# 제 10회 학술 발표회 초록

## <제 1 부>

### (1)

### Neutralization of Boric Acid Solution (12$\omega t$%) with Sodium Hydroxide Solution (50%)

**Sɔng Hoon Lee**
**Kwan Sik Chun**
**Sang Hoon Park***

*Korean Atomic Energy Research Institite*

With the goal of eliminating the constraints associated with bituminization of boron-containing effluents from the primary loops in P.W.R., a neutralization of boric acid solution with hydroxide has been sutdied.

The compounds formed after neutralization were identified by powder X-ray diffraction and atomic absorption spectrophoto-metric technique, and these thermal analysis curves were compared with those of boric acid, sodium tetraborate and sodium metaborate.

The products at various pH ranges should be fo rmed by the following reactions:

1) $H_3BO_3+NaOH \rightarrow NaB_5O_8+8H_2O$
2) $H_3BO_3+2NaOH \rightarrow Na_2B_4O_7+7H_2O$
3) $H_3BO_3+2NaOH \rightarrow Na_2B_2O_4+4H_2O$

For the incorporation of the boric acid solution into asphalt, the optimum condition wouldbe in the range of pH 7 to 8 in whichsodium pentaborate ($NaB_5O_8$) could be formed.

### (2)

### $D_2O$ Scattering Cross Section

**Soo Hyun Suh***
**Seong Yun Kim**
**Dong Hoon Kim**

*Equipment Development Project Division*
*Korea Atomic Energy Research Institute*

In solving the Boltzmann equation of neutron transport, a closed form of the neutron scattering kernel is required to delineate thermal neutron behavior in moderators such as light and heavy water. Particularly thermal neutrons in bound moderator substances agitate in quite complicated way incorperated with thermal motion of molecule and chemical binding energy.

Calculations are carried out for the scattering law, the scattering kernel and the total scattering cross section of heavy water based on the model proposed by Butler. The total scattering cross section computed by use of the code DEUKER is compared with the experimental values.

### (3)

### Study of Strain Aging in Zircaloy-4

**임감순**(핵연료개발공단*)
**박원구**(핵연료개발공단)
**육종철**(한 양 대 학 교)

The strain aging behavior of Zircaloy-4 has been studied as a function of aging temperature, time, oxygen contents or degree of pre-strain for annealed, cold-worked or quenched spiecmens in the temperature range of 175°C to 575°C for 1 to 1000 seconds of aging time. The strain aging in annealed specimen occurs in the temperature range of 175°C to 530°C. At around 300°C, the strain aging stress in annealed Zircaloy-4 has been found to be proportionat to the square root of atomic concentration of oxygen atoms interacting rigidly with dislocations. In cold-worked specimen the strain aging stress decreases rapidly with degree of cold work and prestrain. This suppression is considered to be resulted from the trapping of oxygen atoms by the defects produced by cold work. The quenched Zircaloy-4 under stress shows two stages of strain aging: i.e., the initial stage of strainaging proportional to (aging time)$^{\frac{2}{3}}$ having

an activation energy of 0.43 to 0.49 ev which is considered to be associated with Snoek type ordering of oxygen around dislocation, and the second stage of strain aging proportional to (aging time)$^{\frac{1}{3}}$ which is presumed to be due mainly to long-range dffusion of oxygen atoms.

## (4)

## Effect of Electron-Collective Plasmons Coupling on Multiphoton Resonant Absorption in Laser-Produced Plasma.

**Kwang-Youl Kim**

*Dept. of Muclear Engineering,*

***SNU, Seoul, Korea***

The effect of electron-collective plasmon coupling on multiphoton resonant absorption of laser-produced plasma is investigated by using the collective description of quantum-mechanical many body system consisting of collective plasmon fields and an electron coupled to an electro-magnetic wave in the dipole approximation, by utilizing the time-dependent unitary transformation to an accelelerated frame of reference. It is shown that, in the presence of an intense e-m wave, the coupling between the plasmons and the individual electrons can be remarkably enhanced due to the electron quivering energ. In addition to the above coupling mechanism, the role of plasmon-photon coupling in laser-plasma in teraction is also considered. The coupled kinetic equations for the electron and plasmon (or electron and phonon) distribution functions show that both effects may be of principal importance in laser driven fusion feasibility studies, and must be taken into accound over and above classical collisioeal heating (inverse bremmstrahlung).

## (5)

## The Laser as a Tool for Rotating Plasma Diagnostics

**S. H. Kim**

*Department of Nuclear Engineering*

*Hanyang University*

Theoretical investigation for the determination of plasma parameter and turbulence by laser light scattering is sketched for a rotating plasma in an annular space between two coaxial electrodes by both axial magnetic field and radial electric field. The essential application of laser light scattering is the determination of the isotope separation ratio by the measurement of velocities of each isotope species.

## (6)

## Theoretical Studies on Weakly-Ionized, Rotating Plasma

**S.H. Kim and**

**Sung Sil Ko***

*Department of Nuclear Engineering*

*Hanyang University*

Theoretical studies are made on a steady, weakl ionized, weakly thrbulent rotating plasma in plasma centrifuge. Especially, the dependence o the isotope separation ratio on the relaxatio mechanism by plasma instabilities is both quali tativery and quantitatively investigated.

## (7)

## Plant Safety-The Inspector's Role

**W.A. Ruhlman and Nam H**

**IAEA Expect**

*Nuclear Reactor Division 1* Alomic Energy Bure*

*Ministry of Science and Technology Seoul 110 Kor*

From around 2200 at night until 0400 in t morning, about 20% of electricity used in t Republic of Korea is produced by nuclear powe This paper deals with accomplished fact not wi hypothetical possibilities; Korea is in the nucle age.

Within the lifetimes of almost everyone in this room, the nuclear age burst upon the world with shattering fury. Since that time, sinceits power was adequately demonstrated, people throughout the world have been concerned with the safety of this awesome energy source. Many factors are involved in making nuclear power a safe source of energy, among them are design features, automatic safety systems, trained operators, redundant systems and of course, the regulatory inspector. Any of these factors would makea subject for several presentations, but I would like to cover the role of the inspector in plant safety.

I have met regulatory inspectors from the US, the UK, Canada, Japan and Korea. I have found various perspectives within these individuals of the inspector's role. Some see themselves in a role like General Lee out to make world safe for nuclear power as he fought to make Korea free for peaceful development. Others see themselves in a passive role more like the Greek philosopher Socrates calmly reviewing plans submitted by others to assure that the prospective nuclear facillity is built safely. The real role lies somewhere between these two extremes.

Most of you are familiar with the technique of defining something by defining what is not part of the item or problem. This is really a easier approach than defining the role of the inspector since the role varies over a fairly wide range based on the conditions incurred. It is not the inspectors role to dictate HOW something is to be accomplished. The HOW is left to the individual power plant operator subject to the restrictions placed on WHAT must be accomplished. The HOW is also restricted by the requirements of safe operations and conservatism which were assumed in the Safety Analyses. The inspector also determines, in general, whether actions are in compliance with previously established standards. He does not attempt to perform an instant exegesis of a specific requirement to see if what is being done is adequate, Rather he reviews what is being done against the requirements previously established for what is to be done to see if they are in compliance. The idspector plays the Socratic role of determining acceptability of a proposed action during the review of the licencees Safety Analysis Report when time an working conditions permit the thoughtful, reffective atmosphere necessary for making such decisions, The inspector is also not concerned with efficiency or cost or schedule; he is concerned with safety.

Having stated that he is concerned with safety, we find the inspector immediately faced with two question 1) what concerns safety; and 2) how safe is safe? To answer the first, the inspector must have some clear-cut ground rules. He must at some rely on the system design. I think everyone here caneasily see thatt nothing can be protected from everything. As an example, one of the states in the USA had a proposition placed on the ballot that would require require that nuclear power plants be protected against every knownact of God. Well, since most world religions and legends include a story of a great flood that covered the entire world, passage of that proposition would have required that all nuclear power plants in the state be able to operate or safely shutdown completely submerged! The Christian and Jewish Bibles bothcontain passages that declare that Godparted water on 3 different occassions. Again passage of the proposition would have required power plants in that state to be able to operated with the wates in the intake parted, that is, with acomplete lack of all cooling water. While plants could be designed to operateunder the above conditions, most people would agree that such conditions arenot probable enough to require such protection. On the other hand, plants in the US that use the waters held back by dams for cooling water, do have separate storage facilities for cooling water so that if the dam were to break, they would have sufficient water to cool down the plant, Similarly, plants which are located where ffooding is possible are required lo be able to protect plant equipment against the worst knownffood conditions when cowbined with the worst known rain/storm conditions in the erea. The answer to the first question, what concerns safety, is. those items of the plant which are needed to operate, function or remain intact in order for the plant to cope with the most severe analysed accidents. The answer to the second question, how safe, is still being debated in the US. As you can see from the above examples with flooding and lack of water, someone basically has to make a decision where protection must stop. The answer to the second question is as safe as required by the regulatory body in each country involved, That is some what modified by the agreements between nuclear powers. The International Atomic Energy Agency (IAEA) imposes some minimum requirements on all countries. In addition, countries like Korea and Brazil have additional requirements imposedupon them by the countrices which provide theme with fuel and/or technology.

In both the US and Korea, the inspector's role started as one primarily of design and analysis review with minimal onsite inspection. In both contries, the onsite inspection role continiously increased and more areas are being inspected. The US has now placed resident inspectors at selected US facilities and it appears that AEB will have the first resident inspectors at Kori 1 within the near future. The progression canbest be described as a deepening involvement.

The inspector have also "evolved". In the beginning, the inspector were more scientists steeped in knowledge of the theoretical problems and applications of nuclear theory. Today, the inspectors are more engineers familiar with the operational problems of equipment and systems. The shift has been caused by the shift in problems. The nuclear phenomena are how well defined and the body of expertise and experience has shown that the technology is theoretically safe for peaceful applications. The problems that have been found are those dealing with pumps, valves, switchgear, motors and similar devices which have a wide range of application outside of the nuclear industry.

The direct evolution from scientist to engineering did not produce the individual best designed to meeet the required role of inspector. The basic engineering function is to improve components or processes and to increase efficiency and/or output. These aspects of the normal engineer must be somewhat supressed if he is to fulfill the role of inspecting to improve plant safety. Plant cafety is assured primarily by continuation of processes and operations in accordance with tried and proven formula. The inspector will have a tendency to recommend better ways to perform operations, and these are quite proper as suggestions, but the role requires that compliance with accepted standards be enforced. Although not yet as prevalent in Korea as in the US' the engineer/inspector must also be to write' speak and deal with the public and media. Most engineers are woefully unprepared for these tasks. As a result, some engineers are "trapped" by media personnel. For an example, when asked if a plant is completely safe, the engineer part of the inspector knows that nothing is completely safe; therefore he answers "No." The media then can truthfully print that they asked an inspector if the plant was safe and he said "No." Failure to deal with the media is just as damaging. The press will then report that, when questioned about the nuclear safety of the facility, the inspector refused to discuss the issue.

As you can see, the inspector that is required has several talents. He must be part engineer, part scientist, part public relations man, part writer (since all of his findings must be documented) and last but certainly not least, he must be basically curious and/or suspicious.

The curiosity requirement stems from the need for follow-up. To assure safety, the obvious items are seldom overlooked by the plant operating staff. Oh to be sure there are exceptions to this rule, but most plant operators are really concerned with safe operation. The inspector must detect those subtle deviations from the normal reading or indication. He must then have the curiosity to followup that abnormality to see if it means that a safety issue exists. This leads us to the next phase of the inspectors role, determination of what to lock at and how much to review.

As with any job, experience is the best teacher. It is sort of like looking for rocks. Now any of you that do any gardening know that finding rocks isn't very difficult. When you first plant your garden, rocks are everywhere. Similarly, many problems are obvious when either the first plant of a particular design or the first plant by a particular country or the first plant by a particular utility is being placed into operations. This is normal. As the utility, country or design gains experience, and use the more obvious safety issues are resolved. As with the old garden spot, fewer and fewer rocks are found each year, so to with nuclear plants; fewer and fewer problems are found by the inspectors. In any garden, if you dig a deep enough hole, you will find a rock; in a power plant if you inspect any given area in enough depth, you will find something improper. It may be insignificant, but you will find something. A missing signiture on a form, a missing from; something. As any good gardener can tell you, those deep down rocks aren't the problem, itis those near the surface. Therefore, the effective inspector digs a large number of shallow holes. If he finds no rocks (problems), he can then assume that the plant is being operated safely. But you can't dig all those holes in one spot and make such a judgement; the sample has to be representatives.

I am sure that this audience contains several mathematicians who can lecture for hours on the theory of random sampling. I can't. I can tell you from experience that it works. The inspector's samples are not, strictly speaking, completely random, but that is the basic concept. Again, experience will tell the inspector where problems are more likely to occur. He will then take a random sample from the more likely problem areas. To do this effectively, the inspector must keep abreast of current problems. We have information on problems at all of the plants in the free world available on a fairly routine basis. Symposiums like this one, international meetings, IAEA reports, abstracts published by various governments, and exchanges of inspectors among cooperating countries and agencies within a country all tendto highlight known problem areas. In addition, certain areas inffuence many other areas. These "precursors" are always furtile ground for digging. As previously meotioned, the inspector's own curiosity is vital. While no single inspector qualifies as an omniscient expert, each usually has some particular field of interest and expertise. With the vast ntmbers of inspectors inspecting nuclear plants today throughout the world, each with his own little area of special interest and expertise essentially all areas are covered with very critical inspections. Since all reactors use the same basic technology and the resulting problems are widely disseminated, the role of the inspector is enhensed by the finding and expertise of other inspectors.

As to the future role of inspector, I see increased involvement. The more time you spend looking for rocks, the more rocks you will find. Quite honestly, the nuclear industry's inspector have been becoming more experienced. We are finding more problems. That has, in itself, created a problem. The problems that are found must be corrected. That takes time and manpower and money. It sometimes takes more time to correct a small problem that to correct a large problem. Again as seen in the analogy with the garden it takes less time to remove all the rocks larger that a man's toe. There are simply more small problems in any industry that large ones after the technology becomes reasonably developed.

The inspector rold for plant safety is summed up, then as one of providing additional assurance of safety. The plants are designed, built, and generally operated safely. The inspector sort of keeps things honest as it were. He will find problems. In many cases while the licences is fixing that problem he will himself find other problems or possible problems. There is no other industry employing as many people or with such a capital outlay as the nuclear industry thatt has the safety record that has been accumulated. In over 500 reactor years of commercial nuclear power plant operation, there has not been one nuclear related death.

The final polish, although not often appreciated as such, on the inspector role with safety are you sitting in the audience. As you and the countless millions of others like you around the world ask the regulators of this industry and their inspectors those "difficult" questions, you force the inspectors and the regulatory bodies themselves to become better at their respective jobs. Your questions will inevitably help to mold and fashion tomorrows inspector's role in plant safety.

## <제 2 부>

### (1)

### Studies on the Therapeutic Irradiation and Chromosome Aberrations

**Young Jin Kim*, Jin Yong Kim and Jong Bong Kim**

*Korea Atomic Energy Research Institute*

Five ml of blood samples were taken from cervix, Lung and other cancer patients treated with therapeutic rediation of 1,000r, 1,200r, 1,400r, 1,600r, 2,000r, 2,800r, 3,000r, 3,800r, 4,000r, 4,600r, 5,000r, 5,400r, 5,800r and 6,000r respectively.

Chromosome Preparations were obtained from in vitro leukocyte culture and ar drying method. Types of chromosome aberration and chromosome aberration rates were analized according to the radiation dose.

Two types of abnormal chromosomes, dicentric and acentric chromosomes, were observed in the leukocytes. The polyploid cells were also found in the experimental groups.

### (2)

### 방사선 처리에 의한 벼의 돌연변이 형질의 유전연구

**권신한, 원종락*, 김재리**

한국원자력연구소 방사선 육종학연구실

전리방사선을 작물 종자 및 생체에 처리하면 여러가지 종류의 돌연변이체(mutant)를 얻을 수 있고 이것은 육종사업상 귀중한 재료로 이용되는데 이때 돌연변이체의 각 형질의 유전현상을 정확히 알므로서 육종사업을 효율적으로 수행할 수 있다.

본 연구는 벼품종 진흥종자에 X-선 25kR을 처리한 결과 종자의 영(lemma)에 갈색 반점(brown color spot)을 지니면서 진흥 모품종에 비해 출수기(heading date)가 일주일 정도 빠르고 장간이 돌연 변이체를 얻어 이 변이형질(mutated character)의 우열관계, 관여하는 인자의 수, 그리고 세가지 변이형질의 상호관계를 규명하였다.

영의 갈색반점, 조숙 장간 형질은 각각 열성단인자성(recessive single gene)유전을 하였으며 세 형질을 동시에 고려한 $F_2$에서도 3 : 1의 분리를 하였다. 고로, 이 세 변이형질의 유전관계는 다면적 발현현상(pleiotropism), 밀접한 연관(close linkage)에 기인되는 것으로 추측된다.

### (3)

### 방사성 동위원소 표지에 의한 미소곤충의 비산거리 측정연구

**권신한, 정규회, 유준**

한국원자력연구소 방사선 육종학연구실

식물의 즙액을 빨아먹는 곤충의 표지는 섭식에 의한 방법과 체표에 묻치는 방법이 있다. 솔잎혹파리와 같이 미소한 곤충은 체구가 작아 염색약에 의한 표지는 힘들다. 본인등은 몇가지 핵종을 이용하여 표지법과 비산거리를 조사하였다.

1. 유충시기에 섭식을 시켜서 오랫동안 표지시킬 수 있는 핵종을 $Ca^{45}$이며 수간주입에 의한 방법이 좋았다.
2. $P^{32}$는 수간 주입시 $Ca^{45}$보다 표지는 빨리되나 반감기가 짧아 본 해충에서는 표지효과가 없었다.
3. 노숙유충 및 번데기 시기에 침지하는 방법은 표지율이 낮았으며 우화시기에 체표에 묻게하는 것이 표지율이 높았다.
4. $P^{32}$로 표면처리시 농도는 목재처리상(55×65×25 cm)에 total activity 3mCi가 표지율 86%로 가장 높았다.
5. $P^{32}$로 표지한 솔잎혹파리 성충을 방산한 후 재포획하여 비산거리를 추정한 결과 약 400m이였다.
6. 성충의 재포획율은 약 0.001%이었다.

## (4)

## The Effect of Protent Content and Adsorptivity of Charcoal on the Validity of Insulin Radioimmunoassay

**Kyoung Hee Lee, Ok Doo Awh, and Jae Rok Kim**

*Korea Atomic Energy Researchh Institute*

As a blank plays a pertinent role in the usual sensitive assay, minimizing and equalizing the unadsorbed radioactvity to charcoal in the antibody blank tubes is quite important in pre paring insulin radiommunoassay (IRIA) kit to work its normal assay function.

The effect of protein content in standard insulin tubes on the validity of IRIA, and the adsorptivity of the labelled free insulin to the dextran coated charcoal (DCC) were studied varying protein content from 0.3 to 0.8%. Incubation mixture of different protein content were incubated at 4° for 24 or 48 hrs and subsequently the bound insulin was separated from the unb und (free) insulin by applying the DCC method.

The absorptivity of the free labelled insulin to DCC was slightly decreased with increasing protein content but generally increased with improving the intactness of the labelled insulin. The results indicated that the equality of protein concentration between the standard insulin tube and the serum samples is a minor factor is so far as the adsorptivity of DCC is efficient. The adsorptivity of the $^{125}I$ labelled insulin was slightly improved by using dextran T-70. Thus, dextran T-70 is preferable te T-80 for IRIA.

## (5)

## 土壤 및 農作物의 우라늄 含量
### —槐山 德平里 地域—

**金台淳, 宋基俊*, 柳長杰, 韓康完**
**李 澈, 金洛培, 李仁鐘**

韓國原子力硏究所

槐山 德平里 地域 우라늄鑛床 附近의 環境 放射能이 地域 住民에게 미치는 影響을 調査하기 위하여 實施한 調査 硏究의 一環으로 農耕地 土壤中의 우라늄 含量과 이들 土壤에서 栽培된 農作物中의 우라늄含量을 調査하여 이 地域 住民들의 飮食物 攝取時 體內에 들어가는 우라늄量을 算出해 보았다.

調査된 21個 土壤試料中의 우라늄含量은 30ppm 以上이 2個 圃場, 20—30ppm 가 2個 圃場, 10—20ppm 가 11個 圃場, 10ppm 以下가 3個 圃場이었고 對照 土壤으로 定한 京畿道 楊州郡, 利川郡 內에서 採取한 土壤試料中의 우라늄含量은 각각 5.4ppm 과 4.8ppm 이었으므로 德坪里地域 土壤의 우라늄含量은 對照 地域보다 훨씬 높은 水準이었다.

農作物(德坪里地域)의 우라늄平均 含量은 깨가 0.99 ppm, 감자 0.92ppm. 벼 0.6ppm, 콩 0.52ppm, 보리 0.37ppm, 옥수수 0.26ppm 等이다.

一般的으로 德坪里 地域의 벼, 보리, 팥, 감자의 우라늄含量은 他地方의 그것들 보다 높은 傾向을 보이고 있다.

德坪里地域 住民은 成人 한사람이 1일 飮食物로 攝取하는 우라늄量은 247.3$\mu g$ 程度인데 우라늄放射能은 108$\mu\mu$ Ci 이다.

## (6)

## Radiation-induced graft polymerization of methacrylic acid and methyl methacrylate onto polyester

**공영건*, 최재호, 이종광, 장훈선**

한국원자력연구소 방사선 화학연구실

The radiation-induced graft polymerization of methacrylic acid and methyl methacrylate onto polyoster fabric was investigated with $\gamma$-ray as radiation source, and the rate of grafting was examined.

When acrylic acid, methacrylic acid and methyl methacrylate were grafted onto polyester fabric, grafting efficiency was depended upon the dielectric constant in solvent of monomer mixture.

The yield of graft polymerization was related to the total dose, concentration of monomer, and concentration of swelling agent.

Melting point and glass transition temperature of graft copolymers were analysed by DTA.

Physical properties, such as moisture regain, antistatic property, wicking time were measured.