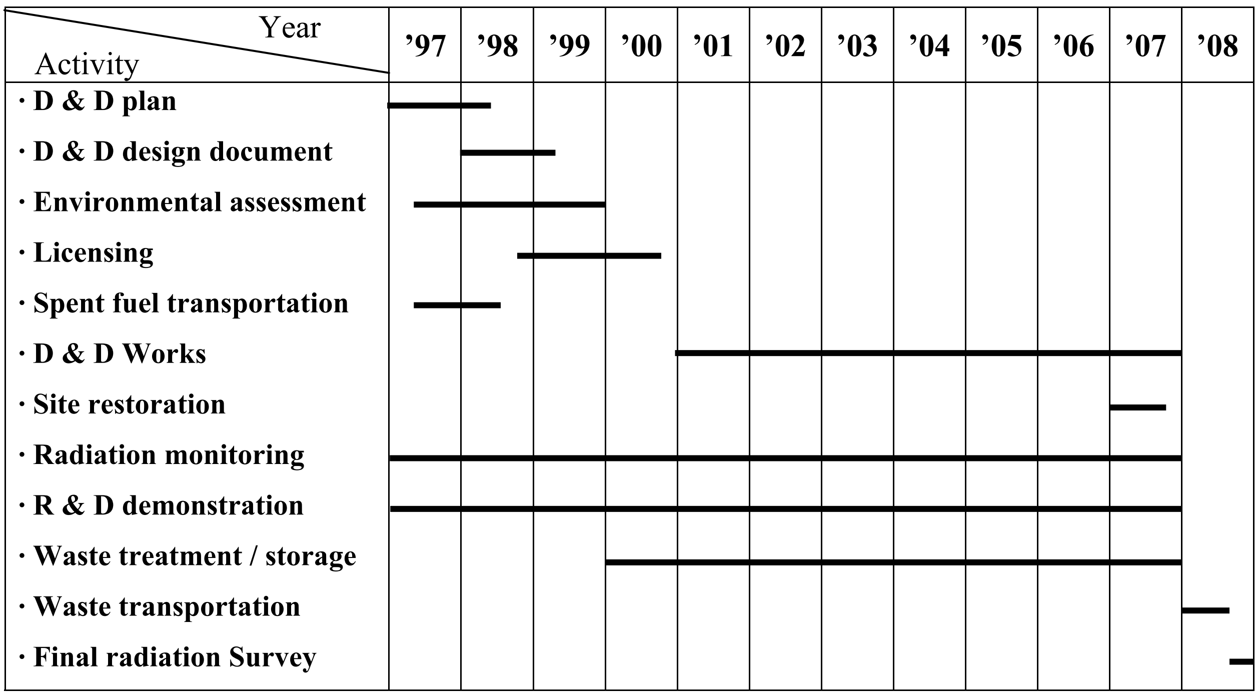

Fig. 2. Project schedule of KRR-1&2 decommissioning

RADIOLOGICAL CHARACTERISATION

The residual radiation and radioactivity level in KRR-1&2 have been measured, analyzed and evaluated to know the status of radiation and the radioactivity level and to establish and provide the technical requirements for the safe decommissioning of the facilities which shall be applied in minimizing the radiation exposure for workers and in preventing the release of the radioactive materials to the environment. The radiation dose rate and surface radioactivity contamination level on the experimental equipments, floors, walls of the facilities, and the surface of the activated materials within the reactor pool structure were measured and evaluated. Radioactivity and radio-nuclides in the pool and cooling water were also analyzed. In the case of the activated reactor pool structures, in which the radiation and radioactivity level are very difficult to measure, a computer code ORIGEN was additionally used for estimation of the residual radioactivity (6). The results of radiological characterization for KRR-1&2 are summarized in Tables 1and 2.

Table I. Surface dose rate and maximum surface contamination of KRR-1 & 2 Facilities

KRR-1		Surface Dose Rate (μSv/hr)		Max. Surface Contamination (Bq/100cm²)	
		Max.	Min.	Alpha	Beta
Reactor Facility	Core vicinity Pool Shield concrete	25,000 48,000 0.23	150 1,200 0.15	- - <0.298	- - 8.63
RI Production Facility	Floor/wall Exp. equipments Lead hot cell	7.0 35.0 0.2	0.15 0.18 0.15	8.18 20.13 <0.298	36.15 45.5 <1.31
KRR-2		**Surface Dose Rate (μSv/hr)**		**Max. Surface Contamination (Bq/100cm²)**	
		Max.	Min.	Alpha	Beta
Reactor Facility	Core vicinity Shield concrete Exp. facility HVAC room	1,400,000 3.0 450 6.0	500 0.15 0.2 0.15	- <0.44 <0.44 <0.44	- 74.01 19.78 <3.84
RI Production Facility	Exp. equipments Lead hot cell Concrete hot cell Underground pit	32.0 7,300 400 640	0.20 0.2 0.3 0.15	<0.44 88.50 6.86 -	2,070.23 132,526.83 253.42 -

Table II. Specific activity of the activated components for KRR-1&2

Components	Material	Sources and Specific Activity	Estimated Weight
KRR-1 Rotary Specimen Rack	Stainless Steel	Fe-55 : 8.93E05 Bq/g Co-60 : 7.01E06 Bq/g Ni-59 : 3.00E04 Bq/g	3.4 kg
KRR-1 Core Reflector	Graphite	H-3 : 4.13E03 Bq/g C-14 : 1.92E02 Bq/g Co-60 : 1.39E02 Bq/g	770 kg
KRR-2 Rotary Specimen Rack	Stainless Steel	Mn-54 : 3.06E06 Bq/g Fe-55 : 1.43E08 Bq/g Co-60 : 1.98E08 Bq/g	3.4 kg
"	Aluminum	Co-60 : 9.69E05 Bq/g	114.6 kg
KRR-2 Shielding Structure	Concrete	Fe-55 : 1.4E08 Bq/m^3 Co-60 : 8.2E07 Bq/m^3 Eu-152 : 1.4E08 Bq/m^3	8 m^3 (20 ton)

As shown in Table 1 and 2, all of the components, except stainless steel components from the Rotary Specimen Rack (RSR), can be classified as low-level radioactive waste.

LICENSE FOR DECOMMISSIONING

Decommissioning Plan and Environmental Impact Assessment

To obtain the license from the government, the decommissioning plan including the environmental impact assessment must be prepared according to article No. 31 of the Atomic Energy Act, which defines the following items:

1. Decommissioning method and schedule,
2. Decontamination method of the contaminated materials,
3. Treatment and disposal method for the radioactive wastes,
4. Countermeasure for the protection from the radiation damage,
5. Environmental impact assessments and its countermeasure,
6. Other matters defined by the Minister of the MOST.

At the same time, the environmental monitoring plan before and during the decommissioning work must be included in the environmental impact assessment report according to Ministry Ordinance No. 96-31 of the MOST.
The environmental monitoring and assessment will be followed until the end of the project and will be regularly reported to the MOST. The purposes of the action are to ensure that the surrounding environment is not affected by the decommissioning activities, to know the tendencies of the accumulation of radioactive materials in the environment and to obtain confidence from the general public by releasing regularly the monitoring results.
In 1997, the meteorological characteristics around the KRR site were obtained by analyzing the meteorological data measured in Seoul by the Korean Meteorological Agency. The annual joint frequency of wind data was calculated by statistical analysis of wind direction, wind speed and atmospheric stability.
But from the year 1999, wind speed and wind direction have been measured continuously, at the request of the KINS, for the purpose of obtaining meteorological data at the KRR site itself. The revised environmental impact assessment report was finally submitted to the MOST in June 2000.

Licensing procedure

The decommissioning plan and the environment impact assessment were prepared according to article No. 31 of the Atomic Energy Act and submitted to the MOST for the license. Those documents were reviewed by KINS, the authority body, from January to December 1999.
The review report made by the KINS was submitted to the MOST for consultation by one of the sub-committee's of the Nuclear Safety Commission: Radiation Protection Sub-committee. The consultation of the review report by the Sub-committee was finished in January 2000. The recommendations made by the Sub-committee were then submitted to the Nuclear Safety Commission, which is the highest advisory group for the MOST on nuclear safety matters. This was approved in November 2000.

RADIATION PROTECTION PROGRAM AND HEALTH PHYSICS

Radiation protection in the decommissioning plan is one of the most important issues to be considered in minimizing the radiation exposure for workers and in preventing the release of radioactive materials to the environment. Because the movements of human and material resources are anticipated during the decommissioning activities, rearranging the restricted area and expanding the radiation protection facilities to effectively perform the radiation control establishing physical protection.

As the survey for contaminated and radio activated materials have to be conducted during the works, radiation measuring equipment were prepared in advance. The site release criteria for unrestricted use were set to 0.4 Bq/cm^2 or 0.4 Bq/g for β - γ emitters and 0.04 Bq/cm^2 or 0.04 Bq/g for α emitters. According to the national Atomic Energy Act, the occupational dose was limited below 50 mSv/5 years and 20 mSv/year both. Considering the safe margin and budget condition, 15 mSv/y was established on the occupational dose target for this project. All of the external and internal doses will be kept in establishing the ALARA strategy (7,8).

Documents such as the radiological control manual, radiation protection procedure; emergency procedure, training program and work procedures were prepared before the practical decommissioning works. All entrances and exits to the working area are accessible only by a radiation work permit using access control equipment.

More detailed radiological surveillance of all working areas will be performed throughout the project to ensure that the prevailing conditions are known and that the appropriate controls are implemented. Monitoring is implemented to limit unnecessary exposures and to prevent the spread of continual contamination.

SPENT FUEL TRANSPOTATION

The return of foreign research reactor fuel to the United States is the result of the atoms for peace initiative undertaken in the 1950's. The intent of the initiative was to provide the peaceful use of nuclear technology to foreign nations in the form of research reactor fuel. In 1978, the United States initiated the reduced enrichment for research and test reactors (RERTR) program to reduce the use of high-enriched uranium (HEU) in civilian programs and promote the conversion of these reactors to low-enriched uranium (LEU) fuels. In March 1996, the Record of Decision (ROD) based on the final environmental impact statement on a proposed nuclear weapons nonproliferation policy concerning foreign research reactor spent nuclear fuel reestablished the return program for spent nuclear fuel enriched in the United States. As part of this decision, the INEEL in the US was designated as the receiving site for KRR-1&2 fuels.

With the consent of the Korean government to the US ROD, the INEEL inspection team conducted inspection of KRR-1 & 2 fuel from two research reactors in Seoul and in Daejeon, Korea during May and June 1997. After that preparation work for the shipment of spent fuel from both sites conducted during June 1998, all of the spent fuel (299 rods) from the KRR-1 & 2 was safely transported to the United States in July 1998 (9).

RADIOACTIVE WASTE TREATMENT

The types of waste materials, which will be considered and encountered during the decommissioning activities, are firstly classified by physical types; solid, liquid and gaseous waste, and by radioactivity; low- and intermediate-level radioactive material. Special wastes such as cadmium, asbestos, sodium lamps, HEPA filters, spent resin; lead etc. will be treated in the proper manner according to the national regulation or guidelines (10).

Liquid Radioactive Waste

All of the operational and existing liquid radioactive wastes are more or less under a free discharge level (less than 1.85×10^5 Bq/m^3) with a quantity of 400 m^3. The main radio-nuclides contained in the liquid wastes are Co-60 and Cs-137.
Liquid radioactive wastes will also be generated during the decommissioning work namely by flushing and equipment decontamination, as well as by the wash down of radioactive areas. Using the least possible quantity of washing liquid will minimize these secondary liquid radioactive wastes.
All of these liquid wastes will be further concentrated by using a natural evaporator, which has been operational since April 1999 with an evaporation capacity of 200 t/y (11). Such a natural evaporation facility has been safely operating for the concentration of the very low-level radioactive liquid waste being produced at KAERI's Daejeon site since 1990. All of the operating data were referred to for the design and construction of the new evaporation unit at the KRR 1&2 site (11,13).
While, radioactive laundry and shower wastes will be treated on site by the membrane facility which has been developed at KAERI. This membrane facility will also be utilized later for the treatment of laundry and shower liquid radioactive wastes arising from the HANARO research reactor in Daejeon.
Simple and movable cement solidification equipment will be installed on site for the solidification of concentrated liquid waste from the natural evaporator. A drying method instead of the solidification of concentrated liquid wastes is also another possible option for further volume reduction.
Since the KRR-1 & 2 and research laboratories were operated for more than 34 years, all of the liquid radioactive waste tanks and ponds are filled more or less at the bottom with slurry. The total quantity of the slurry is estimated at around 4 m^3. It will be less than 1 m^3 after concentration by filtration (12). A study on the proper treatment method of slurry waste is under way.

Solid Free Release Waste

Free release wastes will result from the sections of the decommissioning areas which have very little or no level of contamination or activation associated with them, for example the outer concrete of the KRR-1 and KRR-2 shield tank structures or miscellaneous articles from laboratories.
The inactive concrete waste from the decommissioning of the KRR-1 and KRR-2 shield structures will dominate the volume of free release waste. This volume is estimated to be around 1200m^3 but will depend on the depth of activation of the shield structures. Calculations, monitoring and sampling will be carried out to ensure that the waste is suitable for free release. From the experience of the practical activities on 10 lead hot cells dismantling, most demolished concrete was classified to non-contaminated waste except only 1% of radioactive concrete.

Solid Low-level Radioactive Wastes

The Main production areas of the low-level radioactive wastes are the reactor hall, fuel storage pond, hot-cell, laboratories, resin regeneration facility and old and new radioactive liquid waste

storage tanks for KRR-1 and the reactor hall, fuel storage areas, hot-cells, semi hot-cells, laboratories and radioactive waste storage tanks for KRR-2. It is also expected from the waste storage building, liquid radioactive waste treatment building, and so on.
The Radioactivity of the solid waste produced during dismantling is generally very low, but the physical types will be very diverse; 10 m^3 and other sized tanks, heat exchangers, activated concrete, laboratory equipment, filters & filter housings, ducts, pumps, pipes, reactor components, contaminated concrete or materials, shield doors, beam ports, and compactable and/or combustible waste such as papers, cloths, gloves, shoes etc.
Trained workers under the control of radiation protection personnel most carefully segregate all of the radioactive wastes. Volume reduction will be followed by cutting and/or compaction prior to putting them in a proper container.
Compactable and/or combustible solid wastes such as papers, gloves, shoes, etc will be packed in a 200 liters drum. All the other non-compactable solid wastes will be packed in a 4 m^3 container or other appropriate container sizes (14).

Solid Intermediate Level Waste

It is anticipated that intermediate level waste, of which there will be approximately 1.5 m^3, will be comprised of the stainless steel components of the 3 RSRs (2 for KRR-1 and 1 for KRR-2) and some other stainless steel components from the two reactor cores or their vicinity.
Calculations were carried out to estimate the dose rates associated with the RSRs by using the FISPIN code, which was developed by AEA Technology plc. in the UK.
Based on the operational data from the KRR-1 and KRR-2 reactor, the mass of Co-60 in the RSR would be 2.38×10^{10} Bq giving a dose rate of 8.725 mSv/hr and 6.75×10^{11} Bq with a dose rate of 248.2 mSv/hr, respectively, at a distance of 1 m from the unshielded RSR (6).
The KRR-2 RSR will be transported to the exposure tank of KRR-1 where the two KRR-1 RSRs are actually stored. These 3 RSRs will be cut to take out all the stainless steel components (about 11kg in total) and to put them in a TIF (TRIGA Irradiated Fuel) cask for storage and future transportation (14).

Gaseous Waste

The decommissioning areas are ventilated using the respective building ventilation systems, which provide two levels of filtration. Because of the low levels of contamination within the decommissioning areas, it is considered that the levels of aerial activity generated from the majority of the operations will be insignificant.
However, there is the potential to generate aerial activity during the removal of the activated concrete and removal of the thermal columns. The use of containment with a portable ventilation system during the operation will reduce the environmental discharges. All discharges to the environment will be monitored to assure that there is no abnormal discharge of radioactivity.
Where possible contamination will be removed by swabbing with a suitable decontamination agent. However, the fixed contamination will be removed from concrete surfaces by scabbling. The scabbling head is contained, the dust is vacuumed to a drum, and the exhaust from the vacuum is HEPA filtered.

Temporary Storage of Wastes

All radioactive wastes will be packed in a 4 m^3 container (or other adequate sizes) or in a 200 liter drum in the solid form. All of these wastes will be temporarily stored in the KRR-2 reactor hall until 2008 when a national low- and intermediate-level radioactive disposal facility is operational. Radiation monitoring and protection during that period will be assured by KAERI (15).

PRACTICAL DECOMMISSIONING ACTIVITIES

Cleaning of Hot Laboratories

Since the 1st of Aug. 2001, practical D&D work has been being conducted according to the method statement, radiation protection procedures and work procedures. Contaminated laboratories were the first targets before entering more serious area dismantling. Radiation measurement has been carried out all around the laboratories from the bottom and wall to the zenith in one meter by one meter sections.

As the result of measuring radiation dose are contaminated about 300 cpm in the room and the experimental table and the fume hood is contaminated about 1,000 cpm and one of the supporter is contaminated about 180,000 cpm. The smear test for a sort of glass and various kinds of miscellaneous items is respectively performed to each unit of item and to divide approximate volume. The measurement of dose is conducted at all surfaces of the object.

A part of sink table was contaminated about contamination β: 0.0436 Bq/cm^2~ 0.372 Bq/cm^2. The result of detection and measurement through the radioactive detector was below the lowest limit.

Since decommissioning objects are almost simple assembling structures, which consist of steel and wood, dismantling was conduced by hands-on to use light tools.

All the remaining goods in the laboratories were separated by whether they were contaminated or not. 90% of the remaining goods are non-contaminated. The produced wastes were as follows; papers (363 kg), glasses (51 kg), PVCs (146.8 kg), irons (bulk, 1,250 kg), wood (bulk, 1,490 kg), etc. The non-contaminated wastes were disposed of like industrial waste. And the contaminated waste will be further segregated by contamination level and decontaminated in different ways in view of the maximum volume reduction of the radioactive wastes (16).

Very low level radioactive wastes which below 0.4 Bq/g or Bq/cm^2 for β-γ emitters were temporally stored on the site then disposed of according to the Atomic Energy Act after will be received permission from the Minister of the MOST.

Then the radioactive wastes will be further volume reduced by compaction or other proper methods and put into a $4m^3$ container for temporary storage.

Dismantling the 10 Lead Hot Cells

The isotope production installation divides into 2 production rooms; there are 10 lead hot cells in the room. The dimension of each hot cell is 900mm×1,150mm×2,100mm. As lead hot cells are composed of the concrete structures, lead bricks and 2 shield doors to play role of gate door in the rear part. And also composed of 1 lead glass and 2 remote tongs.

As the neutron source was not treated in the lead hot cells, we expected that structures and equipment in the hot cells be not activated. The contamination level rapidly drops to the level of natural radiation for the reason of the short-life activation and was stopped to use for a long time before decay. Before dismantling and decommissioning level of removable and fixed contamination and the surface dose rates were measured. The activated contamination level is measured by using Smear measurement method.

The objects of relatively high contamination level were glasses, which was that removable contamination level β was 0.45 Bq/cm^2 in the No. 5 cell, and the floor, which was that removable contamination level β was 2.6 Bq/ cm^2. It is so highly measured that the level of tongs is β: 1 Bq/ cm^2 and the level of left wall is β: 2.24 Bq/ cm^2 in the No. 8 cell.

The dismantling of lead hot cells were performed following the removal of outside supply pipes, back door, lead glasses, tongs, lead bricks, filter housing, ceiling and concrete structure. Dismantling of lead glasses and tongs were separated to the hit hammer in the inside after releasing the outer bolts. After dismantling the lead glasses and tongs, all the front of lead hot cells were dismantled by removing lead bricks one by one. It was dismantled so that lead hot cell concrete was cut in to maximum volume and a piece easy to handle using the core drilling method. After drilling a part of concrete crush with a core drilling machine, the rest was demolished with a crusher. The concrete, which was suspended from a movable crane, was taken down slowly. One of the lead hot cells was separated to from 4 to 6 parts. The separated concrete was decontaminated by grinding the surface with a small scabbler. The dust, which came out, was removed and collected by the vacuum cleaner.

Wastes produced by dismantling activities were almost equipment installed in lead hot cell and concrete consisted of the structure. The produced wastes are 20 hot cell doors (6,760 kg), lead bricks (9,492 kg), 10 lead glasses and the others. 911 lead bricks are planning to reuse after decontamination. Total amount of concrete produced by dismantling was 24.014 ton. After decontaminated, wastes larger than 0.4 Bq/g indicated were 0.189 ton, which was classified with radioactive wastes. Samples were collected in each and measured with a HPGe detector. Co-60, Cs-137, and Cs-134 were detected. Maximum value of radioactivity was Co-60 1.748 Bq/g. Another 23.825 ton was classified with free release (16). Fig.3. show the decommissioning activities as cutting, decontamination and measuring on the dismantled radwaste from the lead hot cells.

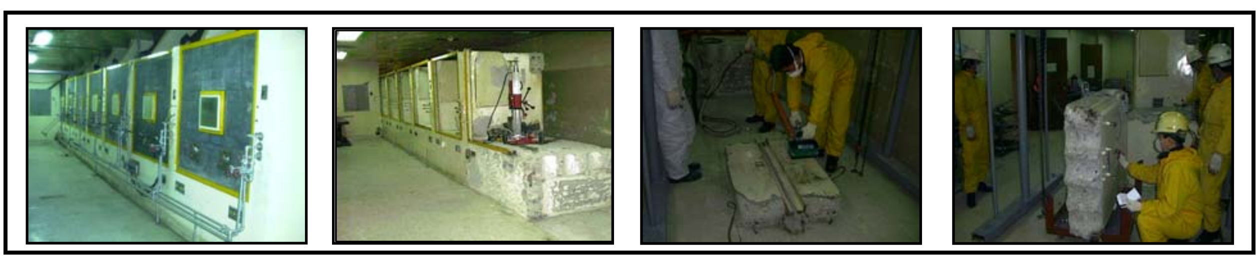

Fig. 3. Decommissioning activities on lead hot cell

RELATED RESEARCH and DEVELOPMENT

Since August 2001, the research and development program for decontamination and decommissioning was launched according to the recommendation made by the Nuclear Safety Commission. Developed technologies and tools will be demonstrated during the KRR D&D work period.

In the first step, the R&D subjects related to the D&D are as follows:
- -Establishment of a database for record keeping and the management of decommissioning data
- -Development of a 3-dimensional computer simulation on the dismantling process
- -Development the remote underwater cutting equipment for highly activated material removal
- -Development of automatic sampling and measuring equipment for radioactively contaminated surfaces.

A concept for a database system for the record keeping and the management of decommissioning information from the KRR-1&2 is being developed now. All information will be put into the KRR Decommissioning Information Database System. Pre-decommissioning records include documents on design, construction and operation. On/post-decommissioning records include documents on decommissioning planning, dismantling and restoration. In the present study, the basics of the decommissioning database establishment were graphically depicted for storage, reading, retrieval, output and updating of decommissioning information.
3-dimensional computer simulation for pre-dismantling is an important step not only for workers protection against radiation risks but also for effective training before the fieldwork. It is very difficult to simulate all dismantling processes for the D&D of KRR-1&2. Thus the major dismantling processes such as RSR dismantling and reactor pool dismantling will be simulated in this research.
Calculation by the ORIGEN 2.1 code of the radioactivity of 3 RSR showed that they would be considered as intermediate level radioactive waste. A careful dismantling study concluded that these RSRs should be dismantled under water. Therefore remote underwater cutting equipment is under development to separate the stainless steel component (intermediate level) from the aluminum alloy body.
Simultaneously, development of automatic sampling and measuring equipment for radioactively contaminated surfaces is underway. This device will considerably reduce the time of the sampling and the measuring of the radioactive surface.

CONCLUSION

The decontamination and decommissioning project of the KRR-1&2 was initially planned to terminate in December 1999, in a 3 year period. It was finally extended until 2008, when the final national disposal facility for low- and intermediate-level radioactive wastes is operational.
Preparation work was carried out before starting the practical D&D works. The preparation works for the decommissioning were to secure radiation measuring and analysis equipment. Simultaneously, some liquid wastes treatment facilities such as a natural evaporator, reverse isomer's equipment for laundry and shower wastes, slurry separator and mobile solidification equipment were prepared or installed. Also several technologies and equipment are developed or purchased for decontamination, cutting and dismantling the objects. There are chemical, ultrasonic, electro-chemical method for decontamination, hydraulic cutting machine for underwater components, electronic cutting equipment for pipe cutting, hydraulic splitter and driller for concrete dismantling, etc.
The practical D&D work has been conducted according to the method statement and work procedures that were prepared during the preparation work period. The first work is the decontamination and dismantling of laboratories and 10 lead hot cells that were used to produce radioisotopes in the KRR-2.
The radioactive waste arising from the dismantling work will be packed mainly in $4m^3$

containers which were designed and manufactured by KAERI for storage the low level solid radioactive waste and stored on-site until 2008. For the whole dismantling work, with respect to the ALARA principle, not only the workers protection from radiation and industrial hazard, but also the environmental protection will be the first priority.
KAERI will make its best efforts to use the current situation as a demonstration opportunity for continued research and development of the D & D field, in view of preparations for the D & D of commercial nuclear power reactors in the future in Korea

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