

Trip Report
Nuclear Safety Research Forum 2007
March 9, 2007, Tokyo, Japan
J.S. Armijo, ACRS¹

Background:

The Nuclear Safety Research Forum 2007 was sponsored by the Nuclear Safety Commission (NSC), the Nuclear and Industrial Safety Agency (NISA) of the Ministry of Economic Trade and Industry, and the Ministry of Education (MEXT). This was the first meeting of its kind. I was told that the sponsors hope to hold future meetings on a regular basis. The meeting focused on nuclear safety research related to aging management, and was attended by approximately 500 people from Japanese government, industry and university organizations. The conference program is shown in Appendix 1. All but three presentations were made in Japanese with concurrent translation. Most of the slides however were available in English. Copies of all papers were provided in conference proceedings and CDs. These materials have been provided to the NRC staff.

I attended at the invitation of Chairman Kunihisa Soda of the NSC and presented one of three papers on safety research trends in foreign countries. Dr. Soda's invitation was the result of goals established by the participants at the 2006 Quadripartite meeting, hosted by the ACRS, to continue international technical exchanges on a more frequent basis. The other foreign presenters at the research forum were Dr. Carlo Vitanza of the Organization for Economic Cooperation and Development (OECD) and Dr. Aybars Guerpinar of the International Atomic Energy Agency (IAEA).

Observations and Comments:

Although a number of safety research topics were presented, the conference concentrated on plant aging and materials degradation in Japan. In general the research parallels activities in progress in the United States and Europe. Unlike the United States, Japanese government and university, industry, and technical societies have worked jointly to create detailed roadmaps for safety research. In view of the finite manpower, facility and budget resources available, this level of

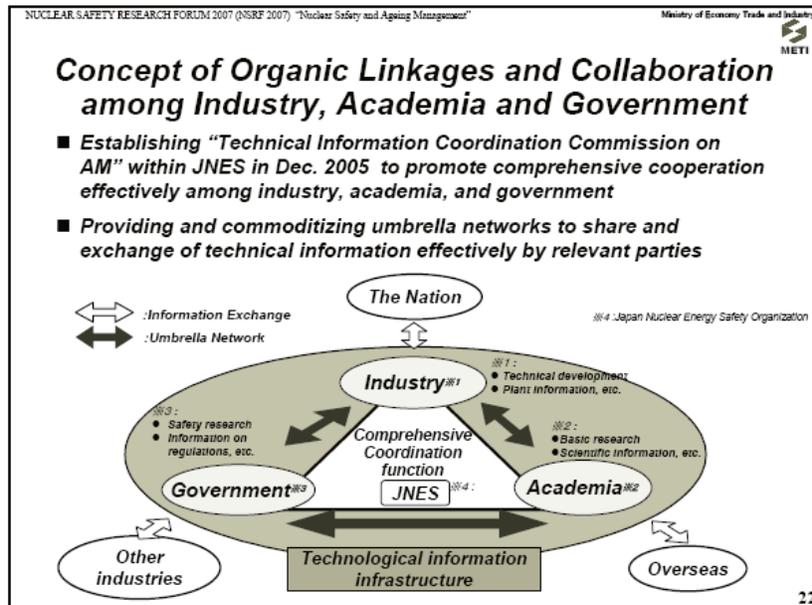


Figure 1. Japanese aging management research concept (from H. Nei, NISA)

¹ The views expressed in this report are solely those of the author and do not represent any position adopted by the ACRS.

integration has the benefit of achieving national consensus on priorities, more focused research programs, and stable funding. The national approach described in Figure 1 does not seem to raise concerns regarding regulatory independence among the Japanese.

Japan has 55 (32 BWR and 23 PWR) nuclear plants, 2 reprocessing plants, and 1 enrichment plant in operation. In addition, 11 nuclear plants will be built in the next 10 years. All of these facilities are governed by “The Framework for Nuclear Energy” issued in October 2005 by the Atomic Energy Commission. Aging management is governed by the “Aging Management Implementation Guidelines for Nuclear Power Plants” and the “Standard Review Plan for Aging Management Technical Evaluation of Nuclear power Plants” issued by NISA. Detailed evaluations are governed by the “Age-Related Technical Evaluation Review Manual” issued by the Japan Nuclear Energy Safety Organization (JNES). The latter manual contains major chapters addressing physical phenomena such as fatigue, stress corrosion cracking, neutron radiation embrittlement, flow accelerated corrosion, insulation degradation, concrete degradation, and seismic safety. It also addresses degradation of safety culture. In addition to regulatory inspections every 13 months and Periodic Safety Reviews (PSR) every 10 years, Japanese plants are required to undergo an Aging Management Technical Evaluation (AMTE) before 30 years of operation. To date 13 plants have completed aging management evaluations. By 2015, 17 additional plants must complete the AMTE in order to continue operation. After that, the plants will receive the regulatory inspections and PSRs as before, and an AMTE every 10 years for an assumed service life of 60 years.

Commissioner Soda’s presentation reviewed the basic policies of the NSC, their prioritized nuclear safety research program, the nuclear research infrastructure, and safety culture. The NSC prioritized nuclear safety research plan governs work over the 2005 to 2009 time period. Research is focused on: improved regulatory systems, light water reactors, advanced reactor and fuel cycle facilities, disposal of radioactive waste and decommissioning, radiation effects, and nuclear disaster prevention. The NSC has increased the priority of aging management and materials degradation research. The primary goals of this research are: to understand the aging mechanisms, to explore technologies to prevent aging-related problems, to predict the progression of aging-related damage, and to develop methods for early detection and evaluation of structural reliability. As part of its research prioritization, the NSC endorses the continued operation of the Nuclear Safety Research Reactor (NSRR), the Large Scale Test Facility (LSTF), the Nuclear Criticality Experimental Facility (NUCEF), and the upgrade of the Japan Materials Test Reactor (JMTR). These are a formidable set of facilities to support fuels and materials safety research and are unmatched in the United States.

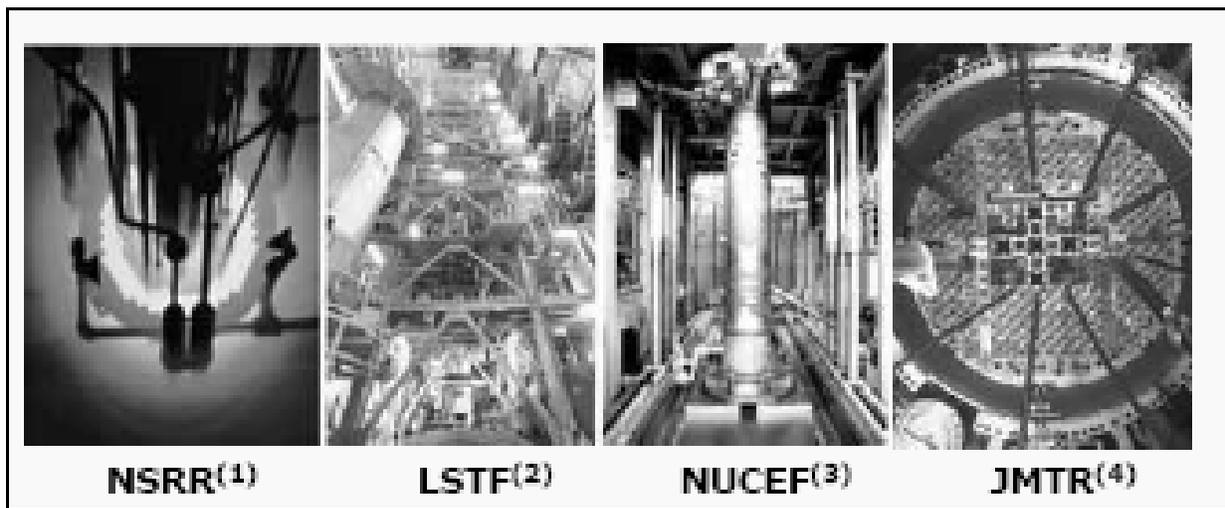


Figure 2. Major Japanese fuels and materials research facilities (From K. Soda, NSC)

Professor Naoto Sekimura of Tokyo University expanded on the development and structure of the aging management safety research roadmaps in his presentation. The development was led by a special committee of the Atomic Energy Society of Japan and included participants from NISA, JNES, universities, research institutes, utilities, engineering companies and nuclear plant fabricators.

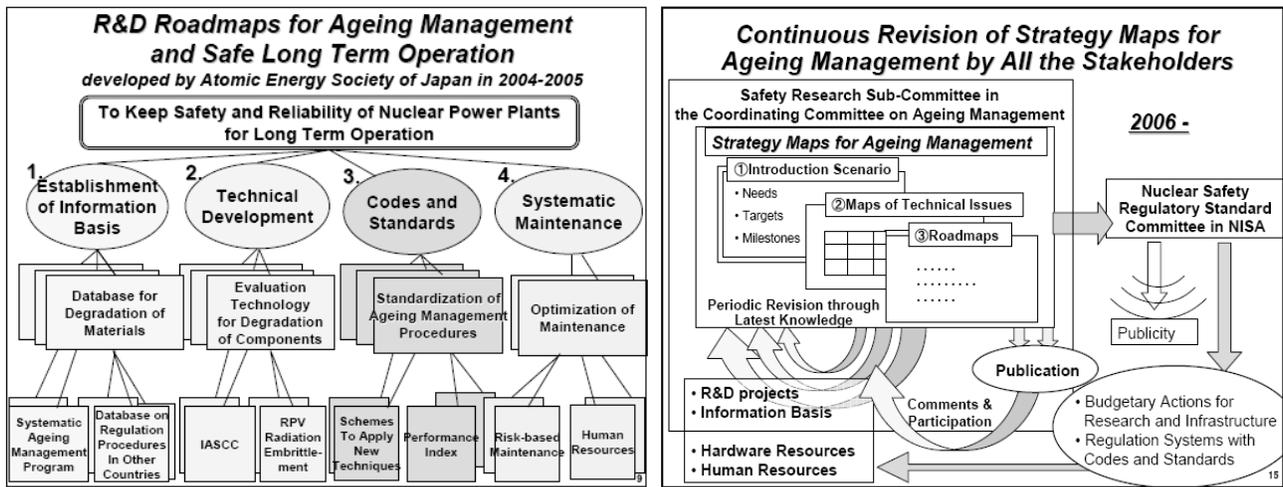


Figure 3. Structure of Japanese aging management roadmaps.

The structure of the current roadmap governing aging management is shown in Figure 3. The roadmap addresses four categories of research. These categories focus on the development of data bases, technical development (R&D), codes and standards, and systematic maintenance. Each category is subdivided into more detailed strategy maps ultimately leading to the selection and

NUCLEAR SAFETY RESEARCH FORUM 2007 (NSRF 2007) "Nuclear Safety and Ageing Management" Ministry of Economy Trade and Industry
METI

"AM Infrastructure Enhancement Project"¹ by the Government

The government publicly sought consigning projects for the purpose of enhancing technological information infrastructure in the "FY2006 AM Infrastructure Enhancement Project" and adopted the following four projects (19 research themes)²

Project	Entity	Project Outline	Research Outline
1 Kinki region cooperative cluster project	Institute of Nuclear Safety System, Inc.	Cooperative project of universities and research institutes in Fukui and the Kansai region with a base in Fukui	Research on the enhancement of management of piping wastage utilizing practical plant data and soundness assessment after repair of facilities
2 East Japan cluster project	Mitsubishi Research Institute, Inc.	Cooperative project of research institutes, academic societies, and manufacturers in the Kanto and Ibaraki region with Tokyo University as its core	Research for comprehensively managing technological information owned by participating organizations and formulating standardizing strategies, research on earthquake safety assessment of ageing piping, and research on assessment of new technologies concerning situation monitoring
3 Tohoku cluster project	Intelligent Cosmos Research Institute	Cooperative project of universities in the Tohoku region with Tohoku University as its core	Research on assessment of mechanism for potential phenomena, surveys on countermeasures, enhancement of accuracy of SCC and piping wastage assessment
4 Ibaraki cluster project	Japan Atomic Energy Agency	Cooperative project of universities and research institutes with Japan Atomic Energy Agency as its core	Research on assessment of embrittlement of weld-heat affected zone of reactor pressure vessels caused by neutron irradiation and assessment of deterioration of cables

¹ ... Scheduled to be implemented for five years from financial year (FY) 2006
² ... There were 7 projects applied in total (38 themes).

24

Figure 4. Materials related aging management research summary.

funding of specific research topics. An example of research activities resulting from this top-down planning (who is doing what) is shown in Figure 4. As shown, the research is distributed by geographic regions and integrated by government, industry or ad-hoc entities. Research work is performed by government laboratories, universities, research institutes, and industry.

An excellent summary of Japanese electric utility activities on plant life management was presented by Yonezo Tsujikura of the Federation of Electric Power Companies. This paper demonstrated consistency with the national plan and focused on aging management evaluations, near and long term plant inspection and maintenance plans, as well as industry funded research and development. This paper identified a plan to develop highly corrosion resistant materials to address materials degradation. Although not discussed in any detail, the approach shown in Figure 5 will use accelerated simulation tests to evaluate materials that are much more resistant to intergranular stress corrosion cracking (IGSCC), irradiation-assisted stress corrosion cracking (IASCC), primary water stress corrosion cracking (PWSCC) and flow accelerated corrosion than those in current operating plants. I believe that this is a very important initiative by Japanese industry. Development and qualification of such materials requires industry commitment and leadership. In view of the past impact of stress corrosion and flow accelerated corrosion on plant safety and economics, we should carefully monitor this research. Surprisingly, I did not hear or see anything about research related to mitigation of materials degradation by improved water chemistry.

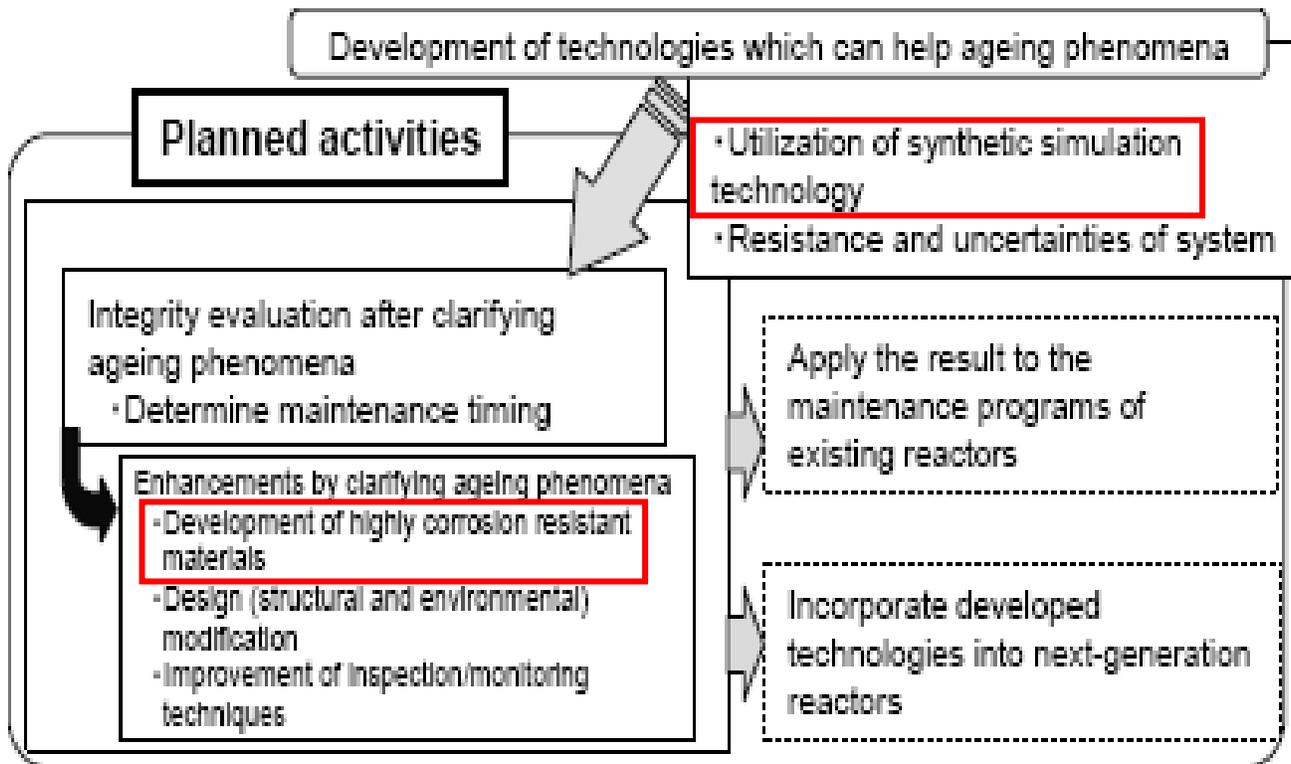


Figure 5 Planned development of highly corrosion resistant materials. (From Tsujikura, FEPC)

Visits to JAEA and Tohoku University:

In addition to the Safety Research Forum, I visited the JAEA and Tohoku University research facilities. Although there was limited time for these visits, my hosts provided good overviews of their research activities.

At JAEA, I reviewed ongoing work on materials degradation issues (IASCC, environmental fatigue and pressurized thermal shock) and fuel issues (LOCA embrittlement and reactivity-initiated accidents). The work is of very high quality and fully consistent with the national plan.

The IASCC test program has required a major investment in the development of facilities and test apparatuses. These tests (performed in the JMTR) are yielding continuous crack growth measurements in near-prototypic reactor environments. Tests to date have demonstrated the effectiveness of hydrogen water chemistry in suppressing stress corrosion crack growth in type 304 stainless steel in BWR water. In addition, these tests are demonstrating that in-reactor crack growth rates are comparable to rates measured in hot cells on pre-irradiated specimens as long as electrochemical potentials are the same in each environment.

The NSRR has been modified to perform reactivity-initiated accident (RIA) tests at prototypic reactor temperatures and pressures and the first such test was performed in August 2006. Prior to these modifications, the NSRR performed 80 RIA tests at ambient temperature and pressure. Data from these tests must be adjusted to account for the higher ductility of fuel cladding at power reactor temperatures. Unfortunately there are major disagreements among experts regarding the methodology to make the adjustments. Future NSRR tests will be decisive in resolving these differences.

JAEA also has an active experimental and analytical program to investigate fuel cladding embrittlement resulting from loss of coolant accidents. Tests on cladding from high-burnup fuel rods are being performed in an apparatus similar to that used at the Argonne National Laboratory. These Japanese tests include both older generation cladding as well as modern M5 and ZIRLO. To date, five tests on high burnup PWR cladding have been performed. Another five tests are planned to complete the program. Test results to date on irradiated cladding compare well with prior tests on unirradiated cladding. At cladding hydrogen concentrations up to 210 ppm, irradiated and unirradiated cladding materials exhibit the same fracture ductility.

At Tohoku University, research ranges from very basic studies aimed at understanding materials degradation mechanisms at the atomic level to applied research aimed at improving the accuracy of crack growth predictions, and nondestructive inspection techniques. Tohoku has extensive research underway on all the stress corrosion cracking phenomena affecting BWRs and PWRs, and a very large program on flow accelerated corrosion. Overall the facilities and staff are impressive.

Appendix 1

Program
Nuclear Safety Research Forum 2007
“Nuclear Safety Research and Ageing Management”
March 9, 2007
The Inoue Enryo Hall, Toyo University, Tokyo, Japan

- 10:00 Opening Address** Atsuyuki Suzuki, Chair, NSC
- 10:05 Session I Keynote Speech**
“Status of Nuclear Safety Research in Japan”
- 10:05-10:30 Kunihisa Soda, Commissioner, NSC
10:30-10:50 Kiyoharu Abe, Deputy Director General for NISA
10:50-11:00 Q&A
- 11:00 Session II Special Speech**
“International Trends of Nuclear Safety Research”
Chairperson: Kunihisa Soda, NSC
- 11:05-11:30 J. Sam Armijo, Member, USNRC/ACRS, Professor, the University of Nevada
11:30-11:55 Aybars Guerpinar, Acting Director, Department of Nuclear Safety and Security, IAEA
11:55-12:20 Carlo Vitanza, Deputy Head, Nuclear Safety Division, OECD/NEA
12:20-12:30 Q&A
- 12:30 Break for Lunch (60min)**
- 13:30 Session III Topical Discussion**
“Nuclear Safety Research and Ageing Management”
*Chairperson: Shojiro Matsuura, Chairman,
The Program Committee of NSRF-2007*
- 13:30-13:55 **Keynote Report**
Naoto Sekimura, Professor, the University of Tokyo
- 13:55-15:55 **Topical Presentation**
Hisanori Nei, Director, Nuclear Power Inspection Division, NISA
Yonezo Tsujikura, Member, Nuclear Power Development and Policy Committee, FEPC,
Senior Executive Officer, Kansai EPC
Hiroshi Miyano, Chairman of Standardizing Committee, AESJ
Masahide Suzuki, Unit Manager, LWR Long Term Reliability Research Unit, Nuclear Safe
Research Center, JAEA
Uichiro Yoshimura, Director General, Safety Standard Division, JNES
Koichi Kashima, Associate Vice President, MSR Laboratory, CRIEPI
- (Coffee Break for 20min)*
- 16:15-17:20 **Panel Discussion**
Presenters of the Topical Presentations
Itsuro Kimura, Chairman, the Special Committee on Nuclear Safety Research, NSC
Kiyomi Ishijima, Director General, Nuclear Safety Research Center, JAEA
- 17:20-17:40 **Q&A**
17:40-17:50 **Summary**
- 17:50 Closing Address** Kenkichi Hirose, Director General, NISA

Please note that simultaneous interpretation between Japanese and English is provided.