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Japan's Role as Leader for Nuclear Nonproliferation

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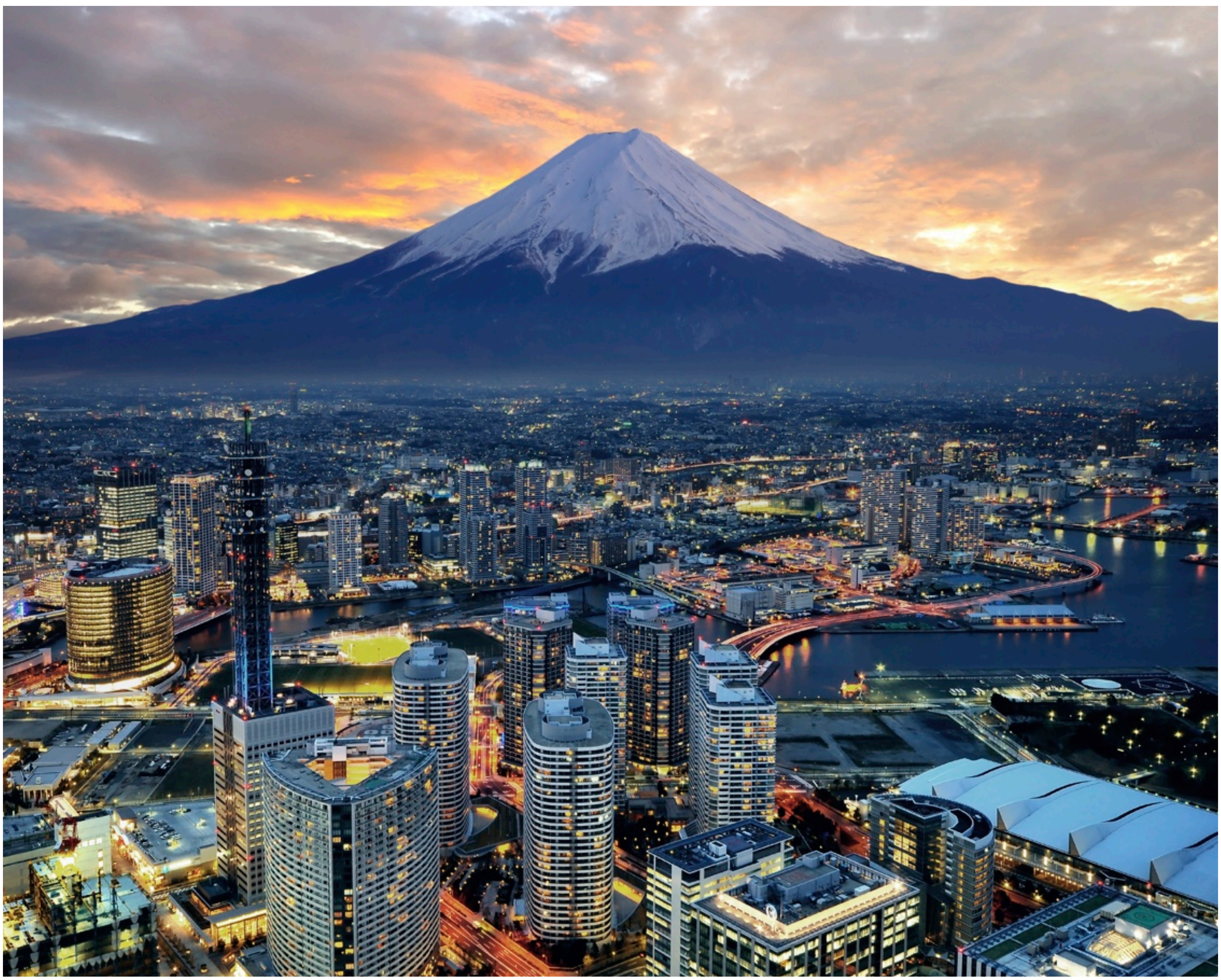

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INTRODUCTION

A country with few natural resources, Japan decided to develop nuclear power technology in 1954 to secure energy for Japanese reconstruction after World War II. Nuclear energy also made for sound economic development. In 2010, Japan imported 96 percent of the primary energy needed to supply its energy consumption, including nuclear power. The four percent of domestic resources consisted of one percent hydropower, two percent renewables, and one percent of oil, coal, and natural gas combined.

However, in Japan, the Japanese fear of the release of lethal ash or radioactive fallout in the case of an accident makes nuclear power controversial. These fears are based on past events like the exposure of the Japanese fishing boat Fukuryu Maru No.5 and the aftermath of the bombing of Hiroshima and Nagasaki. Nuclear related technologies and materials require strict safeguards, especially for non-nuclear-weapon states. While Japan has developed nuclear fuel cycle-related facilities, since 1959 they have been under the safeguards applied to natural uranium from Canada based on INFCIRC/3 — the agreement between Japan and the International Atomic Energy Agency (IAEA). After the Nuclear Nonproliferation Treaty regime formed, Japan gained credibility as a responsible partner from the international community.

Today there are new threats and concerns related to nuclear nonproliferation and security. Japan cooperated with the IAEA and the international community to develop safeguards technologies. From their experience of safeguards in fuel cycle-related facilities, Japan has encouraged the IAEA to build a new safeguards method such as the Additional Protocol.

Since the 2010 Nuclear Security Summit in Washington, DC, Japan has developed technologies for nuclear detection, measurement, and forensics, and held seminars and training courses on security or material accounting for new countries. In this paper, the history of nuclear power in Japan will be provided, and current issues with nonproliferation and security will be discussed. The Japanese role in nuclear nonproliferation and its concept of Safety, Security, and Safeguards (3S) proposed in 2008 at the G8 summit for the peaceful use of nuclear power and advanced technology will also be considered.

HISTORY OF JAPANESE NUCLEAR POWER AS ENERGY SOURCE

1945 – 1960

> *Japan started its policy of nuclear energy use when the prohibition of nuclear related activities was lifted in 1952. It established related laws, and national and private organizations. It made a long-term program for nuclear energy use and described concrete targets within 20 years in it. The first case of safeguards was applied on natural uranium imported from Canada to Japan in 1958.*

The history of nuclear power began as part of the program to produce "atomic" weapons during World War II. Japan also ran research facilities throughout this war.[1]

In 1945, after Japan's unconditional surrender, it was prohibited by General Headquarters (GHQ), which referred to the Supreme Commander for the Allied Forces, from all nuclear related research and development activities including basic physics. But in 1952, the Treaty of San Francisco restored Japanese sovereignty and lifted the prohibition on research and development.

In 1953, U.S. President Dwight D. Eisenhower announced the "Atoms for Peace" program, which shared nuclear technology for peaceful uses; with control of the materials, equipment, and knowledge by an official international agency.[2] The Japanese government reacted quickly and prepared a budget for research and investigation of nuclear energy. Japan had poor resources and needed to consider how to meet its energy requirements.

The Japanese government started its policy to develop and possess nuclear energy technology for peaceful use. In 1954, officials prepared a budget of 235 million yen (about $652,800 at the rate of 360 yen for $1) and created a committee to investigate the use of nuclear energy. The committee was comprised of relevant ministers, academics, and experts from the private sector who discussed how the country should move forward to develop nuclear energy.[3] From the beginning of 1955, Japan and the United States negotiated the nuclear research cooperation agreement, which included the provision of enriched uranium. The agreement was signed in November 1955.

The Japanese government set some segments of nuclear development in governmental agencies such as the economic planning agency or the science and technology agency in 1955 and 1956, respectively. In December 1955, three laws for nuclear energy were passed: the Atomic Energy Basic Law, the Act for Establishment of the Japan Atomic Energy Commission and the Nuclear Safety Commission, and an Amendment of the General Administrative Agency of the Cabinet to establish the Atomic Energy Bureau. In 1957, the Nuclear Reactor Regulation Law was signed.

The Atomic Energy Basic Law is a constitution for progress in policy of nuclear energy use, which stipulates in its Article 2 as Basic Policy that "the research, development and utilization of nuclear energy shall be limited to peaceful purposes, shall aim at ensuring safety, and shall be performed independently under a democratic administration, and the results obtained shall be made public so as to actively contribute to international cooperation." The Atomic Power Division was placed in the Agency of Industrial Science and Technology and a secretariat of the investigation committee was in the Economic Planning Agency.

In 1956, the Atomic Energy Commission (AEC) conceived as the top nuclear energy policymaking group. At the same time, the Atomic Energy Bureau in the Prime Minister's Office took over the Atomic Power Division and the secretariat of the investigation committee.[4] Since its establishment, the commission has planned, deliberated, and decided the following: policy for utilization of nuclear energy, general coordination of related administrative agencies, projected expenses and allocation, regulation of nuclear materials and reactors, and so on.

That same year, the government established the Japan Atomic Energy Research Institute (JAERI) to promote Japan's nuclear research. JAERI's assignments were the basic and applied research of nuclear energy; design, construction and operation of nuclear reactors; training researchers and engineers; and selling and purchasing radioactive materials. In the private sector, the Japan Atomic Industrial Forum (JAIF) promoted public understanding and the First Atomic Power Industry Group (FAPIG) consisted of the 10 companies that constructed Japan's first commercial nuclear power station. The necessary legal system was created to develop nuclear policy and regulate radiation and reactors.[5] The atomic fuel corporation (public corporation) investigated uranium mines and was responsible for the production, fabrication, reprocessing, and purchase and sale of uranium fuel.[6]

Also in 1956, the AEC released the first long-term program for research, development and use of nuclear energy after the Japanese government concluded that nuclear energy development was necessary for the energy security of Japan, and that a plan was needed to effectively perform research and development activities.[7] The program stated that one policy was to establish a system of supplying nuclear fuel and using domestic supply as much as possible. For this purpose, the private sector aggressively investigated and developed domestic uranium resources. Japan needed to develop breeder reactors and reprocessing technology to complete the nuclear fuel cycle. The nuclear fuel corporation carried out reprocessing with domestic technology. Domestic technology also was used in constructing power reactors. Japan initially imported experimental reactors, power demonstration reactors, and power reactors to improve domestic technology from the United States and some European countries to improve its domestic capabilities. Japan's goal to build breeder reactors was because of the efficient use of nuclear materials and expectation of lower energy costs.

In 1957, the White Paper on Nuclear Energy stated its long-term goal to develop 7,000MW of nuclear power stations by FY1975*. To achieve this goal, nuclear power plants would replace a large portion of the planned fossil fuel thermal power plants after 1966; and from 1962 to 1965 150MW would be developed each year — 600MW total for the four years.

The first commercial power plant was a modified Calder Hall reactor by the United Kingdom. To receive this first nuclear power reactor for electric power generation, electric power companies invested in the Japan Atomic Power Company (JAPC). If this type of reactor continued to be used, 90 percent would be constructed with domestic components and human resources in the future. As for breeder reactor development, the plan called for 100MWe to be developed by around 1970.[8]

To ensure sufficient supplies of uranium, the Japanese government signed nuclear cooperation agreements with the U.S. and UK in 1958; and with Canada in 1959.[9]

*According to the White Paper on Nuclear Energy issued in 1976, the commercial power stations' total capacity was 6,602MW in FY1975.

The plan for nuclear power reactor use began. The United States exported the JRR-1, a boiling water-type reactor, 50kW power rating, which started operating in 1957 at JAERI. In December 1959, the JAPC obtained a construction permit to install the reactor in the Tokai power station, 166MWe. Construction started in 1960, became critical in 1965, and started commercial operation in 1966. The JRR-2 followed the JRR-1 and went critical in 1960, but was not yet a domestic product. The Mitsubishi Atomic Power Industries and Sumitomo Atomic Energy Industries were inaugurated in 1958 and 1959, respectively, to develop nuclear technology.[10]

In 1957, the IAEA was created for the purpose of nuclear nonproliferation and safeguards. In 1959, in the first case in the world of using safeguards through the IAEA, Japan imported natural uranium from Canada. INFCIRC/3 — an agreement between the IAEA and Canada, and IAEA and Japan. Agency Safeguards were stipulated in Article III.

> INFCIRC/3 Part II Article III Agency Safeguards 1
>
> The Government agrees that any source material provided by the Agency under or within the framework of this Agreement, and any special fissionable material produced by its use, shall not be used in such a way as to further any military purpose. The Government further agrees that such source material shall not, without the prior consent in writing of the Agency, be used for any other purpose than the project described in Annex A to this Agreement, and that such source material and any special fissionable material produced by its use shall not be transferred outside Japan or beyond the Government's control except with the prior consent in writing of the Agency.

Japan developed nuclear technology to increase internal supplies of nuclear fuels and reduce its reliance on external sources of fossil fuels because of energy security concerns. To achieve this goal, Japan cooperated with other countries, mainly the United States, and invested in and expanded its domestic technologies for nuclear energy use under safeguards.

1961 – 1970

The long-term program was revised because of the change in the circumstances and its experience, and it was written that nuclear energy development was needed for Japanese economic development. The Act on Compensation for Nuclear Damages was enacted to protect victims from damage and contribute to the sound development of the industry. Commercial power plants started construction in 1966. The first safeguards inspections were carried out in 1964 on Japanese facilities. Prime Minister Eisaku Sato stated four nuclear policies about nuclear nonproliferation in 1968.

In 1961, the second long-term program was issued. The reasons behind the revision were as follows:

- More technical information was available, so that wider and more concrete development planning became possible.
- Circumstances of nuclear fuel had changed with an increase of fuel supply from abroad, so that a combination of developing domestic fuel and importing fuel should be considered.
- The complexity of technical issues was discovered. Examining the independent nuclear fuel cycle, development of a fast breeder reactor (FBR) had more complex technical issues than originally expected. It needed a longer term to develop.
- Import of petroleum covered a greater portion of the energy use in Japan because the supply of petroleum became larger and the price became lower.
- Fields to use nuclear technology other than nuclear power reactors would be considered.

The long-term program stated that nuclear energy development was needed for Japanese economic development because of small amounts of domestic energy resources: petroleum, coal and hydropower. From the perspective of economic efficiency, light water reactors (LWRs) were adopted and constructed from 1970. For domestic production in the 1970s, engineers needed to be trained and learn the construction technology in the 1960s.[11]

In 1961, the Ministry of International Trade and Industry investigated the technology and economic efficiency, set funds and provided tax breaks, established a system for domestic construction, selected locations, established safety standards, reviewed the method of fuel procurement and fuel management, and cooperated with the IAEA.[12] The U.S. Price-Anderson Nuclear Industries Indemnity Act inspired Japan's Act on Compensation for Nuclear Damages passed in 1957. The Price-Anderson Act was created because: "Unwilling to risk huge financial liability, private companies viewed even the remote specter of a serious accident as a roadblock to their participating in the development and use of nuclear power. In addition, congressional concern developed over ensuring adequate financial protection to the public because the public had no assurance that it would receive compensation for personal injury or property damages from the liable party in event of a serious accident."[13] Different from the Price-Anderson Nuclear Industries Indemnity Act, the Act on Compensation for Nuclear Damages puts unlimited liability on the utility that caused the accident. Financial security shall be provided at the conclusion of a contract of liability insurance as an arrangement that makes available for compensation of nuclear damage and if the liability were over the amount of indemnity limit, the government would support the utility if necessary.[14] It expedited the implementation of compensation.

The AEC evaluated the economic efficiency of nuclear fuel enrichment and reprocessing. Although the cost estimate was higher for domestic activities than for overseas, the government decided to keep its research and development activities because this issue depended not only on economic efficiency but also on international circumstances, such as political and economic situations.[15]

In 1962, JRR-3, the first domestic research reactor to use natural uranium and moderated by heavy water, achieved criticality. In 1963, JPDR, a BWR by General Electric (GE) -Ebasco, produced electricity. Japanese electric power companies dispatched workers to the JPDR, which was partially constructed by domestic manufacturers.[16]

In 1965, the Advisory Committee of Energy reported that the private sector would secure overseas uranium and the government would establish an information network, provide financial support for investigation, and create low-interest loans for development and mining.[17]

In 1966, the JAPC began constructing the first commercial light water reactor at Tsuruga power station, 357MWe. The development plan for power sources included Fukushima unit1, with a 400MWe power rating, by Tokyo Electric Power (TEPCO), and Mihama unit1, with a 340MWe power rating, by Kansai Electric Power (KEPCO). KEPCO introduced the Pressurized Water Reactor (PWR) by Westinghouse in April and TEPCO introduced the Boiling Water Reactor (BWR) by GE in May. In 1967, Chugoku Electric power used a BWR for Shimane; TEPCO decided on a BWR by GE for Fukushima unit 2; Kyushu Electric power chose a PWR for Genkai; Tohoku Electric Power selected a BWR for Onagawa unit 1; Chubu Electric power decided on aBWR for Hamaoka; and Shikoku Electric Power chose a PWR. In the same year, Japan Nuclear Fuel (JNF), the predecessor of Global Nuclear Fuel – Japan (GNF-J), obtained a license for the consortium of Toshiba, Hitachi and GE.

The selection of reactor type might have been influenced by circumstances regarding imported technology to each company after World War II. The decisions may have depended on what U.S. company the Japanese manufacturers had introduced technologies such as gas turbines or other equipment for power stations. For example, Hitachi and Toshiba introduced technologies from GE, and Mitsubishi Heavy Industries (MHI) used the technologies from Westinghouse. Therefore the nuclear power plants preferred technology from U.S. companies that had previously provided equipment. The Japanese manufacturer of the previous thermal power stations might also have influenced what reactor model the electric power company adopted.[18]

In 1969, the Power Reactor and Nuclear Fuel Development Corporation (PNC) used centrifuges to successfully enrich uranium. The first transport of spent fuel occurred from Japan - from the Tokai power station - to the UK.[19]

In 1970, Mitsubishi Atomic Power and Westinghouse established a fuel fabrication company in Japan.[20] The Tsuruga Power Station also started operating.

The IAEA issued INFCIRC/26 in 1961 and INFCIRC/66 in 1965, which stipulated procedures for safeguards activities. Under the U.S. – Japan nuclear cooperation agreement, it was signed to transfer the safeguards inspection to the IAEA and went into effect in 1963 based on INFCIRC/26. In May 1964, safeguards inspections were carried out at Japanese facilities.[21] Japan – Canada and Japan - UK agreements' safeguards transferred to the IAEA in 1966 and in 1967 respectively based on INFCIRC/66.[22] The Japan – U.S.

nuclear cooperation agreement was revised in 1968. The revised agreement ensured the uranium and plutonium supply with the safeguards carried out by the IAEA.[23] In 1970, the Nuclear Nonproliferation Treaty (NPT) entered into force and Japan ratified the treaty in 1976.

INFCIRC/26 issued in 1961 stipulates the concrete methods of safeguards based on the IAEA statute.

* Safeguards on materials, equipment, facilities and so on supported by the IAEA, and safeguards according to requests from the member states
* On research and examination using nuclear materials, and utilization of nuclear reactors of the capacity of less than 100MWth
* Revision to be expected according to experience and technology development
* Nuclear reactors of 100MWth and higher capacity added later

INFCIRC/66 issued in 1965 is the revision of INFCIRC/26. It stipulates the safeguards method on nuclear materials, equipment, facilities, or nuclear materials used in provided facilities and so on and individual facilities. In 1966, safeguards on reprocessing plants were added (Rev.1), and in 1968, safeguards on conversion facilities and fabrication facilities were added (Rev.2)

Prime Minister Eisaku Sato stated four nuclear policies: 1) promotion of the peaceful use of nuclear energy, 2) efforts toward global nuclear disarmament, 3) reliance and dependence on extended deterrence by the United States, based on the 1960 U.S. – Japan Security Treaty, 4) support for the three nonnuclear principles under the circumstances where Japan's national security is guaranteed.

At the end of the 1960s, eight LWRs for utilities were under construction. MHI closed main contracts for Mihama unit 2 and the secondary systems of Mihama unit 1 and Takahama unit 1. Toshiba and Hitachi made main contracts for Fukushima unit 3 and Shimane unit 1 respectively. It was hoped that 90% of the equipment for Fukushima unit 3 and Shimane unit 1 would be domestic. The government's investments resulted in domestic technologies for nuclear energy.[24]

As of 1970, four reactors in Japan, 25 in the U.S., 28 in the UK, seven in West Germany, and eight in France were in operation. These reactors were no less than 10 MWe each.[25]

1971 – 1980

The long-term program was revised and it stated that nuclear energy was considered a semi-domestic energy source. To expedite locating power stations including nuclear power stations, three laws for power generation were enacted. Japan ratified the NPT in 1976, and the safeguards became dependent on the Japan-IAEA safeguards agreement. The Carter administration announced the United States' new policy on nuclear power in 1977, which affected the operation of the Tokai reprocessing facility that was about to start operation. The Carter administration demanded the International Nuclear Fuel Cycle Evaluation (INFCE) for the peaceful use of nuclear energy and nuclear nonproliferation. On receiving its results, discussion of international institutions for international control of material use started, and today Japan makes public the status of plutonium control and the utilization plan.

The AEC investigated enrichment businesses that considered joining the International cooperative enrichment project, because it was expected that the limit of the U.S. supply was reached in 1980.[26]

In 1972, the long-term program was revised again because of problems with fossil fuels such as air pollution and the rising price of petroleum, new fields of nuclear energy use such as nuclear fusion, the multi-purpose use of nuclear reactors, the reformulation of policy with results from advanced thermal reactors (ATR), Japan's rapid economic growth, and the necessity of international cooperation on nuclear energy development and use. Under these circumstances, it emphasized the semi-domestic source of nuclear energy because of easier transportation and storage than fossil fuel. The economic advantage of fossil fuel decreased with the development of LWRs, and by 1980, fossil thermal power and nuclear power was cost competitive.[27]

The revised program also stated to supply efficient electric power; the power supplied by (or capacity of) nuclear power was required to be 60,000MWe by 1985, and then 100,000MWe by 1990. The actual capacities were 23,931MWe in September 1985 and 31,480MWe in September 1990 according to the White Papers issued in 1985 and 1990 respectively.[28] ATR and FBR were needed to stabilize the domestic energy supply. The first goal of ATR development was 1975 with 200MWe; FBR by 1974 with 100MWth; and of the FBR prototype by 1978 with 300MWe. The independent fuel cycle needed the necessary amount of enriched uranium, which Japan imported from the United States because it had already imported LWRs from the United States. Some uranium enrichment was domestic in the 1980s, and a reprocessing facility started operating in FY 1974.

In 1972, the government designated the development of centrifuge enrichment a national project and standardized the centrifuge machine, developed mass production technology, developed high performance machines, implemented a cascade test, developed safety evaluations for earthquakes and accidents, and analyzed the economic feasibility. Ningyo-Toge uranium enrichment pilot plant started construction in 1978 and began operation in 1979.[29] In parallel to these domestic developments, the Japan-Australia and Japan-France nuclear agreements to cooperate on the purchase of natural uranium concluded in 1972.[30] Under the Japan-France agreement, reprocessing technology was shared from France.

Three laws for power generation were enacted to expedite locating power stations. In addition to nuclear power stations, these laws concerned hydroelectricity and geothermal power stations as well. In 1973, the first oil shock encouraged the Japanese government to promote the introduction of alternative energy resources to oil including nuclear power.[31] In 1972, ten incidents involving operator mistakes, mechanical error, and damaged equipment at the Fukushima-Daiichi, Tsuruga, and Mihama power stations[32] led to a lack of confidence by the Japanese public. LWR planning was developed to improve operations and standardization.[33] In the 1970s, 20 nuclear power plants started operation, and the total electric power capacity reached almost 15,000MWe.[34] At the end of 1970, 11 reactors were under construction or planned in Japan.[35]

Also in 1972, the IAEA issued INFCIRC/153 — a model agreement that stipulates the safeguards for the non-nuclear weapon states in the NPT, and called the comprehensive safeguards agreement (CSA). Japan ratified the NPT in 1976 and concluded the Japan – IAEA safeguards agreement, INFCIRC/255, which is based on this INFCIRC/153 in 1977.

In the 1970s, nuclear proliferation concerns and Japan's energy security were big issues. The world focused on nuclear power after the first oil shock in 1973. More countries acquired nuclear power plants or made plans to cultivate nuclear energy including oil producing countries and developing nations —countries that had not ratified the NPT. Some countries with advanced nuclear energy programs became nuclear suppliers to countries introducing nuclear power.

In 1974, India carried out its first nuclear test. Concerns about nuclear proliferation intensified. Safeguards by the IAEA as well as the physical protection of nuclear materials were considered to prevent proliferation. For countries that had not yet ratified the NPT, the IAEA's safeguards could be applied by a request such as a bilateral agreement between two countries.

In 1977, the Carter administration announced a new nuclear power policy. This policy postponed commercial reprocessing and plutonium recycling, changed FBR's development plan and postponed its commercialization, promoted research for an alternative nuclear fuel cycle, strengthened the capacity for uranium enrichment in the United States, established domestic law for the assurance of the nuclear fuel supply, prohibited the export of the technology and facilities for enrichment and reprocessing, and the implementation of INFCE.

This new American domestic policy affected other countries' use of nuclear energy for peaceful use as stipulated in Article 4 of the NPT. Japan, with few indigenous energy sources, was forced to change and limit its schedule and operation of the Tokai reprocessing plant.

Under construction since 1971, the Tokai reprocessing facility was scheduled to start operation. The United States imported the material for reprocessing. A new joint agreement by the United States and Japan was needed for reprocessing under Article 8c of the Japan-U.S. nuclear cooperation agreement. Japan stressed the need for nuclear power to assure Japanese energy security and economic development. Japan entered negotiations with thoughts to positively strengthen nuclear nonproliferation and promote the peaceful use of nuclear power. Japan maintained during the negotiations that member nations of the NPT should not be discriminated against as the NPT assured the peaceful use of nuclear power for non-nuclear weapons countries.[36]

After the discussion, the United States and Japan released a joint statement with the following points:

- The Tokai reprocessing plant would operate for two years with up to 99 tons of spent fuel.
- For two years Japan would suspend construction of a facility to convert plutonium nitrate to plutonium oxide. The United States assured Japan to supply plutonium for research and development (R&D).
- For two years, Japan would experiment with a mixed extraction procedure in an operational test laboratory in the reprocessing plant with results supplied to the INFCE.
- After two years, if Japan and the United States agreed the co-processing was viable and effective, the Tokai reprocessing plant would be modified to use the new co-processing.
- For two years there would be no new primary measures taken for new reprocessing facilities to extract plutonium, if the co-processing is agreed to be technically viable and effective by both governments.
- Loading plutonium fuel in LWRs would be postponed for two years.
- The IAEA would carry out safeguards activities.
- Japan would improve safeguards and the physical protection of this facility.
- Japan would test safeguards equipment in cooperation with the United States and IAEA, and provide the INFCE with the results.

The "two year" duration in the joint statement was necessary to allow for consideration of the evaluation by INFCE and to establish the nuclear fuel cycle in Japan.[37]

In 1978 Japan scheduled a preparatory meeting to create a private company for reprocessing. In 1980 the Japan Atomic Fuel Service Company began.

Also in 1980, the INFCE concluded in a joint communiqué in the section Summary and Review "*… that nuclear energy is expected to increase its role in meeting the world's energy needs and can and will be widely available to that end; … and that effective measures can and will be taken to minimize the danger of the proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes.*"[38] The INFCE yielded significant results in the field of nuclear power because its analysis covered diverse perspectives. For example, from the perspective of nonproliferation, issues included reprocessing and evaluation of the use of enrichment and plutonium, and concluded that safeguards were the most effective method of nonproliferation. Improved safeguards technology and international systems or alternative methods for more effective safeguards, would be compatible with nonproliferation.

The INFCE determined that no specified nuclear fuel cycle was effective for nonproliferation, meaning the nuclear fuel cycle with reprocessing had nonproliferation disadvantages compared with one without reprocessing. The INFCE recommended that to help prevent proliferation, advanced nuclear states construct large-scale reprocessing plants in their own countries in order to reduce the widespread use of reprocessing in many countries. It concluded that the number of enrichment facilities be limited and their capacities expanded commensurate to demand, and only large-scale nuclear energy producers or large-scale uranium suppliers construct enrichment facilities. There would be no difference between the fast breeder reactor fuel cycle and other fuel cycles, and if FBRs were adopted, nuclear power would be free from the constraint of the uranium supply. While there was no economic advantage using plutonium in thermal neutron reactors, some countries considered it important for energy independence and the assurance of the fuel supply.[39]

According to the "White Paper on Nuclear Energy 1980," "the important achievement of the INFCE is that it provided a venue for dialog between the U.S. and other countries including Japan and Western Countries to accommodate the U.S.'s policy of further restriction on peaceful nuclear use from the perspective of nonproliferation and the others' policy to oppose it. The mutual understanding of each state's status of nuclear use was deepened through the dialog."[40]

In June 1980, the final communiqué of the Summit Conference in Venice, Italy, welcomed the results of the INFCE study and demanded that all the states consider those results when developing policies or plans for the peaceful use of nuclear energy.[41]

Also in 1980, the INFCE held its Final Plenary Conference in Vienna with findings that strengthened the view that:

- nuclear energy is expected to increase its role in meeting the world's energy needs and can and should be widely available to that end;
- effective measures can and should be taken to meet the specific needs of developing countries in the peaceful uses of nuclear energy; and
- effective measures can and should be taken to minimize the danger of the proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes.

International cooperation was necessary and the findings included technical, legal and institutional measures as well as possible developments in the field of safeguards.[42]

On receiving the results of the INFCE's study from 1977 to 1980, international institutions like International Plutonium Storage (IPS), International Spent Fuel Management (ISFM), and the Committee on Assurances of Supply (CAS) considered having the IAEA play a main role in these activities.

The IPS wanted residual plutonium from reprocessing under international control to prevent its diversion for military use. However, this goal was abandoned because of a conflict among the perspectives of Western countries, developing countries, and supplier countries. The IAEA issued "Guidelines for the Management of Plutonium" (INFCIRC/549). Under the guidelines, each state announced its stock of plutonium at each facility to improve transparency. In 1991, Japan revealed it possessed less plutonium than the quantity needed for sustaining the nuclear fuel cycle in the report of the Advisory Committee on Nuclear Fuel Recycling Program of the Atomic Energy Commission. Japan also made public the plutonium control in 1994. Each year Japanese utilities publicized their plutonium use plans before the separation of plutonium.

ISFM stored the spent fuel from nuclear reactors under international control. Japan attended the discussion because its importance to nuclear nonproliferation and the IAEA's commitment to enhance technology for the storage of spent fuels.

CAS assured the fuel supply, which contributed to nonproliferation. However, discontents in some developing countries argued that the suppliers limited the export of materials and technologies.[43] The IAEA is still debating how best to cooperate with regards to the fuel supply.

1981 – 1990

The Hexapartite Safeguards Project, an international project for developing safeguards for enrichment facilities, was launched in 1980 due to U.S. concerns of enrichment facilities safeguards. While centrifuge enrichment facilities operated around the world, the sensitivity of enrichment technology limited discussions of safeguards on these facilities. Japan cooperated with the development and improvement of safeguards systems and technologies on enrichment facilities with its measurement technology at the Ningyo-Toge enrichment facility. In 1985, the Tokai reprocessing facility started full-scale operation after the INFCE's evaluation. Japan exported reactor vessels to China under the condition of peaceful use.

In 1979, the Ningyo-Toge pilot plant started operation. In 1980, Japan joined the Hexapartite Safeguards Project to develop safeguards for enrichment facilities. U.S. concern that the IAEA had not progressed sufficiently on applying safeguards to enrichment facilities, though the commercial operation of these facilities had started, led to the creation of this project. The IAEA had not completed the Facility Attachment (FA), which described the inspection methods of the sensitive enrichment technology. The United States suggested that nations with enrichment facilities in operation, under construction, or under preparation join an international cooperation project. The member nations included the United States, Japan, United Kingdom, West Germany, the Netherlands, and Australia. The IAEA and EURATOM also joined the project. The project developed the technical basis for enrichment facility attachments to IAEA safeguards.

The project consisted of four teams: 1) facility design, 2) observation and sealing, 3) material accounting, and 4) safeguards strategy. Japan led Team1 for facility design. Japan suggested the project adopt the material accounting method used at the Ningyo-Toge enrichment facility, and still used at the Rokkasho enrichment plant.[45] By 1982 all the facilities of Ningyo-Toge started operation. The enriched uranium produced there was used in Fugen, ATR, which started operating in 1979.

In March 1981, nuclear power comprised 12 percent of Japan's electric generators.[44] By November 1981, 22 nuclear reactors (15,511MWe in total) operated commercially, with 11 under construction, and six under preparation in Japan.

In 1982, the long-term program was revised again. It stated for the energy security and economic development of Japan; the capacity of nuclear energy for electric power generation was expected to reach 46,000 MWe by 1990. Japan depended on overseas suppliers for natural uranium as the source of nuclear fuel. It would pursue a long-term supply contract or the independent development of uranium mining to ensure this resource and increase the enrichment of domestic uranium. Japan reprocessed domestically. By 2010, the FBR would be in practical use. MOX fuel was expected to be used in LWRs before and after the FBR was developed. As for ATR, a demonstration reactor was expected to be constructed in the early 1990s by the private sector.

In 1983, Ningyo-Toge was selected for a Prototype Enrichment Plant. The Federation of Electric Power Companies asked the Governor of Aomori Prefecture to endorse facilities for enrichment, reprocessing, and storage. In 1984, the facilities became Japan Nuclear Fuel Limited (JNFL) facilities. The governor accepted it in 1985. JNFL started construction on the commercial enrichment plant in 1988. By 1989, the prototype enrichment plant in Ningyo-Toge commenced operations.

Japan carried out the third LWR improvement and standardization plan between 1981 and 1985. The plan provided earthquake resistant designs and licenses, and established basic specifications for standard plants. Advanced BWR (A-BWR) and Advanced PWR (A-PWR) were to be developed and then introduced for consideration of new construction. Evaluations showed they had a higher safety, reliability, and capacity rate, in addition to a lower level of radiation exposure for workers. A-BWR and A-PWR were improvements over the previous BWR and PWR from the perspectives of operation, cost, electricity capacity, and the effective use of uranium. The target goal for these reactors to begin operation was the mid-1990s.[46]

In 1985, the Tokai reprocessing facility started full-scale operation. That first year the facility reprocessed 73.5 tons of spent fuel, with a cumulative amount of 252.8 tons of spent fuel since 1977.[47] As of 1986, electric power companies contracted with reprocessing companies in the UK and France for 3,400tU total for LWRs and 1,100tU for gas-cooled reactors.[48] In 1985, a commercial reprocessing plant was constructed in Rokkasho, Aomori Prefecture. The Japan Atomic Fuel Service designed it in 1987.

In 1981, the new Reagan administration focused on restoring its allies and encouraging friends to cooperate with peaceful nuclear energy use. *The Statement on United States Nuclear Nonproliferation Policy on July 16, 1981*, stated:[49]

- The United States will cooperate with other nations in the peaceful uses of nuclear energy, including civil nuclear programs to meet their energy security needs, under a regime of adequate safeguards and controls. Many friends and allies of the United States have a strong interest in nuclear power and have, during recent years, lost confidence in the ability of our nation to recognize their needs.

- The administration will also not inhibit or set back civil reprocessing and breeder reactor development abroad in nations with advanced nuclear power programs where it does not constitute a proliferation risk.

The *U.S.-Japan joint decision and statement of October 30, 1981*, agreed to:[50]

- Establish a long-term agreement by the end of 1984 to permanently settle the question of reprocessing.
- Allow the full-fledged operation of the Tokai reprocessing plant until then. (Before the statement was issued, the operating term and plutonium extraction amount was decided in 1977.)
- Lift the limitation on construction of commercial sized reprocessing plants.

The United States and Japan started negotiating the U.S.-Japan nuclear cooperation agreement. From past experience, Japan entered the negotiations with the goal of introducing a program for reprocessing and transporting plutonium. Japan wanted authorization for a lump set of activities set in advance, instead of requesting authorization for each activity individually. Japan preferred to establish and maintain a long-term stable nuclear fuel cycle within Japan for its energy security. However, the United States focused on its national security.

While the United States agreed to the Japanese program, it needed to satisfy the conditions stipulated in the Nuclear Nonproliferation Act (NNPA), which required an ability to cancel the agreement under certain conditions. Japan argued that the only condition refer to a nonproliferation issue instead of the United States' national security. However, national security was an indispensable condition for the United States. It was agreed that the decision to halt the Japanese plutonium program must be made by a senior official and that the term be limited in scope and duration. Negotiations started in 1982 and were agreed upon in 1987. The new bilateral agreement came into force in 1988.[51]

Meanwhile, China's nuclear power plan started and cooperation between China and Western countries became active. In 1983, China entered a nuclear cooperation agreement with France and resumed meetings with the United States. In 1984, China joined the IAEA. China signed agreements with West Germany, the UK, Japan, and the U.S. in 1984, 1985, and 1986 respectively.

In 1984, Japan agreed to export a reactor pressure vessel to the Qinshan Nuclear Power Plant in China with the following conditions: 1) the pressure vessel could only be used in the Qinshan Nuclear Power Plant for peaceful use and not used in any manner for military purposes, and 2) the Qinshan Nuclear Power Plant would invite Japanese parties to improve technical cooperation and to boost bilateral cooperation concerning the construction and the operation of the Qinshan Nuclear Power Plant.[52] The letter could be interpreted as a "verifiable agreement" between Japan and China to ensure the equipment be used only in the plant and for peaceful uses, while expressing the amicability of future visits due to diplomatic sensitivity. Though Japan and China had not yet signed an official bilateral agreement, the letter stipulated the conditions for sharing technology and the Japanese government exported nuclear-related equipment to China .

1991 – 2000

The fuel cycle included the ATR, but soon escalating costs resulted in the A-BWR with a full MOX load replacing the ATR . The AEC decommissioned the Fugen prototype ATR. The regular use of MOX fuel was expected to start in the mid- 1990s. With the collapse of the Union of Soviet Socialist Republics (USSR), nonproliferation and security became major issues. There was also great concern over the possibility of Iraq's clandestine activities and the refusal of the Democratic People's Republic of Korea (DPRK) to allow a safeguards inspection. The IAEA safeguards strengthened through the "93+2" program. Japan's expertise and experience contributed to safeguards on various types of facilities. The NPT was extended indefinitely with a review conference held in 1995.

In 1988 and 1989, the prototype facilities in Ningyo-Toge started operation to establish a nuclear fuel cycle in Japan. By 1996, the Ningyo-Toge plant started enriching recovered uranium. From 1993 to 1997, Ningyo-Toge carried out operation tests on a utility-sized cascade— a series of centrifuge machines.[53] JNFL constructed a uranium enrichment facility in Aomori prefecture using Japanese domestic technology and began operating in 1992. The production output increased by 150tSWU/y, and in 1998, the capacity had become 1,050tSWU/y.[54] The long-term program issued in 1994 stated that the necessary amount of enriched uranium was 5,000tSWU/y, and the target for domestic enriched uranium would be 1,500tSWU/y by 2000.

Most reprocessing of Japanese spent fuel occurred abroad, though the Tokai reprocessing facility was operating. In 1992, France shipped reprocessed plutonium to Japan to load the Japanese prototype FBR, Monju. In the UK, a reprocessing plant for spent fuel started operation in 1994.[55] The JNFL started construction in Aomori of a reprocessing plant equipped to produce 800tU/y, It received spent fuel in 1998, and started operation tests in 1999.[56]

In April 1994, the prototype FBR, Monju, reached criticality and transmitted electric power in August 1995. However, a sodium leak in the secondary system, which has no nuclear or radioactive materials, occurred in December the same year and stopped the reactor's operation.[58]

In 1995, the Federation of Electric Power Companies demanded that the ATR demonstration reactor planned in Ohma, Aomori prefecture be replaced by a LWR with a full load of MOX fuel. Power generated by the ATR cost three times more than the LWR. The AEC agreed to replace the projected ATR with the A-BWR with MOX. The A-BWR was economically efficient and technologically available, and achieved a balance of plutonium supply and demand. The Fugen prototype ATR was decommissioned by the AEC in 1998.[57]

By 1995, MOX fuel was loaded into more than 1,700 fuel assemblies worldwide. As a test, Japan loaded MOX fuel in the Tsuruga and Mihama power stations from 1986 to 1991.[59] Regular use of MOX fuel was expected to start in the mid-1990s.[60]

In 1994, the 8th long-term program stated that Japan would use MOX fuel in PWR and BWR by the late 1990s, in 10 reactors by 2000, and then a few more than 10 reactors in 2010.

In 1998, KEPCO applied for and was approved to use MOX fuel. In 1999, TEPCO applied and was approved in 2000. However, both projects were postponed due to the falsification of data during a MOX fuel examination, which resulted in the reconsideration of the exam for imported fuels.[61]

By the mid-1990s, nuclear energy supplied 30 percent of the electric power in Japan. In 10 years, 15 LWRs started operation with an added capacity of 15,803MWe. In 1990, nuclear power supplied 27 percent of the electricity, and in 2000, it supplied 34 percent.[62]

After the USSR collapsed, anxiety soared over the proliferation of the USSR's nuclear technologies, nuclear materials, and equipment. In 1992, the International Science and Technology Center supported scientists and engineers from Russia and the newly independent states of the former Soviet Union to research nuclear technology for peaceful use by Japan, the United States, EU, and Canada. These scientists and engineers lost their jobs after the USSR collapsed.[63]

In the early 1990s, concern about Iraq's clandestine activity and the DPRK's refusal of a safeguards inspection prompted an effort to strengthen IAEA safeguards through the "93+2" program (named because it began in 1993 and took two years to complete). The IAEA program investigated undeclared nuclear activities and materials, and strengthened the safeguards inspection. In addition to conventional safeguards inspections based on INFCIRC/153, INFCIRC/66, and voluntary offers, the IAEA introduced the short-notice inspections under a complementary access provision of the Additional Protocol (AP).

Japanese experts joined the Technical Committee under the IAEA Board of Governors to help develop the AP. They discussed the details of the protocol, and Japan made valuable contributions based on their past experience with safeguards on various facilities associated with the nuclear fuel cycle. Japan signed the AP in 1998 and ratified it 1999.[64]

The AP allowed the IAEA an enhanced right to access and collect information from facilities and places not covered by the "comprehensive" safeguards agreement, in addition to sampling in facilities. As of July 2012, 117 countries (a majority of the world's nations) and the EU have ratified the AP. The INFCIRC/540 issued in 1997 was the model protocol for the AP.

At the NPT review conference held in 1995, the treaty was extended indefinitely. That decision influenced the future of the nuclear nonproliferation regime, which impacted the peace and stability of the world. As the Cold War ended, the decision to extend the treaty was unforeseeable in the fast-changing international arena. Regional conflicts rose as did concern of nuclear proliferation to neighboring states, as nuclear weapons states progressed with arms reductions.

Concerning efforts to rein in nuclear testing, the 1990s had setbacks and successes. In 1994 and 1995, France and China carried out nuclear tests. In 1998, India and Pakistan conducted nuclear tests. However, in 1992, the United States began a moratorium on testing and in 1996 signed the Comprehensive Test Ban Treaty (CTBT) although in 1999 the U.S. Senate decided against ratification. Japan played a constructive role in advancing this treaty and its capabilities. For instance, Japan used seismology to detect nuclear tests in an effort to expedite the CTBT's monitoring network. The Japanese organized seminars to cultivate seismology specialists in developing countries to establish an international regime. Although the CTBT did not enter into force before the 1995 NPT Review Conference, the Japanese contribution might have persuaded the decision.[65] As of August 2012, eight nations need to ratify the CTBT for it to enter into force.

The year 2000 concluded with the release of the 9th long-term program for Japan's nuclear energy program.

2001 - 2011

The use of MOX fuels in LWRs was delayed due to incidents and accidents that occurred at some facilities. The Rokkasho reprocessing facility also fell behind schedule for technical reasons. New safeguards were applied to Japan to reduce the number of inspections while maintaining detection capabilities. Japan joined efforts of international cooperation for nonproliferation and cooperated to enhance the development of nonproliferation technology. At the 2010 Nuclear Security Summit held in Washington, DC, Japan led in improving nuclear security in the world. The year 2011 focused on security issues of LWR after the meltdown at the Fukushima-Daiichi Nuclear Power Plant.

People concerned with nuclear energy, business, law, local communities, and the mass media comprised the long-term program committee because of the public's anxiety and distrust after incidents like the sodium leak at Monju and JCO's criticality accident.[66]

The principles to formulate a new Long-Term Program state:

- Based on the history of nuclear energy in the 20th century, the new Long-Term Program defines problems to be solved and prescribes long-term strategies to be carried out to develop the diverse potential of nuclear energy. By returning to the start, the significance and role of nuclear energy will be reexamined in comparison with other energy options, taking into consideration changes in lifestyle, societal values, the views of the international community, and developments in science and technology.
- Amid growing public concern and distrust of nuclear energy, a prerequisite for any nuclear energy policy is the understanding and confidence of the Japanese people, society, and the international community. The new Long-Term Plan must provide specific guidelines to parties involved in nuclear energy and send a clear message domestically and internationally.
- The new Long-Term Plan will determine the roles of the central government and the private sector, with emphasis on concepts and policies that must be adhered to and pursued steadily, now and in the future. With regard to research and development to meet needs in changing situations, the new Long-Term Program will provide diverse options to carry out research and development projects flexibly, based on timely and proper assessment.

The new Long-Term Plan stated that the share be maintained of nuclear energy in the power generation mix, from the viewpoint of coping with changing circumstances and of moving Japan's energy supply to one of high economic efficiency and supply stability, while producing small amounts of carbon dioxide emissions. A target number was not provided because previous goals were off actual amounts and because the new program was issued just after the accidents at Monju and JCO. The commission focused more on improving the public's understanding of nuclear energy.

By 2000, 51 nuclear power reactors operated with the capacity of 44,920MW.[67]

The Long-Term Program explained that while the nuclear power program progressed as planned, delays affected the projected figure of 16 – 18 LWRs with MOX fuel by 2010. The Japanese utilities refined quality control measures for fuels after data falsification occurred by a British corporation in 1999. At the end of 2010, four power reactors using MOX fuel started commercial operation and test operation: Genkai-3 in December 2009, Ikata-3 in March 2010, Fukushima Daiichi-3 in October 2010, and Takahama-3 in December 2010.

While the reprocessing plant in Rokkasho, Aomori prefecture received spent fuels from LWRs, it suffered from technical trouble and will not begin full-operation until after 2011.[68]

In 2006, the Resource and Energy Agency and the Ministry of Economy, Trade and Industry developed a plan to focus *the nation of Japan on nuclear energy* (Genshiryoku Rikkoku Keikaku). This plan required the steady implementation of the nuclear cycle and the simultaneous pursuit of nuclear enhancement and nuclear nonproliferation. The implementation schedule called for nuclear energy to supply 30 – 40 percent of electric power after 2030, the fuel cycle be fully implemented, and the introduction of the FBR commercially by 2050.

In 2002, the concept of Integrated Safeguards (IS) was introduced to reduce the number of safeguards inspections by the IAEA while preserving the detection capability. The IAEA developed the IS because of issues in Iraq and DPRK that occurred in early 1990s. While the AP strengthened the IAEA safeguards, the IS procedure streamlined the safeguards activities for nations with little concern about proliferation of nuclear materials or activities. To apply the IS, nations obtained a broad conclusion from the IAEA. To obtain a broader conclusion, a nation accepted CSA and AP for a certain period of time, and as a result, the IAEA concluded no diversion of nuclear material under safeguards and no clandestine nuclear material and activities. Japan obtained the broader conclusion in June 2004, and IS was implemented in September that same year.[69] To maintain IS, Japan must obtain the broader conclusion each year, which it has.

In 2000, the Generation IV (Gen-IV) International Forum convened to lay the groundwork for the fourth generation of nuclear energy systems. The Gen-IV system features enhanced safety and is proliferation resistant.

That same year, the IAEA General Conference launched the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) to ensure that nuclear energy could meet the energy needs of the 21st century in a sustainable manner. INPRO Members collaborate on topics of joint interest. The results of INPRO's activities are made available to all IAEA Member States.[70] In 2006, Japan joined it to promote nuclear energy use in Japan and introduced technologies in developing countries.

The International Nuclear Energy Research Initiative (I-NERI) fostered collaborative R&D with international partners for advanced nuclear energy systems.[71] In 2004, Japan exchanged notes with the United States for I-NERI. The United States and Japan have cooperated on the development of innovative fuel technology and other technologies.

In 2004, the Global Threat Reduction Initiative (GTRI) was created to prevent highly enriched uranium (HEU) from the United States or former Soviet Union from falling into the hands of terrorists. Under GTRI, highly enriched uranium was returned to the United States and Russia, which reduced the amount of nuclear and radioactive materials available to threaten the international community. Japan soon converted the experimental reactors that used HEU to use low-enriched uranium (LEU).

In 2006, the United States introduced the Global Nuclear Energy Partnership (GNEP). Under this proposed plan, member states, including Japan, would have shipped spent nuclear fuel to the United States for reprocessing with the resulting plutonium shipped for use in reactors. GNEP partners would voluntarily give up nuclear enrichment and reprocessing technologies in exchange for sending their nuclear waste to supplier countries for reprocessing. Developing countries would use the plutonium for peaceful purposes such as electric power generation. The U.S. and Japan cooperated including the joint design of the U.S. nuclear fuel cycle facilities, developing the advanced burner reactor (ABR), and expanding the safeguards concept. But GNEP experienced delays due to concerns from a number of developing countries that their rights would be taken from them. Recognizing these concerns, in 2010, the Obama administration reformed GNEP into the International Framework for Nuclear Energy Corporation (IFNEC). The organization and its roles were adopted from GNEP but the new organization was careful to not suggest that any countries' rights would be infringed.[72]

In 2010, the Obama administration convened the Nuclear Security Summit in Washington, DC. The summit was the largest gathering of heads of state organized by a United States president since the 1945 United Nations Conference on International Organization. Japan's contributions included its work to improve nuclear security in the world with R&D on nuclear detection, measurement, and forensics; to support human capacity building in Asian countries; to establish a better system for the accounting of materials; and to provide training.

As a country with few domestic energy resources, Japan relies on nuclear power for energy security. Japan innovated nuclear power reactors, improved enrichment technologies, built FBRs, constructed reprocessing plants and their safety systems, and developed a comprehensive nuclear nonproliferation system that included safeguards technology. Japan expected to export its nuclear power plants to developing countries with plans to use nuclear power for peaceful uses.

On March 11, 2011, the Great East Japan Earthquake off the Pacific coast of Tōhoku and the tsunami that followed overwhelmed nuclear power stations in the area. The damage to the Fukushima-Daiichi Nuclear Power Plant was extremely serious with the meltdown of three reactor cores and the release of radioactive materials. The investigation is still under way with continued discussion in Japan of safety regulations and nuclear policy. The natural disaster—earthquake and tsunami—exposed vulnerabilities that caused a station black out (SBO), the failure of the cooling system, and the release of radiation. Nuclear safety and security were issues raised at the 2012 Nuclear Security Summit held in Seoul.

After the terrorist attacks on September 11, 2001, the Japanese government revised the Nuclear Reactor Regulation Law to enhance the protection of nuclear materials and facilities based on INFCIRC225/rev.4, The Physical Protection of Nuclear Material and Nuclear Facilities. Japan's security efforts have focused on the prevention of threats with intrusion detection cameras, sensors, fences, and guards. Following the March 11 event, Japan contemplated additional safety measures and security efforts to determine whether a terrorist attack could cause an SBO or cooling system failure. According to reports, access control of the power station after the accident was a problem. Additional considerations included physical protection, equipment used to mitigate the effects, and systems to request support from outside organizations and states.

CURRENT ISSUES AND THE JAPANESE ROLE IN NONPROLIFERATION

Much work remains to be done to strengthen nuclear nonproliferation. Japan is a nuclear nonproliferation leader based on specific actions set out in the 2012 Nuclear Security Summit, and when compared with countries that have rejected the Additional Protocol and have continued to conduct nuclear tests.

Since it imported its first nuclear power reactor in 1956, Japan has enhanced technologies for the peaceful use of nuclear power and developed high-quality products, some of which are only produced by Japanese manufacturers. Japan introduced light water reactors in 1961 by importing the technology. With government support, Japan also increased the percentage of domestic technology used in reactors, with some products only provided by Japan.[73] Japan has further developed its fuel cycle to include enrichment and reprocessing technology for its energy security. All facilities are under IAEA safeguards and Japan nurtures a culture of transparency.

> Japan Steel Works (JSW) is the only manufacturer of large single-piece pressure vessels for large nuclear reactors, which reduces the risk of radiation leaks. The JSW equipment hammers and forms large ingots without defect.

Japan experienced and learned important lessons from two large accidents. The first, a criticality accident, occurred in 1999 at the fuel conversion company JCO in Ibaraki-Prefecture, and the second took place at the Fukushima-Daiichi Nuclear Power Plant in Fukushima- Prefecture in 2011. The Fukushima-Daiichi accident exposed the vulnerability of nuclear power plants, which will affect future security measures around the world. Japan modified its regulatory system after the JCO accident, and will change regulations and reconsider safety and security measures after the accident at Fukushima-Daiichi.

As the number of countries that introduce nuclear energy for electric power generation increase, the issue of nuclear nonproliferation, security and safety will become more important. For more than 60 years, Japan used its own experience with nuclear energy to develop technologies to enhance the security of nuclear use in the world.

Safeguards and Additional Protocol

In 1957, the International Atomic Energy Agency provided the international framework for the peaceful use of nuclear power. Japan concluded agreements with Canada and also with the IAEA, safeguards agreement INFCIRC/3, to import natural uranium for its Canadian research reactor, JRR-3. Japan's agreement with the IAEA stipulated that the material only be used for peaceful purposes and not be exported to other countries without the IAEA's agreement. This streamlined the safeguards system.

In 1961, INFCIRC/26 was the first document to codify concrete methods for safeguards. In 1963, the safeguards under the U.S.-Japan agreement transferred to the IAEA with the first safeguards inspections carried out on Japanese nuclear facilities the following year.

In 1965, INFCIRC/26 updated as INFCIRC/66. INFCIRC/66 mandated special fissionable and other materials, services, equipment, facilities, and information made available by the IAEA or at its request or under its supervision or control not to be used to further any military purpose. It also applied to India, Pakistan, and Israel —the states outside the NPT.

With the enactment of the NPT in 1970, member states applied safeguards under the INFCIRC/153 agreement, which required safeguards on all nuclear materials at declared facilities in each state. Japan ratified it in 1976. These comprehensive safeguards (CS) applied to all materials at declared facilities in a non-nuclear weapon state's nuclear program, in contrast to facility specific safeguards under INFCIRC/66.

However, the safeguards system experienced a shock in 1991 when strong concern emerged over the possibility that Iraq, an NPT member state, was seeking a clandestine nuclear weapon program with undeclared nuclear materials. In response, the IAEA strengthened its safeguards in 1993 with "Programme 93+2."

In 1997, the Additional Protocol (AP: INFCIRC/540) obligated states to declare nuclear related activities that had not been declared under the conventional "comprehensive" safeguards and bestowed IAEA with the authority to access facilities other than the ones declared under conventional safeguards. Japan was the first state using nuclear power plants for electricity generation to apply the AP.

Integrated Safeguards (IS) applied to Japan in 2004. The IS combined the CS and the AP for effective and efficient safeguards activities. The IS applied to states which obtained "The Broader Conclusion," which is a conclusion that all remaining nuclear materials are for peaceful activities and that there is an absence of *undeclared* nuclear material and activities in the state. Japan was the first case where the IS applied to a state that had a large scale nuclear power program.[74]

Japan contributed in the development of the safeguards system and equipment. In particular, Japan participated in the Hexapartite Safeguards Project for enrichment plants and carried out demonstration tests of the equipment and technologies used at the Ningyo-Toge enrichment facility. Based on the project results, Japan developed a monitor for pipes to verify the enrichment under the Japan Support Programme for Agency Safeguards (JASPAS), which is in practical use during safeguards inspections. The Tokai Advanced Safeguards Technology Exercise (TASTEX)—a joint project of Japan, the U.S., France and the IAEA to improve safeguards equipment at the Tokai reprocessing plant— improved surveillance cameras and measurement systems at reprocessing plants. JASPAS continued to carry out the tasks under TASTEX of Japan's own accord. JASPAS accomplished more than 100 tasks to innovate technology for safeguards inspections such as measurement, surveillance, and containment.[75]

A significant IAEA concern is that dozens of countries have not agreed to the AP. While every country has the right to use nuclear power, some do not like this right to be questioned. Leaders of some countries resent the challenge posed by other nations or international organizations.[76] As mentioned earlier, as of July 2012, with the exception of 64 countries, 117 countries have adopted the AP. Some of the 64 countries have significant nuclear activities.[77] In 2011, the Nuclear Suppliers Group (NSG) board meeting (INFCIRC/254) strengthened the guideline for transporting enrichment and reprocessing equipment. However, the guideline did not require states to adopt the AP due to strong opposition from Argentina, Brazil, and South Africa during the board meetings. The AP issue is rather difficult to settle. However, Japan has played a role in encouraging more countries to adhere to the AP.

Nuclear Suppliers Group (NSG) is a group of nuclear supplier countries, which seeks to contribute to the nonproliferation of nuclear weapons through the implementation of Guidelines for nuclear exports and nuclear related exports.

The NSG Guidelines are implemented by each Participating Government in accordance with its national laws and practices. Decisions on export applications are taken at the national level in accordance with national export licensing requirements.[78]

The NSG was formed by a group of nuclear supplier states that were convinced after the first Indian nuclear explosive test that the NPT alone would not halt the spread of nuclear weapons.[79]

Some of the issues are that the NSG guidelines are non-binding and that information on the items most member states judged as unauthorized exports among them is not effectively shared.[80]

For example, though Vietnam had not agreed to the AP, it was considering importing Japanese nuclear plants. Japan gave a seminar to Vietnam on the AP, which might encourage them to adopt it, and can conditionally provide the plants. Countries interested in exporting Japanese products sign cooperation agreements with Japan that includes a condition of nonproliferation. Countries that import nuclear plants from the United States or France also might require agreements with Japan because at least one major component of the plants was produced in Japan.[81] Thus, Japan has leverage to encourage these countries to apply the AP.

Iran recently announced it developed centrifuge enrichment technology and used it to produce enriched uranium. Though Iran stated the enriched uranium was for peaceful nuclear use, countries including the United States were skeptical because of its past clandestine activities, the military dimension to Iran's nuclear program, and the refusal of a special inspection by the IAEA.

Though the United States and the EU imposed sanctions on Iran, Japan imports about 10 percent of its oil from Iran. To help support sanctions on Iran, Japan reduced oil imports from Iran, which allowed the United States to exempt it from a block of the Central Bank of Iran.

Sanctions might change Iran's behavior but it might not change Iran's determination to move ahead with enrichment. Another option includes a dialogue between Iran and western countries, including the United States. If Iran accepted full safeguards, implemented the AP requirements, agreed to limit enrichment to less than 5 percent, and limited the size of its nuclear program, then it might convince the international community right of its intention to use nuclear power for peaceful uses.

If those conditions were met, Japan could cooperate with Iran to improve its energy security. Iran's current electricity sources are stressed by industrial and economic development, and an increase in population. Though Iran uses oil and gas to power its electricity generation stations, it is exploring hydro technology and is planning to develop more nuclear power reactors. In 2011, Iran started operation of the Bushehr nuclear power station with a capacity of 1000MWe. Iran's Five-Year Plan calls for an increase in nuclear power capacity to 20,000MWe by 2025.[81]

Though Iran's security environment is very different from Japan, Japan can help Iran develop nuclear power and safeguards. As a non-nuclear weapon state, Japan's experience with technology and safeguards is different from Russia, China, or India, which are enhancing their competitiveness in the global market for nuclear energy technology. As Japan has nuclear facilities, other than reactors, that fall under the IAEA's safeguards, it might advise Iran on designs that ease the installation of safeguards equipment and introduce safeguards without difficulties, in addition to establishing a domestic material accounting system.

Iran must adopt a transparent nuclear energy program in order for the international community to trust it to proceed with its electric power supply program.

Japan could provide Iran with power reactors with the condition of the IAEA's safeguards system and the AP. Japanese technology might be appropriate for Iran's purposes because both countries face the threat of earthquakes. Fault lines run across Iran and Bushehr is located near a point where three fault lines converge.

Iran must enter into a verifiable agreement not to proliferate nuclear technology or knowledge to other states, including any developed indigenously or provided by Japan.[82] A good reference is Japan's experience exporting a pressure vessel to China's Qinshan Nuclear Power Plant in 1984. China agreed to the condition of a visit by Japan to examine the Qinshan power plant's construction and operation.

The Bushehr Nuclear Power Station was designed by Germany, PWR Convoy model. In 1979, Unit 1 was 80-85 percent complete when construction was suspended. The reactor containment dome and other structures were seriously damaged by attacks during the Iran-Iraq war in 1980-1988.[83]

When Russia resumed the project, they constructed it using the already-built structures.

Substantial differences between the two designs complicated the construction, such as replacing equipment and operations associated with this uncommon situation.

Operators required unique training due to the combined designs. Usually nuclear power plant operators drill at the training facilities of each plant's type of PWR or BWR because the design is the same. Because the Bushehr NPP has an exclusive design, the operators might not receive proper operations or emergency training. This could pose a safety concern at the Bushehr NPP.

Iran recently announced it started operation on an enrichment facility and refused an IAEA safeguards inspection. While Iran has the right to peacefully use nuclear power, it must allow safeguards inspections under the international agreement

To cooperate with the IAEA, Iran could use Japan's technical advice and equipment support in addition to its vast experience of safeguards on similar facilities.

"Even with careful safeguards, I think it will take many years for the international community to view Iran as a state absent proliferation concern. However, it would be very positive if Iran's experience with Japan led it towards confidence building measures." Said Ms. Christina Walrond, the assistant to the Associate Dean for Planning, Research, and External Relations of George Washington University's Elliott School of International Affairs.

Reprocessing and Nuclear Fuel Cycle

Reprocessing and the nuclear fuel cycle are controversial because the expensive technology raises concerns of nuclear proliferation. Nuclear policy experts voice various opinions about the closed fuel cycle.

If a non-weapon state established a closed fuel cycle, that state could have the "capability" to build nuclear weapons, since experts define "threat" as intent and capability. "Intent" in the short term could be difficult to confirm, while "capability" involves a long-term struggle and is watched by international regimes.[84]

Most experts agree that there would be great concern if Japan closed its fuel cycle. Some experts agree that a closed fuel cycle could spark a nuclear arms race with Japan's neighbors, while others say that Japan's rigorous safeguards system might allow it to construct a multinational reprocessing plant — assuming Japan surmounted the obstacles of domestic politics or facility capacity.

Japan has started the Rokkasho Reprocessing Plant (RRP) and has begun construction of a MOX fuel fabrication plant (J-MOX). According to Dr. James M. Acton, a senior associate in the Nuclear Policy Program at the Carnegie Endowment for International Peace, if the facilities are to operate, they should operate together because if Japan operates the RRP without J-MOX, it will build up stocks of Pu, setting a bad example for nonproliferation writ large.

Nuclear Testing and the Fissile Material Cut-off Treaty (FMCT)

Japan is a major exporter of nuclear power plants. In addition, most plants exported from the United States and France have incorporated at least one part or major piece of equipment produced by Japan. By using this leverage, Japan could induce countries that import nuclear power plants to join the international effort to prevent nuclear tests. If facilities imported by a country were used in nuclear tests, that material might be produced by a Japanese product or by Japanese equipment. Therefore, Japan can require those states to ratify the Comprehensive Nuclear Test Ban Treaty (CTBT) and negotiate the Fissile Material Cut-off Treaty (FMCT) as well.

The CTBT has not entered force because eight Annex 2 states have yet to ratify the treaty -- China, Egypt, Iran, Israel, and the U.S., which have signed the treaty, and North Korea, India, and Pakistan, which have not signed it. Annex II states are the 44 states that participated in the negotiation of the CTBT from 1994-1996 and possess nuclear power or research reactors at the time.

Japan considers the CTBT one of the most important pillars of nuclear nonproliferation and disarmament. Japan promotes ratification of the treaty at conferences and meetings. Japan's foreign ministers promote ratification by the eight Annex II states at bilateral meetings. Japan created a system to monitor nuclear tests and developed facilities to measure seismic movement, microbarometric oscillation, and radionuclides.

Japan supplies equipment for this international monitoring system or for holding training courses to monitor seismic movements to developing countries.[85]

The FMCT is under negotiation. It would prohibit the production of high-enriched uranium and plutonium for nuclear explosive devices. Japan held bilateral meetings and workshops with key states to maintain momentum.[86]

Nuclear Security

Japan is a politically stable democratic country. It has never experienced the theft of its nuclear materials.

Russia stores some of the largest stockpiles of fissile material. Russia also suffers from problems with corruption and high unemployment. It is not difficult to imagine a Russian worker at a nuclear facility might be susceptible to bribery.[87] Several incidents that involved trafficking or smuggling in Germany, the Czech Republic, or Russia derived from the former Soviet Union or its allies.[88]

Japan is a non-nuclear weapon state with strict safeguards for its nuclear materials and facilities. Japan should continue to strengthen its own security of nuclear materials and nuclear facilities using its technology.

Since the 2010 Nuclear Security Summit, Japan has developed nuclear security technology. It built the Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN) in Tokai-mura and held seminars there. Through the U.S. - Japan nuclear security working group, Japan worked on nuclear forensics, nuclear measurement, and nuclear detection.

The ISCN has six pillars: integral operation with technology development; state-of-the-art technologies; accumulated experiences; cooperation with domestic and foreign organizations; use of existing facilities; and provide support as needed. Based on the pillars, the center provides assistance for capacity-building, for infrastructure development, for research and development of technology, and international collaboration.

Japan investigated the possibility of incorporating the needs of some Asian countries in the ISCN curriculum and other education programs focused on human-capacity building. In October 2011, Japan held a workshop with the U.S. Department of Energy on INFCIRC/225 Rev.5, a guideline on physical protection. The center introduced virtual reality software to train against attacks or trespass. They also offered a course on safeguards and State Systems of Accounting for and Control of Nuclear Material (SSAC). The course included a workshop on the AP Declaration of Vietnam. Seminars were also held on the peaceful use of nuclear energy, nonproliferation, and security in Kazakhstan, Mongolia, and Malaysia. The center supports the development of laws and regulations and accounting systems to states that need them.

The Needs Survey was held for Thailand, Malaysia, Singapore, the Philippines, Indonesia, Vietnam, Kazakhstan, Mongolia, and Bangladesh in 2010 and 2011.

ISCN develops technology to measure and detect nuclear material and conducts nuclear forensics under the auspices of the U.S. –Japan nuclear security working group. Nuclear forensics technology is used to identify production areas or facilities by analyzing the isotope ratio or impurities. This would help improve deterrence of criminal acts or terrorism and investigations into any acts that are carried out. The center uses its laboratories to develop the measurement, detection, and forensics technologies.

United States - Japan Nuclear Security Working Group Fact Sheet [89]

March 2012

Since the establishment of the U.S.-Japan Nuclear Security Working Group at the U.S.-Japan Summit meeting in November 2010, the Group has fulfilled its responsibility to identify and coordinate tangible outcomes for the 2012 Nuclear Security Summit, including the promotion of robust security for nuclear materials at civilian nuclear facilities and during transport by making achievements in the following nine areas:

Goal 1: Cooperation within the Integrated Support Centre for Nuclear Nonproliferation and Nuclear Security (ISCN)

In December 2010, the ISCN was created in the Japan Atomic Energy Agency (JAEA). Both parties collaborated on the development and execution of ISCN programs for strengthening nuclear nonproliferation and nuclear security in Asian countries, including an inaugural Regional Training Course on Physical Protection of Nuclear Material and Facilities for participants from 16 countries in October 2011.

Goal 2: Research and Development of Nuclear Forensics, Measurement and Detection Technologies, and Sharing of Investigatory Best Practices

Both parties moved towards a common understanding of and information sharing in nuclear forensics, and had fruitful discussions on the requirements for and capabilities of nuclear forensics over the course of several workshops and meetings. Both parties initiated three technical cooperation projects on nuclear forensics to support joint R&D in nuclear material signatures such as uranium age dating measurements, and to establish parameters for a national nuclear forensics library.

Goal 3: Cooperation on Safeguards Implementation

Built on a long history of cooperation on safeguards implementation, the JAEA and the Department of Energy (DOE) expanded the scope of cooperation by signing five new safeguards implementation projects of high priority for effective and enhanced safeguards, and began increased coordination and cooperation in the area of safeguards training. Both parties recognized the Exchange of Notes between the U.S. and Japan on 9 March 2012 setting the terms and conditions of their cooperation in the fields of nuclear security and other areas will facilitate those projects.

Goal 4: Sharing Best Practices for Nuclear Security in New Facility Design

Both parties mutually visited Rokkasho and Savannah River to observe the construction sites of MOX fuel fabrication facilities. The JAEA and Sandia National Laboratories (SNL) together are developing a draft Security-by-Design Handbook for developing world countries as a joint research project to identify best practices for incorporating security considerations early into the design process of new nuclear facilities.

Goal 5: Cooperation on Transport Security to Reduce the Chances of Theft or Sabotage

For the purpose of achieving mutual understanding of the structure of transport security and its implementation in line with international guideline INFCIRC/225/Rev.5, both parties will conduct a Table Top Exercise on Transport Security March 26 – 28 in Honolulu, Hawaii.

Goal 6: Convert Reactors to Reduce the Use of HEU and Complete Down-Blending Operations

Both parties moved towards converting highly enriched uranium-fuelled research reactors where technically and economically feasible and the timely removal and disposal of nuclear materials from facilities no longer using them. In Japan, the JAEA is preparing to down-blend the HEU of the Yayoi reactor and that of the National Institute of Advanced Industrial Science and Technology. Kyoto University and the DOE's Argonne National Laboratory have continued to work together on the feasibility study for converting the Kyoto University Critical Assembly to the use of low-enriched uranium. There is steady progress working toward the shipment of Japan Materials Testing Reactor HEU fuel to the United States.

Goal 7: Implement INFCIRC / 225 / ReRev.5

The ISCN effectively conducted both a domestic workshop and a regional workshop on INFCIRC/225/Rev.5 in cooperation with the DOE's National Nuclear Security Administration and SNL, to help promote better understanding and implementation of the new nuclear security recommendations in the document. Both parties also support the development of Implementation Guides for INFCIRC/225/Rev.5 for eventual publication by the IAEA.

Goal 8: Integrating Response Forces into Dealing with Theft and Sabotage at Facilities

The U.S. observed the integrated exercise with the joint participation of the police, the coastguard and operators held at the Rokkasho Reprocessing Plant and to conduct the force-on-force exercises workshop in Tokyo in December 2010. Likewise, the Japanese observed force-on-force exercises at Cooper Nuclear Station and participated in the workshop at the Nuclear Regulatory Commission headquarters in November 2011. Through these occasions, both sides exchanged views and ideas to enhance the mutual capacity of integrating response forces when dealing with theft and sabotage at facilities.

Goal 9: Joint Study on Management of HEU and Plutonium: Reduction of Material Attractiveness

Both parties collaborated to conduct a joint scientific study on material attractiveness and practical methods to reduce material attractiveness against terrorist threats. As the joint scientific report is compiled, both parties will explore the possibility of further expanding the scope of cooperation.

Two problems with past nuclear security frameworks include their voluntary and non-binding nature, and the lack of states to ratify them. For example, the modified Convention on the Physical Protection of Nuclear Materials (CPPNM) of 2005 required each state to protect nuclear facilities and materials during transport and against theft or sabotage, but —as of December 2011— 50 states signatories are needed to complete ratification.[90] The International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT) required states "to put in place domestic laws to investigate possible offenses as well as arrest, prosecute, or extradite offenders."[91] In October 2006, the Global Initiative to Combat Nuclear Terrorism (GICNT) was a non-binding forum for sharing information. It took steps to strengthen activities in three areas: nuclear detection, nuclear forensics, and the response and mitigation at the plenary sessions in 2010 and 2011. The World Institute for Nuclear Security (WINS) promoted the implementation of best practices. WINS published some guides about security and provided workshops with experts.

As more countries choose nuclear power as a source of electricity, nuclear security becomes more important. Nine countries – some in the Middle East – are planning to introduce nuclear power plants.[92] Nuclear security should be higher and more robust. Nuclear security regimes have not been transparent and uniform because the security systems developed in each state. The international regime is mostly on a voluntary basis, so there is no strong regime toward common objectives. A transparent and uniform regime is needed.

Global governance was one issue raised at the 2012 Nuclear Security Summit held in Seoul. While a comprehensive system is needed, small countries are reluctant to change the current system due to a lack of resources.

Ms. Alexandra Toma, executive director of the Connect U.S. Fund believes sharing ideas for a security regime with other countries is one possible solution. She said, "Since small countries do not have many resources, they are at a disadvantage compared with larger nations, which can allocate many resources to nuclear security issues. Suppose 100 people consider security issues in the U.S. government and only a few people consider them in each small country, the U.S. has the greater ability to help others and generate innovative ideas to improve the global nuclear security system. A system to share resources and learning is needed."[93]

A comprehensive, transparent, and efficient system that benefits all countries and stems the tide of nuclear terrorism and nuclear insecurity must be developed to close the loopholes in global nuclear security. The first Asian country to introduce and develop nuclear technology from Europe and the United States, Japan can bridge the sharing of ideas between countries. Japan's experience is invaluable to small countries new to nuclear security.

Each country defines "nuclear security" in a different manner, depending on its most "urgent" threat. For example, corruption in Russia and sympathizers of al-Qaeda in Pakistan might pose greater risks and compromise the security of nuclear and fissile materials. Toma added that as a major trade hub, Malaysia must pay closer attention to the export control laws that govern transit.[94] Also, Japanese technology to detect and measure nuclear materials can be shared among the Nuclear Security Summit Centers of Excellence of Asia.

The 2012 Nuclear Security Summit also focused on the intersection of safety and security, a urgent concept after the Fukushima-Daiichi accident. A terrorist attack could substitute for the massive tsunami that caused the accident. While complementary as preventative measures, safety and security are incompatible in an emergency because enhanced physical protection might reduce work efficiency. As the investigation continues into the Fukushima-Daiichi accident, there might be some interface between safety and security in the solution. The accident analysis will provide Japan with ideas, best practices, and lessons learned.

Though each country is responsible for nuclear security, international cooperation encourages states with nuclear facilities and materials to improve security to prevent theft and terrorist attacks on facilities. Of the nine countries seeking to acquire new nuclear facilities, Lithuania, Turkey, Vietnam, and Jordan have contracts or are negotiating with Japan to buy nuclear plants. Japan can bolster international cooperation by encouraging these countries to enhance their security and participate in training provided by the ISCN.

A Japanese company is exporting nuclear power projects to developing countries. Japan is currently working with Jordan and Vietnam, and is negotiating with Lithuania and Turkey.

Japan can enhance international society by sharing information, providing technologies to detect and measure radiation, and establish standards for nuclear forensics. The Seoul Communique identified eleven important areas. Japan's experiences focus on radioactive sources, the intersection of security and safety, and nuclear forensics.

Lithuania

In 2009, Ignalina — which was the only nuclear power station in Lithuania — shut down because of EU safety concerns, as it had a design similar to the Chernobyl nuclear power station. Nuclear power produced three-fourths of the gross electric power generation in Lithuania. The power station also allowed Lithuania to export electric power to its neighbors. Since the power station closed, Lithuania lost an efficient domestic electric power supply and a source of foreign exchange.

Lithuania now imports more fossil fuel from Russia than ever before. To increase its energy security, Lithuania decided to build a new nuclear power station.[95] Three Baltic States and Poland agreed to construct the new nuclear power station at Ignalina to stabilize the electricity supply in the region. The power grid for the Baltic States, Europe, and the former Soviet Union needs to be strengthened.

Before Japan exports a nuclear power plant to Lithuania, education and training in operations, safety, safeguards, and security of a light water reactor are necessary. Lithuania's nuclear fuel supply should also be considered.

An interim spent fuel storage facility will store the spent fuel.

Lithuania has approved the IAEA safeguards agreement and Additional Protocol, with the Broader Conclusion and Integrated Safeguards to the Safeguards Statement since 2010.

Turkey

The lack of government financial guarantees has put Turkey's nuclear power ambition on hold since 1970.[96]

Russia will lead the construction of the 4800MWe nuclear power plant, which is planned to begin in 2013. Japan has shown interest in other plants, with Proposals from Toshiba and TEPCO for ABWRs. Negotiations were suspended after the accident at Fukushima Daiichi.

Anatolia Energy Ltd (AWH Corp: Australia) and Aldridge Uranium Inc. (Canada) agreed to acquire a 75 percent interest in uranium deposits in Turkey. This agreement was modified. The Rosatom agreement will develop a fuel fabrication plant in Turkey.

The Safeguards Agreement and the Additional Protocol are in force for Turkey. Turkey does not have The Broader Conclusion.

Vietnam

Electric power in Vietnam is comprised of 38 percent hydro, 33.6 percent gas, and 18.5 percent coal. Vietnam — with its vast economic growth — wants to introduce nuclear energy to its electric power supply. The projections for the nuclear power share are 1.5 percent in 2020, 6 percent in 2025, 8 percent in 2030, and 20-25 percent by 2050.[97]

Vietnam first considered nuclear power in 1995 and with plans surfacing in 2006. Russia will finance and build a 2000MWe plant at Phuoc Dinh. Construction is planned to begin in December 2015. Japan signed to construct a second power plant at Vinh Hai. It is also planned to start construction in December 2015.

Russia will supply all the fuel and repatriate used fuel for the life of the plan. The fuel will be reprocessed in Russia. The central Quang Nam province in Vietnam quoted 8000tU of Uranium resources.

While the Safeguards Agreement has been in force since 1990, Vietnam did not ratify the Additional Protocol. Japan encouraged Vietnam to accept the Additional Protocol in return for nuclear technology and plants. It is difficult to encourage states to accept the Additional Protocol, but Japan is negotiating with Vietnam.

Jordan

With no oil resources, little coal and limited natural gas, Jordan imports more than 95 percent of its energy sources according to the World Nuclear Association.[98] Jordan does have 111,800tU of uranium, or two percent of the world's uranium. Jordan announced it would accept foreign capital and import nuclear power plants to develop its uranium mine . The revised 2007 Atomic Law created nuclear engineering departments in domestic colleges to educate and train future nuclear power engineers.

Jordan's nuclear power plan will introduce four 1,000MWe class plants in the next 30 years, with the first expected by 2018.

The planned nuclear power plants will run on domestic uranium, but enrichment and fabrication for the first power plant will take place abroad due to the cost advantage. Jordan will consider domestic enrichment for the future power plants.

Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) is an international research center located in Jordan. Current projects include industry radiation, material science, biology, agriculture, and environmental science.

Korea will import a research reactor with 5MW.

Both the Safeguards Agreement and Additional Protocol are in force. The Broader Conclusion was drawn in 2010.

CONCLUSION

While there are various opinions on Japanese nuclear policy and the Japanese role in the international community, this paper has shown that Japan plays important roles use of peaceful nuclear energy and prevention of nuclear proliferation. Its nuclear program features:

- Japan is the only non-nuclear weapon state that has full fuel-cycle technologies and facilities.
- Japan uses nuclear power under international safeguards.
- Although Japan in 2011 had a serious accident at Fukushima-Daiichi, its technology is still among the best performing in the world.

Japan is covered by various safeguards methods and technologies due to its nuclear facilities for enrichment, fabrication, reactors, reprocessing, storage, and R&D. Japan is a model for safeguards for non-weapon states and supports countries developing a safeguards system. Japan first developed its nuclear technology after importing a nuclear reactor from the U.S. and the UK.

Its nuclear program has been consistent with nonproliferation and peaceful purposes. Japan leverages its nuclear technology to encourage countries considering nuclear power to ratify the AP and use it only for energy security. While China, India, and Russia are also large nuclear technology exporters, they do not apply safeguards like Japan. Unlike China and Russia, Japan is a vigorous democratic country.

Japan's influence in Asia and the world would weaken if it stopped its nuclear program. The influence of states not under safeguards who consider exporting nuclear plants will grow. Japan must maintain its role to secure nuclear technology and materials, and promote nonproliferation around the world.

It is important to take nonproliferation and Japan's role into account when deciding Japan's fuel cycle policy. While reprocessing is considered a nonproliferation issue, the use of domestic technology is also significant for nuclear nonproliferation. Countries that rely on nuclear power produce spent fuel and require assurances that include fuel supply, new fuels and spent fuel. Whether or not it pursues commercial scale reprocessing, whether spent fuel will be disposed or reprocessed in Japan, its important that proliferation-resistant technology and systems continue to be developed. The technology developed through Japan's R&D program improves nuclear security and safeguards for the international community. Japan would lose its position as thought leader if it discarded its nuclear technology and knowledge.

Japan stands at a unique point. Though it boasts few natural resources, Japan has economic power. Japan is interdependent and thus has strong motivation to build good relationships with other countries. It offers valuable support to new states looking to acquire nuclear energy, in terms of regulation, education, and training.

In conclusion, Japan leads by:

- Continuing to improve nonproliferation efforts in Japan and other countries
- Providing education and training for countries hoping to acquire nuclear power
- Developing technology for advanced safeguards and security
- Using technology to support new countries and encourage them to keep peaceful use
- Showing Japan as a model state of safeguards

Japan imported nuclear technology from Europe and the United States and has further developed it over the years. Strict safeguards limited the use of nuclear power to peaceful purposes, and Japan developed nuclear security and safeguards for countries in the Western Bloc earlier than other countries in Asia. Given its experience and advanced technology, Japan shared its technologies and ideas with the international community. Japan provided significant contributions to the governance of the international regime and to the security of countries considering the use of nuclear power and small countries with additional nuclear security concerns.

Japan should recognize its position in the international community and use this position to determine Japanese nuclear policy. Japan should use its leverage as a supplier of advanced technology to encourage countries that need Japanese products. Its experience with the peaceful use of nuclear power and its reputation as a responsible player make Japan a world leader in the international nonproliferation and security regime.

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