Nuclear Sociology: A Unique Experience for Human Resource Development

Jor-Shan Choi
Nuclear Non-Proliferation Research Laboratory
Department of Nuclear Engineering and Management

International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programs

Abu Dhabi, United Arab Emirates

17 March 2010
Objective of Nuclear Sociology Study

Foster future nuclear professionals

Integration of Knowledge

Policy and Regime
Nonproliferation
Peaceful Use of NE

Technology
Nuclear Engineering, &
Safeguards Technology
Unique Feature of Nuclear Energy Program in Japan

The Only Non-Nuclear Weapon State with Commercial Nuclear Fuel Cycle Facilities under NPT

Rokkasho Enrichment Plant (JNFL)

Tokai Plutonium Fuel Center (JAEA)

Light-water reactor 55 Units
(49.58GWe)

Prototype FBR “MONJU” (JAEA)

Rokkasho Reprocessing Plant (JNFL)

Tokai Reprocessing Plant (JAEA)
Nuclear Engineers graduated from Universities in Japan

Ministry of Education, Culture, Sports and Technology
Human Resource Development in Japan

**Industry**
- Power company: 10,000
- Manufacturer: 56,000

**University**
- Graduates: 450/year

**Regulatory Agency**
- NSC: 100
- NISA: 330
- JNES: 240

**Research Institute**
- JAEA: 4,000

Loan employee

Training program

Newly employment

Lecture / Join research / Human resource development

Support / Training program

NSC: Nuclear Safety Commission in Japan
NISA: Nuclear Industry and Safety Agency
JNES: Japan Nuclear Energy Safety Organization

JAEA: Japan Atomic Energy Agency

Source: S. Tanaka, 1st FNCA Panel Mtg., 2007
Human Resource Development at the University of Tokyo

- Japan’s “Nuclear Energy Policy” encourages the cooperation among the government, universities and related organizations.

- The University of Tokyo (Todai) re-established Department of Nuclear Engineering and Management in the graduate school of engineering on April 1, 2005.

- Education on Nuclear Nonproliferation started in the Department – “Nuclear Non-Proliferation Research Laboratory” : A cooperative program between Todai and JAEA.
Tokyo University: Global COE Program (2007 – 2012)

Nuclear Education and Research Initiative

Systematic Education and Research including Nuclear Energy Sociology

Nuclear Energy Sociology
What is Technology for Society?
In collaboration with people outside Univ.

Nuclear Energy
Technology Innovation
Through comprehensive and interdisciplinary approach

Radiation Application
Therapy, diagnosis, biology, etc.
Spread in interdisciplinary fields: medicine, agriculture and so on

“We prepare next generation researchers to grasp the perspectives of complicated and divergent fields of nuclear energy.” - Dr. Yoshiaki OKA, Prof. UT, Program Leader -

Nuclear Non-Proliferation
- To coexist with the peaceful use of nuclear energy
- To identify the technological and systematic problems
Main courses of study in the Department

- Advanced Nuclear Energy
- Advanced Accelerators and Medical Physics
- Nuclear Socio-Engineering
Present Lectures in Nuclear Non-Proliferation Studies

• International Projects and Cooperation
  - Energy and Nuclear Program of individual countries (USA, Europe and Asian countries)
  - Projects of International Nuclear Cooperation, GEN-4, INPRO, etc.
  - Projects by Nuclear Energy Agency of OECD
  - CTBT
  - Cooperation on denuclearization, etc.

• International Nuclear Nonproliferation Policy
  - Chronology of international nuclear nonproliferation
  - International law and regimes related to nuclear nonproliferation
  - Regional issue on nuclear nonproliferation
  - Disarmament council
  - Various concepts of international security
  - Nuclear non-proliferation issues in Middle-east, North Korea, South Asia.
  - WMD and terrorism

• International Safeguards
  - Chronology of international Safeguards system
  - State system for accountancy and control
  - Safeguards Technologies, Inspection & complementary access, etc
  - Proliferation Resistance Technologies
  - Monitoring System of CTBT
  - Export control, Physical Protection, etc.
Students Benefited by Out Reach Programs

- Internship to IAEA, JAEA, other organizations,
- Participations in forum, workshops, summer schools with other universities,
- Conducting research in the Non-Proliferation Research Laboratory

G-COE Students in International Transparency Workshop on Regional Nuclear Non-Proliferation in Asia Pacific (20-22 Feb. 2008)
Students Benefited by Out Reach Programs

Cooperation with IAEA - Safeguards Training Course

Safeguards Training Course are conducted by JAEA under entrustment by MEXT of Japan.

Participants: mainly from Asian countries (Kazakhstan, Uzbekistan, China, Bangladesh, Malaysia, Indonesia, Thailand, Myanmar, Vietnam, Singapore, Korea)

October 20-31, 2008
Students Benefited by Outreach Programs

Student Participation in Todai Forum in Cambridge University (UK), Nuclear Nonproliferation Workshop (28 April 2009)

Students met Mr. Amano, DG of IAEA when he visited our Lab in Nov. 2009
A New Nuclear Non-Proliferation Study Committee

• A new study group on nuclear non-proliferation was formed in UT in October 2008.
• The group consists of UT staff, UT PhD students, engineers/researchers from nuclear industries, utility companies, JAEA, and journalist.
• Many non-proliferation-related issues (technical and political) are discussed with wider views.
• The group discussed the viability of nuclear fuel cycle concepts including multilateral/multinational control and fuel supply in Asia.
Current Research/Studies at Nuclear Non-proliferation Research Laboratory

• Nuclear Nonproliferation Policies
  – India-USA Civilian Nuclear Agreement
  – Assurance of nuclear supply/Multi-national Approach on Nuclear Fuel Cycles,
  – Building nuclear nonproliferation culture,
  – Study on International Laws,
  – Solution of CTBT
  – International and Regional Cooperation and Transparency study

• Nuclear Nonproliferation Technologies
  – Proliferation-Resistant Technologies
  – Advanced Technologies for International Safeguards
  – Verification of states’ intention (Efficient Information System)
  – Others
Multinational Approach to Nuclear Fuel Cycle

Current business practice for fuel-cycle services

**Front-End**
- Utility/Reactor Operator
- Contract
- Yellowcake
- Fuel Suppliers

**Back-End**
- Spent Nuclear Fuel (SNF)
- SNF On-site Wet Storage
- Contract/Nuclear Agreement
- On- or Off-site Dry Storage
- Reprocessing
- Repository currently not available

Separate contracts for fuel services, Enrichment service could be political and restrictive

Reprocessing service restrictive, No repository available, Utilities constipated with spent fuel
Indefinite Spent Fuel Storage

Key Decisions on Spent Fuel Management:

<table>
<thead>
<tr>
<th>Before:</th>
<th>What can be done</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of full core reserve</td>
<td>Re-rack</td>
</tr>
<tr>
<td></td>
<td>Transfer to pools of co-located reactor(s)</td>
</tr>
<tr>
<td></td>
<td>On-site dry storage</td>
</tr>
<tr>
<td></td>
<td>Transfer to away-from-reactor storage (AFR, wet or dry)</td>
</tr>
<tr>
<td>End of plant operation</td>
<td>On-site dry storage</td>
</tr>
<tr>
<td></td>
<td>Transfer to AFR storage</td>
</tr>
<tr>
<td>Plant decommissioned &amp; returned</td>
<td>Transfer to AFR storage</td>
</tr>
<tr>
<td>to green site</td>
<td>Transfer to disposal repository</td>
</tr>
</tbody>
</table>

The US experience on Spent Fuel Storage (years)

- Wet: Longest >40
  Average: 16-25
- Dry: Longest >20
  Average: 12-16
- The USDOE has opened and inspected dry storage casks at INL

Indefinite spent fuel storage will eventually lead to the need for centralized AFR storage. Could regional storage be possible? How to start?
Multinational Approach to Nuclear Fuel Cycle

A new model of fuel-cycle services for newcomer countries

**Front-End**
- Spent Nuclear Fuel (SNF)
- Utility/Reactor Operator
- Contract
- Fresh Fuel Supply

**Back-End**
- SNF On-site Wet Storage
- SNF take-back/take-away?

A Nuclear Consortium

**Increased interest in packaged deal for fabricated fresh fuel**

**Can packaged deal for spent nuclear fuel be provided?**
Possible Outcome

- Newcomer countries have access to nuclear power at market prices.
- Fresh fuel supplies are assured at competitive prices.
- Spent fuel from less-stable region of the world could be taken-back/taken-away on a contractual and time basis.
- Spent fuel in existing nuclear programs can be managed in a cooperative manner.
- Spread of sensitive fuel cycle technologies (enrichment/reprocessing) reduced or eliminated.
- Allow the expanded use of nuclear energy with reduced proliferation risks and environmental/waste burden.

- This is not a restriction to a country’s own fuel cycle development.
- It is an option aiming at improving nonproliferation and waste management.
- If a country decides to develop its own enrichment and reprocessing, it will have to deal with the nonproliferation and wastes issues and conform to international safeguards, safety, and security standards.
Future Challenges

• To produce graduates who can contribute to nuclear non-proliferation in international organizations like IAEA,
• To truly merge engineering education and sociology education,
• To maintain intern program; continuous dispatch UT students to IAEA, JAEA and other nuclear fields,
• To improve and maintain quality of lectures by invitation of world class experts and to motivate the student,
• To find more international exchange opportunities (longer term) to promote students in this course,
• To steadily develop meaningful research in the Non-proliferation study committee and to convey clear messages to global nuclear community on nuclear non-proliferation.
Thank you for your attention.