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New Trends in Non-Proliferation and the Nuclear Fuel Cycle

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Summary

Uranium and plutonium, which are indispensable materials for the civil use of nuclear energy, are also necessary ingredients for manufacturing nuclear weapons.

From the beginning of the history of peaceful nuclear power, therefore, which started with US President D. Eisenhower's 'Atoms for Peace' speech, the question of the non-proliferation of nuclear weapons has been taken into account.

The civil use of nuclear energy has developed over the past fifty years. Light water power reactor technology is fully commercialised, though several elements in the associated nuclear fuel cycle, especially the recycling of plutonium and the disposition of nuclear wastes, are yet to be developed further.

After decades of stagnation in the civil use of nuclear technology at a global level, the nuclear community is now moving toward the realization of a 'nuclear renaissance'. Non-proliferation considerations should be, and are, taken into account.

The non-proliferation of nuclear weapons is a very important political objective for the international community. Various political, economic and military measures have been implemented to achieve this objective. A group of measures, which can be called 'regime measures' has also been introduced, i.e. nuclear safeguards, export control and physical protection measures. These measures have also evolved to meet with shifts in the importance of political objectives. The international community has witnessed such shifts several times during the Cold War and the post-Cold War era.

Non-proliferation considerations will continue as an important political issue, which the nuclear community will have to take into account it when it considers new developments.

Introduction

The 20th Century was a century of science and technology. Many scientific discoveries and their commercialisation have helped human development and

even changed human society drastically. Computer science, space technology and life sciences/biotechnology are some examples of such science/technologies which have had great influence on society. Nuclear energy was also born in the 20th Century and has had a very strong impact on human society. The 20th Century was also a century of war. In this century we had two World Wars and the Cold War. Military technology was developed and utilized in this century, especially the technology used for weapons of mass destruction (WMD). Nuclear weapons were manufactured during the Second World War, and they became the key factor in the power of hegemony during the Cold War. The 20th Century was also a century of nation states. Many powerful imperial states of the 19th Century, e.g. Russia, Austria-Hungary, Turkey and Ching Dynasty China, disappeared during the 20th Century. British, German and Japanese imperial states changed their character to democratic nation states in this century. Like most big scientific projects, the development of nuclear energy – whether for peaceful uses or military uses – required huge resources. The existence of strong nation states was opportune for the supply of the resources required for developing nuclear energy. Thus, the social environment of the 20th Century was right for the development of nuclear energy.

Since human society decided to promote both the peaceful and military uses of nuclear energy, there are, inevitably, links or interfaces between both uses. The first actual use of nuclear energy was for weapons purposes. The peaceful uses of nuclear energy were developed at a later stage. Once it was recognized that there were two separate purposes, it became important to ensure nuclear materials and technology from peaceful uses was not diverted to other uses. The concept of non-proliferation of nuclear weapons became one of the major issues in the international politics.

But what will be the social environment surrounding the development and utilization of nuclear energy in the 21st Century? If the social environment of the 21st Century allows the continued development and utilization of both purposes of nuclear energy, what will be the relation between those two uses? I will describe my personal views on these questions in the following sections.

Brief history of nuclear energy development

Uranium and plutonium, which are indispensable materials for the civil use of nuclear energy, are also necessary ingredients for the manufacture of nuclear weapons. From the beginning of the history of peaceful nuclear energy, therefore, which started with US President D. Eisenhower's 'Atoms for Peace' speech in 1953, the non-proliferation of nuclear weapons was considered and taken into account. Eisenhower proposed the establishment of an international atomic energy authority to promote the development of nuclear energy for peaceful uses under control of an international body. Soon afterwards, the first international conference on the peaceful uses of nuclear energy was held in Geneva, Switzerland, in 1955, and much necessary information to promote the development of nuclear energy was made available to the public.

The International Atomic Energy Agency was established in 1957. Major functions of the IAEA are to encourage and assist research and development of nuclear energy for peaceful uses; to apply safeguards in order to ensure that

nuclear materials, etc. are not used for any military purpose; and to establish safety standards for the protection of health and the minimisation of danger to life and property. Although the IAEA was not all that active in administering safeguards in the early stages of the history of nuclear energy, its promotional and safety activities helped to advance the development of the peaceful uses of nuclear energy.

However, a more important tool for the further development of nuclear energy was the bilateral cooperation between the developed and developing nations. Several nations well advanced in the peaceful uses of nuclear energy cooperated in developing such peaceful uses with less advanced nations. I would like to take the case of Japan.

Japan started its nuclear research programme in 1954. The Japan Science Council decided that Japanese nuclear research must be limited within the scope of peaceful uses, and that three principles, i.e. democratic way, autonomous operation and openness of result, should be the basis of its research activities. The following year the Japan-US Nuclear Research Cooperation Agreement entered into force. The first nuclear research reactor in Japan (JRR-1) was imported, based on this agreement, and went critical in 1957. As for commercial power stations, Japan imported the first power reactor from the United Kingdom (Tokai No.1, GCR type, operation from July 1966). Since then, US-type power reactors have been introduced into Japan (the first one was Tsuruga No.1, BWR type, operational from March 1970). Supplier states were requested to conclude bilateral governmental agreements prior to the start of cooperation, and these contained the supplier's rights, including prior consent rights for reprocessing, enrichment and the transfer to a third country, as well as bilateral safeguards and inspections. Japan was not a unique case. Supplier countries had requested similar control mechanisms before beginning cooperation with recipient countries. By such bilateral mechanisms, the world nuclear community made sure that peaceful activities were not diverted to military uses (i.e. to the manufacture of nuclear weapons).

Until the mid-1970s, nuclear energy development in the world seemed to expand smoothly. The number of nuclear power stations and the number of states with operating nuclear power stations increased. In this period, the world centre for nuclear energy development was, in my belief, the USA.

At that time, the world was in the middle of the Cold War. The USA and the USSR made efforts to increase the quantity and the quality of their nuclear weapons. Before the entry into force of the Non-Proliferation Treaty (NPT) in 1970, the UK, France and China became nuclear weapon states (NWS). NWS, especially the USA and the USSR, wanted no further increase of nuclear weapon states. In 1974, India exploded a nuclear device, which India claimed was a peaceful nuclear device. The world had suffered the first oil shock. This experience triggered a wave of decisions to construct nuclear power stations in many states. These events, which occurred in the mid-1970s, caused a review of nuclear energy policy in the USA. US President J. Carter changed US civil nuclear policy, and in 1977 postponed indefinitely civil reprocessing and the utilization of plutonium in the USA.

The core of peaceful nuclear energy development in the world was gradually to shift from the USA to Europe in the 1970s. As civil nuclear technology in European countries had matured they showed great interest in exports. When Japan began construction of its reprocessing plant at Tokai-Mura, it received technical cooperation from French industry. In addition to the UK and France, West Germany intended at that time to acquire reprocessing capability. Germany also signed a large commercial deal with Brazil. (Subsequently, these German projects did not materialize.)

Throughout the 1980s, global non-proliferation efforts were intensified, and, until the end of the Cold War in 1989, this non-proliferation regime seemed to be relatively successful. However, since the world entered the post-Cold War era, many events have happened and these events have required us to revisit the effectiveness of the global non-proliferation regime. At the same time, the core of nuclear energy development in the world has, in my view, moved from Europe to Asia. There has been no definite new nuclear power plant construction programme in either Europe or the USA (at least until quite recently), but three North-East Asian countries and Taiwan, China are now constructing new nuclear power stations in their territories. Japan and China are also building civil fuel cycle facilities.

Some social scientists have argued that the world has entered into a new era following the terrorist attacks of 11 September, which may be called the 'post post-Cold War era'. We must reconsider the adequacy of the present non-proliferation regime in connection with this event. It is said that Al-Qaeda and bin Laden have sought to acquire nuclear weapons. The risk of exploding a radiological bomb, or so-called 'dirty bomb', has been highlighted. At present the international community is seeking the best ways to respond such questions.

On the nuclear energy development side there has been a recent call for a 'nuclear renaissance'. In the USA and Europe, there have been several new developments, which aim to consider the importance of nuclear energy in the context of the new global environment. One of the criteria for selecting projects to be pursued should, it is argued, be the proliferation-resistant capability of nuclear fuel cycle/reactor type. We must consider further the other elements of possible changes of global environment in the 21st Century. I will argue this point later in this paper.

The non-proliferation regime

Throughout the history of the peaceful development of nuclear energy, non-proliferation considerations have been paramount. As described above, US President Eisenhower's 'Atoms for Peace' initiative proposed the creation of a worldwide promotion/control body. This idea was realised in 1957 with the establishment of the International Atomic Energy Agency (IAEA). The IAEA has three main objectives, i.e. the promotion of peaceful nuclear energy development; maintaining nuclear safety and radiation protection; and nuclear safeguards, i.e. to prevent diversion to military uses. The IAEA and its safeguards are very important instruments in maintaining the conditions for non-proliferation. But they are not the only ones. The global non-proliferation regime consists of many different measures or elements.

One can categorize the various measures of the non-proliferation regime into: (a) 'regime measures', and (b) 'non-regime measures'. Regime measures could be considered as 'supply-side measures'. The NPT, IAEA safeguards, export control regimes, regional systems like Nuclear Weapon Free Zone Treaties, etc. are examples. These measures intend to deter, prevent or detect the diversion of various items needed for nuclear weapons, and to make it difficult for any country that wants to acquire nuclear weapons. However, non-proliferation measures are much broader than those of regime measures. One may call the other measures 'demand-side measures'. If any country wishes to have nuclear weapons, there must be one or more reasons for it wishing to do so. Therefore, by analysing each specific situation, some measures, which might increase the disincentives to become a nuclear weapon state, or decrease the incentives to do so, could be taken by the international community. Such measures might include economic assistance, military assistance, increasing regional stability, or economic sanctions. KEDO (Korean Peninsula Energy Development Organization) power reactors could be classified in this category.

The non-proliferation regime and various associated measures have changed continuously, in accordance with changes in international political circumstances. When the NPT was negotiated, the major concern of the international community was the possibility of the diversion of nuclear materials in the peaceful nuclear fuel cycle in those states in which civil nuclear activities were expanding. The NPT and IAEA safeguards system (INFCIRC/153), based on the NPT, became a centrepiece for non-proliferation regime measures. The IAEA safeguards system for the NPT (the 'comprehensive safeguards system') was formulated by the ad hoc Safeguards Committee of the IAEA Board of Governors in 1971, and its technical system indicates that the main target of the verification system was to detect (and to deter) the diversion of significant amounts of nuclear material from the civil commercial nuclear fuel cycle. One might argue that diversion, which might occur in Japan, West Germany, Italy, Sweden or Switzerland, was the real target. By creating this international tool, the main regime for non-proliferation was moved from a bilateral control system to an international one.

After implementation of the NPT safeguards system, various supplementary measures were put into effect. The Nuclear Suppliers Group issued its guidelines for the transfer of nuclear material, equipment, etc. in 1977. The Convention on the Physical Protection of Nuclear Material (CPPNM) entered into force in 1987. The implementation of nuclear weapon free zones was expanded. The Tlatelolco Treaty (NWFZ Treaty for the Latin American Region) became effective in 1968, and the Rarotonga Treaty (for the South Pacific area) entered into force in 1986. Also, control measures in the governmental bilateral agreements were strengthened.

The global non-proliferation regime in the Cold War era worked relatively well. Until the end of the Cold War, the international community did not observe any overt proliferation of nuclear weapons. South Africa clandestinely produced nuclear weapons from highly enriched uranium, but later abandoned them and joined the NPT as a non-nuclear weapon state. However, since the end of the Cold War, the international community has experienced new challenges to the regime. Iraq has clandestinely developed a nuclear weapon manufacturing programme. The Democratic People's Republic of Korea (DPRK) violated the

provisions of NPT Safeguards Agreement. The international community strengthened the global non-proliferation regime by producing an Additional Protocol to the Safeguards Agreement (INFCIRC/540). The Nuclear Suppliers Guidelines have been expanded to include a dual item list. The IAEA's physical protection guidelines have been revised several times. (The most recent revision was made in 1999, INFCIRC 225/Rev. 4.)

The limitations of the NPT regime were recently revealed. India and Pakistan, who have refused to become parties to the NPT, became actual nuclear weapon states. Although the NPT was extended indefinitely at the Extension Conference in 1995, progress on nuclear disarmament, which is quoted in Article 6 of the NPT, did not satisfy many non-nuclear weapon states who are party to the treaty. In five Review Conference meetings, the conference on three occasions failed to issue a final conclusion. The Comprehensive Test Ban Treaty (CTBT) and the Fissile Material Cut-off Treaty (FMCT), which are important supplementary measures for nuclear disarmament/non-proliferation, are not yet effective. As for the FMCT, negotiations have not been started. The limited status of the Additional Protocol (INFCIRC/540) is noticeable. It has entered into force in only 26 states so far. Given the tendency towards unilateralism of the Bush Administration in the USA, the international community is finding it difficult to adapt the global non-proliferation regime to the present international political situation.

Nuclear energy development and non-proliferation in the 21st Century

Following 11 September, the world entered a new era. In this new era, the presence of non-state actors will be more significant. Regional conflicts stemming from ethnic or religious problems will not cease, and therefore global security problems will become a more important political issue. The appetite for nuclear weapons will not decrease, although the preference will be for a small number of nuclear weapons rather than large nuclear strategic forces.

As the international community proceeds with the development of peaceful nuclear energy in the 21st Century, it must consider the surrounding social and political situation, which is mentioned above. Both the International Generation Programme led by the USA and the IAEA's INPRO Project take into consideration this circumstance and have identified proliferation resistance levels as one of the key factors in selecting the type of nuclear reactors and fuel cycle facilities for the future.

There is no panacea for the global non-proliferation regime. The regime will be composed of many independent, different measures in the 21st Century. International safeguards, export control, physical protection of nuclear materials and facilities, measures to combat illicit trafficking of nuclear and radioactive materials and NWFZ are major components. Early commencement and conclusion of negotiations on the FMCT and entry into force of CTBT will strengthen the regime. A more technological approach, namely, consideration of the proliferation resistant fuel cycle, should become an additional important element of these matrixes.

In my view, nuclear energy development in the 21st Century must be accelerated, because society will require nuclear energy as a major component of the world's electricity resources. As the GEN IV and INPRO Projects indicate, nuclear power reactors and fuel cycle facilities in the 21st Century should have several characteristics, namely greater cost-effectiveness, more safety and greater proliferation resistance. National governments might seek to concentrate their resources more to regulatory aspects in the medium/long term, thereby shifting responsibility for development to industry. In the 21st Century, nation states are being challenged by many types of non-state actors: multi-national industry, international/regional organizations, NGOs, NPOs, transnational terrorist groups, etc. Nation states' political power will decrease, but maintaining peace and security for their citizens should be the first objective of any nation state in the future. Implementation of non-proliferation, therefore, is one major role of the nation state. As for the relationship of nuclear energy development and non-proliferation implementation, the key word is 'synergy'. To gain a more effective 'synergy' situation, I would like to propose several personal recommendations.

- (1) More frequent information exchange amongst various sectors should be organized in order to accelerate mutual understanding.

Many actors exist in these fields, e.g. government officials, industry specialists, academics and representatives from the mass media. Also, various types of specialists are involved, e.g. nuclear engineers, political scientists, diplomats, national regulators and verification experts. More frequent, in-depth information exchanges should therefore be organized. In particular, closer cooperation between nuclear engineers and verification experts (including safeguards practitioners) to discuss the relation of nuclear energy development and non-proliferation is essential for the success of future programmes.

- (2) Coordination among various elements of the non-proliferation regime should be intensified.

Traditionally, coordination activities among diplomats who deal with international treaties, export control experts who are responsible for the export control regime (NSG), safeguards experts (IAEA, other safeguards authorities) and physical protection experts occur infrequently. Information exchanges between CTBTO, IAEA, CD (Conference on Disarmament in Geneva) are also infrequent. A collective effort by all parties is the first requisite to ensure successful performance. I would like to urge that closer coordination among all those concerned should be pursued more vigorously.

- (3) Strengthening and unification of various elements of national systems is needed.

In many states, various elements of national control system are administered separately. National systems of nuclear material accountancy, physical protection control systems and export control systems belong to separate organizations in many countries. The USA is assisting in the establishment of MPC&A (a system of material protection, control and accounting), for each facility in the independent states of the Former Soviet Union. I would propose that this concept be extended to all states, not necessarily FSU but states in other regions of the

world. The goal would be the establishment of National Non-Proliferation Control Systems (NNCS).

Conclusion

The 20th Century was the century of science and technology, the century of war and the century of the nation state. What will the 21st Century be called? We do not know yet. But we can imagine what kind of century the 21st Century will be.

The advances in science and technology will continue. Some significant technologies, such as computers, the life sciences and space, may disclose their negative impacts to society. A holistic development of science and technology might be required.

War, civil war and regional conflict will not cease. Nuclear disarmament will, hopefully, continue, but both state and non-state actors will continue to prefer to possess nuclear weapons. The usefulness of small-scale nuclear weapons may increase.

Political and economic competition between nation states and non-state actors will become more prominent. The power of the nation state will be gradually weakened, but it will still play a very important role in international society.

If my vision for the 21st Century is correct, an increasingly important role in the development of peaceful nuclear energy, which I consider indispensable for future society, will be vested in the industrial sector. The intended objectives of GEN IV and INPRO projects, namely a more cost-effective, safer and more proliferation-resistant approach are, in my view, well defined. Closer international cooperation will be required to realise these objectives satisfactorily. On the other hand, nation states will be occupied primarily in maintaining peace and the security of their own people. The non-proliferation of nuclear weapons will, together with further nuclear disarmament efforts, help to secure a better life for people in nation states. To strengthen these non-proliferation objectives, national governments will have to consider more effective approaches, such as the establishment of NNCS, as well as cooperation with other non-state entities.

Non-proliferation consideration will, therefore, continue to be an important issue in the political field, and the nuclear community will have to take this into account when it considers new industrial developments.