Prospects of Nuclear Power Expansion and the Condition for its Realization[1]

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Thank you Mr. Chairman. I want to thank also the Organizer of this session for inviting me to discuss with such distinguished guests about the actions necessary for global nuclear energy community to take to promote nuclear energy utilization in the world, as a means to rise to the challenge of energy security and climate change.

Ladies and gentlemen, major developed countries including Japan have already expressed their commitment to the reduction of greenhouse-gas emissions to 50% of the current level in the first half of this century in order to combat global warming. This means that we should innovate our energy and other related systems to make the annual global carbon-dioxide emissions in 2050 13Gigaton Carbon/yr below that predicted in the business-as-usual case.

As the global demand for energy will surely continue to significantly increase since countries everywhere seek to eradicate poverty and improve living standard, it is required for our global society to pursue the increase in the use of low carbon energy supply technologies such as nuclear energy and renewable energies, replacing low efficiency fossil fuel based energy production systems with high efficiency systems, along with the persistent introduction of energy conservation and energy efficiency improvement measures.

It is reasonable for the global nuclear community therefore to have a vision that nuclear energy, which supplied about 16% of global electricity in 2007, will contribute in many parts of the world as one of the mainstay technologies for electricity and heat generation to foster economic growth, energy security and a low carbon economy simultaneously.

To achieve this vision is formidable, however, as it is necessary to replace 900 GWe coal-fired power plants with nuclear power plants for avoiding 1.3Gigaton Carbon/yr or just one-tenth of the target in 2050. This means that global nuclear capacity should increase to about 1400GWe in 2050, which corresponds to the capacity OECD Nuclear Energy Agency found to be reached in 2050 under its high scenario in its 2008 Nuclear Energy Outlook.

It is clear that to reach this level would require mobilizing much greater industrial, human and financial resources than currently exist within nuclear and related industries and I believe it important for global nuclear community to energetically act for;

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- Sustaining safe and efficient operation of existing nuclear power plants, steadily installing new plants and managing used-fuel and waste generated in appropriate manners,
- Shaping environment for facilitating the peaceful uses of nuclear energy in every part of the world, and
- Realizing competitive and sustainable nuclear energy technology through unremitting R&D activities.

I will elaborate what JAEC is promoting to rise to these three challenges in the following.

First, to sustain safe and efficient operation of the fleet of existing nuclear power plants and install new capacity that is necessary to satisfy the need for energy; the Commission is asking nuclear energy community to work hard to;

a) Maintain the public trust in both the plant operator's safety management and the effectiveness of regulatory activities for nuclear safety, security and nonproliferation by promoting open and transparent risk communication with the public unremittingly.
b) Execute plant ageing management activities for existing plants to ensure their high capacity factor and superior safety and economic performance throughout their life of 60 years at least.
c) Make it possible to deliver safe management and disposal of radioactive wastes and used fuel.
d) Assure market force to continue to drive the construction of nuclear power plants that are necessary for satisfying the need for electricity and/or GHG emission reduction.

The management of used fuel and disposal of high level radioactive waste remain key challenges in many countries. The delay or failure thus far of disposal facility programs for high level radioactive waste continues to have a significant negative impact on the image of nuclear energy.

Experts agree that the geological disposal of high level radioactive waste is safe and technologically feasible. Nonetheless, so far no geologic repositories for high-level radioactive waste have been licensed. Progress is being made in some countries though and the selected site has received political and local support in Finland, as you know.

In Japan, Government is strengthening public information activities on this matter, communicating the available public support for the sustainable development of the communities that entertain the site from the view point of equity of benefit, as well as the safety and the importance of the repository.

Secondly, to shape the environment for promoting the peaceful use of nuclear energy everywhere in the world, JAEC is working in cooperation with international community to;

a) Build a global consensus that nuclear energy is an essential measure against global warming;
b) Support countries considering the introduction of nuclear power internationally; and
c) Strengthen the international system for ensuring nuclear safety, security and nonproliferation.

As for global consensus on nuclear energy, the global nuclear community should seek the recognition of nuclear energy as an activity for the clean development mechanism project in the post-Kyoto Protocol framework currently under deliberation, and ask international financial organizations such as the World Bank to catalyze the investment in the construction of nuclear power plants in developing countries and those for water desalination, in particular, considering that clean water supply is rapidly deteriorating in developing countries.

To support countries considering the introduction of nuclear power, the global nuclear community should, first of all, actively support the IAEA so that the Agency can strengthen its human and financial resources for helping such countries work systematically towards the introduction of nuclear power, in accordance with the IAEA's milestone document that specify the way to build the infrastructure for nuclear power utilization such as human resources, legal frameworks including safety and security regulations, management of radioactive waste and so on.

At the same time, developed countries should also promote direct collaboration with such countries to facilitate their nuclear infrastructure development through dialogue, consultation and joint activities, recognizing that human resource development and stakeholder engagement are central issues that need urgent attention and support from long term viewpoint.

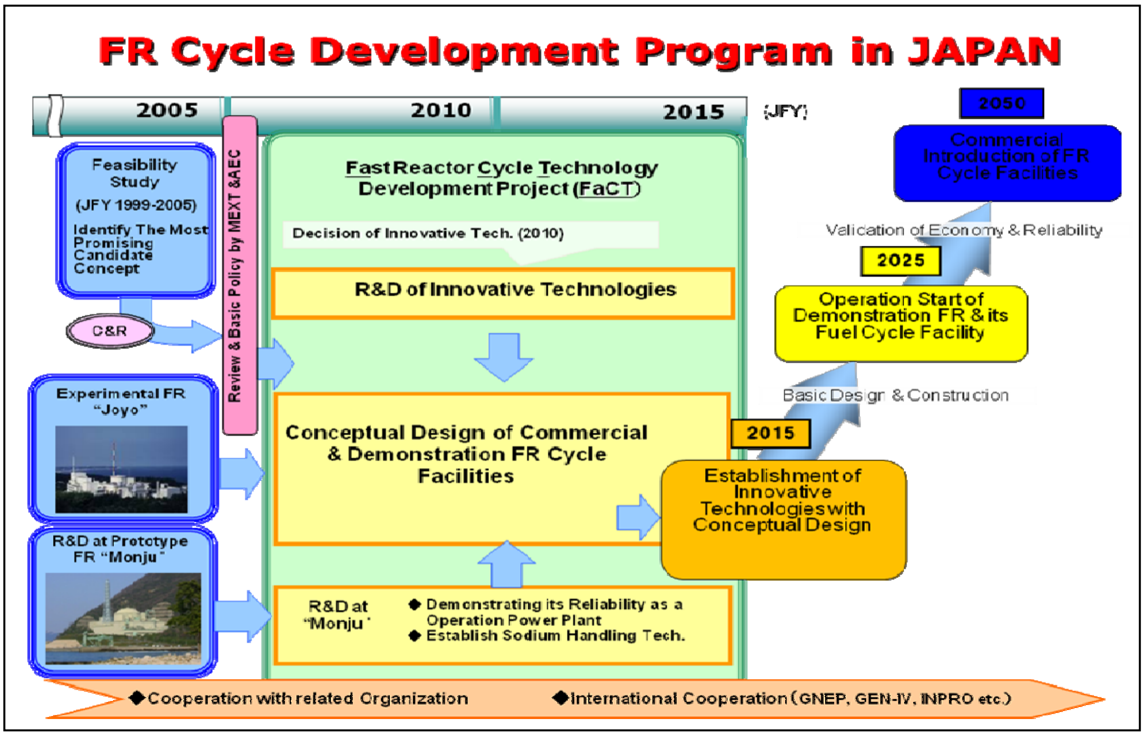
In parallel, global nuclear community should make efforts for reinforcing the IAEA's legal authority in nuclear verification, safety and security, promoting the universalization of the Additional Protocol and inducing positive acceptance of various IAEA review missions for mutual learning.

The third challenge is to incessantly pursue technology innovation aiming at realizing sustainable nuclear energy technology from the long term perspective. The goals of this pursuance are;

a) Efficient resource utilization by introducing breeders that makes it possible to multiply energy production of uranium up to 60;
b) Waste minimization by recycling plutonium and minor actinides using fast neutron reactors that make it possible to significantly reduce the heat generation rate of vitrified waste from reprocessing and increase the density of their disposal in a geological repository;
c) Improved intrinsic proliferation resistance of fuel cycle systems by way of co-extraction of plutonium and minor actinides in reprocessing and utilization of minor actinide bearing fuel;

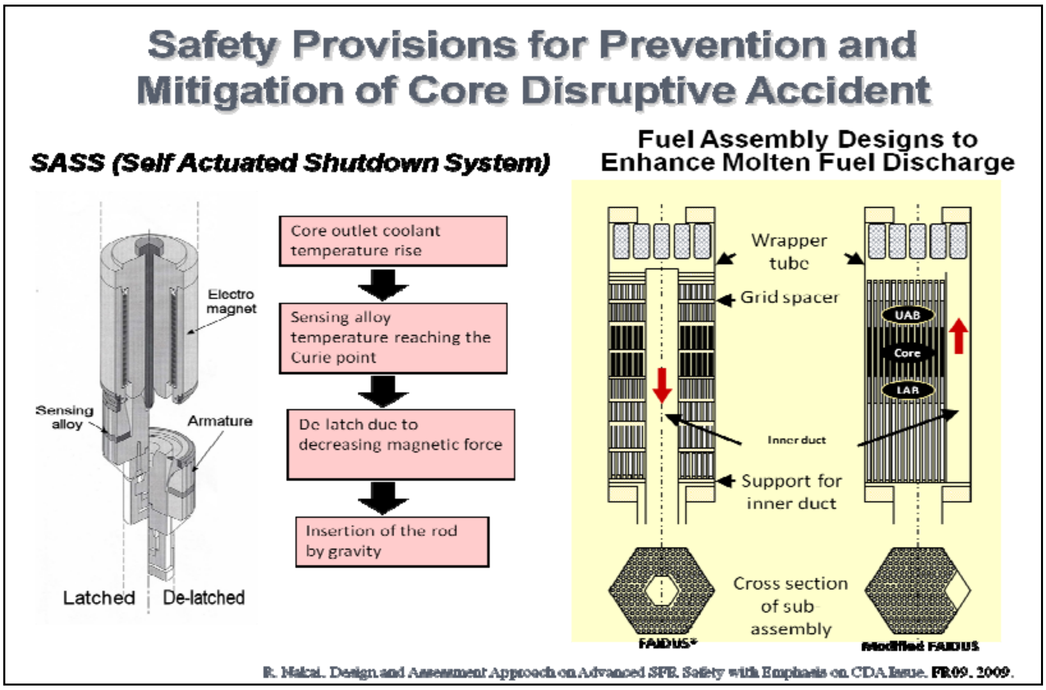
d) Introduction of small and medium-sized reactors that stimulate innovative nuclear power business models owing to reduced high upfront cost, shortened lead-time, and the adaptability to isolated grid and non-electrical application.

In the case of Japan, major governmental effort is devoted to the research and development of fast reactor and its fuel cycle technology, aiming at its commercialization in the energy supply market of the latter half of the 21st century, satisfying the requirement of enhanced safety, economy, reliability and fuel utilization, low heat generation rate of radioactive waste to be disposed of, and increased proliferation resistance, among others. Currently the project is at the stage of developing system concept, narrowing candidate for coolant to sodium, fuel to mixed oxide with uniform loading of minor actinides.



One of the issues under consideration is how to achieve economic competitiveness: the design team is currently pursuing the feasibility of two-loop cooling system of large diameter piping made of modified 9Cr-1Mo steel, intermediate heat exchanger integrated with coolant pump, containment vessel made of steel plate reinforced concrete, adoption of an advanced seismic isolation system for building design etc.

The second major issue under research and development is how to establish the assurance of an innovative feature schematically shown in the following figure to make the hypothetical core melt phenomenon non-energetic one for sodium-cooled large core reactors with positive coolant void coefficient. We want to introduce this feature as we believe it important to make sure the energetics of core melt phenomenon of sodium cooled core as benign as that of light water reactors. We are demonstrating the effectiveness of this feature by utilizing modeling and simulation technology as well as mock up experiments in test reactors.



The third major issue is how to implement minor actinide recycling. We are studying the feasibility of advanced aqueous reprocessing technology that recovers mixed plutonium and miner actinides from used-fuel and simplified pelletizing fuel fabrication technology to fabricate U-Pu-MA fuel.

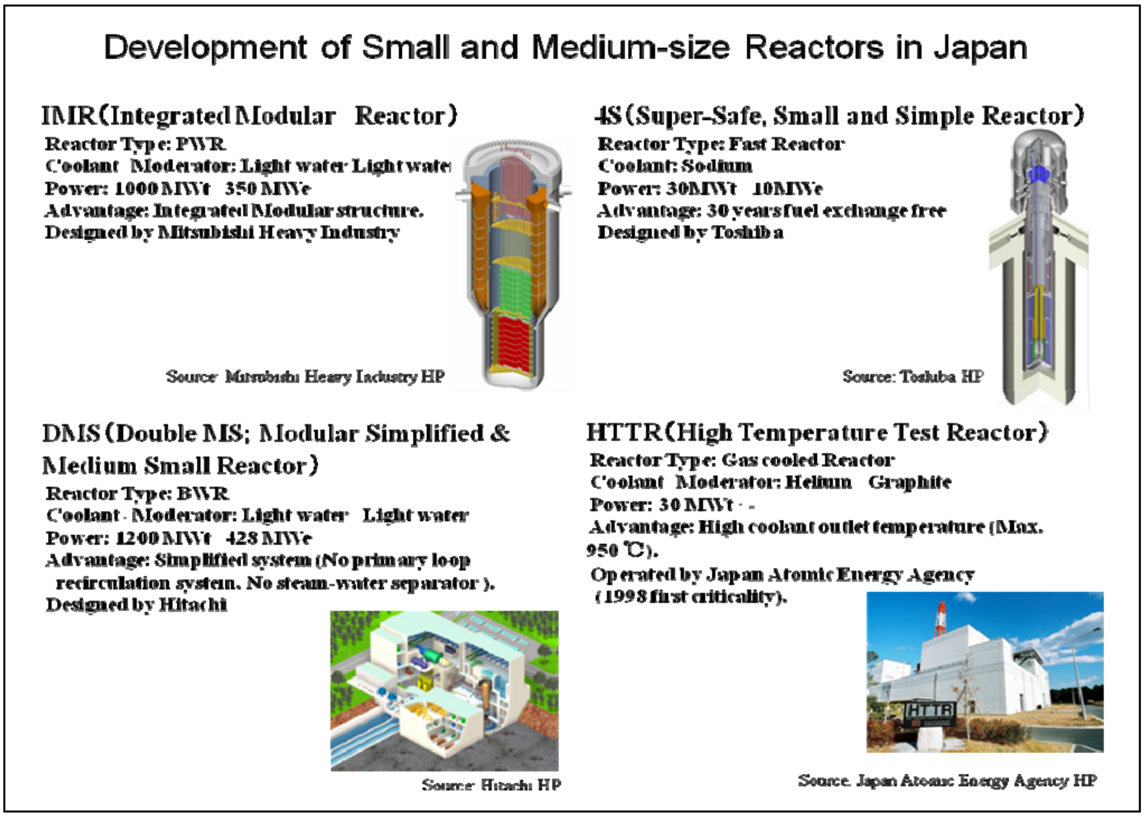
One of the unresolved issues in this endeavor is the necessary degree of MA recycling that should be realized from the viewpoint of endowing necessary intrinsic proliferation resistance, considering that MA recycling has no particular advantage in terms of safety of high-level waste disposal, and that minor actinide-bearing fuels feature a considerable increase in gamma and neutron doses and of the decay-heat, which would require specific protection and cooling means for every stages of fuel cycle including fuel transportation.

The degree of proliferation resistance results from a combination of system's intrinsic features coming from design choices that play a key role both in making the system a non-attractive route to diversion and in facilitating the implementation of safeguards, and extrinsic measures that result from the national and international decisions and undertakings related to the assurance of nonproliferation. Since 1970's, the IAEA, International Nuclear Fuel Cycle Evaluation (INFCE) study and other studies stated that an absolute intrinsic proliferation resistance, although desirable, is not achievable in the foreseeable future. After thirty years this statement is still valid.

Nevertheless, we are promoting the R&D of this system to find fuel cycle technologies with intrinsic proliferation resistant feature that makes diversion of fissile material difficult and facilitates the implementation of the IAEA safeguards. This is because firstly we want to reduce the risk of proliferation at the nuclear power systems that should be used widely in the future and secondly we want to reduce the need for human and financial resources for the IAEA to execute its safeguards obligation.

We are encouraging at the same time the establishment of international standards for proliferation resistance, taking into account the possible limitation of nuclear fuel cycle activities to those under multilateral framework, by developing methodologies to analyze proliferation risk of a fuel cycle system in the international cooperative frameworks of GIF and INPRO.

Finally I would like to briefly touch upon Japan's efforts for pursuing the possibility of small and medium-size reactors. Japanese industries have been promoting design studies and related R&D activities of small and medium size reactor for power generation such as 4S (Toshiba) for small power station, IMR(Mitsubishi), DMS(Hitachi), CCR(Toshiba) for medium power generation and High temperature gas cooled Reactor HTTR(JAEA) for hydrogen generation and other industrial application, as shown in the following graph. The characteristics that they are pursuing to make these concepts competitive are simplified and integrated system configuration, shorter construction period by factory build, and long-life core and or without on-site refueling.



A key issue for their realization is how to overcome the reality that we cannot decrease the cost of R&D, engineering and licensing costs in proportion to the output power of a reactor and we may need a prototype unit as all designs have some degree of innovation in components, systems and engineering for pursuing safety and competitiveness.

In conclusion, the global nuclear community should have a vision that nuclear energy will contribute as one of the mainstay technologies for electricity and heat generation to the fostering of economic growth/poverty eradication, energy security and low-carbon economy.

To realize this vision, the international nuclear community should collaborate to help the capacity building of many countries that want to utilize nuclear power plants and pursue the universal compliance of international norms for nuclear safety, security and nonproliferation.

It is also important for the international nuclear community to develop advanced technologies that will contribute to the sustainability of the global community, including fast neutron reactors and its fuel cycle technologies that should satisfy the goals for safety, reliability, economy, resource utilization and proliferation resistance desirable for the nuclear energy systems in the future society.

Thank you for your attention.