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FOREIGN TRIP REPORT

ORNL/FTR-3647

DATE: June 20, 1990

SUBJECT: Report of Foreign Travel by F. J. Homan, Director, Reactor Programs

TO: A. W. Trivelpiece

FROM: F. J. Homan

PURPOSE: To attend the second meeting of the United States/Japan Coordinating Committee (UJCC) on Liquid Metal Reactor/Fast Breeder Reactor Research and Development

SITES VISITED:
6/6 Headquarters of JAPC, Tokyo
6/7 Travel from Tokyo to Tsuruga
Tour of MONJU Reactor
6/8 PNC Atom Plaza, Tsuruga

Abstract

The second meeting of the UJCC was held in Japan on June 6-8, 1990. The first day was devoted to presentations of the status of the U. S. and Japanese Fast Breeder Reactor (FBR) programs and the status of specific areas of cooperative work. Briefly, the Japanese are following the FBR development program which has been in place since the 1970s. This program includes an FBR test reactor (JOYO), a pilot-scale reactor (MONJU), a demonstration-scale plant, and commercial-scale plants by about 2020. The U. S. program has been redirected toward an actinide recycle mission using metal fuel and pyroprocesssing of spent fuel to recover both Pu and the higher actinides for return to the Liquid Metal Reactor (LMR). The second day was spent traveling from Tokyo to Tsuruga for a tour of the MONJU reactor. The tour was especially interesting. The third day was spent writing the minutes of the meeting and the return trip to Tokyo.

Report of Foreign Travel to Japan
by F. J. Homan
June 4-9, 1990

Background

The United States/Japan Coordinating Committee (UJCC) was created by the Memorandum of Understanding (MOU) dated September 22, 1988, between the U. S. Liquid Metal Reactor (LMR) R&D Steering Committee and the Japan Liquid Metal Fast Breeder Reactor (LMFBR) R&D Steering Committee. The charter and method of operation of the UJCC are spelled out in the Functions and Management document. As specified in this document, annual meetings are to be held alternately in Japan and the U. S. The first meeting was held in June 1989 in Idaho Falls, Idaho. The June 1990 meeting in Tokyo/Tsuruga was the second meeting. The purpose of the meetings is to monitor technical progress in cooperative activities between the U. S. and Japan. An agenda for the meeting is attached (Appendix 1). Participants at the meeting were:

From the U.S.
J. D. Griffith, U. S. Department of Energy (DOE)
K. E. Horton, DOE
Y. I. Chang, Argonne National Laboratory (ANL)
M. Korenko, Westinghouse Hanford Company (WHC)
F. J. Homan, Oak Ridge National Laboratory (ORNL)
J. L. Scott , DOE-NE representative in Japan from ORNL

From Japan
M. Iizumi, Japan Atomic Energy Research Institute (JAERI)
T. Takahashi, Power Reactor and Nuclear Fuel Development Corporation (PNC)
M. Hori, PNC
A. Takeda, Japan Atomic Power Company (JAPC)
Y. Kurihara, JAPC
S. Fukuda, Central Research Institute of the Electric Power Industry of Japan (CRIEPI)
H. Nakagawa, JAPC
M. Miura, JAPC

Meeting Content

The first day was devoted to progress reports on individual programs. Copies of the viewgraphs used by the speakers are available in the Reactor Programs office. The second day was devoted to travel by train from Tokyo to Tsuruga, followed by a briefing and tour of the MONJU Reactor. The third day included a wrap-up session to finalize the Record of Discussion and to travel back to Tokyo.

- Introductions from Japan side (Takeda)
  - Introduced Japanese delegation
  - Discussed changing situation for nuclear energy in Japan

- Introduction from U. S. side (Griffith)
  - Introduced U. S. delegation
  - Discussed changing situation for nuclear energy in the U. S.
    + Emphasis given to Integral Fast Reactor (IFR) by Secretary Watkins
    + Reprogramming of funds for actinide recycle in FY-1990 budget
    + Climate for nuclear energy becoming more favorable
    + National Academy of Sciences (requested by Congress) study expected in September 1990.

- Status report on Japanese FBR program (Takahashi)
  - Time line for FBR development program (JOYO, MONJU, Demonstration Reactor, Commercial Reactors)
    + JOYO: 100 MWt, critical in 1977
    + MONJU: 280 MWe, critical in 1992 (planned)
  - JOYO milestones
  - JOYO core parameters
  - JOYO operating data
  - JOYO fuel irradiation parameters
  - MONJU plant parameters
  - MONJU schematic
  - MONJU plant organization
  - MONJU construction schedule
  - MONJU functional test schedule
  - Questions:
    + What is expected economic performance of Japanese FBRs (Griffith)? *Answer:* Somewhere between 0.8 (commercial plant) and 1.5 (demonstration plant) times the cost of LWRs, depending on the success in resolving the "Key Technical Issues for Commercialization of FBR Power Plants."
    + Who will operate MONJU (Chang)? *Answer:* PNC
    + What are the plans for fuel reprocessing? (Chang): *Answer*: Scheduled for after the year 2000. Will be done in the PNC Tokai works.

- Present Status of Demonstration FBR (DFBR) Design Study (Miura)
  - DFBR design study scope and schedule
  - DFBR development program activities
    + 3-year cost reduction study
    + Investigation of innovative technology and evaluation of cost reduction effect
    + Investigation of FBR systems including innovative technology
    + Evaluation study of maintainability and repairability
    + Reactor type evaluation study (loop vs tank)
    + Conceptual design study
  - Demo FBR specifications
  - Schematic of top-entry loop-type reactor
    + Small plant, easier to design for seismic loads
    + U-shaped piping, new concept, has never been considered before. An issue is whether the piping can be designed to avoid the consequences of a simultaneous siphon break in all loops. Horizontal movement during an earthquake is the source of pipe rupture.
    + Considering seismic isolation to eliminate siphon break event

- Schematic of tank-type reactor
  + Heavy components
  + Less susceptible to damage during seismic event
- Questions
  + What are LWR capital costs used in cost comparisons (Chang)? *Answer:* $2133-2533/kW.
  + Have reliability and maintainability costs for loop and tank designs been considered (Chang)? *Answer:* Yes. Results show that the top entry loop type is 3% more expensive to construct, but when reliability and maintainability costs are considered (considerably less for loop type), the life-cycle costs are about the same.
  + How many design options for advanced components will be pursued (Griffith)? *Answer:* Japan and Europe have a different perspective than the U. S. For a reactor system to be deployed in 2030 or later, many changes will take place. The first plants must be operable, but the designs must be flexible enough to accommodate advanced components such as electromagnet pumps and double-walled steam generators, which may not be available by the turn of the century. The Japanese program will debate later this year whether such components will be considered at the DFBR design stage. New technology will be introduced on a step-by-step basis.
  + Are passive safety concerns among those considered in the Japanese comparison of loop vs tank (Chang)? Dr. Chang admitted some personal bias relative to this question. The tank design started with EBR-II. The tank (in Chang's view) has improved safety characteristics over the loop. *Answer:* Safety was considered in the evaluation; however, passive safety was not the focus. The trend in Japan is introduction of mixed oxide fuel, not passive safety. The Japanese feel that in the future passive safety will grow to be more of an issue, but not at this stage of Commercial FBR design.
  + Can passive heat removal be designed into the loop-type reactor? Natural convection? Simultaneous siphon break (Griffith)? *Answer*: The design relies on the siphon and depends on the external loop. The discussion as to whether reliance can be placed on the external loop will continue during the design evaluations this year. The safety issue of loop vs tank has been ongoing for two decades. The capability for natural convection is a top priority issue within the Japanese program. More criteria are needed to distinguish between the two designs. For example, earthquake phenomena make the Japanese concerned about large containers (tank design). Japanese evaluate these issues differently than in the U. S.

- Status report on U. S. Advanced Reactor/Actinide Recycle Program (Griffith)
  - Perspective on nuclear power in the U. S.
  - Location of commercial reactors
  - Economic growth trends
  - Nuclear power's potential future contribution
  - Obstacles to nuclear power's future
  - DOE current nuclear strategy
    + NAS expected to endorse redirection of DOE LMR program to actinide recycle role (in September 1990 report)
    + $5.3 million reprogrammed in FY 1990 to actinide recycle, $2 million currently in FY-1991 budget.

  + 20-20 hindsight reveals that early civilian reprocessing technology relied heavily on military reprocessing technology. This resulted in two major concerns:
    (1) Pure Pu streams
    (2) Highly toxic waste stream
  + U. S. should have been looking from the beginning at removing actinides, and addressing proliferation concerns.
- LMR program scope and approach
- LMR design description
- PRISM schematic
- Actinide recycle drivers
  + Yucca Mountain repository planned capacity is 70,000 MTHM
  + This amount will have accumulated by 2010 in the U. S.
- IFR system
- LWR/ALMR actinide recycle schematic
- Questions:
  + Does the use of a containment dome derive from public acceptance or from technical reasons (Kurihara)? *Answer*: To reduce regulatory uncertainty. The design might have a positive void coefficient of several dollars. Innovations in the past have focused on cost reduction. Focus is now changing to "do-ability" of all aspects of the design. DOE would like to arrive at 1995 with confidence that the plant can be licensed, that actinides can be recycled, and that actinides can be removed from LWR fuel.
  + Is actinide recycle based on both Pu and the TRU elements (Hori)? *Answer*: Yes
  + What percent of power generation will be met using LMRs for actinide recycle? How is emphasis being distributed? (Hori). *Answer*: Cannot base LMR program on resource extension. Funding for this program (breeding) is dropping fast. The waste management application (actinide recycle) has sufficient public interest that it looks promising.
  + Can you comment on the effect the interest in actinide recycle will have in Europe and Japan? Will they follow in the same path (Nakagawa)? *Answer:* That will be an option if the U. S. develops the technology. Problems with pure Pu streams are starting to show up (for example, Pu being shipped from France). Pure Pu streams must be addressed in the future.
  + Won't existing investment in Purex plants be wasted if the world goes to actinide recycle (Nakagawa)? *Answer*: No. It may be possible to recycle Pu and then go to actinide recovery later. May be able to skip reprocessing of Pu for LWRs.
  + Can you comment on the economics of small vs large reactors? Don't more small reactors increase risk? *Answer*: The economics of scale are complex. The U. S. has not obtained the economics of scale from large plants that should have been there. Many trades have been shown to be important:
    * 85% of the cost is in the balance-of-plant (BOP) if BOP is built to safety grade standards.
    * If BOP can be built to industrial standards, costs can be reduced (65% of cost if BOP not safety grade). If the plant has passive safety, which does not depend on the performance of the BOP, this may be possible.
    * Smaller plants are easier to make passively safe. Also, smaller plants (modular) can be factory fabricated and shipped by rail to the construction site, rather than being constructed in the field.

    * Economic comparisons to date appear to favor modularity, but more work remains to be done.
    * A major concern is the number of modules to be operated. The experience base is insufficient to evaluate this. The risk studies need to compare a large number of passively safe modules, or a few large plants which are not passively safe.
    * Griffith's opinion: metal fuel cycle and actinide burning are more important issues than the size of the plant
  + Is it possible to achieve passive safety with small or medium plants? *Answer:* The key event is the loss of heat sink without scram. Only small plants can resist this challenge.

- Integral Fast Reactor (IFR) Program Status (Chang)
  - Highlights of technical progress
    + Irradiation performance of U-Pu-Zr and U-Zr fuels
    + Run beyond cladding breach tests
    + New whole-pin furnace
    + U. S.-European joint study on safety comparison of metal and oxide fuel
    + Core design optimization for actinide recycle and low sodium void reactivity
    + Electrorefining experiments
    + Anodic dissolution of irradiated fuel pins
  - EBR-II fuel cycle facility
  - Schematic of electrorefiner
    + Less U, Pu left with cladding hulls using electrorefining than is possible with aqueous processing
    + Cost of electrorefiner: $1.2 million
  - Schematic of cathode processor
  - Schematic of casting furnace
  - Proposed equipment location in air and argon cell
  - Prototype demonstration of IFR fuel cycle
  - Pyrochemical process for LWR
  - Salt transport conceptual process
  - Magnesium extraction conceptual process
  - Potential advantages of pyroprocessing
  - R&D plan for Phase I (FY 1990-1995)
  - Questions:
    + How is actinide recycle positioned in the plan for reprocessing metal fuel (Kurihara)? *Answer:* Nothing extra is required to recycle actinides. That is part of the overall program scheme. New processes are to be applied to LWR fuel. New initiatives to develop these processes are to be carried out in parallel to the IFR program.
    + What is the decontamination factor for transuranics (TRU) (Hori)? *Answer*: A decontamination factor of 1E-3 is the minimum goal. Would like to go to 1E-4.
    + Isn't batch processing of TRU with curium difficult to handle (Hori)? *Answer:* A cumulative of less than 1% total actinides will be mixed with 80% U, 20% Pu. Curium will be much less than 1%. No problems expected, however, performance under irradiation has to be demonstrated.

- Presentations of individual cooperative programs: Nine individual presentations were made describing the progress of specific programs. In general, the work was on schedule and within budget. Specific problems, such as with the JASPER (Japanese/American Shielding Program of Experimental Research) program, were highlighted. Ken Horton

(DOE) presented programs 2, 4, 6, 8, 9. Frank Homan (ORNL) presented programs 1, 3, 5, 7. Questions were held until all 9 presentations had been completed. The presentations are listed below:

(1) PNC/DOE Joint Collaboration on the Oxide Fuel Cycle
(2) PNC/DOE MONJU Tag Gas Capsule Procurement
(3) JAPC/DOE Modified 9Cr-1Mo
(4) PNC/DOE SMA on Fuels and Materials
(5) PNC/DOE CREDO
(6) PNC/DOE Operational Reliability Testing
(7) PNC/DOE JASPER
(8) JAPC/DOE Double Wall Tube Steam Generator
(9) JAPC/EPRI Information Exchange

- Questions on individual cooperative programs
  - An agreement was made in July 1989 between the U. S. and CRIEPI for exchange of information on metal fuel development. Technical progress meetings were held in December 1989 and again in May 1990. Nothing was said about this cooperation today. Can something be said for the record (Fukuda)? *Answer* (Chang): Dr. Neuhold was going to address this, but it was apparently dropped from the program for this meeting. This is a very important program and should be at the top of the priority list. It was agreed that a summary report would be prepared for the record by the wrap-up meeting scheduled for June 8, 1990.
  - When will Fast Flux Test Facility (FFTF) be shut down (Takahashi)? *Answer* (Griffith): DOE has recommended to Congress that FFTF be shut down at the end of FY 1990. What Congress will do is uncertain. Contingency plans are being developed for a September 30, 1990, shutdown.
  - Will the delay in the Tower Shielding Facility (TSF) restart affect the currently planned JASPER program (Takahashi)? *Answer* (Griffith): DOE intends to restart the TSF and complete the JASPER program.
  - Will the data management system for the Centralized Reliability Data Organization (CREDO) be operational in August 1990 (Takahashi)? *Answer* (Griffith): Yes.
  - Can you comment on the MOU between JAPC and EPRI (Electric Power Research Institute) (Kurihara)? It expired at the end of last year. *Answer* (Horton): The agreement will be revived at the beginning of FY 1991, with the stipulation that the period of the contract will be automatically extended.
  - Has the concern about the environmental effects of operating the double-walled tube steam generator (DWTSG) been resolved (Miura)? *Answer* (Griffith): Yes. Modifications (to the cooling tower) have been made at ETEC (Energy Technology Engineering Center) which will meet the state requirements for release.

- Briefing and tour of MONJU (June 7, 1990)
  - Briefing:
    + Time line for FBR project in Japan
    + Construction schedule for MONJU
    + Historic milestones for MONJU
    + Reactor parameters for MONJU
    + Location of MONJU
    + MONJU plant layout
    + MONJU construction status (84% complete)
    + Location of components
    + Schematic of main buildings
    + MONJU core configuration

  + Schematic of primary and secondary systems
- Videotape describing site preparation, construction of the harbor, movement of components from the harbor to the reactor site.
- Tour: The tour lasted about one and one-half hours. It was very well organized and conducted. MONJU is a very impressive reactor. The total cost will be about $4 billion, with $1 billion of that spent on site preparation. The tour guide described the selection and development of the site. The tour included both primary and secondary system piping and major components.

• Wrap-up session to review the Record of Discussion
  - There were three iterations on the Record of Discussion. The final product is attached.
  - Final Questions
    + Why is FFTF being shut down? *Answer* (Griffith): No suitable mission could be found to justify the cost of operating FFTF. The Governor of Washington (Gardner) has a group looking for a civilian mission for the reactor. The results of their study are not known to DOE.
    + What are the projected operating costs of MONJU (Korenko)? *Answer* (Hori): No formal estimates exist yet. Rough estimates have been made on the basis of personnel costs. PNC will have an engineering department of 160 persons on site. Subcontractors will have additional staff, but the numbers are not known. The figures compare with 350 JAPC FTEs and 500-600 subcontractor staff to operate two LWRs on another site.

Appendix 1

Agenda for The Second Meeting of the UJCC

JUNE 5, 1990

① JUNE 6,(Wed) 1990 — at ABC meeting room,JAPC , TOKYO

10:00 - 10:20 Greetings and Introduction of Attendees
— By Dr.Takeda /Mr.Griffith

10:20 - 12:00 Status Report of Japanese FBR Program — By JAPAN
(MONJU-by PNC 、DFBR-by JAPC)

12:00 - 13:00 Lunch (at Restaurant "Rui " , Sankei kaikan)

13:15 - 15:10 Status Report of US LMR Program — By US

15:10 - 15:30 (Coffee break)

15:30 - 17:00 Status Report of Cooperation Activities
DOE/JAPC、DOE/PNC 、DOE/CRIEPI — By DOE
EPRI/JAPC 、EPRI/CRIEPI — (By EPRI)

18:00··· Reception / Dinner (Kasumigaseki Bldg. TOKAI Club)—invited By JSC

② JUNE 7,(Thu) 1990 — at MONJU ,TSURUGA

8:40～ 11:40 (Train) TOKYO → ISURUGA (Hikari「209 」、No.15 platform)

11:40～ 12:00 (Bus) Transportation From TSURUGA Station to Green Plaza Hotel

12:00 - 13:00 Lunch (at Green Plaza Hotel)

13:00～ 13:50 (Bus) Transportation From Green Plaza Hotel to MONJU Site

14:00 - 15:00 Introduction of MONJU

15:00 - 16:30 MONJU Tour

16:40～ 17:30 (Bus) Transportation From MONJU Site to Green Plaza Hotel

18:30··· Reception / Dinner (Green Plaza Hotel) —invited By USC

③ JUNE 8,(Fri) 1990 — at PNC Atom Plaza、TSURUGA

8:30～ 9:00 (Bus) Transportation From Green Plaza Hotel to PNC Atom Plaza

9:00 - 10:00 Future Cooperation and General Discussion

10:00 - 10:30 Review of the Minutes
— (End of Meeting) —

Distribution

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