Attachment 3

Present Status of the Activities in the Field of Utilization of Research Reactors (URR)

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The Activity of the Utilization of research reactors in 2008

＜Workshop in Vietnam on NAA and RRT＞

(NAA : Neutron Activation Analysis)
(RRT : Research Reactor Technology)

- Date
  NAA : October 16 – October 20, 2008
  RRT : October 19 – October 23, 2008
- Venue : Dalat, Vietnam
- Participants: 26 in total
  Australia, Bangladesh, China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand, Vietnam
  and Dr.Machi of FNCA Coordinator of Japan
- Main theme of this year's NAA and RRT Workshop
  Making activity plans of new themes approved at the Coordinators Meeting in 2007.
  It was confirmed in the Coordinator Meeting in 2007 that the activities of NAA and RRT project from 2005 to 2007 were very effective for enhancement of research reactor utilization.

The new themes of NAA and RRT projects were approved to start from 2008 to ensure further enhancement of research reactor utilization. These new themes were selected in the Coordinator Meeting in 2007.

The Workshop Activities of NAA Project

- Participants
  Australia, Bangladesh, China, Indonesia, Japan, Korea, Malaysia, Philippines, Vietnam,

- New Phase NAA Project
  Through the previous activities, NAA technique of participating countries had got to the stage in which socio-economic benefit was redounded. Therefore, the projects will be extended to themes as follows.
  (1) Geochemical mapping and mineral exploration
  (2) Monitoring food contaminations
  (3) Monitoring environmental contamination

These activity plans of themes were discussed and agreed.

The Workshop Activities of RRT Project

- Participants
  Bangladesh, China, Indonesia, Japan, Korea, Malaysia, Thailand, Vietnam

- New Phase RRT Project
  The objective of the project is to improve and equalize the level of safety analysis techniques among participating countries to assure the promotion of effective utilization of research reactors.
  The following codes have been selected as common codes for safety analyses.
  (1) COOLOD-N2 : Steady state thermal hydraulic code
  (2) EUREKA2/RR : Nuclear & thermal hydraulic coupling code for transient change

The activity plan for the new theme was discussed and agreed. It was also confirmed that the activity would be effective for education and encouragement to engineers for research reactors.

Present Status of Activity in the Field of Research Reactor Technology (RRT)

Dr. Kiyonobu YAMASHITA
Project Leader of Japan
Director of Department of Research Reactors and Tandem Accelerator
Japan Atomic Energy Agency (JAEA)

I. Name of the Project: Research Reactor Technology（RRT）
in the Field of Utilization of Research Reactors (URR)

"Theme"
Safety Analyses of RIA (Reactivity Initiated Accident) and LOFA (Loss of Flow Accident) for Research Reactors.

II. Objective of the Project

To improve and equalize the level of safety analysis techniques among participating countries to assure the safe and stable operation of research reactors for the promotion of effective utilization.

III. Project Review of 2008

1. Country report in the workshop

Current status of thermal hydraulic analysis method was reported and discussed as follows.

(1) Bangladesh
The NCTRIGA code and the PARET code are used to analyze some important thermal hydraulic and transient analyses of the TRIGA MARK-II research reactor. In the future, the safety calculation will be done with the COOLOD-N2 and EUREKA2/RR. Under FNCA project, Bangladesh expects to improve the capability and manpower on thermal hydraulics and transient analysis of the TRIGA MARK-II research reactor through sharing knowledge and experience in safety analyses with other participating countries.

(2) China
The CARRCO code is used to calculate parameters such as temperature, pressure and mass flow rate for fuel assemblies. The code of RELAP5/SCDAPSIM/MOD3.2 is used for transient analyses. The share of COOLOD-N2 and EUREKA2/RR is welcome and these two codes can be used for complementary safety analyses for CARR (China Advanced Research Reactor). The CARR will achieve the first criticality in June, 2009.

(3) Korea

The MATRA-h code and the RELAP5 code are adopted to conduct thermal hydraulic analysis and the safety analysis for HANARO (Highly Advanced Neutron Application Reactor). Through the some safety analyses of HANARO, it is proved that the reactor system and components satisfy their specified functions against any postulated accident. Under FNCA activity, Korea expects the sharing of the knowledge and know-how for the thermal hydraulic analyses and the safety analyses of an advanced research reactor using a plate type fuel.

(4) Japan

COOLOD-N code and EUREKA2 (Reactivity-Accident analysis code) code had been used for safety analyses and thermal hydraulic design of JRR-4. Results of safety analyses by these codes satisfied every requirements for safety of JRR-4.

These codes also had been used for safety analysis of JRR-2, JRR-3 and JMTR. There are many achievements and experience for safety analyses. It is very valuable for all participants to share these codes and knowledge.

(5) Malaysia

RELAP5 is used for the safety analyses of steady state and transient calculation of RTP (1MW Reactor TRIGA PUSPATI). It uses a one-dimensional, two-fluid model, consisting of steam and water. So, the code is rather complicated for the research reactor like RTP.

Currently, the study is ongoing to upgrade reactor power from 1MW to 2 or 3MW. Malaysia hopes to use COOLOD-N2 and EUREKA2/RR for RTP safety analyses.

(6) Indonesia

Thermal hydraulic analyses for RSG-GAS (The Multipurpose Reactor of GA. Siwabessy) have been carried out by using several codes like HEATHYD, COOLOD-N, PLTEMP and PARET. The calculation results using COOLOD-N showed very good agreement on the coolant, plate and meat temperature distribution and the heat flux. In the future, COOLOD-N2 and EUREKA2/RR will be used for updating the safety analysis report of RSG-GAS for steady state and transient condition.

(7) Thailand

In FNCA project, Thailand hopes to advance the COOLOD-N2 and EUREKA2/RR modeling for TRR-1/M1 (Thai Research Reactor-1/Modification 1) through the cooperation. Although Thailand has some experiences in using these codes to model TRR-1/M1, the models should be improved for better agreement with the measurement. As the ultimate outcome of the FNCA project, Thailand wants to increase the competency of the personnel in performing these analyses so that the technology can be transferred to the NPP (nuclear power plant) reactor engineers for the future Thai NPP project.

(8) Vietnam

In analyzing the steady state thermal hydraulic and transient conditions for DNRR (Dalat Nuclear Research Reactor), COOLOD-N2 and RELAP5/MOD3.2 code are used. The use of these codes is very useful to perform safety analyses for the mixed fuel core loading. Vietnam hopes to improve the modeling of thermal hydraulics and transients of DNRR and the new research reactor by using COOLOD-N2 and EUREKA2/RR, and also to share the information and knowledge among participating countries. In addition, Vietnam also desires to increase the competence of personnel in the field of safety analyses for research reactors.

2. Summary of the workshop

(1) The workshop was held successfully with participants from Bangladesh, China, Indonesia, Korea, Japan, Malaysia, Thailand and Vietnam.
(2) Information on current status of thermal hydraulic analysis method in each country was well exchanged.
(3) Japan demonstrated how to install and execute common code (COOLOD-N2; Steady state thermal hydraulic code)
(4) All participants have been convinced that the RRT-project strongly support safe and stable operation as well as advanced utilizations of research reactors.

IV. Major activity in 2009

Preparation before workshop

- Participating countries calculate domestic reactor with COOLOD-N2 and sample problem with EUREKA2/RR.

Activity in workshop

- Japan demonstrates calculation procedure of reactivity initiated accidents and loss of flow accidents with EUREKA2/RR.
- Japan explains sample problem with EUREKA2/RR.
- Participating countries present calculation results with COOLOD-N2
- Participating countries present installation status and result of sample problem with EUREKA2/RR.

Review of Present Status of the Activities in the Utilization of Research Reactors —Neutron Activation Analysis (URR/NAA)

Dr. Mitsuru EBIHARA
Project Leader of Japan
Professor
Department of Chemistry, Graduate School of Science
Tokyo Metropolitan University

I. Name of the Project: Neutron Activation Analysis (phase III)

II. Objectives of the Project

NAA project for the new phase starting form FY2008 is to apply neutron activation analysis (hereafter, NAA) to three different target materials, (i) geochemical samples for mineral exploration, (ii) food samples for monitoring their pollution level and (iii) marine samples for monitoring the environmental pollution level. Individual countries may choose any of the three target materials in consideration of their current situations. The objectives of this projects are (i) monitoring the environmental quality using NAA (especially for the food samples and marine samples), (ii) working together with end-user including environmental protection sectors and (iii) appealing NAA to such end-users.

III. 2008 workshop in Vietnam

This year's workshop was held in Dalat, Vietnam from October 16th to 20th, 2007. From this workshop, a representative from Australia participated, together with nine other countries (Bangladesh, China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand and Vietnam). There ware three activities; (i) country reports on NAA activities and application of research reactors, (ii) Development of an implementation Plan for the new phase of NAA sub-projects in the area of geochemical mapping/mineral exploration, monitoring food contaminants and monitoring environmental contamination, and (iii) for each of the sub-projects, there was to be a leader speech, followed by presentations on country activities and plans, and discussion of objectives goals and implementation plans.

IV. Project review FY2008

(i) Australia Whilst a number of relevant measurement programs are imminent, no significant work has been undertaken by us to date. During a major shutdown of the OPAL research reactor in March it is planned to undertake engineering tasks that will aim to improve the long-term stability of the neutron flux at the NAA irradiation positions.
(ii) Bangladeshi 60 beach sand samples were collected from different locations of Cox's Bazar

with depth variation to identify heavy minerals depositions and impurities in heavy minerals were determined by INAA. The analyses are in progress. At the same time, 61 rice samples were collected from highly arsenic affected areas, moderately affected areas and non-affected areas and were analyzed by INAA.

(iii) China

Sample preparation of four kinds of rice from different origin and rice certified reference material. The rice samples were whetted 100 mush and baked at 80 0C of oven for 24 hours. Short irradiation of NAA for four kinds of rice: eight short half-life elements have been determined which included Al, Br, Cl, Cu, K, Mg, Mn, Na etc. Long irradiation of NAA for four kinds of rice will be carried out during next months.

(iv) Japan

Monitoring of Environmental Contamination and Environmental Changes. In order to investigate the transition of urban tidelands, core sediment samples were collected in Yatsu tideland in Tokyo Bay . The vertical distributions of elements were determined by INAA and prompt gamma-ray analysis at JAEA. Main purpose of this study is to clarify the transition of the environment from the variation of concentrations in sediments. Principal Components Analysis (PCA) was.

(v) Korea

Ginseng samples of domestic origin are to be analyzed by INAA. Target elements are essential and toxic elements. Currently, sample collection was completed and sample preparations have been executed.

(vi)Malaysia

Marine sediment samples were collected along Peninsular Malaysia, Sabah and Sarawak coastal area. The nuclear analytical technique was applied for analysis of trace and toxic element in marine sediment samples to identify the level, distribution and contamination sources. Utilizing of INAA for food analysis studies have been implemented to determine the amount of the essential and toxic elements in foodstuff of on average Malaysian dietary intake and to study sufficient elements level in foodstuff for the dietary intake.

(vii) Thailand

So far, some data on varieties of Thai rice were obtained. Rice and soil from the paddy filed are collected. With short irradiation of NAA of rice, eight short half-life elements (Al、Br、Cl、Cu、K、Mg、Mn、Na etc.) were determined. Long irradiation of NAA will be carried out during next months.

(viii) Vietnam

A market basket study in 2009 involves the collection of 100 foodstuffs from city and countryside. The concentration of trace elements will be analyzed by INAA, RNAA and AAS. The daily intake of the elements for adults in the different provinces will be estimated. Sediment, seawater and biota will be sampled at the coastal area of the Ninhphuoc and Ninhhai Districts in the Ninhthuan Province. More than 20 elements in the marine environmental samples will be determined by k_0 and relative NAA techniques.

Summary Report of FNCA Project: Application of Cyclotron and Positron Emission Tomography (PET) in Medicine

Dr. Noriah Binti JAMAL
Manager, Unit of Radioisotope Technology,
Malaysian Nuclear Agency (Nuclear Malaysia)

1. BACKGROUND

During the Ministerial Level meeting for FNCA in December 2005, the topic of "Cyclotron and PET in Medicine" was presented by the Malaysian Minister of Science and Technology and was accepted by the FNCA committee as one of the FNCA project. The project is lead by Malaysia. It is a three years project and commenced in August 2006.

2. OBJECTIVE OF THE PROJECT

The overall development objectives of the project are as follows:

a. Improvement of diagnostic technique for Nuclear Medicine in Asian countries.
b. Early detection of diseases with advanced technology contributes to human health betterment in Asia.

The specific objectives of the project are as follows:

a. Project Section I: Imaging (Instrumentation)

Theme: Quality Assurance and Quality Control (QA/QC) of PET Imaging
Activity: Publish of Guidelines for Performance Measurement of PET Imaging System

b. Project Section II: PET Pharmaceuticals

Theme: QA/QC for PET Radiopharmaceuticals (Japan)
Radiation Safety Aspect in Cyclotron Facilities Used for Radionuclide Production (Malaysia)
Activity: Publish of Guidelines for PET Drug Product and Guidelines for Safety of Cyclotron Facilities Used for Radionuclide Production

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c. Project Section III: Clinical

Theme: Clinical Diagnosis of PET Scan
Activity: Publish of Case Review for the " Atlas of Clinical PET" in CD format

3. ACTIVITY OF THE PROJECT

Three (3) FNCA workshops and seminars were held in Kuala Lumpur, Malaysia on the Applications of Cyclotron and PET in Medicine. The workshops and seminars were jointly organized by Malaysian Nuclear Agency (Nuclear Malaysia), Ministry of Science, Technology and Innovation, Malaysia (MOSTI) and Ministry of Education, Culture, Sports, Science & Technology of Japan (MEXT).
Discussions were also done by the country representatives through e-mails.

The workshops were organized to discuss and finalize the draft documents as to achieve the specific objectives of the project. While the open seminars were organized as to disseminate information and to share their knowledge to the end users, which includes the following:

a. Introduction to the Programmatic Activities of FNCA in Nuclear Medicine
b. An overview of the Current Situation of Nuclear Medicine in Malaysia
c. PET Technology, Radioisotopes Production and Application of Cyclotron Technology: Radiopharmaceuticals & Radiochemistry
d. PET Technology, Radioisotopes Production and Application of Cyclotron Technology: Regulatory Aspects
e. Application of PET in Clinical Practice

4. OVERALL ACHIEVEMENTS OF THE PROJECT

Of the 9 member countries of FNCA, 7 member countries have participated actively in this project to different degrees since its inception in 2006. Outputs of the project are as follows:

a. Project Section I: Imaging (Instrumentation)
Output: GUIDELINE FOR RADIATION PROTECTION AND PERFORMANCE EVALUATION OF PET-CT IMAGING

b. Project Section II: PET Pharmaceuticals
Output: QUALITY ASSURANCE AND QUALITY CONTROL OF 18F-FDG

c. Project Section III: Clinical
Output: PUBLISH OF CASE REVIEW FOR THE “ATLAS OF CLINICAL PET” IN CD FORMAT

5. SUMMARY AND CONCLUSION

The project is completed and successful in achieving its objectives. Guidelines planned to be established has been finalized, documented, compiled and adopted. Documenting and sharing of clinical case studies has been established. Capacity building among FNCA member countries has been increased through training enhancement among Physicist, Physician, Pharmacist, Radiologist, etc.

6. EXTENSION OF THE PROJECT

The Malaysian Minister of Science and Technology, during the Ministerial Level meeting for FNCA in December 2008 announced to extend the project for another two years focusing on radiation safety of PET facilities, which is very much related and important but involving a new scope of the project.

During the recent (6^{th} – 10^{th} Jan., 2009) FNCA workshop and seminar which has been held in Kuala Lumpur, Malaysia, representatives from FNCA member states agree on the followings:

a. This FNCA project to be extended to include further expansion of the existing scope.
b. To include and preparing the guideline for radiation safety aspect in Cyclotron and PET radiopharmaceutical production.
c. To include pre-installation and acceptance criteria for Cyclotron.
d. To develop the Quality Assurance guidelines in all sub groups.
e. To carry out surveillance on personal exposure dose in PET/CT and Cyclotron facilities for optimum application.

Summary; Application of Cyclotron and PET in Medicine (PET)

Keigo ENDO, M.D.
Project Leader of Japan
Chairman and Professor, Diagnostic Radiology and Nuclear Medicine,
Gunma Graduate School of Medicine

. Objective of the project

The specific objectives of the project are as follows:

a. Project Section I: Imaging (Instrumentation)

- **Theme**: Quality Assurance and Quality Control (QA/QC) of PET Imaging
- **Activity**: Publish of Guidelines for Performance Measurement of PET Imaging System

b. Project Section II: PET Pharmaceuticals

- **Theme**: QA/QC for PET Radiopharmaceuticals (Japan); Radiation Safety Aspect in Cyclotron Facilities Used for Radionuclide Production (Malaysia)
- **Activity**: Publish of Guidelines for PET Drug Product and Guidelines for Safety of Cyclotron Facilities Used for Radionuclide Production

c. Project Section III: Clinical

- **Theme:** Clinical Diagnosis of PET Scan
- **Activity**: Publish of Case Review for the "Atlas of Clinical PET" in CD format

II. "Atlas of Clinical PET"

a. Contents of the Database

Case presentation

■ Identification (Keyword for search engine)

Category (oncology/neurology, cardiology, infection,others)

System:	Respiratory etc	Organ: lung etc
Diagnosis		(ex. Lung cancer)
Date of examination		day/month(eg January)/ year
Tracer used:		(ex. 18F FDG-PET)
Sex		
Age		

- Chief complaint
- Indication (diagnosis/staging/assessment of therapy/restaging/others)
- Present and past history
- Clinical Examination
- Investigations
- Image findings and interpretation
- Final diagnosis (confirmed diagnosis)
- Additional comments or opinions
- Images: PET or PET/CT images & Reference Images (CT, MRI,US)
- Teaching Point (including pearls and pitfalls)
- Cross references: eg artifact/normal variant
- References (max of 5)
- Contributor (Hospital/Institutions, Country)

b. Progress

Country Contribution of FDG-PET cases

Country name	Number of FDG-PET case submitted
China	**30**
Japan	**25**
Malaysia	**23**
Thailand	**17**
Philippines	**9**
Total	**104**

Summary; Radiation Oncology（RO）

Dr. Hirohiko TSUJII
Project Leader of Japan
Executive Director, National Institute of Radiological Sciences (NIRS)

. Objective of the Project

Improvement of human health by establishing and improving standard radiotherapeutic techniques for common cancers in Asian countries

II. Activities

1. Publications
   - The standardized treatment was established in the 1st clinical study (**Cervix-I**) and was reported in the international journal (*Radiother Oncol 84:314-319, 2007).*
   - The result of the 2nd study (**Cervix-II**) was reported in the international journal (*Int. J. Radiat Oncol Biol. Phys. 70: 1522-1529, 2008)*.
   - The result of the 3rd study (**Cervix-III**) was submitted to the journal (IJROBP, 2009).
   - "The Handbook in Brachytherapy Physics" was published and distributed to each country's participant for improvement of QA/QC.
2. Chemo-radiotherapy for Uterine Cervical Cancer (**CERVIX-III**)
   - A total of 120 patients have been enrolled, in which the incidence and severity of acute toxicity were within acceptable level.
   - The 3-year local control was 80.9% and 3-year overall survival was 68.8%.
   - The efficacy and safety of concurrent chemo-radiotherapy (CCRT) were confirmed in this clinical study. The CCRT has increasingly been used in many Asian countries.
3. Current Clinical Trial for Locally Advanced Cervical Cancer (**Cervix-IV**)
   - To prevent para-aortic lymph node metastasis, a new clinical study of combined chemotherapy and extended-field radiotherapy was designed and initiated.
   - Of the 25 patients recruited, **18** patients were evaluable, in which a higher incidence of dose limiting toxicity (Grade 3 and 4), both hematological and non-hematological toxicities, has been encountered, which made it difficult to complete the protocol treatment.
   - It was therefore decided to discontinue CERVIX-IV and formulate a new protocol or to continue it with modification.
4. Chemo-radiotherapy for nasopharyngeal cancer (**NPC-1 for TxN2-3**)
   - Between 2005 and Jan 2009, a total of 104 patients were enrolled. There was a good response to the treatment with disappearance rate of gross tumor (clearance rate) at 6 month after the initiation of treatment being 94% (87/93). The 2-year overall survival was 79%.
   - It was decided to continue the study and to recruit more than 120 patients.
5. Chemo-radiotherapy for nasopharyngeal cancer (**NPC-II for T3-4N0-1**)

- Between 2005 and Jan 2009, a total of 48 patients were enrolled. There was a good response to the treatment with disappearance rate of gross tumor (clearance rate) at 6 month after the initiation of treatment being 95% (39/40).
- The overall 1 and 2- year survival rates were 95% and 84%, respectively.
- The NPC-II will be continued for another year to recruit more than 70 patients.

6. Quality Assurance / Quality Control (QA/QC) of Radiotherapy
   - "The Handbook in Brachytherapy Physics" was distributed to each country's participant.
   - Concerning the QA/QC for external beam radiotherapy, the postal dose survey was initiated using glass dosimeter. The results of intercomparison measurements using glass dosimeters done at 7 centers in 4 countries on 20 photon beams were reported. In all, 17 beams were within optimum level, 2 beams within the tolerance level, with 1 beam out of tolerance level. It was subsequently rectified and brought to within the tolerance level.

IV. Future Plans

1. Possibility of the next protocols was discussed. For cervix cancer, CRT +adjuvant chemotherapy was suggested as one of them. A new trial including extended radiation fields needs to await results of the current study (CERVIX-IV). For NPC, a trial with or without adjuvant chemotherapy was also suggested. Further discussion will be continued at the next meeting.
2. A need for more description of educational qualifications and training was suggested.
3. The meeting suggested Malaysia as the host for the next workshop subject to an agreement of the Government of Malaysia. The tentative schedule is January 18-22, 2010, in Kuching.
4. The importance to present the results in national and international meetings was emphasized.
5. Although the budget for the project was reduced FY2008, which only supported one participant from each country, the project has achieved significant outputs and is worthy to continue. It is important to convince the coordinator of each country and to get funding for additional participants. It is highly recommended that the Project Leader and/or persons involved in the registration of cases should come to the meeting. Continuity in participants' attendance is crucial to keep track of issues/data associated with the trials in order to maintain high quality of data input. Therefore, it was suggested that at least two participants from each country for each cervix and NPC trials attend the meetings.

Summary of Mutation Breeding Project in 2008

Dr. Hitoshi Nakagawa
Project leader of Mutation Breeding Project
Institute of Radiation Breeding, NIAS, Japan

Mutation Breeding Project includes 3 multi-lateral research programs; on insect resistance in orchid (FY2003-2009), on disease resistance in banana (FY2004-2008), and on composition or quality improvement in rice (2007-2011).

1. Banana Specialist Meeting

Sub-project meeting on disease resistance in banana was held in Kuala Lumpur, Malaysia on 7-10 August, 2008. Final Reports on the banana were presented by the participants from Bangladesh, Malaysia, the Philippines, and Vietnam. The conclusion of the discussion is as follows: 1) Each participating country except for Bangladesh, which participated in the project in 2007, have selected candidate lines resistant to *Fusarium* wilt or banana bunchy top virus. It is needed to evaluate these promising lines in large-scale trials for the registration in farmers' fields for 2 more years. The budgets of these trials will be provided by each government until 2009 or 2010 except for Vietnam. Therefore, Bangladesh, Malaysia, the Philippines, and Vietnam requested that this project should be extended for another two years.

2. Workshop

FNCA 2008 Workshop on Mutation Breeding was held in Dalat City, Vietnam on November 19 - 23, 2008. Reports on subprojects of orchid, banana and rice were reported by the participating countries. The presentation from participating countries except for Korea, which did not dispatch delegates, reports on the project and discussion on the project was made as follows:

1) Composition and quality in Rice

(1) Bangladesh: Four **salt tolerant** rice landraces were collected from the two coastal districts of Bangladesh and their **protein content** were estimated along with IR 64 following micrio-Kjeldahl method. Gamma ray(350 Gy)-irradiated M_1 plants of these salt tolerant rice were raised in the field and were harvested as M_2 populations in the following aman season (July-December, 08). Optimization of media composition for ***in vitro* regeneration** of plants from mature seeds of salt tolerant rice has been established and 16 green plants of the said variety are now growing in the pot with vigor.

(2) China: Rice mutation breeding of **low amylose** content in China had been started since 2006. Selections were conducted in M_2 populations with desirable agronomic traits and 578 M_2 lines were obtained in 2007. 435 M_3 lines were primary analyzed for low amylose content with rapid measurement in 2008 and 12 mutant lines from 3 restorers were preserved. Among them, 3 lines crossed with the other varieties with **good quality** and 6 crosses were obtained.

(3) Indonesia: Hybrid seeds between cv. IR36 (indica) and cv. Koshihikari, were irradiated by 200 Gy gamma rays. Selections were conducted in M2 populations with emphasize on **plant height** and **days to heading**. One dwarf M3 line, two semi-dwarf M3 lines, and one early maturity

line were selected. Five hundreds of unselected M3 lines are also maintained for screening of **amylose** contents.

(4) Japan: The mutant strains of cv. Koshihikari obtained by gamma ray irradiation and EMS treatment were selected and backcrossed with cv. Koshihikari to eliminate the undesirable characters except for the low amylase trait. **Amylose** content of these F_3 lines varied from 2.5% to 10.0%. Three rice leading varieties in Japan were irradiated with gamma rays and an ion beam. From these M_2 seeds, six new mutants with **low amylose** contents were isolated.

(5) Malaysia: This Project is focused on developing new rice cultivars with **high yield under minimal water requirement**. Seeds of selected elite genotypes were irradiated with gamma rays (300, 400 Gy) and exposed to selection pressure using different levels of PEG. A total of 38 potential mutants families from MR211 and MR219 were successfully evaluated in the field with minimal water requirement. These mutant lines will further tested for **yield**, **resistance to blast** and selection for **low amylose** content.

(6) The Philippines: Seeds of cv. IR72 previously exposed to gamma rays (200, 300 Gy) were planted in the field to isolate mutants with **high protein** with low to intermediate **amylose** contents. Four mutants with low to intermediate amylose content were obtained. These mutants will be studied further to confirm whether they breed true or segregate in the M4 and later generations.

(7) Thailand: Mutation breeding of **low phytic acid** rice in Thailand had been started since 2003. A popular high yielding variety (SPR1) was irradiated with gamma ray (200 Gy). Several **high yielding** mutant lines were selected. In addition, M3 seed of CNT1 and CNT80 are being assayed for phytic acid content to develop low phytic acid lines.

(8) Vietnam: During 2007-2008, some groups of breeders and biologists continue effective collaborations in efforts for pure line selections under field trials of rice mutants (**low phytic acid**, **wide adoptability** of **aromatic rice**, and their crossings with **high quality** and **tolerance** in Mekong River Delta (South Vietnam) and Red River Delta (North Vietnam). These combinations of true breeds with special **high quality** were awarded National Medals of Labour in 2007-2008 and released for large scale productions in multi-locations. Some useful **markers** strictedly related to genes and characters for selections of promising mutant lines with **high yield** and good **tolerance to drought and salinity** have been developed.

Discussion and Conclusion:

Standardization of the technique and control varieties for the evaluation of quality and contents of amylose, protein, phytic acid and aroma

1) Standard variety, IR64 for indica rice and Koshihikari for japonica rice, should be added to the material for the evaluation of rice quality.
2) Standardization of evaluation techniques for content and composition of (1) amylose, (2) protein, (3) phytic acid, and (4) aroma shall be determined.
3) Evaluation methods of amylose and protein have been determined and mailed to all the participants.
4) Evaluation method of phytic acid will be informed by Thailand.

2) Disease Resistance in Banana

Discussion on extension of Banana Project

All the participants discussed the extension of Banana subproject and agreed to the conclusion of sub-project meeting held in Malaysia.

3) Insect Resistance in Orchid

This project is formerly conducted by Malaysia, Thailand, and Indonesia and Japan. The main objective is to produce orchids resistant to insect infestation through mutagenesis. Exchanging orchid tissue culture materials among participating countries was done in the early phase of the collaboration. Malaysia, which is now a participating country, used *D.* Sonia Red 17 and *D. jayakarta*, which were received from Thailand and Indonesia, respectively, as well as *D. mirbelliannum* as starting materials for mutagenesis. Protocorm-like bodies (PLB) of them were irradiated with ion beams by JAEA and gamma ray. Following irradiation and five periodic subcultures, complete plantlets were regenerated. A portion of these plantlets was used for *in vitro* insect screening tests and the rest were transplanted into pots and grown to maturity until flowering. Flowering mutant plants were subsequently screened for insect resistance in greenhouse. The severity of insect infestation on orchid flowers was analyzed, and from this, an infestation severity index was developed. Plants that showed tolerance to infestation were identified and propagated. To date, 50 *D. mirbelliannum* lines irradiated with ion beams have been identified as potential mite tolerant mutants, whilst 2 *D. jayakarta* as potential thrip tolerant mutants.

3. The Workshop for Ion Beam in Japan

Dr. Tanaka presented how to prepare the material for the Ion Beam Workshop. And, the Secretariat office of FNCA in Japan introduced a tentative schedule of the Workshop and ion beam irradiation to rice seeds in JAEA, Japan in January 2009.

Review of Biofertilizer Project in 2008

Shotaro ANDO[1] and Tadashi YOKOYAMA[2]

[1]National Institute of Livestock and Grassland Science, National Agriculture and Food Research Organization, [2]Institute of Symbiotic Science and Technology, Tokyo University of Agriculture and Technology

In order to supply food to increasing population in Asia, agricultural production should be increased and a large amount of fertilizer is required. Most of fertilizer is chemical fertilizers, however oil and natural gas are needed to produce chemical fertilizer and shortage of rock phosphate, which is a low material for phosphorus chemical fertilizer, is beginning a serious problem. Furthermore, improper use of chemical fertilizer and other agrochemicals damage agro-environment, for example nitrate pollution in ground water. Therefore, establishment of environmental friendly sustainable agriculture in Asia and reduction of agrochemical input are required. This biofertilizer project aims to reduce the amount of chemical fertilizer input without decreasing yield of crops, by using function of beneficial microorganisms in biofertilizer, which increase availability of plant nutrients from soil.

We carried out the first phase of biofertilizer project from 2001 to 2006. Important outcomes from the first phase were 1) Combination of clay loam soil and charcoal (3:1) was suitable carrier for biofertilizer, 2) Field demonstrations were performed and confirmed the effectiveness of biofertilizer to several crop productions from 2003 to 2006, 3) Microbial activities in carriers sterilized by irradiation kept higher level than those by heat autoclave, and 4) Use of biofertilizer reduced cost and increased farmer's income by reducing the amount of chemical fertilizer application.

The second phase of biofertilizer project started last year and main purpose of the new project are 1) Development of multi-functional biofertilizer which consists of multiple inoculants with promoting plant growth or inhibiting plant diseases, 2) Selection of inoculants through conventional screening and improvement of inoculants by radiation-based microbial mutation breeding, and 3) Using radiation sterilization of carrier using Co-60 to control quality of carrier.

FNCA 2009 workshop on biofertilizer project, "Multifunctional Biofertilizer for Sustainable Agriculture" was held on February 23 to 26, 2009 in Jakarta, Indonesia. Host organization was National Nuclear Energy Agency (BATAN), Indonesia and Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan. A total of 15 participants from 7 countries, viz. China, Indonesia, Japan, Malaysia, the Philippines, Thailand and Vietnam were attended. In the workshop, activities of each country were reported and plans for the next year were discussed. Open seminar and technical visit were also implemented.

Country reports of FY 2008 were summarized as follows:

China

Five pot experiments were designed to evaluate the effect of different combinations of multi-functional inoculants to soybean, corn and paddy rice. Inoculants with *Trichederma* sp., which are antagonistic strain to soil born disease, had distinctive effect to plant growth on soybean.

Indonesia

Compost was chosen for carrier in the project phase 2, because organic material is easy to obtain and can be produced near the biofertilizer producer. The compost with original total bacteria of 10^8 cfu/gram could not eliminate the indigenous bacteria by irradiation at 20 kGy, but compost with

fewer original bacteria of 10^6 cfu/gram was eliminated by irradiation at 20 kGy.

Japan

In order to obtain mutants that are tolerant to environmental stress, radiation method of carbon ion beam irradiation to soybean root nodule bacteria and screening method of ion-beam-irradiated strains were developed.

Malaysia

Compost from empty fruit bunches (EFB) of oil palm and palm oil mill effluent (POME) is used as a microbial carrier in Nuclear Malaysia's biofertilizer products. It was introduced that Malaysian Agri Hi-Tech, agricultural biotechnology company specializing in mycorrhizal product, sent containers and bottles for gamma irradiation.

The Philippines

Gamma irradiation at 30 kGy and heat autoclave were compared for sterilization of *Azospirillum* strains in Bio-N. The results were same, but gamma irradiation method had advantages in efficiency and texture of the carrier. Field experiment of *Azospirillum* inoculation to paddy rice was conducted.

Thailand

The effect of multi-functional biofertilizer, *Bradyrhizobium* with *Azospirillum* and *Beijerinkia*, application to soybean was evaluated. The impact of carrier sterilization on growth and survival of rhizobia was determined.

Vietnam

Multi-functional biofertilizer was developed with *Azotobacter*, *Streptomyces*, and *Bacillus*. It suppressed root disease and nematode damage of pepper in the field.

The group visited the biofertilizer trial plots for vegetables in Pacet Field Station, Department of Agriculture. The treatments were negative control (50% and 100% farmyard manure, FYM) and inoculation with biofertilizer combined with 50% FYM. It was observed that broccoli, cabbage and carrot gave positive response to the biofertilizer application. The group also visited the biofertilizer factory of PT Hobson Interbuana, which produces biofertilizer for soybean (Rhizo-Plus) using irradiated carrier. In this factory, peat as a carrier was packed in a small plastic bag and send for gamma irradiation. After irradiation, liquid culture of multiple strains with *Bradyrhizobium* was injected to plastic bag. Guarantee period is 6 months and Rhizo-Plus is distributed to many islands of Indonesia. The successful example of this company will be used as a good model for promoting biofertilizer production with carrier sterilized by gamma irradiation.

In a workshop, we discussed mainly 4 topics. 1) Improvement of quality of inoculants with carrier sterilized by radiation in comparison with heat autoclaving, 2) Availability of radiation facilities and cooperation between nuclear institutes and agriculture institutes, 3) Test results of multifunctional biofertilizer, and 4) Strategy for extension of biofertilizer.

Then, experimental plan for 2009 was updated. Three main target crops, soybean, vegetables and paddy rice, and combination of microorganisms were selected. Experimental plan for carrier sterilization by irradiation was listed to determine proper dose for different types of carrier and pretreatment. Cost of irradiation of carriers should be calculated including transportation expenses of carriers in each country in comparison with autoclaving.

Review of Present Status of the Activities on Application of Electron Accelerator - The Forum for Nuclear Cooperation in Asia (FNCA) -

Dr. Tamikazu Kume
Project Leader of Japan

1. Name of the Project: Application of Electron Accelerator -Radiation Processing of Natural Polymer-

2. Objective of the Project
   The main objectives in phase 2 (FY2006-2008) are:
   1) To emphasize the advantage of radiation processing in modification of natural polymers
   2) To carry out promotional activities of the developed product to market
   3) To develop new technology on Radiation Processing of Natural Polymers

3. Project Review FY2008
   The project consists of two parts on the technical aspect of radiation processing of natural polymer, i.e. a) Radiation crosslinking of hydrogel of natural polymers for healthcare and environment and b) Radiation degradation of natural polymers for plant growth.

   The results and outcome of the workshop are:
   a) Open Seminar on "Radiation Processing of Natural Polymer" was held on the first day of Workshop in Shanghai and attended by 90 participants from industries, universities, research institutes and members of FNCA Workshop.
   b) An exhibition that consisted of posters and product display was held and participated by Bangladesh, China, Indonesia, Japan, Malaysia, Philippines, Thailand and Vietnam.
   c) For hydrogel as soil conditioner, VAEC has commercialized the super water absorbent by radiation grafting of acrylic acid to cassava starch and produced 30 tons for market promotion.
   d) The radiation degraded chitosan was commercialized in Vietnam as plant growth promoter/elicitor and in China as fish and animal feed. Indonesia, Thailand, Bangladesh and Philippines are continuing R&D on the plant growth promoting effects.
   e) Expert Mission to Member Countries: Two experts of Japan and Vietnam were sent from FNCA to Indonesia for the demonstration of the radiation degraded chitosan as plant growth promoter/elicitor. The chitosan was irradiated at BATAN (500L/batch) and shipped to Bangladesh, Japan, Malaysia, Philippine, Thailand, Vietnam and Sri Lanka (RCA).
   f) Support for the Project in Malaysia: Two experts from Vietnam and Japan were invited by Nuclear Malaysia and supported to initiate the project on "Application of Radiation Degraded Chitosan as Plant Growth Promoter and Plant Elicitor". Oligochitosan was produced using a continuous liquid gamma irradiator (1.5 – 2 ton per cycle) and used for the field trial at paddy plantation of 24 ha.
   g) Guideline preparation: Book of guideline on development of hydrogel and oligo-saccharides

by radiation processing will be completed on March, 2009.

h) Collaboration with RCA: India, Pakistan and Sri Lanka as representative of the RCA countries have participated in the FNCA workshop. It was agreed to continue the collaboration on radiation processing of natural polymers.

FNCA EVALUATION REPORT

Project name: Application of Electron Accelerator (Phase 2)
- Radiation Processing of Natural Polymers -

Project leader (country): Dr. Tamikazu Kume (Japan)

Date: 16 February 2009

Object of project:
To emphasize the advantage of radiation processing in modification of natural polymers
To carry out promotional activities of the developed products to market
To develop new products on radiation processing of natural polymers

1. Major outcome of project

(1) Development of technology

The experience, data and technical information on radiation processing of natural polymers are shared with other members of the FNCA countries.

1) Application of radiation degraded natural polymer has been commercialized in Vietnam as plant growth promoter and in China as fish and animal feeds. Application of chitosan as plant growth promoter/elicitor is continuing the filed test in Indonesia, Japan, Malaysia, Thailand and Vietnam. Philippines is studying the carrageenan as plant growth promoter.

2) Hydrogel by radiation crosslinking of natural polymer has been commercialized in Korea (carrageenan "Cligel" for wound dressing), Malaysia (sago starch "Esllon" for face mask) and Japan (CM-cellulose gel for bedsore and coolant). The hydrogel for medical use is waiting the government approval in Malaysia (sago-starch for wound dressing) and Philippines (chitosan for bio-implant). The clinical stage or basic study is continuing in Bangladesh, China, Indonesia, Thailand and Vietnam.

3) Dried hydrogel for super water absorbent prepared by radiation grafting of acrylic acid to cassava starch was commercialized in Vietnam and the application of hydrogel for water absorbent in agriculture was proposed as the cooperative project with RCA.

(2) Transfer of technique and knowledge

1) Open Seminar and exhibition was an important activity in promoting the technology to end users. It was held at every workshop and attended by a large number (around 100) of participants from industry, university and research institutes.

2) Expert mission in Philippines, Thailand, Vietnam and Malaysia was effective to make up for the detail discussion of individual program in each member country.

3) Demonstration for production of radiation degraded chitosan as plant elicitor was performed at BATAN, Indonesia and the products were distributed to Bangladesh, Indonesia, Japan, Malaysia, Philippines, Thailand, Vietnam and Sri Lanka of RCA member country for the field test of plant growth.

4) FNCA experts were invited to Malaysia for the technical transfer of irradiated chitosan as plant growth promoter and elicitor. Oligochitosan produced using a continuous liquid gamma irradiator was applied for the field trial at paddy plantation of 24 ha.

Publications:

1) Proceeding of workshop was published as JAEA-Conf 2007-007 and JAEA-Conf 2008-009.

2) Eighteen (18) papers were published in the international journal and local journal.

3) Guideline book on Development of Hydrogel and Oligo-saccharides by Radiation Processing will be published to standardize the methods and distribute to the users.

Patent:

1) F. Yoshii, T. Kume, T. Murakami, “Polysaccharide hydrogel”, United States Patent, No. US 7,208,593 B2 (Apr. 24, 2007).

2. Evaluation indicators

Socio-economic impact (Application or Achievement of project objection): 4 point,

Scientific impact (Basic technology or Activity): 5 point

3. Project outlook

[√] Continuation [ ] Change/Revision [ ] Termination

The reason for the above decision:

The radiation processing is a useful and effective tool for modification of natural polymers. The efforts should be continued to determine the economic viability of the products and to transfer the technique to the end user. In addition, the field test using irradiated chitosan at BATAN should be continued to obtain the results.

4. Ripple effect to other fields

(1) Natural polymer being an environment friendly material is becoming more attractive and in demand to replace synthetic materials in many products and applications.

(2) List of the irradiation facilities (electron accelerator and Co-60 gamma-ray irradiator) was updated and listed on the website of FNCA.

5. Opinion about the project (problems, ideas, remarks, proposal)

Most of the FNCA projects such as radiation degradation of natural polymer for plant growth promoter/elicitor, radiation crosslinking of natural polymer as hydrogel for wound dressing have reached either pilot scale or commercialization. The next logical step for these projects under the FNCA framework is the technology transfer between countries through bilateral and multilateral cooperation. FNCA can facilitate the technology transfer through the workshop and providing experts.

Project Proposal for FNCA Application of Electron Accelerator
-Radiation Processing of Natural Polymer in Agriculture-

1. Backgrounds
   - Objective of the project is to develop technology of electron beam (EB) irradiation system that has a variety of applications and good safety features.
   - Application of hydrogel for wound dressing of natural polymer by radiation crosslinking has reached either clinical test stage or commercialization in each member country.
   - The plant growth promoter/elicitor by radiation degradation of natural polymer is in the stage of field test in many member countries.
   - Radiation crosslinked/grafted super water absorbent gels would have a great potential as soil conditioner but further R&D in cooperation with RCA is recommended.

2. Project Period
   FY 2009 to FY 2011 (3 years)

3. Subjects
   1) Radiation degradation of natural polymers
      *Plant growth promoter and plant elicitor
      *Aquaculture and animal feeds
   2) Radiation crosslinking of natural polymers
      * Hydrogel for super water absorbent

4. Objectives of Project
   1) To emphasize the advantage of radiation processing in modification of natural polymers
   2) To carry out promotional activities of the developed product in the market
   3) To develop new technologies on radiation processing of natural polymers

5. Work Plan
   1) Comparison and evaluation of γ, EB and other conventional methods on the modification of natural polymers
   2) Field test of degraded chitosan for plant growth promoter/elicitor in member countries using the same sample prepared at BATAN
   3) R&D on radiation crosslinked/grafted super water absorbent gel, especially focusing on its effectiveness in drought area in cooperation with RCA

6. Expected Output
   - Transfer the technology between member countries and to end user
   - Establish the optimum condition for plant growth promoter/elicitor through the filed test
   - Develop the high quality hydrogel for super water absorbent
   - Develop new value added products for commercial application

7. Workshop
2009: Indonesia, Evaluation of plant growth promoter/elicitor
2010: Thailand, R&D on super water absorbent
2011: Philippines, Evaluation and technical transfer of products to end user

Three Year Plan of the FNCA Project on Application of Electron Accelerator

	FY2009	**FY2010**	**FY2011**	Notes
1. Overall Schedule	The 10th FNCA Meeting The 11th CM (Japan)	The 11th FNCA Meeting The 12th CM (Japan)	The 12th FNCA Meeting The 13th CM (Japan)	
2. Electron Accelerator Workshop	Autumn, 2009 (Indonesia)	Autumn, 2010 (Thailand)	Autumn, 2011 (Philippines or Bangladesh)	Launch of New Project from FY2012
1) Main Subject of Workshop	**Plant Growth Promoter/Elicitor**	**Super Water Absorbent (SWA) Gel**	**Evaluation and Technical Transfer to End User**	
2) Contents of Workshop	• Study on plant growth promoter /elicitor of natural polymers and cost evaluation • Evaluation of field test using oligochitosan • Study on oligochitosan as fish and animal feeds • Information Exchange on Technical Transfer • Open Seminar and Exhibition	• R&D on radiation crosslinked /grafted SWA gel • Improvement of the quality of SWA gels (i.e. lifetime, new polymer systems, etc.) • Study on CMC/Polyacrylate developed by India in cooperation with RCA • Open Seminar and Exhibition	• Comparison and evaluation of γ, EB and other methods • Study on technical transfer to end user • Cost evaluation and application of SWA gels in drought area • Evaluation of project and Proposal of New Project • Open Seminar and Exhibition	
3. Expert Mission	**According to the request**	According to the request	According to the request	
4. Database of Irradiation Facilities (EB and γ)	Update	Update	Update	
Participating Countries : Bangladesh, China, Indonesia, Korea, Malaysia, Philippines, Thailand, Vietnam and Japan (total 9 countries)				

Review of Status of the Activities on Application of Electron Accelerator-Radiation Processing of Natural Polymers in the Philippines

Charito T. Aranilla
Philippine Nuclear Research Institute
Department of Science and Technology (DOST)
Commonwealth Ave., Diliman Quezon City 1101, Philippines

I. Name of Project: Application of Electron Accelerator – Radiation Processing of Natural Polymers

II. Objectives of the project:

a) To emphasize the advantage of radiation processing in modification of natural polymers
b) To carry out promotional activities of the developed products to market
c) To develop new products on radiation processing of natural polymers

III. Project Review

A. Radiation Crosslinking of Natural Polymer

(1) Semi-commercialization of PVP-Carrageenan Hydrogel for Burn/Wound Dressing

The Philippine Nuclear Research Institute (PNRI) has fully developed the PVP-Carrageenan hydrogel wound dressing by radiation processing. It has been awarded a Patent last October 28, 2008 (No. 1-2000-02471) by the Bureau of Patent, Philippine Patent Office. Clinical testing for burns/bedsores and the techno-economic feasibility study have previously been completed. The product has been given the brand name "Skin-up".

In order to assist the technology transfer of the PVP-carrageenan hydrogel, PNRI has received a grant from the Department of Science and Technology (DOST) through its technology transfer program (TECHNICOM). This project is consist of two phases and is being carried out in collaboration with Biotecos Co., a private cooperator.

Phase I of the semi-commercialization project has been completed was solely undertaken by PNRI. The project's main objective is to set-up a semi-commercial plant for the production of hydrogels

which will serve as a demo plant for the private company. The pilot plant and equipment have been set up in the PNRI premises.

The project is already in Phase II which will end this June, 2009. The objectives are: (1) to test the capability of the newly constructed pilot plant; (2) to establish QA/QC system for the production of hydrogel; (3) to undertake dosimetry works for full capacity of the irradiator; (4) to conduct clinical studies in hospitals; (5) to conduct a market acceptability study. The summary of activities for phase II and the extent of accomplishment are presented in Table 1.

Negotiations between PNRI and Biotecos Co. are underway for the final signing of the Memorandum of Agreement (MOA). It is expected that the MOA will be signed before June, 2009.

Table 1. List of Activities of PNRI and Biotecos Company for Phase II

Activities	Status
A. PNRI	
1. Production of hydrogels	Upscaled to 100L volume; capacity of the pilot plant estimated to be 1,000 pieces for 8” x 8” or 4,000 pieces for 4” x 4” per day on 8 hours a day work; DUR determined with the newly upgraded Co-60 facility
2. QA/QC systems for the production of hydrogels	Procedures being established e.g. bioburden, sterility, physico-mechanical tests
3. Stability testing of hydrogels	Aging test using ASTM F 1980–07 on-going
4. Operating Manual Preparation	Writing ongoing
B. Biotecos Co.	
1. Establishment of trial centers in Metro Manila	On-going
2. License to Operate from DOH and BFAD Registration	On-going; initial communication submitted

3. Market acceptability study	On-going; promoted, through direct distribution of free samples to doctors (surgery department heads/ hospital directors) in 29 hospitals strategically scattered in different areas in central and northern Luzon.

(2) Development of PVP-Chitosan Injectible Hydrogel for the Treatment of Vesicoureteral Reflux

Innovative studies on radiation processing of polymers were conducted by developing radiation-crosslinked PVP-Chitosan hydrogel as implant for treatment of vesicoureteral reflux. PVP-Chitosan solution was crosslinked and sterilized by gamma-ray irradiation. Outputs for this study are:

(a) Optimized concentration of components and irradiation dose to form hydrogels with high insoluble fraction that will pass the G26 needle.
(b) Based on animal study, PVP-Chitosan gel implant can be considered biocompatible and non-migratory. However, animal study will be re-conducted in accordance to Bureau of Food and Drugs (BFAD).
(c) Clinical trials suspended pending the approval of the Ethics committee.

(3) Synthesis and Carboxymethylation of κ-carrageenan for Development of Hydrogels for Various Potential

The success of scientific efforts on radiation crosslinking of polysaccharide derivatives became the solid bases for the research study on derivatizing carrgeeenan by carboxymethylation process in order to widen the applications of carrageenans. Major results of the study are:
(a) Optimized parameters for carboxymethylation.
(b) Synthesized carboxymethyl-κ-carrageenan derivatives with high DS.
(c) Synthesized CMkC hydrogels via radiation crosslinking.
(d) Preliminarily investigated application as superabsorbent material, wound dressing, and metal absorbent.

B. Radiation degradation of natural polymers

(1) Preparation of carrageenan oligomers and bioactivity tests

Degraded carrageenans by irradiation in powder and aqueous has been characterized. Carrageenan oligosaccharides with molecular Mw 5000-10000 were

obtained using three different irradiation processes shown in Table 2. High dose irradiation for powder is not favorable for oligosaccharide production since it leads structural damage of the carrageenan structure at 200 kGy and above. This was proven by dynamic light scattering studies of irradiated carrageenan. Low dose irradiation is suitable for production of oligosaccharides from carrageenan. This was done using dilute solution of carrageenan or using low molecular weight (LMW) carrageenan in concentrated solution as starting material.

Table 2. Process for preparation of carrageenan oligosaccharides

Type of carrageenan	Irradiation condition	Bioactivity tests
kappa iota	Solid state, 100 kGy, ambient	Rice seedling/Vegetable by hydroponics
Ka kappa	1%, 30 kGy	Tissue culture of potato
Hydrolyzed kappa	4%, 15 kGy	Seed germination of soybean

(2) Basic researches

Studies on radiation effects on carrageenan have been done extensively and results are published in international journals.

(a) L.V. Abad , S. Okabe, M. Shibayama, H. Kudo, S. Saiki, C. Aranilla, L. Relleve, and A.M. De la Rosa, 2008. Comparative studies on the conformational change and aggregation behavior of irradiated carrageenans and agar by dynamic light scattering. Int. J. Biol. Macromol, 42, 55-61.

(b) L.V. Abad, S. Saiki, H. Kudo, Y. Muroya, Y. Katsumura and A.M. De la Rosa, 2007. Rate constants of reactions of κ-carrageenan with hydrated electron and hydroxyl radical. Nuclear Inst. and Methods in Physics Research, B, 265, 410-413.

(c) L.V. Abad, S. Okabe, S. Koizume, M. Shibayama, 2006. Small-angle neutron scattering on irradiated kappa carrageenan. Physica B, 381, 103-108

IV. Socio-economic Impact of Project

This project is embodied in one of the programs in the Medium-Term Nuclear Science and Technology Plan of PNRI, in support of the National Science and Technology Plan of the DOST and the Medium-Term Philippine Development Plan, 2004-2010.

The project addresses to the challenge of improving the quality of Filipino life through:

- provision of low-cost and high quality products from locally-available resources processed by radiation technology and;
- conduct of quality research for development of new materials for various applications.
- realization and delivery of technical results to end-users through technology transfer

V. Future Plans

The PNRI has signified participation to the following research activities for the next phase.

1. Radiation degradation of chitosan and carrageenan

General Activity:

Field test using oligo-chitosan provided by BATAN through large scale demonstration and oligo-carrageenan produced by PNRI as plant growth promoter/elicitor.

Specific Activities:

(1) Conduct in-house small-scale field test in collaboration with Agriculture Research Group, PNRI
(2) Conduct large-scale field test in collaboration with IRRI

2. Hydrogel application for health care

Study on the effects of addition of antibacterial agent (silver nano-particle, etc) on PVP-Carrageenan hydrogel.

3. Other basic studies

(a) Characterization of irradiated carrageenan fractions
(b) Biological testing and antioxidant properties of irradiated and non-irradiated commercial grade and dried carrageenan seaweed sap for tissue culture
(c) Carboxymethylation of kappa-carrageenan seaweed and crosslinking of derivative for synthesis of super absorbent material as soil conditioner.

Summary of the FNCA 2008 Public Information of Nuclear Energy

Mr. Minoru KUBO
Project Leader of Japan
Executive Officer, Director of Public Relations Department
Japan Atomic Energy Agency (JAEA)

1. FNCA 2008 Project Leaders Meeting on Public Information of Nuclear Energy

(1) The FNCA 2008 Project Leaders Meeting (PLM) on Public Information (PI) of Nuclear Energy was held on November 10 – 14, 2008 at Zi Yu Hotel in Beijing, China.

(2) The China Atomic Energy Agency (CAEA) and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan jointly hosted the Meeting in cooperation with the Nuclear Safety Research Association (NSRA) of Japan and the International Atomic Energy Agency (IAEA).

(3) Following the Opening Session, a presentation of the country reports was made by each FNCA PI PL. The topics covered in the country reports consisted of the public information activities in FNCA member countries (exhibition, seminar, lecture, meeting etc). And the "IAEA Support for Introduction to Nuclear Power" was presented by IAEA from the viewpoint that the IAEA plays in providing assistance to countries with nuclear power plants and to those planning to build one.

(4) "Forum on Nuclear Energy: Prospects and Development" was held at the Zixiayuan Meeting Room. Five speakers presented the topics on the energy issues. 60 participants took part in the forum.

(5) An Information Workshop on Risk Communication for Nuclear Communicators, which was jointly organized by the IAEA and MEXT, was held during two days at the Zixiayuan Meeting Room. About 40 participants (composed of PI PLs and local participants) attended the workshop. However, the PI PLs had the opportunity to attend only the first day's session and participate in the practical exercise on risk communication of a "Proactive Scenario for Nation Introducing a NPP".

(6) Information exchange has served as a very valuable tool for the promotion and dissemination of nuclear information. Hence, as recommended in the past PI PL meeting, the sharing of DVD and printed materials among FNCA member-countries should be continued. DVDs, pamphlets and posters have been presented and shared among member countries.

(7) It was decided in the PIPL meeting that each country would conduct an opinion survey and report the results or status in the meeting in 2007. In this regard, all the PIPLs presented their

report /status of the opinion survey. The proposed opinion survey on nuclear power under the FNCA was also discussed. The PIPLs agreed to have common questions suitable to all member countries. The initial questionnaires should be prepared by first quarter of 2009.

(8) Future plans were discussed such as the next PLM on PI, the opportunities for media, diplomats, minister's councilors and NGOs to attend seminars/workshops on nuclear energy and to visit nuclear facilities in countries with advanced nuclear power program.

2. Regional Speakers Bureau (RSB) in Malaysia

The workshop on the Scientific Meeting on Medical Imaging will be held on 14th of March, 2009, at Kota Bharu, Kelanta in Malaysia. 2 speakers are requested in the field of the Medical Imaging and Public Information with regards to the RSB.

Summary of Review of HRD and ANTEP

Dr. Jun SUGIMOTO
Project Leader of Japan
Director, Nuclear Technology and Education Center (NuTEC)
Japan Atomic Energy Agency (JAEA)

The objective of FNCA Human Resources Development (HRD) Project is to strengthen the foundation of nuclear technology in Asian countries by performing HRD related activities, such as understanding the needs of HRD in the nuclear field, exchanging information and survey on nuclear HRD, discussion on future HRD cooperation and joint study of training materials. Currently HRD Project focuses on ANTEP (Asian Nuclear Training and Education Program), which has a function of information exchange and coordination between available HRD programs and needs from FNCA member countries.

FNCA 2008 Workshop on HRD was held on November 2-4, 2008 in Dhaka, Bangladesh. It was reported that 18 (7: long-term, 11: short-term) out of 65 possible matching cases have been successfully implemented in Japan's program through ANTEP for 2008-2009. Survey of HRD needs and program for 2009 has been conducted, and out of 74 continuing and additional needs, 56 needs have been identified as relevant of programs in ANTEP. It is emphasized that HRD needs should be consistent with each country's national nuclear programs and priorities.

Nuclear human resources development has been identified as one of most important issues in FNCA countries with expanding use of nuclear technology. FNCA HRD Project has contributed to strengthen the foundation of nuclear technology in Asian countries by HRD related activities, including the establishment of ANTEP. Improvement of ANTEP functions, such as increased program matching with needs, increased offers of program and contribution, and enhanced cooperation between ANTEP and IAEA is to be pursued.

For inclusion in Australia's paper for the FNCA OM & MM November 2008

PROPOSED NEW PROJECT

Dr. Ron Cameron
Chief of Operations
Australian Nuclear Science and Technology Organisation (ANSTO)

The FNCA Nuclear Safety Culture Project held its final workshop meeting in Beijing 26-27 March 2008.

Prior to that final workshop, Project Leaders and participants were asked to complete a survey outlining the main highlights of the project for their country or institute, and make suggestions for a possible replacement project. The following options were put forward and considered:

- Continue Safety Culture Project with some re-scope and taking into account new documents
- Knowledge Management in Research Reactors
- Ageing Management in Research Reactors
- Operational Safety of Research Reactors
- Safety Management Systems

These were discussed in some detail at the workshop and, although potential benefits as well as drawbacks were identified with each option, the meeting participants felt that each of the options were potentially beneficial overall. On this basis, the workshop participants chose not to make a specific recommendation as to which should be selected and pursued.

In consideration of the final report of the FNCA NSC project, Australia proposes a new project on Safety Management Systems to be part of the FNCA programme. This new project would be an evolution of the NSCP in that it will build on some of the self-assessment and peer review framework.

For the project to be successful, the host country/institute would need to be ready to accept a peer review, which is a fundamental component of the five project designs. As with the NSCP peer review process, it is not the intention to impose a review on member countries but it is hoped that, in the spirit of mutual cooperation, each participating country feel able to accept this requirement.

Aim of proposed project

To identify key aspects of Safety Management Systems for Research Reactor Facilities; to develop peer review methodologies; and, by mutual agreement undertake such peer reviews at designated institutes.

Project process

The project would undertake the following steps:

- Conduct a workshop to identify key aspects of Safety Management Systems for Research Reactor Facilities;
- Work with ANSN TG SM RR on developing the most significant aspects;

- Invite delegates to seek permission from their institutes/countries to host a peer review;
- Undertake the peer review and report at next workshop.
- Repeat process at different host countries for five years.

Expected benefits

The project would deliver the following benefits

- Clear enunciation of the key elements and expectations of the safety management system in relation to management of Research Reactor Facilities;
- Interaction between ANSN TG and FNCA project;
- Self-assessment and assessment by peer review of the degree of implementation of those elements / expectations;
- Feedback from the reviews at plenary workshops on findings and responses;

Resources needed

The funding requirements for this proposed project would be similar to those for the existing NSC project. ANSTO would have to formalise this and prepare budgets. Australia is proposing to pay the travel and accommodation of one delegate from each participating country, (except Japan which will fund their own participants). Initially workshops would be held to develop the self-assessment and peer review questions and prompts. Once defined, and a willing host country/organisation found, the peer reviews would commence, one per year, possibly separate from the workshops and with a smaller group than the full workshop.

Overlap / interaction

This project could overlap with the ANSN Topical Group on Safety Management of Research Reactors (TG SM RR), but the overlap could be managed by close interaction and coordination, to jointly develop the list of essential elements. The ANSN TG SM RR has a similar scope but ANSN does not usually undertake peer reviews or assessments.

Timing

It is proposed to hold the initial workshop in the 3rd quarter 2009, and the first peer review in 1st quarter 2010.

While ever there is a perceived ongoing benefit, the peer reviews and workshops should continue annually.

However, we propose to have a conclusion date for the project, tentatively set for the end of 2015. This could be extended if there is perceived ongoing benefit and budgetary and other resources.

Formal Proposal

This paper constitutes the formal project proposal put forward by Australia.

Present Status of the Nuclear Safety Culture Project

Dr. Tsutomu Yokoyama
Project Leader of Japan
Counseling Expert, International Relations Office
Incorporated Administrative Agency Japan Nuclear Energy Safety Organization
(JNES)

[1] Objective of the Project

- Establishment of a forum for information exchange on safety culture development
- Encouragement of adoption of safety culture principles in national policies for research reactors
- Development of safety culture performance indicators and evaluation with the indicators
- Encouragement of application of the principles of the Nuclear Safety Convention principles to research reactors

[2] Achievements from March 2008 to February 2009

(1) Project assessment

Project assessment by participants at 2008 March workshop in Beijing concluded that:

- the project provided an excellent opportunity for participants to learn from each other,
- the project had significant positive impacts in the member countries to promote strong NSC,
- the project encouraged strong commitment to furthering NSC in the member countries,
- a new project is expected to be initiated following the completion of NSC Project.

(2) Drawing up of Project Summary Reports

ANSTO (Australia, project leader) and NSC Japan Operation Group summarized the project achievements in summary reports.

[3] Specific Social Impacts of the Project

The status of the development of nuclear safety culture is described by the following stages:

Stage I: Compliance with safety regulations as an organizational goal.
Stage II: In addition to compliance with regulations, awareness and pursuit of safety performance are set as organizational goals.
Stage III: High level awareness of safety is achieved and sustainable safety improvement activities are being promoted by all individuals.

At the start of the Project, many of the participating countries were at the Stage I. After 11 years operation of the Project, nuclear safety culture in all the participating countries has been significantly improved and reached the Stage II.

[4] Activities planned for FY2009

It was concluded that the Nuclear Safety Culture Project has attained its original objectives. On the other hand, many of the participating countries are expressing their intention to introduce nuclear power generation programs, which means that improvement of safety culture is becoming even more important as a key issue for successful introduction of nuclear power generation. Considering such situation, a proposal of a new project or joint activity with the IAEA's ANSN project is expected.

Radiation Safety and Radioactive Waste Management (RS&RWM)

Prof. Toshiso Kosako
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(1) Objectives for RS&RWM project

- Enhance the quality of Radiation Safety and Encourage the good Management of Radioactive Waste
- Information Exchange to Enhance Regional Cooperation in RS&RWM
  - Introduce International Movement and Issues, and Facilitate Good Understanding of RS&RWM
  - Provide practicable information concerning Safety Principles and Regulatory Systems on RS&RWM
  - Application of Technology on RS&RWM

(2) Workshop in FY2008

a. Time and Venue

FNCA2008 Workshop on the Radiation Safety and Radioactive Waste Management（RS&RWM）was held in Sydney Australia from November 3 to 7, 2008, hosted by ANSTO and MEXT.

b. Confirmation and Agreement

All FNCA PLs recognized the valuable technical discussions and networking opportunities provided by the FNCA RS & RWM Workshop. The benefits of this workshop included information exchange and the sharing of experiences on common radiation safety and radioactive waste management issues. The PLs were unanimous in their support for the FNCA RS&RWM workshop and the need to sustain this cooperation to ensure that radiation safety and radioactive waste management issues are being continually addressed in this region.

(3) Achievement and Next Steps

Achieved in 2008:

- Agreed with establishing a consolidated report on Radiation Safety
- Information and opinion exchange for the siting design of RW disposal

Expected in 2009:

- Preparation for a consolidated Report
- Information and opinion exchange for radiation measurement systems
- Review and discussion for calibration and standardization on radiation measurement
- For facilitating above subjects, HP will be used and Newsletter will be published twice

- 2009 RS&RWM workshop will be held in Vietnam, hosted by VAEC.

Next Step

2010 RS&RWM workshop is expected to be held in Tokyo in accordance with AOCRP-3.(AOCRP: Asian Oceanic Congress on Radiation Protection)