CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: 2003 International Symposium on Radiation Safety Management (ISRSM).20.06002.01.102

DATE/PLACE: November 5–7, 2003
Daejeon, Republic of Korea

AUTHOR: G. Douglas Gute

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TRIP REPORT

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Dates of Travel and Countries/Organizations Visited

November 5–7, 2003
Daejeon, Republic of Korea

Author, Title, and Agency Affiliation

G. Douglas Gute, Senior Research Engineer
Center for Nuclear Waste Regulatory Analyses (CNWRA)

Background/Purpose

The purpose of this trip was to attend and present a paper at the 2003 International Symposium on Radiation Safety Management (ISRSM). ISRSM is an international conference that addresses a broad spectrum of topics pertaining to radiation safety management. Some of the sessions that were held at the symposium included Radioactive Waste Disposal, Spent Fuel Management, and Radiation Protection Technology, among others. Attending this meeting enabled the CNWRA staff to present to the international community the methodology used by the CNWRA to evaluate and assess the seismic response of free standing dry storage casks supported by a reinforced concrete pad. Specifically, the presentation, entitled "Seismic Stability of Unanchored Spent Nuclear Fuel Storage Casks" and coauthored by G. Ofoegbu and A. Chowdhury, delineated the basis for the boundary conditions, material properties, and discretization used in performing a soil-structure interaction analysis by way of the finite element method. Such interactions with the international community enhances the credibility of the CNWRA staff in providing effective technical assistance to the NRC in its oversight of nuclear waste storage and disposal activities.

Abstract: Summary of Pertinent Points/Issues

I attended the 2003 ISRSM conference to present a paper entitled "Seismic Stability of Unanchored Spent Nuclear Fuel Storage Casks." The paper, which discussed the methodology used by the CNWRA to evaluate and assess the seismic response of free standing dry storage casks supported by a reinforced concrete pad, was prepared as a Repository Design and Thermal-Mechanical Effects Key Technical Issue activity. The conference provided an opportunity to learn about the most recent developments and projected activities of the Republic of Korea nuclear power program and related waste disposal strategies. In addition, the various technical sessions that I was able to attend (i.e., Spent Fuel Management, Decontamination and Decommissioning Technology, and Radiation Protection Technology) were very informative.

Discussion

This report will note highlights of the technical sessions I was able to attend rather than describing particular talks in detail. The conference opened on Wednesday, November 5, 2003, with remarks from Mr. H.G. Shim, president of Korea Hydro & Nuclear Power Co., Ltd (KHNP)/Nuclear Environment Technology Institute (NETEC), followed by a welcome address by Dr. S.R. Yoo, president of the Korean Association for Radiation Protection (KARP). During

these opening talks it was pointed out that, because of their lack of natural resources, the Republic of Korea imports nearly 100-percent of the fuel (both fossil and nuclear) required for their country's electrical power generation. Moreover, the Republic of Korea derives a high percentage (approximately 50-percent by the year 2010) of their electrical power from nuclear facilities. According to the Special Address (see Attachment 1), presented by Dr. K.J. Lee, president of the Korean Radioactive Waste Society (KRS), Wie-do island has applied for consideration as the nation's site for low- and intermediate-level radioactive waste disposal and interim high-level radioactive waste storage. Dr. Lee went on to say, however, that this application does not necessarily have the full support of the local populace. The Special Address was followed by a Special Presentation by Dr. C.K. Lee, Chairman of the Korea Electric Power Industry Code (KEPIC) Committee (see Attachment 2).

I attended the Spent Fuel Management technical session on Wednesday afternoon. This was also the session where I presented the CNWRA soil-structure interaction methodology paper. The Spent Fuel Management technical session addressed very diverse subject matter. For example, other presentations dealt with conditioned spent fuel, electrolytic reduction of Uranium Oxide in LiCl-Li_2O molten salt, and overviews of various dry storage systems and transportation casks available from commercial firms (i.e., CASTOR®, CONSTOR®, NUHOMS®, and HI-STAR®/HI-STORM® storage and transportation casks).

Thursday morning, November 6, 2003, I attended the Decontamination and Decommissioning Technology technical session. The presentations discussed the potential advantages of metal surface decontamination by plasma and electrochemical processes, recycling of contaminated metal scrap by melting (currently being used in Germany), and a soil washing decontamination process (presently being evaluated by NETEC).

The Thursday afternoon technical session on Radiation Protection Technology focused primarily on radiation monitoring issues. Presentations addressed radiation monitoring intervals, setpoints, analytical estimation methods, new detection devices, and so on.

On Friday, November 7, 2003, we were treated to a tour of the Engineered Barrier Test Facility for Near Surface Disposal of Low- and Intermediate-Level Waste (see Attachment 3) and the Vitrification Pilot Plant facility (see Attachment 4).

Proceedings

CNWRA Library.

Pending Actions/Planned Next Steps for NRC

None.

Points for Commission Consideration/Items of Interest

None.

SIGNATURES:

Doug Gute, Senior Research Engineer

11-17-2003
Date

Asadul H. Chowdhury, Manager
Minging, Geotechnical, and Facilities Engineering

11-17-2003
Date

CONCURRENCE:

Budhi Sagar
Technical Director

11/18/2003
Date

ATTACHMENT 1: Special Address

Special Address

Dr. K. J. Lee

President of KRS

Good Morning Ladies and Gentlemen !

Dr. Chang-kun Lee, chairman of committee of KEPIC, Dr. In-soon Chang, president of Korea Atomic Energy Research Institute, Seong-ryul Yoo, president of Korean Association for Radiation Protection, Mr. Hong-ki Shim, president of Nuclear Environment Technology Institute and distinguished participant specially from foreign countries, on behalf of Korean Radioactive Waste Society, I would like to express my sincere congratulations on its opening of the fourth symposium of the International Symposium on Radiation Safety Management.

As mentioned before from previous address, last July, the Korean government announced that Wie-do, an island located in south-western part of Korea, has applied for the potential site of low and intermediate radioactive waste disposal facility and interim spent fuel storage. Since then, the safety and public acceptance of the radioactive waste disposal site became a national big and controversial issue in Korea.

In this respects, this symposium is timely matched and it is a great honor for me to specially address to all of you.

Korean Radioactive Waste Society was newly founded in this June. The society hopes to correct the unfounded fears of radiation

safety and to provide the true technical informations on the radioactive waste disposal facility and eventually to enhance the public acceptance to the radioactive waste. Thus, in regard with the safety of the radwaste managements, this symposium is really coincident with the aims of Korean Radioactive Waste Society.

Nuclear energy is playing an important and constructive role in many fields, particularly in electric power production.

At the same time, we have observed a growing public awareness in safety of nuclear power and radwaste. Large amount of radwastes has been generated and accumulated at the interim storage facilities at each nuclear power plant site in Korea. The storage capacity is expected to be run out in short period.

So in order to keep the steady and stable electricity generation in korea, safe radwaste management and assurance of the repository construction are the most urgent matters with the highest priority.

In this regards, ever since founded in 1997, specially this years ISRSM meetings has been drawing much attention and expected to contributing significant promotion to the overall Korean radwaste managements. To provide the radwaste safety and proper explanation understandable to the public, it is recognized that active international discussion and exchange of information are real essential parts of the whole activities.

I understand that this symposium will definitely do touch upon this matter and will contribute to proceed toward this directions.

Let me now conclude my talk by congratulating and expressing my deep appreciation to all of you, specially oversea participants, for attending this conference. I certainly welcome to this Daeduk Science town, which is not only a science mecca in Korea but also

called as Korean silicon valley.

I certainly sense the enthusiasm and the excitement in the air of beautiful mountain, Gaeryong, tints of its falling leaves.

I wish you all a most pleasant stay in Daejon. Korea has nearly 5000 years of history and her historical remains can be found everywhere. Korea has a mixture of western and oriental cultures existing in perfect harmony.

Please be sure to take with you our goodwill and memorable moments on your way back home.

Thank you for your attention.

ATTACHMENT 2: Special Presentation

The Safe Management of Nuclear Energy, Populations and Fuels

A Special Lecture at International Symposium
on Radiation Safety Management
5-7 November 2003, Daejeon, Korea

Organized by Korea Hydro & Nuclear Power Co., Ltd. and
Korean Association for Radiation Protection.
Sponsored by OECD/Nuclear Energy Agency and IAEA.

Chang Kun Lee, Chairman of KEPIC Committee

李 昌 健 (Korea Electric Power Ind. Code)

Good morning, everyone!

It is a great time of the year in which to be assembling, as we are doing here: The sky is azure blue and high, the sunshine is mild, a lot of tree leaves turn to enticing flowers, and farmers are going to finally relax after the harvest.

Today many distinguished members of the international nuclear community are assembled herein to discuss various topics of common interest, and wrestle with knotty issues and burning questions related to radiation safety management. It is hoped that this gathering will serve as an excellent opportunity and venue for all the knowledge providers and recipients as well as observers.

This year marks the 100-year anniversary of the 3rd Nobel Physics Prize awarded to the Curies for their work on natural radioactivity in conjunction with Henri Becquerel for his discovery of the X-ray. These remarkable people ushered in the Nuclear Age. Indeed it was Marie Sklodowska Curie who in the latter years of the 19th century first used the word "radioactivité". And also one hundred years ago, Wilbur and Orville Wright achieved flight (for 59 seconds) on an engine-powered vehicle for the first time in human history (though Brazilians may dispute this, claiming the record for Brazilian flight pioneer Alberto Santos-Dumont, as well as the persistent claim of some Germans).

Exactly half a century ago, U.S. President Dwight Eisenhower delivered a famous speech, now known as Atoms-for-Peace Speech, to the United Nations General Assembly. A few months prior to this, Edmond Hillary and Tenzing Norgay had conquered Mount Everest, a peak then considered unscalable.

The Curies and Becquerel tried to fathom the hidden nature of energy emanating from the depth of an atom, whereas the Wright brothers as well as Hillary and Tenzing sought to extend the realm of human experience by reaching out for high, higher elevations. In the same spirit, we in the nuclear community are asked constantly to expand the horizons of what is possible through new and novel, peaceful applications of nuclear energy.

In short, whereas researchers like Curie were engaged in extending depth by explaining phenomena at the minutest level, other pioneers were pushing onto new elevating heights, and, yes, we in the international community are engaged in the work of expanding societal width, expanding the boundaries of what is possible. What then are the dimensions along which we should be working?

We have gathered here in an attempt to develop the wherewithal to make this world safer, more affluent and grounded on sustainable basis through the use of nuclear energy, with maximum emphasis on efficiency and especially safety. All the ways & means available to us must be deployed to this end. Where our aspiration alone to attain these goals is not enough, our continued perspiration must come to the fore. Only through the combined effort of aspiration and perspiration, and preferably guided by inspiration from above, will we overcome all obstacles of which the world offers us many. We urge all nuclear scientists and engineers to redouble their "multi-spirations" endeavors in addressing various critical nuclear issues and engineering hurdles that face us.

There can be no doubt that strict radiation management must receive one of the highest priorities in the nuclear sector. In the same vein, there must be an in-depth analytical scrutiny as to whether the maximum permissible level currently being set forth for radiation safety management is scientifically logical and practical for the nuclear industry. We suggest that the international nuclear community seek remedy, if possible, on this impending issue in terms of real safety perspectives, for the people, of the people and by the people concerned.

I just ran into a friend of mine who was in a Middle Eastern country recently. During his stay there, and somewhat to his surprise, he saw many young women,

including college students, whose noses were covered with Band-Aid. He learned that these girls had undergone plastic surgery to reduce the size of their noses. What was the reason for this cosmetic procedure? Well, these girls obviously wanted to look more beautiful, and dodge the whispers of people commenting on their big noses.

Similarly, here in Korea, one of the most lucrative of professions is that of the plastic surgeon who day in and out works to reconstitute the bridge of nose and to raise the nose height of his women clients. Therefore, if you happen to find a Korean girl whose nose is comparable to the Western or Arabic standard, then you may be free to presume that it might have been fabricated by someone else. Where in one country, the nose is subjected to the scalpel; in another country, the nose has to be built up. Thus, we see that the height of nose for a girl that is considered ideal is largely a matter of public perception. Or perhaps there is a universal ideal of beauty which shuns extremes.

Likewise, the maximum permissible dose of ionizing radiation set by the ICRP is a number derived more from theory-based concepts rather than from empirical data. This level of "safe" radiation is in fact below the actual radiation levels from the natural environment found in many parts of the world. So, it's not surprising that this number has been challenged, for instance, by scientists who advocate the effect of radiation hormesis. The word "hormesis" is from the Greek word "hormaein" meaning "to excite" or "fierce" (The word "hormasen" occurs, for example, in Matthew 8:32, Luke 8:33 and Acts 19.29 in the New Testament, and the related word "horme" in Acts 14:5, James 3:4 and Revelations 18.31). If low-level radiation indeed has the capacity to "excite" human health and increase stamina, surely the currently prevailing notions on the maximum permissible doses of radiation must be subjected to fresh review and adjustment, just like the height of a girl's nose, for the benefit of people. Particularly so when the artificially rigorous bar hurts the purse of the customers, without contributing at all to their health.

Population

The world population at the starting year of anno Domini stood at about 0.25 billion, it is generally believed, and it doubled to reach 0.5 billion in the Post-Renaissance era. It passed the one billion mark in the latter years of the Industrial Revolution. In summary, it took 1650 years for global population to double from the beginning of A.D., and 200 years after that, but the doubling time is down to merely 40 odd years these days, as shown in Table 1. Will it be possible for Planet Earth to feed, clothe and shelter all these greedy and extravagant billions in the years to come? If so, for how long?

Table 1. Doubling Time of World Population

Year	A.D. 1	1650, Post -Renaissance	1850, Latter Years of the Industrial Revolution	1930	1975	2000	2017	2050
Population in Billions	0.25	0.5	1	2	4	6	8	10
Doubling Time in Years	1650	200	80	45	42			

About 100 years ago, our great-grandparents led their lives very simply and frugally: On average a person used only about 200 kinds of household items in her/his daily life. But the number of household items in the contemporary age amounts roughly to 33,000 kinds as listed in Table 2---a computer keyboard, paper clips, hair conditioner, TV remote control, and you name it. Now the problem lies not only in the rapid increase in this number but also in the tremendous quantity for each item like many dozens of rolls of toilet paper and so on. Let's take an example and look at the case of Korea.

Table 2. Number of Household Items for Maintaining Daily Life

Household Items	100 Years Ago	Nowadays
Total No. of Household Items for Maintaining Daily Life	200	33,000
No. of Household Items for Making Life Convenient	72	500
No. of Absolutely Necessary Household Items	16	100

The Republic of Korea launched into her formal socio-economic development in 1962. During the span of 40 years to the present, the Korean population has increased 1.77 fold, while the increases in total electricity consumption and per-capita electricity consumption during the same time span have been recorded at 255.4 and 141 times as shown in Table 3. The increase in total installed power-generation capacity comes to 129 times, wherein the nuclear share accounted for 29.3% (15,716 MW out of 53,801 MW total) at the end of 2002. The consumption of water, energy, paper, plastics, metals, fabrics, and all other industrial products has seen dramatic increases similar to that for electric consumption.

Table 3. Changes in Korean Population and Electricity

Year	Population, Million	Total Installed Power -Generation Capacity, MW	Total Electricity Consumption, TWh/year	Per-Capita Electricity Consumption, kWh/year
1962	26.5	416	1.2	46
2002	47	53,801	306.5	6511
Ratio of 2002/1962	1.77	129.4	255.4	141

A keynote speaker at a plenary session of Solid State Physics Society held in the United States some years ago mentioned that the number of papers and reports submitted is increasing at such an exponential rate that, should the same trend continue indefinitely into the future, the total weight of all such academic publications just from his Society alone would exceed the weight of earth per se within 150 years.

Is such a scenario plausible? Even if the outcome is less dire, how about the environmental devastation from the production, handling and use of all the requisite materials and commodities? Even now the intemperate emission into the atmosphere of so much CO_2 , SO_2 , NO_X and dust from fossil fuel combustion is wreaking havoc to the environment and to human life. Although the increase in carbon dioxide concentration in the atmosphere, ozone depletion in the stratosphere, acid rain, etc. are amply recognized as being suicidal to the human race, there are no remedial measures for them, except, of course, for nuclear energy.

Consequently, a certain historical inevitability accrues to nuclear energy, which must be tapped to keep civilizational wheels turning and electric candles lit: There simply is no other alternative. An irreproachable level of nuclear safety, judicious radwaste & radiation management and public acceptance are, of course, all prerequisites for a wide utilization of nuclear energy.

Up until a few years ago, many world intellectuals presumed that an Armageddon would be unavoidable, and that it would take the form of an all-out nuclear war. With the collapse of the Soviet Communist Empire, however, the much-feared Doomsday scenario has become remote and not at all inevitable. In its place, we now face another form of corrosive explosion: Namely, Malthusian population growths and attendant polluting of the environment.

Out-of-control population growths and skyrocketing industrial production spell a death sentence for mankind. Man's inherent instinct to multiply and beget his offspring, his intense desire to expand his work-scope domains and conquer his environment without bounds are nothing but instruments for digging his own grave, and all such actions result in detrimental substances being discharged in ever massive quantities into the biosphere: Man is slowly poisoning his well. And there is no stopping power in this regard.

Since some while ago, however, we are seeing the invisible hands, as it were, of Mother Nature exerting their moderating influence. There is a built-in, self-regulating mechanism that ensures that things don't get too out of control in nature. You can see such a self-equilibrating system at work, for example, in the advanced countries and in the case of Korea and Japan.

One of the vital societal issues for Korea these days is the rapid decrease in the birth rate and the concomitantly rapid increase in the average life span. The twin goals of a small nuclear family and long healthy life spans were urged as being desirable and exhorted during the years of industrialization, the 1970s and 80s. However, we have strayed too far from the optimal line. For instance, the average number of children per Korean couple last year was recorded, to our chagrin, at 1.1, the lowest among the OECD countries and most probably the lowest in the world. This number will further decrease in the years to come. Inevitably Korea will suffer from a shortage of working manpower and a surplus of dependent old folks and, consequently, the nation will face a serious imbalance between social welfare dependents and workers who support the needy.

A Korean demographer recently warned that Koreans, as a nation, would eventually face extinction from Planet Earth within the next 4 centuries, should the prevailing attitude amongst those of the breeding age---namely, the pursuit of a convenient life without many children---persist. The projection on the future of the Japanese population (currently at 1.3 children/couple) by a Japanese demographer yielded a result almost similar to the Korean case, though it shows a better longevity till total extinction from lack of reproduction: That is, 600 years.

These days, there are many youngsters in Korea who, for a number of reasons, remain single and do not get married. One of their main reasons is said to be that they cannot find an ideal partner. Most Korean boys want to mate with a girl who has the looks of a Cleopatra, a Marilyn Monroe or a Miss Universe, or a Miss Korea. But girls who meet their unreasonably high standards very seldom exist, and there are usually practically none around them. On the other hand, a Korean girl's specifications for her partner or husband are usually as follows:

1. He must be valiant and nice-looking, like a Korean tiger.
2. He must be straightforward and energetic, like a bear.
3. He must work hard like a bull and make lots of money, and remit all the earned money to his wife's on-line bank account.
4. At home, he must be gentle and soft, like a sheep and, above all, he must follow her like sheep.
5. Most important of all is that he must be loyal, self-sacrificing and obedient to his wife like a dog, like a Korean Jindo dog.

Unfortunately, Korean tigers are almost extinct as a species. And there are not many bear-like, bull-like, sheep-like, and dog-like Korean boys who can meet all these stringent criteria required of a partner by a Korean girl. Hence the high expectations go largely unmet and so many leftover youngsters remain single, not contributing to the population growth of this country.

There is a general belief among young people here in Korea nowadays that it is ideal not to have any children even after marriage, and that it is optimal maybe to have only one child, but two are too many. The saying is, if one has three children, he or she is called a barbarian, while those who procreate four or more are looked down with contempt and viewed as some kind of a primitive beast!

Well, I have three kids (and, conforming to my analysis, all single!) So, following their classification, I can be rebuked as a barbarian. But it seems that I am pardoned on account of my age. In any case, Korea is now a very civilized country where we cannot find newly emerging or wild beasts any more, and this explains in large part the extreme low birth rate.

So, maybe there is hope for the world, after all. As more countries climb the development curve, population growths will surely moderate and some sort of an equilibrium may become possible by the gradual intervention of Mother Nature's invisible hands.

Fuels

The quality upgrading of fuels in the past has been reflected in changes in H/C (Hydrogen/Carbon) ratio of fuels. The H/C ratio of wood, leaves and other biomass fuels is about 0.1, whereas those of coal, petroleum and gas are 1, 2 and 4, respectively. This ratio is null for nuclear and is infinite for hydrogen fuel, as depicted in Table 4. It is predicted that the palmy era of natural gas, nuclear fuel and hydrogen will occur in years 2020, 2035 and 2050.

Table 4. Historical Changes in H/C Ratio of Fuels

Fuel	Wood	Coal	Petroleum	Gas, Methane	Nuclear Fuel	Hydrogen
H/C Ratio, Hydrogen/Carbon	0.1	1	2	4	0	
Palmy Era	Until World War I	1940	2000	2020	2035	2050

It is apparent that the carbon contents in fuels have decreased with time, yet the carbon dioxide emission into atmosphere has significantly increased, especially in the 20th century, due to the tremendous amount of fossil fuel combustion. In general, CO_2 emission has surpassed nature's inherent capacity for absorbing carbon dioxide, thus resulting in global climate change. More than 100 years ago, Friedrich W. Nietzsche was already lamenting that Earth is suffering from an awful skin disease, and that the very pathogenic bacteria are human beings. Were he to be alive today, he would have diagnosed the malignant tumor and skin cancer afflicting the surface of this planet, and the nasty smell resulting from these diseases, correctly as greenhouse gases.

There are no quick panaceas for healing these chronic diseases. I do believe, however, that nuclear energy can be harnessed to develop a strong medicine---the abundant supply of cheap and available hydrogen by nuclear means in place of fossil fuel. In this connection, safe radiation management is extremely important in realizing this historical accountability successfully. At the same time, the deployment of a good number of top-notch research staffs together with sufficient funding and proper time allocation to this all-important project is the key to overcoming engineering barriers. We all know that engineering breakthroughs can be made by capable researchers at well-equipped research institutes administered by capable managers. What then are the definitions for "research" and "research institutes"? I think they are as follows:

Research

If you steal an information from only one source,

It is called plagiarism(剽竊); however

If you steal lots of information from many sources all the time,

It is called research.

A Research Institute

Must be a den of brilliant thieves

Who know when, where and how to steal information

And steal what they need as much as they need and

yet are so talented as to never get caught red-handed,

And on no account be accused of plagiarism no matter what.

There is still a common denominator between a software thief and a hardware burglar: Both of them prefer the deep of the night for carrying out their secret work. Nevertheless, the former is fond of working under a light, whereas the latter moves stealthily under the cover of darkness!

I think a factual record from history can be regarded as a pluperfect fossil, so long as it remains intact. However, when such a fossil is seasoned with contemporary ingredients and cooked with politico-sociological recipes, it can be converted into a form of present tense. If the direct line between the pluperfect fossil and reality is extrapolated forward, it may be extended toward the future, wherein vision can loom on the horizon of mirrors called "the past."

In this regard, I would like to deal with the rise or fall of a nation due to wood from a historical perspective. The reason I introduce the wood concept in this talk is the fact that for the past tens of millennia, mankind have used wood as a major fuel as shown in Table 4.

The Koryo Dynasty reigned over the Korean peninsula for 474 years from 918 to 1392 A.D., and its fall came with the fall of wood as follows:

The mighty Mongol cavalries invaded Koryo Kingdom in the 14th century, and destroyed the whole country. In fact, descendents of Genghiz Khan were flying through the steppes on their quick-moving small horses, and laying low places like Baghdad (Hulagu), China (Kublai Khan), Central Asia (Tamerlaine) and India (the Mogul Emperors)---and Korea was simply one more casualty. In the aftermath, following the belligerence and total destruction, the royal household was obliged to rebuild the palace out of ashes. The state religion was Buddhism at that time, and this meant that roughly 1,800 Buddhist temples had to be rehabilitated or newly constructed nationwide. Some 80,000 wooden printing plates (81,258 plates, to be precise) for the Grand Buddhist Scriptures, completely burned down by the Mongol horde, also had to be re-carved. Civilians had to rebuild their houses as well.

At this point, the Mongols and Koryo Kingdom penned a "bilateral" agreement to jointly invade Japan. For the implementation of this naval invasion operation, Korean shipbuilders were mobilized to build 3,000 warships. But the invasion attempt twice ended in a fiasco. The Allied Forces of the Korean and Mongol fleet (like the Spanish Armada off England) unexpectedly encountered a fierce typhoon, which sent to sea bottom most of the warships. The Japanese were thankful for the "divine wind", and called it "kamikaze". All these endeavors directly induced a simultaneous and huge demand for wood, and this meant chopping down of trees up and down the Korean peninsula.

The result was a massive felling of trees, followed by of grave soil erosion, which in turn led to rivers being muddied up. Mountains, denuded of trees and foliage, began to erode. As farmlands failed from the new eco-stresses, and oppression from the corrupt ruling classes continued unrelentingly, many farmers ran off to the mountainous highlands and became slash- & burn subsistence farmers (火田民), while others became roving bandits. In fact, these people were not accounted for as nationals, the reason being that they were neither listed in the census nor tax -payers. They were truly people outside the pale, living beyond the norms of normal society.

Please remember that slash- & burn-farmers are similar to clouds of grasshoppers that descend and eat into every green thing. They both move around from place to place and leave in their wake barren landscapes. All the mountains once inhabited by these slash- & burn-farmers became completely stripped and barren, and started discharging lots of soil into riverbeds. To make a complicated story simple, the fall of the mountain initiated by the sufferings of trees was a prelude to the fall of the people and eventually led to the fall of Koryo Dynasty.

The people and forests of the Republic of Korea were severely devastated during World War II, and more so during and after the Korean War. The mountains again were home to a multitude of slash- & burn-farmers. From 1975 through 1978, however, under the so-called New Hamlet Movement campaign (Sae-ma-eul woon-dong), the government relocated all the mountain inhabitants to villages and towns using as an incentive financial aid in the amount of 450,000 Won (worth several thousand dollars at that time) per household. And this radical measure could be implemented because there was an abundant supply of domestic anthracite coal, and a thriving economy made foodstuffs available even to the poor and destitute. Trees were planted under a reforestation campaign. Thus, the Republic of Korea was able to avoid the fall of people and of state, which was Koryo's fate.

As you know, most of the farmlands, rivers and mountains in North Korea are in a state of devastation for one reason or another, and the regime consequently is on the verge of total collapse. Given tight totalitarian control over them, the people of North Korea cannot run off freely to the mountains. Still, some 1/3~1/2 million people have managed to escape to Manchuria for their survival.

In North Korea today, food, fuel and timber are extremely scarce commodities, to the point where it is very hard for common people to buy coffins for a funeral. Only Labor Party members are given the privilege of buying a coffin at the pre-set official price. The general populace has to purchase coffins at black market rates. In the black market, a coffin costs 10~12 times the official rate, equivalent to the annual wage of an ordinary worker. That's the reason why the majority of North Koreans resort to burying the dead without a coffin---this is called "direct plantation, (直播)", in contrast to "transplantation(모내기)" where a coffin is used. For the direct plantation, the grieving family, relatives and friends have to use a stretcher to carry the dead to the graveyard. In this case, the best stretcher readily available is a door. This explains why so many buildings and public schools in rural areas of North Korea remain door -less. The situation reminds me of the post-WWII wretchedness in some parts of Europe, where people pillaged graveyards at night, digging up coffins for firewood.

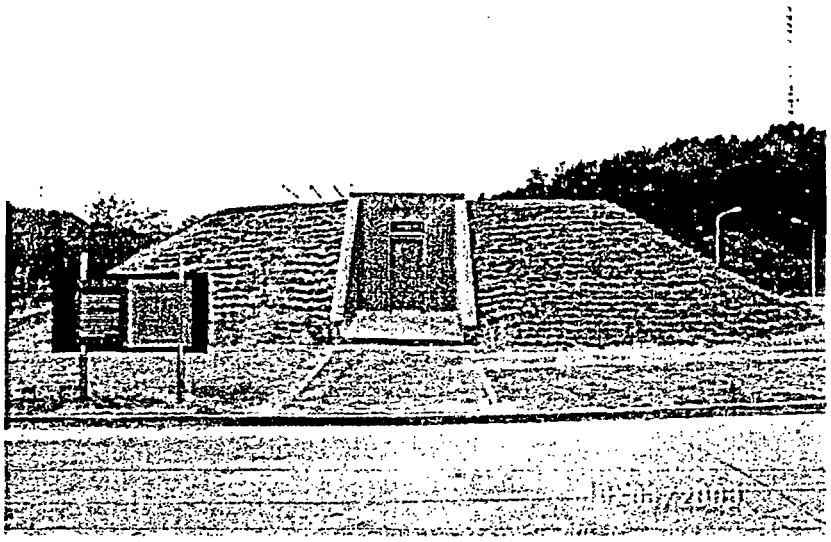
There are rallies every day in North Korea where assembled people shout slogans about building up their country to be a land of paradise and where they yell out their professed determination to protect with their very own lives their vaunted Leader, but the perverse reality is quite the reverse. In fact, the situation in North Korea these days resembles the terminal stage of Koryo Dynasty in terms of the fall of tree-soil -river-mountain-people cycle. This comparative analysis is valid not only for the destiny of statehood but it can be extended globally in macro-terms to the entire world with respect to the long-term future of Homo sapiens, in a sense that the mountains of fossil fuel on this planet are stripped and burned intensively.

My message today is that, if fossil fuel is burnt at current intemperate rates into the future and if clean & green nuclear energy is not widely utilized with safe radiation management, then the whole world will end catastrophically, and human civilization will come to an untimely end. However, it is my belief that human beings are endowed with reason and wisdom and they will use them judiciously and creatively to get themselves out of the current jam. Therefore, let us mobilize our diehard efforts for promoting the nuclear arena so as to "live" in healthy, wealthy and worthy fashion. Otherwise or if we fail, it would turn out to be "evil" instead of "live". In this context, all of you are encouraged to tap into your wisdom, squeeze your brains and sharpen your pencils so as to begin to come up with the most productive, creative, futuristic and mutually beneficial solutions triggered by this meeting.

Thank you for your attention!

ATTACHMENT 3: Engineered Barrier Test Facility for Near Surface Disposal of LIWL

Engineered Barrier Test Facility for Near Surface Disposal of LILW



This test facility is specially designed to demonstrate the performance of engineered barrier system for the near-surface disposal facility under the domestic environmental conditions.

Test facility occupies nearly 200m^2 of total floor area and is composed of two floors. At upper floor, six test cells are located for the performance test of engineered cover barrier. Lower floor comprises experimental rooms and exhibition space with mockups of the disposal facility.

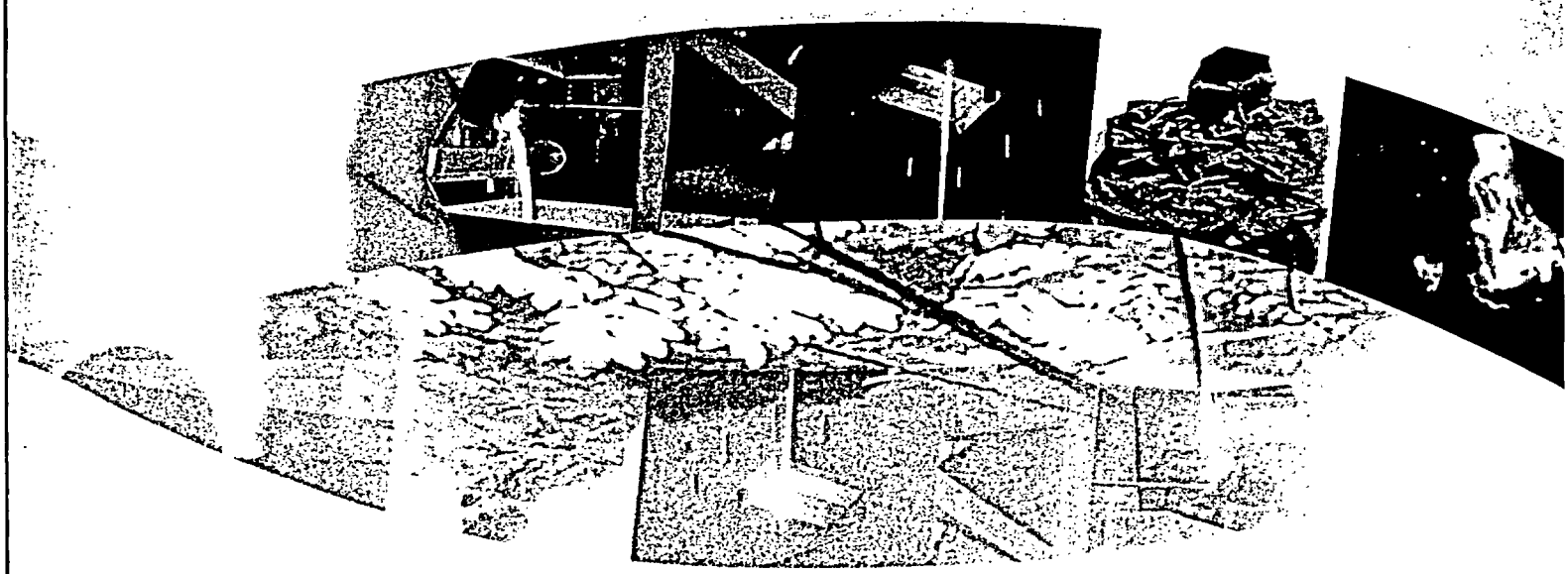
Comprehensive measurement systems are installed within each test cell. Long-term monitoring of the multi-layered cover is implemented according to different precipitation scenarios with artificial rainfall system. Monitoring data on the moisture content, temperature, matric potential, lateral drainage and percolation of cover-layer system are systematically managed by automatic data acquisition system. The periodic measurements are collected and analyzed by a dedicated database management system, and provide a basis for design and performance verification of the disposal cover and vault.

clkim@khnp.co.kr (+82-42-870-0360)

ATTACHMENT 4: Vitrification Technology for Low-and Intermediate-Level Radioactive Waste

방사성폐기물 유리화 기술

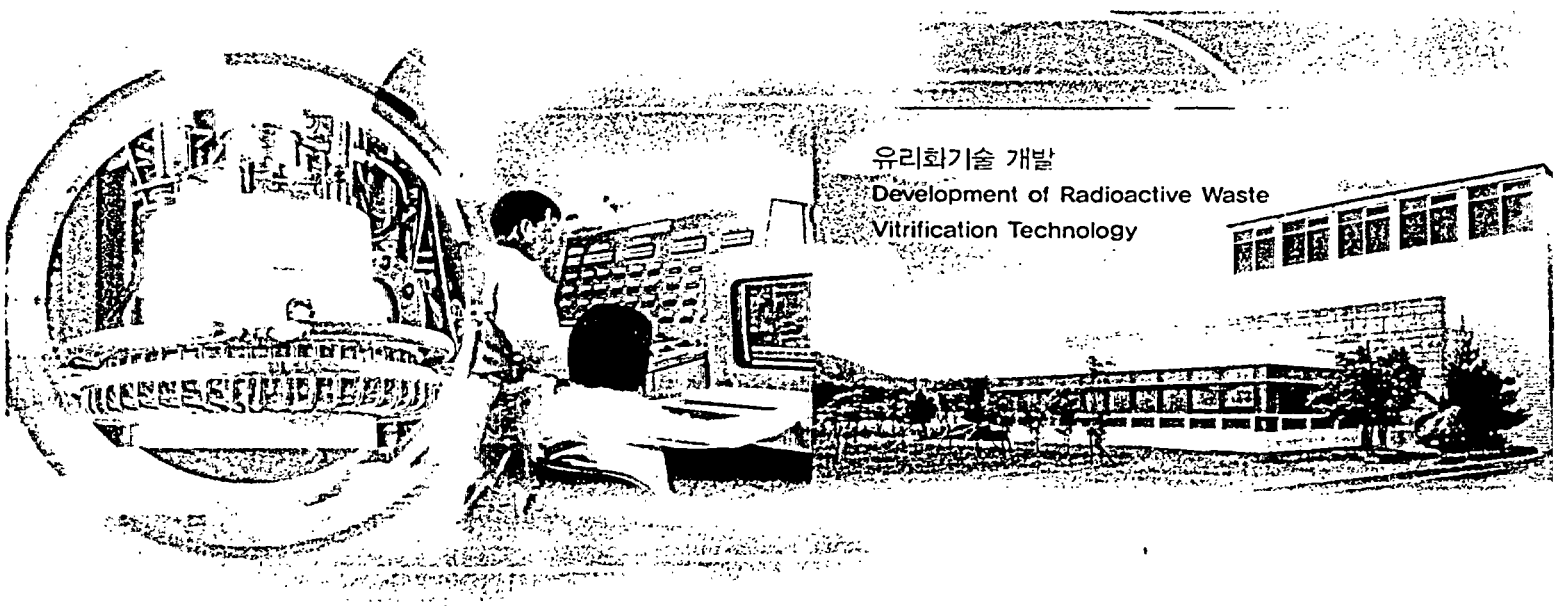
Vitrification Technology for Low-and Intermediate-level Radioactive Waste

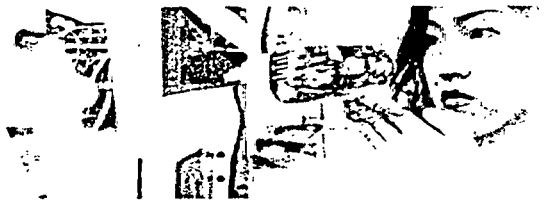


KHNP
한국수력원자력(주)
Korea Hydro & Nuclear Power Co., Ltd
원 자 력 환 경 기 술 원
Nuclear Environment Technology Institute

방사성폐기물의 안전성!
유리화기술이 보증합니다.

Vitrification technology assures
the safe management of radioactive waste.



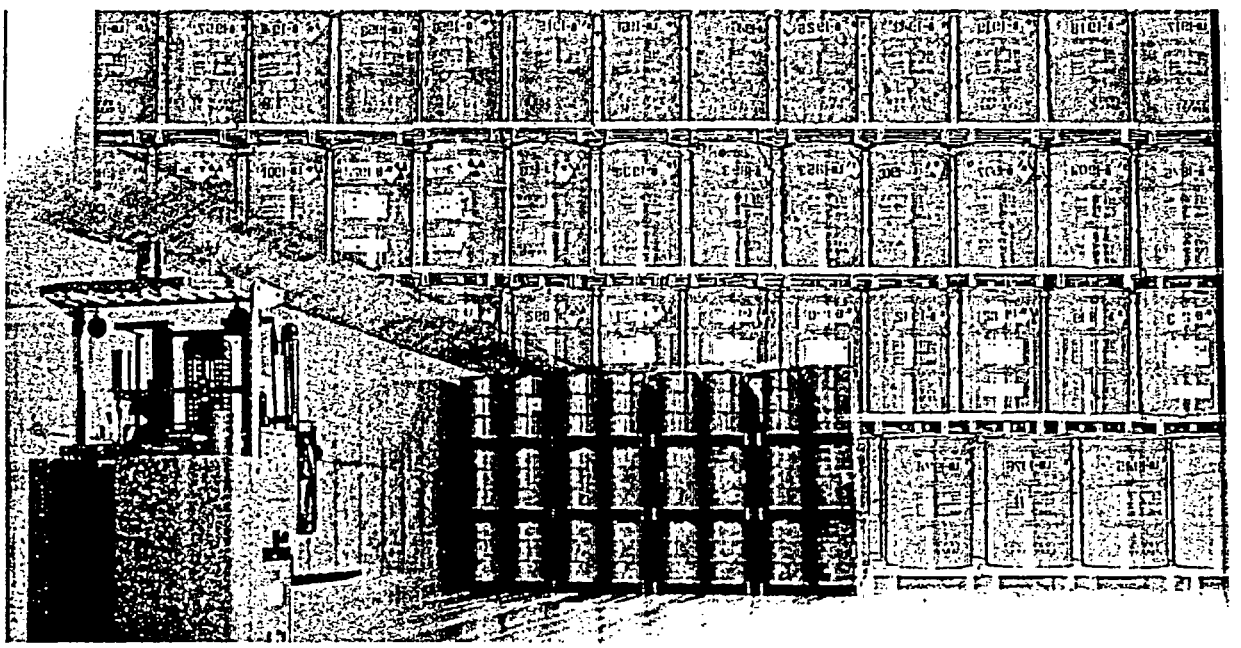


방사성폐기물을 안전하게 처리할 수 있는 기술개발은 원자력을 이용하고 있는 우리 세대의 의무입니다!

Development of the safe treatment technology for the low- and intermediate-level radioactive waste (LILW) is a responsibility of current generation who uses the nuclear power.

우리나라의 원자력발전은 20여년의 세월을 거치면서 이제는 우리가 사용하는 전력의 약 40%이상을 공급하는 국가 주력 에너지원으로 성장하기에 이르렀습니다.

Korea has achieved rapid growth in nuclear power generation since 1978. Korean nuclear power plants (NPPs) currently provide with more than 40% of national electricity demand. Thus, nuclear power is the major source of electricity in Korea.



▲ 원자력발전소에 저장되어 있는 방사성폐기물 (On-site storage of LILW)

원자력산업의 성장에 따라 필연적으로 발생되는 방사성폐기물을 안전하게 관리하기 위해서는 종합관리시설이 필요합니다. 그러나 방사성폐기물에 대한 지역주민들의 불안감으로 종합관리시설의 적기 확보에 어려움을 겪고 있습니다.

유리화 기술은 방사성폐기물의 안전관리에 큰 전환점을 이루는 기술입니다. 유리화기술은 방사성폐기물을 유리구조와 결합시켜 방사성물질이 환경으로 유출되는 것을 근본적으로 차단할 수 있을 뿐만 아니라 부피가 혁신적으로 감소되어 방사성폐기물의 처분 안전성 확보는 물론 관리시설 건설을 위한 처분사업의 안정적 추진에도 크게 기여할 수 있을 것으로 기대됩니다.

Inevitably, the LILW is generated as a byproduct during the operation of NPPs and has been stored in on-site storage buildings which could not accept further wastes in the near future. Futhermore, there has been difficulties in the repository selection because of NIMBY(not in my back yard) attitude of resident to the LILW disposal.

Vitrification technology will not only enhance the safety of the waste disposal repository because the LILW is incorporated into the stable glass matrix, but also greatly contribute to the further promotion of Korea's disposal repository program because it can achieve remarkable waste volume reduction.

유리화 기술이란 ?
What's Vitrification Technology ?

유리화기술은 방사성폐기물을 유리구조와 결합시켜 안정된 형태로 가두어 두는 기술을 말합니다.
Vitrification technology can incorporate the radionuclides in the LILW into the stable glass matrix through ionic bond with glass structure.

유리화란 단순히 폐기물과 유리를 섞는 것이 아니고 유리의 분자구조와 방사성폐기물을 결합시키는 것입니다. 그렇기 때문에 깨지거나 물에 닿아도 방사성 폐기물이 외부로 유출되지 않습니다.
마치 색유리를 깨거나 물속에 넣어도 색이 빠지지 않는 것과 같은 이치입니다.

유리화된 방사성폐기물은 방사성물질이 환경으로 유출되는 것을 근본적으로 차단할 수 있을 뿐만 아니라 유리화 과정에서 폐기물의 부피가 혁신적으로 감소되기 때문에 방사성폐기물 처분사업의 안정적 추진에도 크게 기여할 수 있는 혁신적인 기술입니다.

▶ 유리구조 (Glass Structure)

방사성물질이 유리구조와 화학적으로 결합하여 매우 안정한 상태가 됩니다.

The radionuclides in the radioactive waste are expected to remain in stable glassy state.

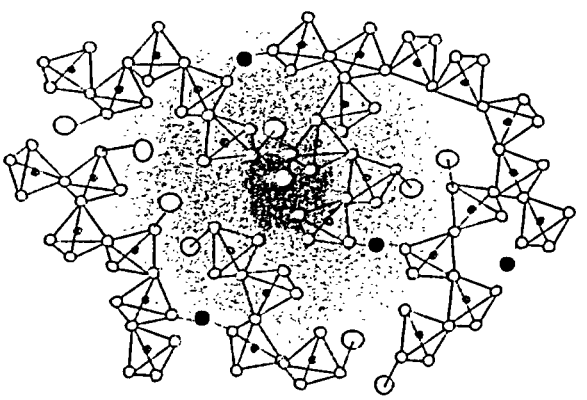
▼ 부피 감소 효과 (Volume Reduction Effect)

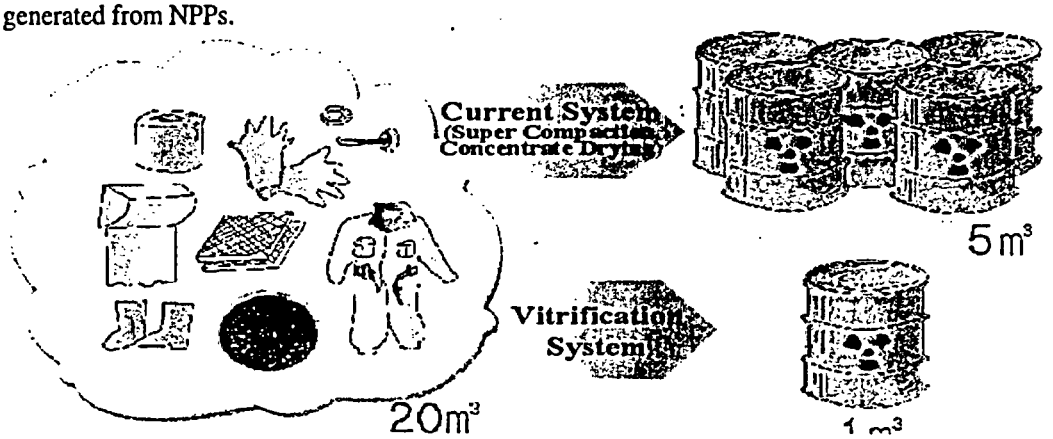
유리화기술은 원전에서 발생되는 모든 가연성 및 비가연성 중·저준위 방사성폐기물의 최초 발생 부피를 1/20이하로 줄일 수 있습니다.

The vitrification technology can achieve large volume reduction factor of higher than 20 from the intial bulk volume of all combustible and non-combustible LILW generated from NPPs.

Vitrification technology is to incorporate radioactive nuclides in the stable glass matrix as radioactive wastes are fed on the glass melt.
Thus, release of radioactive nuclides to the environment at the disposal site could be fundamentally prevented, even if the vitrified form is broken and contacted with water.

In addition, vitrification technology can significantly reduce the volume of radioactive waste as well as greatly enhance its disposal stability.
Thus, this technology can contribute to the further promotion of Korea's disposal repository program.





유리화 기술개발 현황
R&D Status for Vitrification Technology

유리화 기술개발을 완료하고 2007년 세계 최초의 유리화 상용설비 운영을 목표로 건설을 추진 중에 있으며, 국제원자력기구(IAEA)등으로 부터 그 기술력을 인정받아 해외 여러 나라에서도 우리의 유리화기술 도입을 적극 검토하고 있습니다.
The world first commercial vitrification plant for the LILW will be built in 2005 and its commercial operation will start in 2007. IAEA decided to support our project for 3 years in 2002. Furthermore, several countries have shown great interest in the adoption of our technology.

1994년 유리화기술에 대한 타당성 연구를 시작으로 가연성 폐기물과 비가연성 폐기물을 분리 처리하는 복합공정을 독자적으로 개발하였으며, 국제공동연구로 유리화실증설비 개발을 완료하고 대덕연구단지내에 유리화실증시설을 건설하여 모의 폐기물에 의한 유리화 실증시험을 성공적으로 마쳤습니다.
뿐만 아니라 폐기물의 종류에 따라 안전성과 감용효과가 우수한 최적의 유리를 개발하여 실증시험을 통해 그 성능을 입증하였습니다.

현재 유리화에 대한 기술개발을 완료하고 2007년 세계 최초의 유리화 상용설비 운영을 목표로 건설을 추진 중에 있습니다.

A feasibility study of the application of vitrification technology to the LILW has been conducted from 1994 to 1995. As a result of the feasibility study, an innovative combined vitrification process was selected in order to treat combustible and non-combustible wastes, respectively. A pilot scale vitrification plant which was developed by an international joint R&D has successfully simulated the behavior of a commercial vitrification plant as closely as possible.
Furthermore, the glass formulation which could be applicable to both treatment of single stream of radioactive waste and mixed radioactive waste was successfully verified by the pilot scale vitrification tests.

A vitrification plant which may be the world first commercial vitrification plant will begin its operation in 2007.

■ 추진일정 (Milestone)

Feasibility study	Orientation test	Pilot test	Commercialization
(October '94-October '95)	(July '96-March '98)	(April '98-August '02)	(September '02-December '06)
• Laboratory tests, technical and economy assessment • Combined system (CCM+PTM) suggestion	• Bench marking test • Test using SGN/CEA equipment • Pilot plant design	• Pilot plant construction • Glass formulation • Design data production for commercialization	• Commercial plant design/ construction • In-situ measurement system for glass composition • Cold and hot tests • Operation license

Vitrification Technology

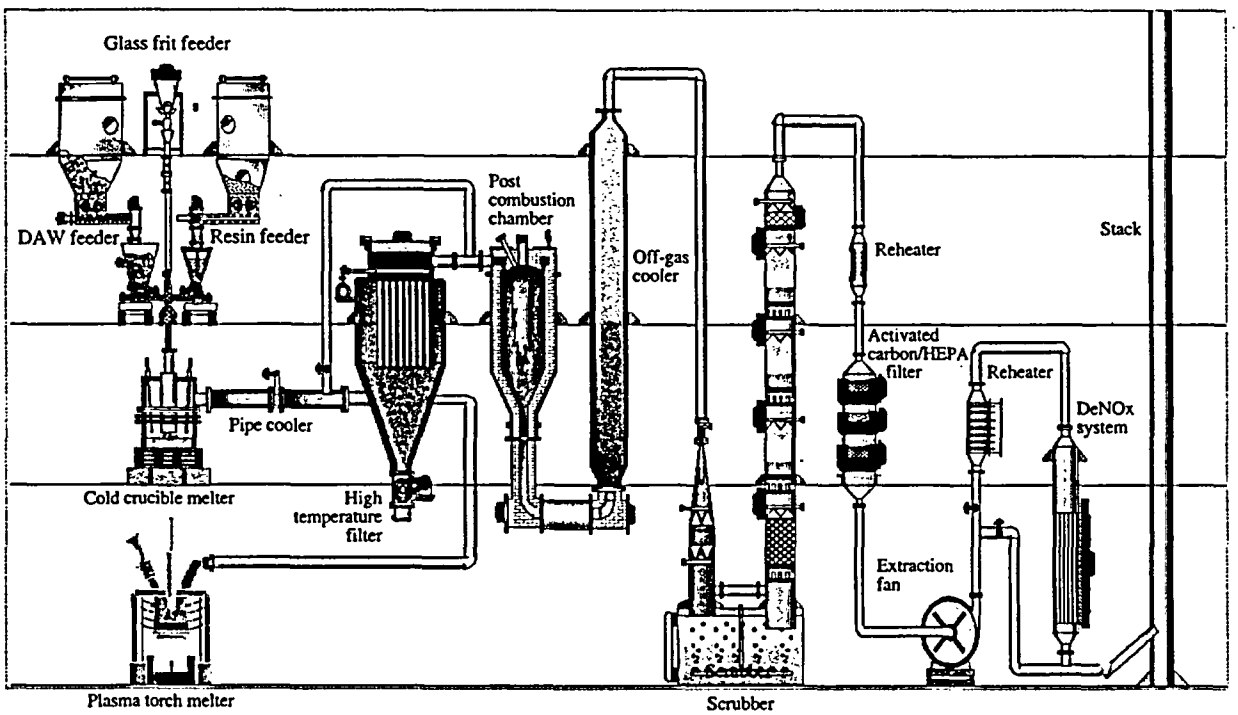
유리화 설비의 구조
Vitrification Facility

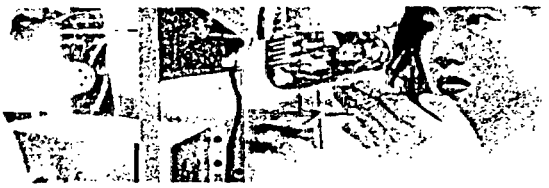
유리화 설비는 크게 유도가열식 저온로와 플라즈마토치 용융로 그리고 배기체 처리계통으로 구성되어있습니다.
The vitrification facility is comprised of Induction Cold Crucible Melter(CCM), Plasma Torch Melter(PTM), and Off-gas Treatment System(OGTS).

방사성폐기물은 크게 가연성 폐기물과 비가연성 폐기물로 분류됩니다.
가연성 폐기물은 유도가열식 저온로에서 처리되고, 비가연성 폐기물은 플라즈마 토치 용융로에서 처리됩니다. 이 과정에서 발생되는 분진이나 유해개스는 배기체 처리시설을 통하여 완벽하게 처리됩니다.

The LILW is classified into two categories, that is, combustible and non-combustible wastes.
The combustible and non-combustible wastes are vitrified in the CCM and PTM, respectively.
Dust and harmful gases generated from both melters are completely removed and cleaned in the OGTS prior to release.

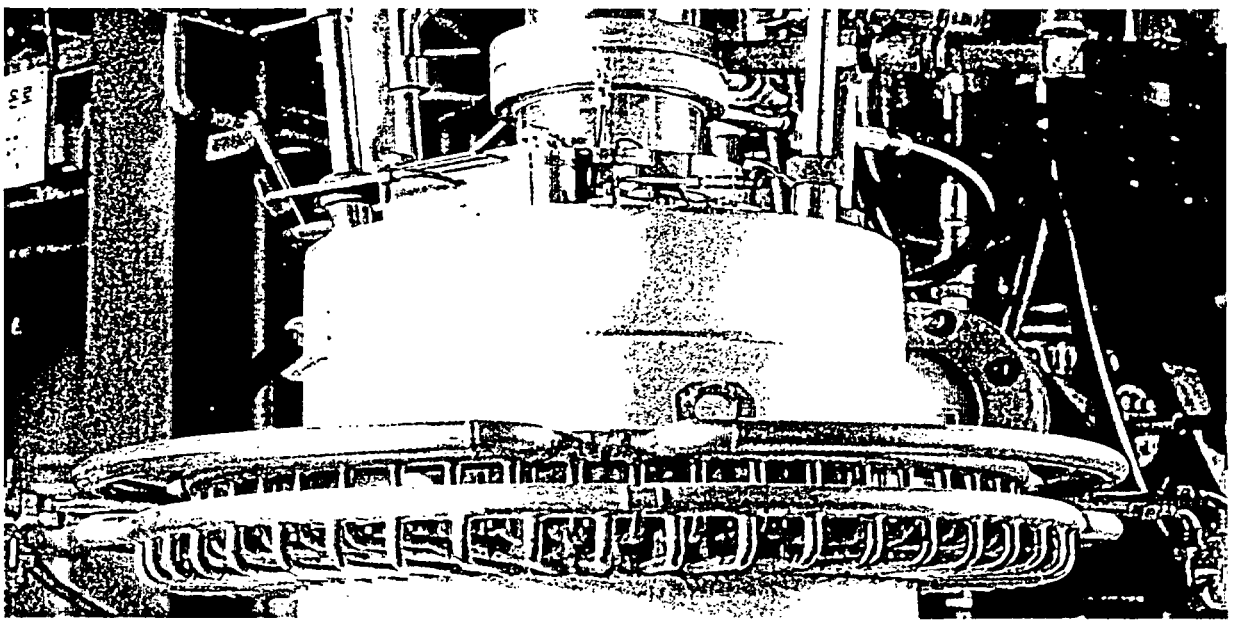
■ 유리화 실증설비 구조도 (Pilot Scale Vitrification Plant)





유도가열식 저온로 Induction Cold Crucible Melter (CCM)

유도가열식 저온로는 원자력발전소에서 발생되는 장갑, 덧신, 작업복 등과 같은 가연성 폐기물을 연소, 분해하여 유리화 합니다.
The combustible radioactive waste such as gloves, shoes, protective clothes, papers, plastics used by workers and spent ion-exchange resins generated from the water purification processes is burned, pyrolyzed, and finally vitrified in the CCM.



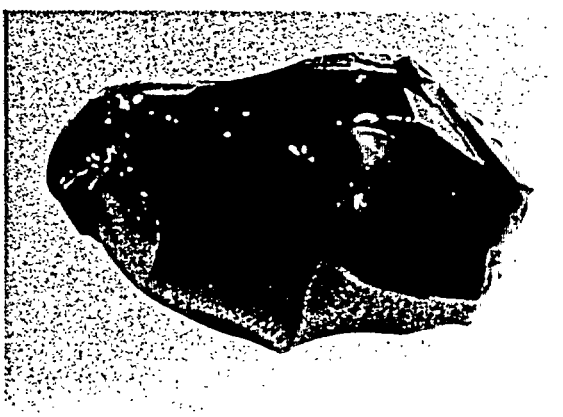
▣ 유도가열식 저온로(CCM)

■ 유도가열식 저온로란 ? (what's the CCM ?)

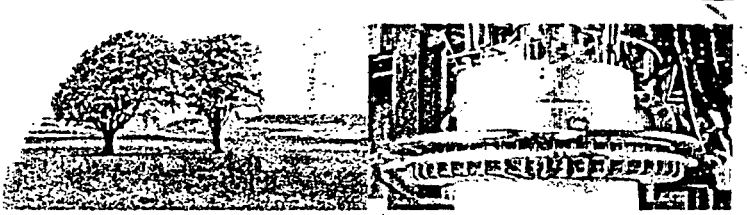
도코일로 둘러 쌓인 수냉식 저온로 내에 유리를 넣고 고주파발생기를 통하여 유도코일에 교류전류를 흘려주게 되면 유리에 유도전류가 발생되고 이때 발생한 열로 유리를 녹이고 폐기물을 연소시키는 용융로를 말합니다.

The CCM is a water cooled melter in which electric currents are directly induced by an external high frequency generator. This allows high thermal power to be generated right in the glass melt. Thus, the glass is melted and the combustible waste is thermally decomposed.

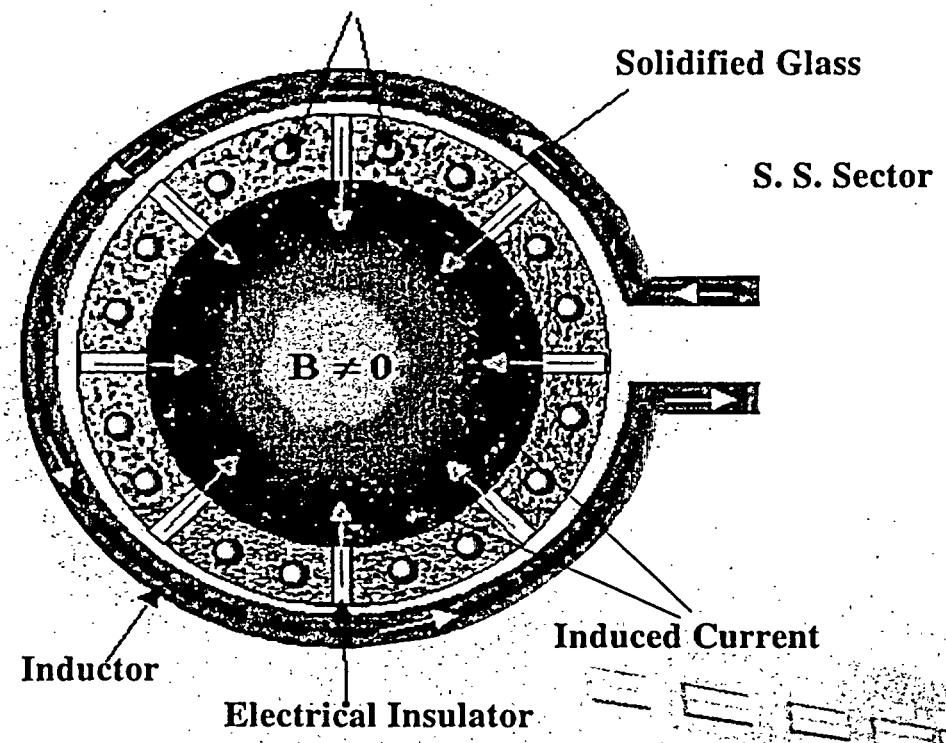
▣ 유도가열식 저온로 연소장면
(Waste vitrification in CCM)



▣ 가연성 폐기물을 유리화한 고화체(Vitrified Form)

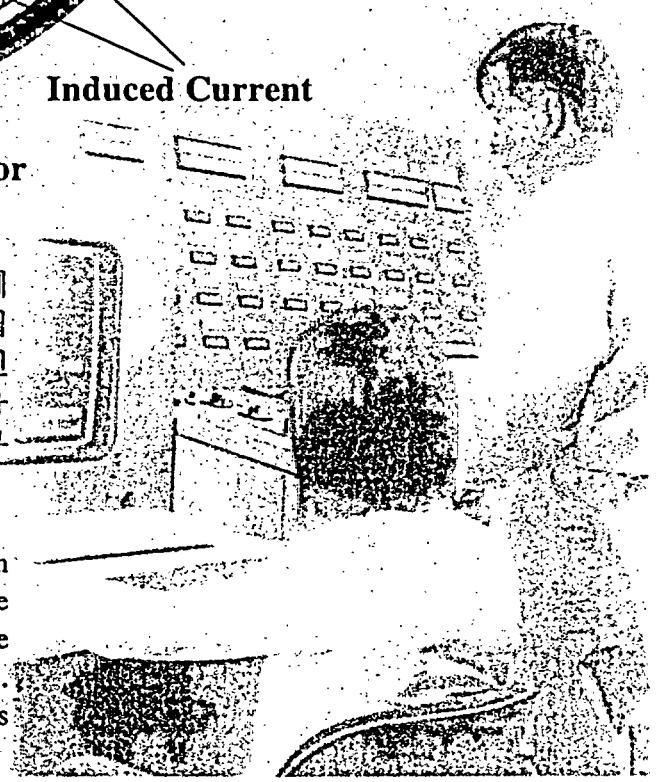


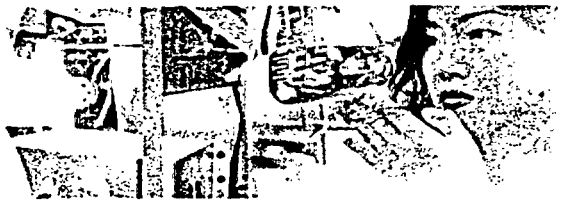
■ 유도가열의 원리 (Principle of induction heating)



용융로 주변을 감싸고 있는 유도전류자(inductor)에 고주파 교류 전류를 흘려주면 전자기장(B)이 형성됩니다. 이 전자기장은 용융로를 구성하고 있는 스테인리스 섹터와 섹터사이의 전기 절연체를 통하여 용융로 내부로 침투해 들어갑니다. 이로 인해 용융로 내부에 유도 전류가 발생하여 유리를 녹이게 됩니다.

The magnetic field(B) is generated due to high frequency AC passing in inductor surrounding the CCM. The magnetic field penetrates into the CCM through electrical insulators between S.S. sectors of the CCM. Therefore, induced current is generated in the CCM and then melts glass.



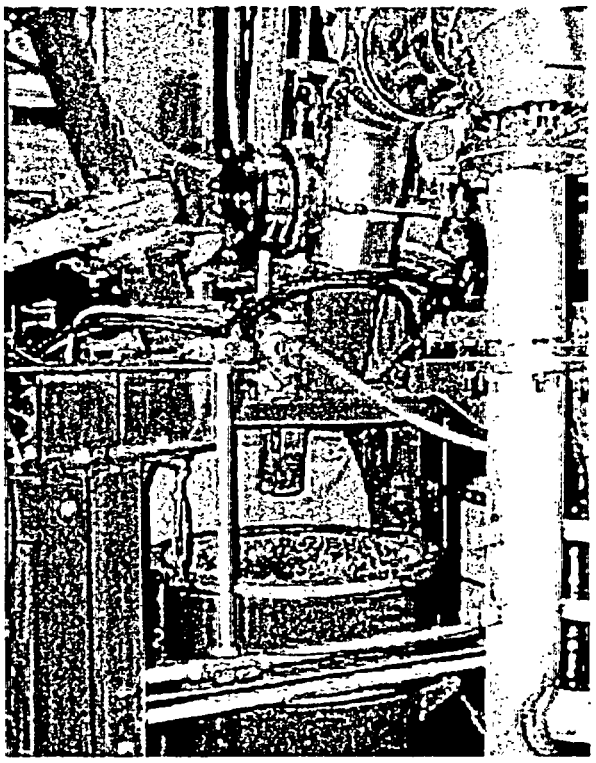


유리화 설비의 구조
Vitrification Facility

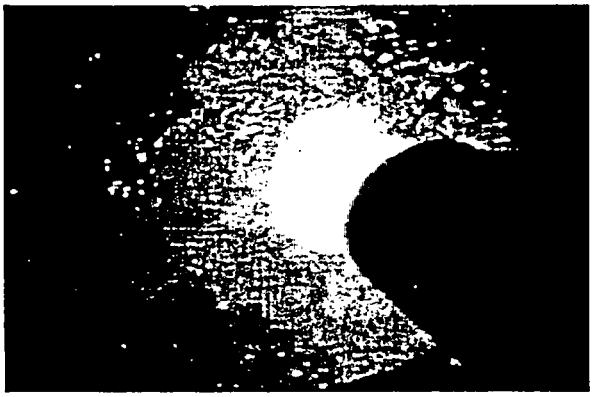
플라즈마토치 용융로 Plasma Torch Melter (PTM)

플라즈마토치 용융로는 콘크리트, 토양, 철재류와 같이 연소시킬 수 없는 폐기물을 고온으로 녹여 고화체를 만들어내는 설비입니다.
Non-combustible waste such as metal scraps, concrete, spent glasses, spent filter, and used light bulbs is melted in the PTM.

▼ 플라즈마 토치 용융로 (PTM)

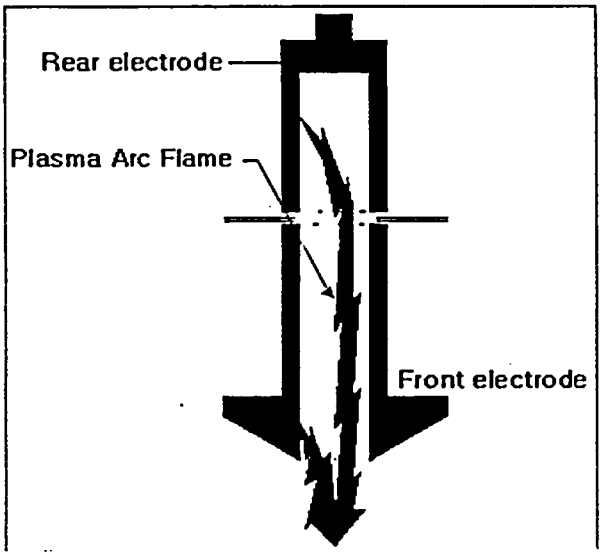


▼ 용융장면 (View of plasma torch melting)



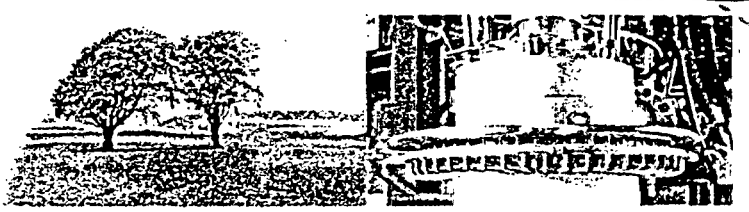
▼ 토양을 용융시켜 만든 고화체 (Glass-Ceramic Form)

▼ 플라즈마토치란? (What's plasma torch?)



플라즈마 토치는 두 전극 사이에 고전류를 흘려 아크를 생성시키면서 질소, 알곤 등의 가스를 흘려 보내 가스를 플라즈마 상태로 전환시켜 고온의 화염을 발생시키는 장치입니다.
플라즈마 상태는 자연에서 관찰되는 번개 현상과 같이 물질내 원자핵과 전자가 분리된 상태로서 물질을 분류하는 고체, 액체, 기체에 이어 물질의 제 4상태로 분류됩니다.

The PTM can melt non-combustible waste using a plasma torch which produces a very hot flame in the temperature range of 7,000~10,000℃ by ionized gases. Plasma state is an electrically neutral, highly ionized gas composed of ions, electrons, and neutral particles. It is a phase of matter distinct from solids, liquids, and normal gases.



유리화 설비의 구조
Vitrification Facility

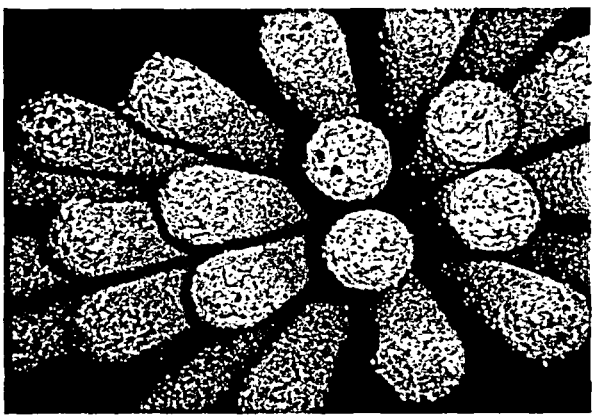
배기체 처리 시스템 Off-gas Treatment System (OGTS)

용융로에서 폐기물을 처리할 때 발생되는 분진이나 배기개스는 여러 가지 공정을 거쳐 인체나 환경에 무해하게 완벽하게 처리됩니다.
Dust and off-gases generated from both melters(CCM and PTM) are completely removed and purified prior to release through the multi-step off-gas treatment process.

1단계 (1st step)

용융로에서 발생되는 분진은 세라믹으로 된 고온의 필터를 통해 99.9%가 제거됩니다.

More than 99.9% of the dust generated from both melters is removed by high temperature filter.

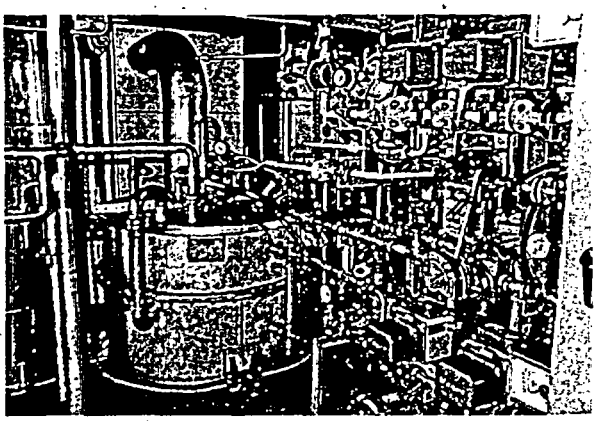


▲ 내부에 장착된 고온필터 (High Temperature Filter)

2단계 (2nd step)

후단연소기라는 고온의 연소기를 통해 일산화탄소나 다이옥신 등과 같은 유해개스가 완전연소 됩니다.

The post combustion chamber is used to completely burn organic off-gas species such as carbon monoxide, hydro-carbon, dioxin, and so on generated from the combustion process and convert these harmful gases into pure water and carbon dioxide.

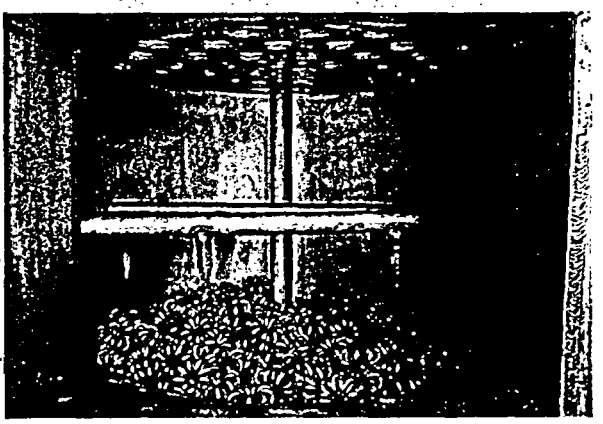


▲ 후단연소기 (Post Combustion Chamber)

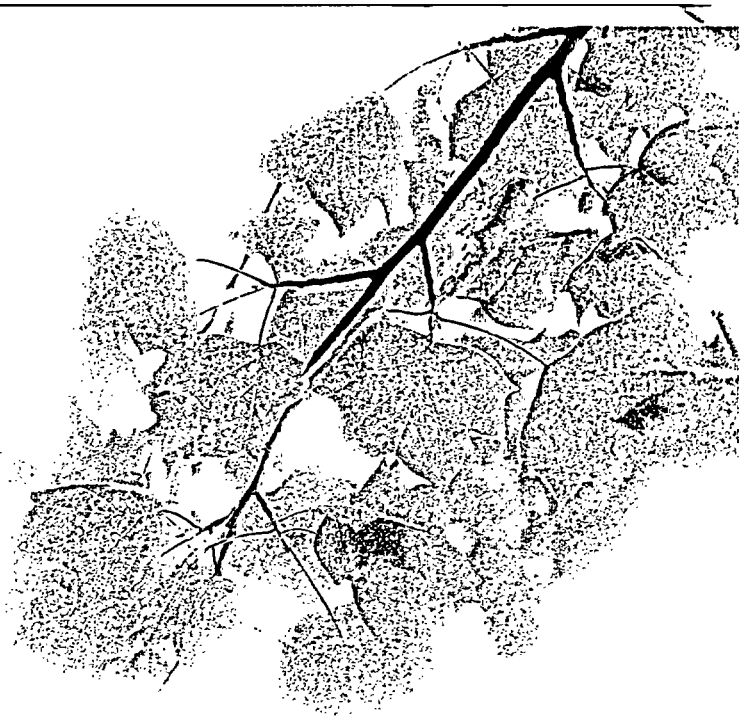
3단계 (3rd step)

1, 2단계에서 처리되지 않은 산성기체들은 세정기내에서 여러가지 화학적 처리과정을 거쳐 제거됩니다.

The scrubber removes the dust in the off-gas stream and absorbs soluble acid gases.
Acid gases such as sulfur oxides and hydro-chloride are neutralized with the sodium hydroxide added and are removed as salts in the jet and packed scrubbers.

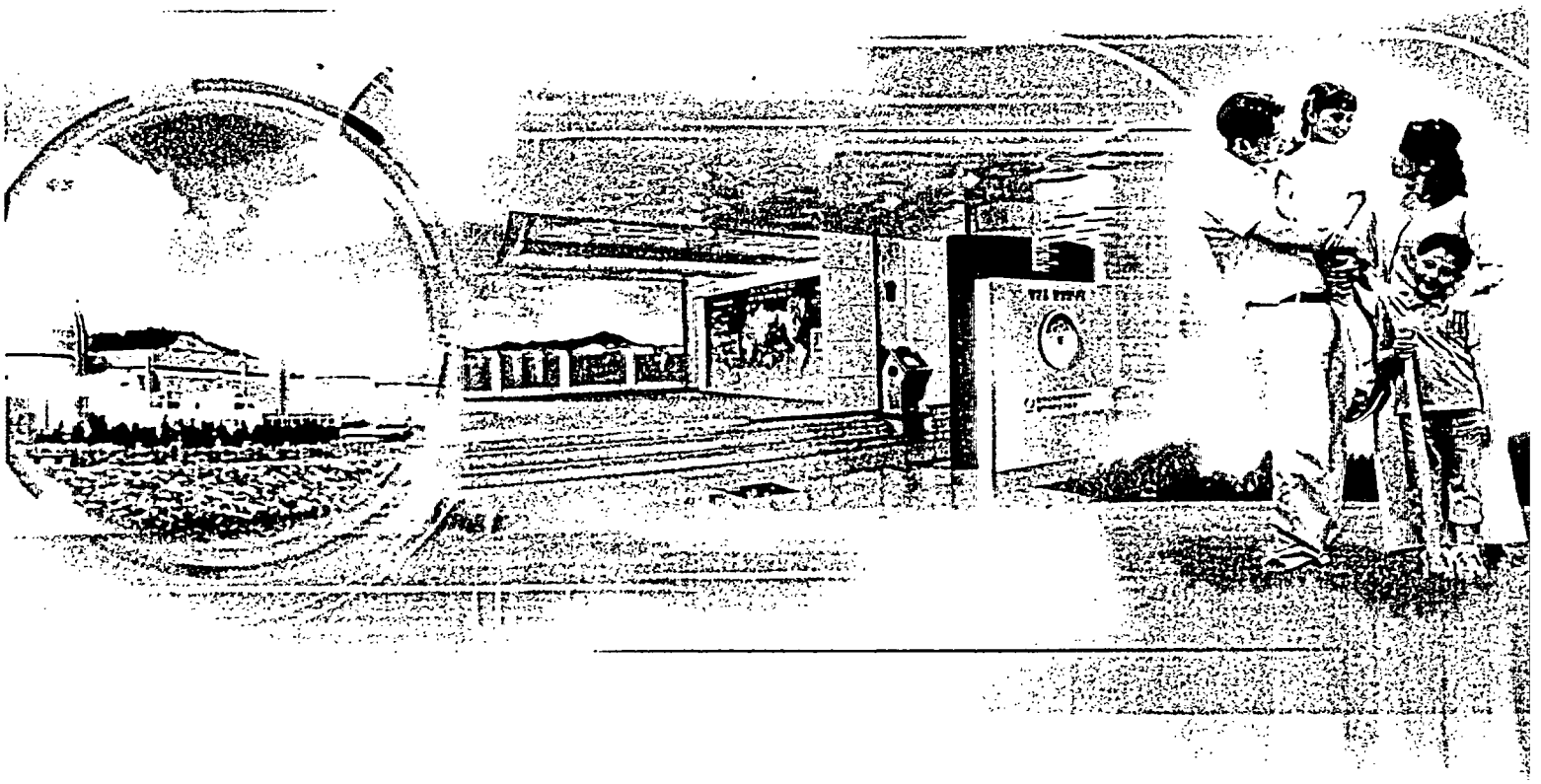


▲ 세정기 내부 (Scrubber)



방사성폐기물 깨끗하고 안전하게 관리하겠습니다

We will do our best for the clean and safe management of radioactive waste.



깨끗한 원자력을 선도하는 환경친화적 기술!

Environment-friendly
vitrification technology leads the clean nuclear power!

KHNP

한국수력원자력(주)
Korea Hydro & Nuclear Power Co., Ltd
원 자 력 환 경 기 술 원
Nuclear Environment Technology Institute
305-353, 대전광역시 유성구 덕진동 150번지
전화 : (042) 870 - 0330
팩스 : (042) 870 - 0269
Dukjindong 150, Yuseong-gu, Daejeon, 305-353, KOREA
TEL : +82-42-870-0330 FAX : +82-42-870-0269
homepage : www.knetec.com