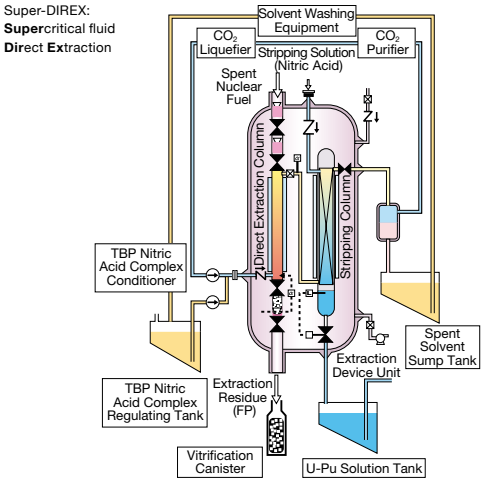

Mitsubishi Activities for Nuclear Fuel Cycle Development

HIROSHI SAGAWA*1 YUKIHIDE MORI*1
KAZUHIKO KURODA*1 TATSUHIRO YOSHIZU*1

In October 2005, the basic targets under the Framework for Nuclear Energy Policy[1] of this country were approved in a Cabinet meeting and the nation is proceeding with the steadfast promotion of the light water reactor fuel cycle and the research and development of the fast breeder reactor fuel cycle (FBR fuel cycle)[2] aiming at full production around 2050. MHI has contributed greatly to the design, construction and commissioning of facilities related to the light water reactor fuel cycle including the Rokkasho Reprocessing Plant, and is involved proactively in the R&D of the FBR fuel cycle, as typified by its initiative role in the promotion of the basic design of the Recycle Equipment Test Facility proposed by the Independent Administrative Institution Japan Atomic Energy Agency (JAEA), thus contributing to the stability of energy supplies in this country as well as a reduction of the environmental burden.

1. What is the nuclear fuel cycle?

The nuclear fuel cycle refers to the reuse of the remaining non-fissioned uranium and newly produced plutonium after extracting them from the spent nuclear fuels released from nuclear power plants by means of reprocessing processes (**Fig. 1**).[2] Both the effective use of uranium and the reduction of radioactive waste[3] are made possible by virtue of this cyclic system.

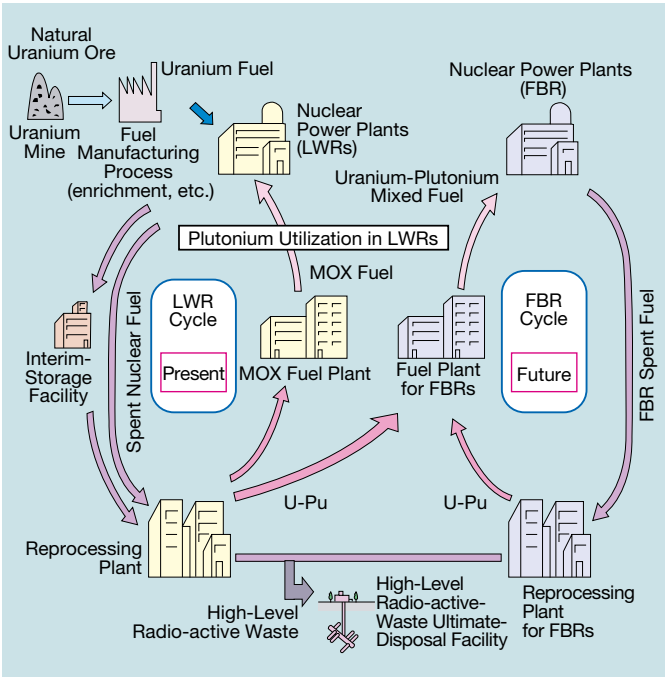

Fig. 1 Nuclear fuel cycle[2]

To be more specific:

a. Although uranium will not last for 100 years from now if continuously used at the current pace, the utilization of plutonium by means of FBRs could dramatically improve the utilization efficiency of uranium resources, thereby making a significant contribution to the stable supply of energy.

b. If spent nuclear fuels are recycled, the volume of high-level radioactive waste could be reduced to approximately 1/3 compared to direct disposal, thereby contributing to the reduction of the environmental burden.

2. MHI's activities for promoting the nuclear fuel cycle

2.1 Activities toward establishing the LWR fuel cycle

(1) Rokkasho Reprocessing Plant

Japan Nuclear Fuel Ltd. is currently implementing active tests using spent LWR fuels aiming at completing construction in 2008. MHI has participated in the project from the basic design phase and has taken charge of the design, manufacture and commissioning of the head end facilities for shearing and disssolution of the fuel assemblies under license from France as well as analytic facilities for analyzing the samples transferred from the overall plant.

(2) Plutonium utilization in LWRs

Plutonium utilization in LWRs is making steady progress as epitomized by the prior understanding and approval gained from local people in the Genkai Power

*1 Nuclear Energy Systems Headquarters

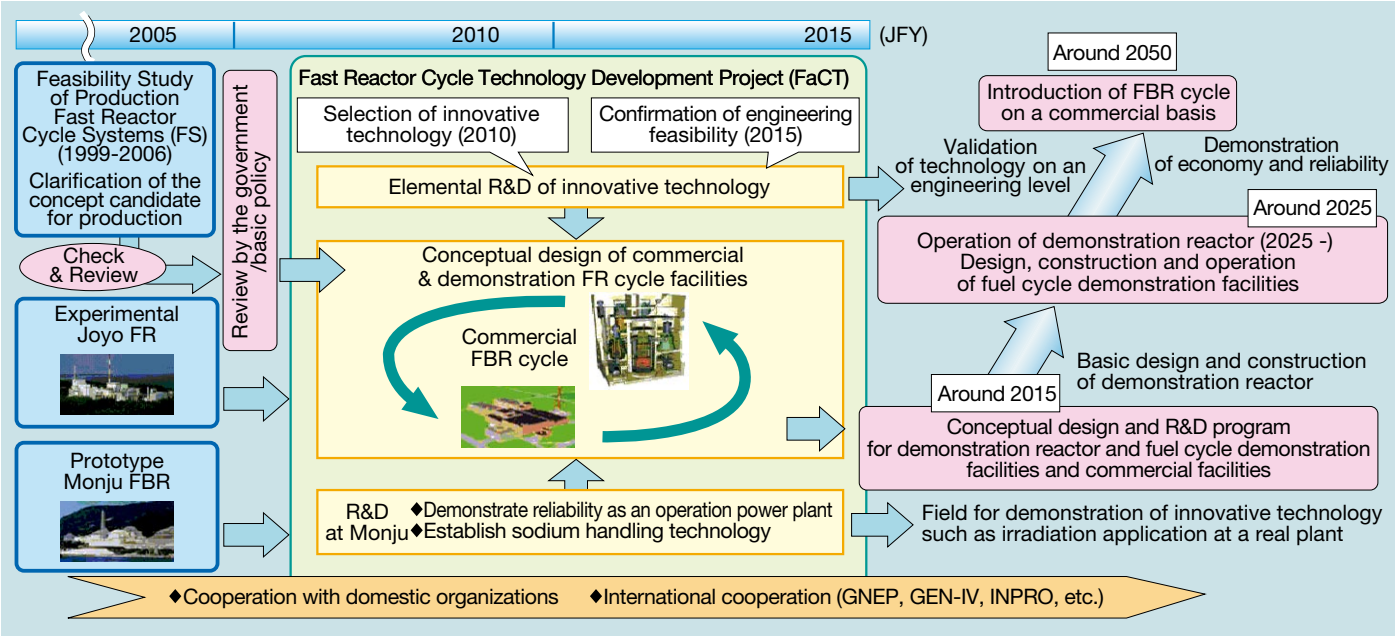

Fig. 2 FBR Fuel Cycle Technology Development Project[3]

Plant of Kyushu Electric Power Co., Inc. and the Ikata Power Plant of Shikoku Electric Power Co., Inc. MHI is committed to promoting plutonium utilization in LWRs over a wide range of fields related to mixed oxide fuels (MOX fuels) such as design, safety evaluation, reactor core design, impact assessment of plant equipment, transport-container design and conditioning of fuel fabrication.

2.2 Activities toward the early production of the FBR fuel cycle

(1) Conceptual road map toward a commercial FBR

FBR cycle technology is an energy technology for the effective utilization of limited uranium resources which will reduce the environmental burden to support a sustainable society, and accordingly its development will need large-scale and long-term support by the nation and is hence ranked as an Essential National Technology.[4] MEXT decided the combination of a sodium-cooled fast breeder reactor, advanced aqueous reprocessing and simplified pellet fuel fabrication[5] as the main concepts to be developed intensively in the future based on the outcome of the JFY 2006 Feasibility Study of Commercialized Fast Reactor Cycle Systems (FS) Phase II.[5] In response, JAEA plans[3] to take a step-by-step approach toward promoting the FBR fuel cycle through innovative technology, systematization of the preparations for recycling equipment radioactive tests and an overview of the results of R&D on the transition from the LWR fuel cycle to the FBR fuel cycle until 2010. It also proposes conceptual design and R&D programs from 2015 onward for commercial and demonstrative facilities in 2015, for check and review by the state (**Fig. 2**).

(2) Participation in the design of Recycle Equipment Test Facility

MHI is proactively involved in the development of machines and equipment for practical use, while taking an initiative role in the basic design of the Recycle Equipment Test Facility implemented in JFY 2006 and 2007.

(3) Development of supercritical direct-extraction method (Super - DIREX method)

MHI has been engaged in the development of technology to extract uranium and plutonium directly from spent nuclear fuels by applying supercritical fluid since 1997. In May 2004 it succeeded in the world's first direct extraction of uranium and plutonium from fragments of MOX fuel pellets in cooperation with the former Japan Nuclear Cycle Development Institute and

Fig. 3 Outward Appearance of Direct Extraction Test Equipment[7]
Former JNC/Test equipment installed inside the CPF glove box

Nagoya University (**Fig. 3**).[6]

With this technology, the simplification of the main processes in aqueous reprocessing was attained, and the reduction of high-level radioactive liquid waste was made possible owing to minimizing the quantity of nitric acid required for extraction, thus the possibility of improved economic efficiency of reprocessing facilities increased.

3. Conclusion

MHI recognizes the importance of the nuclear fuel cycle which is a national project and has been proactively involved in that program from the initial stage of the development. In response to the recent Cabinet approval of the Framework for Nuclear Energy Policy,[1] the government, JAEA, electric power utilities and plant makers are requested to promote increased development through mutual coordination and combined efforts, and MHI also is prepared to work actively to contribute its share to this important project.

References

1. Japan Atomic Energy Commission, "Framework for Nuclear Energy Policy" (2005)
2. Nuclear Energy Subcommittee of the Electricity Industry Committee, Advisory Committee on Energy and Natural Resources, "Nuclear Energy National Plan" (2006)
3. Japan Atomic Energy Agency, "Collection of FaCT Seminar Materials" (2007)
4. Council for Science and Technology Policy "Promotion Strategies Classified by Field" (2006)
5. Japan Atomic Energy Agency, Japan Atomic Power Company,Ltd., "Phase II Final Report of Feasibility Study on Commercialized Fast Breeder Reactor Cycle Systems" (2006)
6. Tomozo Koyama, Yukihide Mori, et al., "Study of Direct Extraction of U, Pu from Spent Nuclear Fuels by Super-DIREX Reprocessing Method"
7. Technical Development Relating to the Direct Extraction of U, Pu from Spent Nuclear Fuels by Super-DIREX Reprocessing Method (19) - Summary of the Achievements -, Atomic Energy Society of Japan, Annual Meeting in Spring 2005 (2005)


Hiroshi Sagawa


Yukihide Mori


Kazuhiko Kuroda


Tatsuhiro Yoshizu