Technical Meeting on Strategies and Opportunities for the Management of Spent Fuel from Power Reactors in the Longer Timeframe (International Atomic Energy Agency/IAEA)

Feasibility of Japanese nuclear fuel cycle by overlooking energy scenario, R&D and human resource development towards 2100

25th, Nov. 2019 16:00～16:30
@Global Centre for Nuclear Energy Partnership (Bahadurgarh, India)

Isamu SATO (Tokyo City University)
Tadashi INOUE (Central Research Institute of Electric Industry)
Reiko FUJITA
Contents

1. Self-Introduction: Isamu SATO of TCU

2. Japan situation in the Nuclear cycle industries fields

3. Introduction of research committee’s activity of “Atomic Energy Society of Japan”

4. TCU example of attracting “human resource” (one of “staffing” who has nuclear engineering skills)

5. Conclusion
1. Self-Introduction: Isamu SATO of TCU 1/2

【Place of birth】: NAGASAKI (the last atomic bombed place)
→"Atomic Energy" became one of my most interests in my life.

【Experience1】: working in Japan Atomic Energy Agency for 15 yrs
- Post Irradiation Examination (PIE) for the Fast Reactor 'JOYO'
  concerning FP behavior
- MOX fuel design for MONJU fuel at the restart (~2006)
  concerning fuel material properties
- High temperature behavior of FP in irradiated fast reactor fuels
  concerning FP release behavior in SA

PIE facility of JAEA(Oarai)

Most of PIE facility of JAEA is used for 3, 4 decades yrs,
there are many problem on the radioactive wastes,
also including irradiated fuel handling.
Then, TEPCO Fukushima-Daiichi NPP accident happened.

My interesting moved to irradiated fuel handling.
1. Self-Introduction : Isamu SATO of TCU 2/2

【Experience2】：working in Tokyo institute of Technology for 1.5 yrs
-Project managing of a MEXT project: “Advanced Research and Education Program for Nuclear Decommissioning”
  concerning TEPCO Fukushima Daiichi NPP decommission

【Experience3, Now】：working in Tokyo City University
-Classes : “Nuclear fuels and materials engineering”
  “Nuclear Decommissioning engineering”
  “Backend safety engineering advanced”
  and etc.

-Research:
  “Fundamental research on effective utilization of metallic FP particles”
  “Experimental research on metallic FP behavior during making high level radioactive wastes” and etc.

Simulated metallic FP
2. Japan situation in the Nuclear cycle industries fields 1/5

【The dawn of nuclear industry (1940〜1970)】
- 1954, The policy decision: Peaceful use to atomic energy
  → “Atomic energy law enactment” (1955)
- Relative **organization** establishments
  → Atomic energy commission (1956)
  → Nuclear fuel Corp. (1956)
  → Japan atomic energy research institute (1956)
  → Japan atomic power Co. Inc. (1957)
  → Power reactor and nuclear development Corp. (1967)

【"Modification and Standardization” (1970〜1980)】
- The first, second and third modification and Standardization were conducted to modify the nuclear plants economically and efficiently.

The number of plants and nuclear electricity ratio increased gradually until 2011, although we had the largest issue; **irradiated fuels**.
2. Japan situation in the Nuclear cycle industries fields 2/5

【The “nuclear Renaissance” in Japan (2004 ～, before “2011”)】
- Although “TMI-2” and “Chernobyl” accidents happened, Japan nuclear industry proceeded successfully.

【Electricity generation ratio in Japan】

The trend was forward to only one side direction, which leads to nuclear Increase without consideration of irradiated fuel treatment.
2. Japan situation in the Nuclear cycle industries fields 3/5

【Today’s situation in Japan (after “2011”)]

- TEPCO Fukushima Daiichi NPP accident happened as a trigger of “Great East Japan earthquake”.

- “Nuclear severe accidents”, re-recognition for all of Japanese people (including radioactive materials)

- The NPP licensing process (for re-start) became to be more difficult.

- Although a part of Japanese people have been taking objection to “Nuclear Power” before this accident, the Japanense present movement looks like “one-sidedly”, without consideration of whole energy issues.
2. Japan situation in the Nuclear cycle industries fields 4/5

【Today’s situation in Japan (after “2011”)]

- Rokkasho Reprocessing Plant: The plant stops after the start of “the Active Test (from 2006)”, because it has some troubles on some technical and political matters. The schedule is terribly late. 
  ……………….I don’t know which they’re serious or not.

- The porotype fast breeder reactor, “Monju”, is going to be in the decommissioning process, now the irradiated fuels are removed from the core to the pool.
  ……………….even for wide understanding people, the decommissioning process might mean that FBR is not suitable to this society......It looks like this.

- In Japan or the World, what kind of aspects does the nuclear industry including reprocessing and, of course, nuclear waste face on? Don’t we need to think about global warming?
2. Japan situation in the Nuclear cycle industries fields 5/5

【Picking-up some important key words in Japan】
- Decommissioning of TEPCO Fukushima-Daiichi NPP
- Electricity generation needed for the social scenarios
- Fast reactor development needed for the material balance
- Reprocessing plants needed for the material balance
- Irradiated fuel treatment (some options)
- Radioactive waste (especially high level)
- To prevent the Global warming
3. Introduction of Research Committee’s Activity of “Atomic Energy Society of Japan” 1/7

“Research Committee on Feasibility of Nuclear Fuel Cycle”

【The aim of establishment of this committee】
- We recognize that Japan is facing toward a crossroad, which the nuclear industry proceeds or quits. It includes decisions of how to, what, why and what speed.
- Japan society prefers to “stable”. Saying in the nuclear field, more than 8 yrs after the 1F accident, “the original scenario” might take up its old position, which means the nuclear industry trend will go forward to only one side direction. In the other words, it would lead to nuclear Increase without consideration of irradiated fuel treatment, and without self-examination for 1F.
- It is never acceptable for the society, we feel.
3. Introduction of Research Committee’s Activity of “Atomic Energy Society of Japan” 2/7

“Research Committee on Feasibility of Nuclear Fuel Cycle”

【The aim of establishment of this committee】

- “Apart from the original scenario”, we have to discuss aspects for the nuclear industry to proceed. Therefore, the committee must be organized by members who have experiences in wide nuclear fields.

- Industry-University-Government
- Reprocessing
- Nuclear fuel fabrication or PIE
- Chemical processing
- Strategy
- Core design
- Fuel design
- Radioactive waste management

【Experiences of members】

- The main themes are as follows;
  - Irradiated fuel options (reprocessing, disposal, long term storage)
  - Plutonium treatment (no use, use in FR)
  - Human resource development

【Overlooking social consensus】

on the basis of

Energy strategy, Uranium resource, Reprocessing, Nuclear cycle strategy, Fast reactor
3. Introduction of Research Committee’s Activity of “Atomic Energy Society of Japan” 3/7

“Research Committee on Feasibility of Nuclear Fuel Cycle”

Various quantity evaluation related to nuclear electricity generation
(We need the Various quantity evaluation as a base data and/or members’ consensus)

Main parameters
- Nuclear electric power generation (A: ↑, B: →, C: ↓)
- The reactor type (LWR, FR)
- Reprocessing (yes, a part yes, no)
- Plutonium treatment (LWR-MOX, FR-MOX, store)

Evaluation points
- How much uranium resource will we need?
- How much stored irradiated fuel will we have?
- When and how many reprocessing plant will we need?
- Will Plutonium be remained or not?
- How much radioactive waste will we have?

Conducted by K. Nishihara (JAEA)

Nuclear Material Balance code*1

3. Introduction of Research Committee’s Activity of “Atomic Energy Society of Japan” 4/7

“Research Committee on Feasibility of Nuclear Fuel Cycle”

【Various quantity evaluation related to nuclear electricity generation】

Electricity generation (GWe)

A: ↑
Nuclear power: ~40%

B: →
Nuclear power: ~21%

C: ↓
Nuclear power: 0%
3. Introduction of Research Committee’s Activity of “Atomic Energy Society of Japan” 5/7

“Research Committee on Feasibility of Nuclear Fuel Cycle”

Various quantity evaluation related to nuclear electricity power generation

Results: B2

Plutonium generation

The reactor: only LWR

- Stored Pu
- Pu in LWR-MOX
- Pu in irradiated UO₂

Plutonium (10³ kg)
The amount of stored plutonium depends on used reactor type, because the phase to utilize FR mainly is late.

In a case that only LWRs continue to use, “non-useful” plutonium increases.
3. Introduction of Research Committee’s Activity of “Atomic Energy Society of Japan” 7/7

“Research Committee on Feasibility of Nuclear Fuel Cycle”

【The goal of this committee】
- Around 2100, will the electricity generation situation be suitable to the society?
We are taking effort to obtain “RECOMMENDATIONS” with social consensus to support the question above.

【Base data】
- Various quantity evaluation
- Recent energy strategy
- Reprocessing & FR develop.
- Uranium resource
- and so on

【Arguing points from each member】
- Quite-free opinions apart from each position (which is similar to the society?)

【Analysis of each point by small groups】
- “small group” means well-understand will be obtained.
- “Scenario planning” method will be used.

“RECOMMENDATIONS” with social consensus
- Scenario
- R&D
- Human resource develop.
4. TCU effort of attracting “human resource” (one of “staffing“ who has nuclear engineering skills)

【Human resource development】
- Human resource development is one of large themes in the Japan nuclear field. At first, attracting students is important. Why do we do?

【Emphasis Research】 in AERL of TCU
“Research on Effective Utilization of FPs”
- Metallic FP inclusions of Pd-Ru-Rh-Tc-Mo could be used “directly” in limited areas?
- Because they are radioactive, what is those benefits?

4. Conclusion and….. 

• Japan situation in the Nuclear cycle industries fields  
  - 1F NNP decommissioning is most important, in addition, we must consider the nuclear industry in Japan on the basis of situations such as electricity generation, social scenarios, reprocessing, irradiated fuel, fast reactor, waste and global warming.

• Introduction of research committee’s activity of “Atomic Energy Society of Japan”  
  - Research Committee on Feasibility of Nuclear Fuel Cycle has established. In the committee, we are discussing on a lot of nuclear fields containing the social matters to contain “RECOMMENDATION” with social consensus to make decision on Scenarios, R&D and Human resource development in the nuclear field.

• TCU example of attracting “human resource”  
  - Atomic Energy Research Laboratory of TCU conducts 【Emphasis Research】“Research on Effective Utilization of FP’s” as a attractive research for human resource staffing.
4. Conclusion and.....

【The last of palm tree in EASTER island】

In a book “Collapse: How Societies Choose to Fail or Succeed” written by Jared Mason Diamond (2005)

In the old days, EASTER island is subtropical zone, where there were a lot of plants, of course, tall palm trees too. But, now, it don’t have large plants containing palm trees, and it is quite dry. Why?

They were made by the people’ muscles, so many “ropes” made of palm tree were needed.

Why did they make them?

Authority display......

They had understood to damage the environment by cutting trees.

In the nuclear fuel cycle,
What is palm tree?
What do we do for what?
Here, What is “think”, and what is “consider”?

Moai statue

In the old days, EASTER island is subtropical zone, where there were a lot of plants, of course, tall palm trees too. But, now, it don’t have large plants containing palm trees, and it is quite dry. Why?

They were made by the people’ muscles, so many “ropes” made of palm tree were needed.

Why did they make them?

Authority display......

They had understood to damage the environment by cutting trees.

In the nuclear fuel cycle,
What is palm tree?
What do we do for what?
Here, What is “think”, and what is “consider”?

Jared Diamond
(Prof. of UCLA)
Thank you for your attention!!