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NUCLEAR RENAISSANCE AND NONPROLIFERATION

The expected *renaissance* of nuclear energy sector gives a new impetus to discussions about new approaches towards nonproliferation. The analysis of economic aspects of global energy development indicates the trends and challenges for nuclear energy sector and implies that this industry has a good growth potential if safety and security (nuclear, radiation, environmental, proliferation risks) are ensured and sufficient fuel resources are available. Such turn of events is caused by increasing tensions at the fuel markets and the need to enhance energy security of Russia and the world.

To cut off the shortage of energy on the planet, there is a need for dramatic expansion of nuclear energy uses. According to our estimates, by mid-century the total capacity of nuclear facilities may increase five times. All this may result in accessibility of nuclear materials and higher risks of nuclear technology proliferation leading to the acquisition of nuclear weapons. To prevent such developments, mankind should start thinking anew and devise additional measures, at least, to keep the risks at the current level. Such measures should be taken in all spheres – political, institutional, and technological.

POLITICS MATTERS

Political sphere is apparently the most unpredictable from the point of potential changes and optimal solutions. It is clear that at the current stage neither institutional nor technological measures (except military ones) undertaken at the international level can prevent the creation of a nuclear weapon by a more or less developed nation, if the latter has taken the political decision to do so. Even the absence of nuclear energy capacity in such state can hardly save us from the risk of nuclear proliferation. At present, one may only claim that the eradication of political motivation of some countries to possess nuclear weapons is the effective way to prevent horizontal proliferation, i.e. to limit the number of nuclear weapon states.

One of the factors facilitating the common solution would be to expand as much as possible the engagement of nations in implementation of institutional and technological measures within the framework of the nonproliferation regime.

Under the current circumstances, the matter of particular concern related to the nuclear material and technology expansion is the nuclear component of international and sub-national terrorism.

There are two cases here – a terrorist organization may be supported by some state or may act independently of all states and in secret. The first option implies that similar steps (prevention of inter-state horizontal proliferation) should be taken to curb such efforts. The second option allows us to use effectively institutional and technological means.

As far as the threat of nuclear terrorism is concerned, one has to bear in mind an obvious thing. It would be enough for the terrorists to create one or a few simplest A-bombs, in order to achieve their goals. In case of a state, one may speak about the development of an arsenal of advanced nuclear explosive devices and delivery systems. The efforts of terrorist groups may also be aimed at making a so called dirty bomb or at destroying a hazardous radioactive facility with the help of conventional weapons and, hence, provide for contamination of the area.

It would be advisable to conduct permanent studies of the existing nonproliferation challenges, as well as potential risks that may emerge in the course of large-scale and rapid nuclear energy development. Such approach would enable the international community to take adequate, non-chaotic measures and not to lag behind the security threats. This research should be based on systemic analysis of nuclear energy development and unbiased assessment of factors that exacerbate proliferation risks.

The list of such factors include growing nuclear energy capacity; increasing number of states using nuclear energy; increasing number of nuclear power plants (NPPs), including regional low-capacity ones; increasing number and types of fuel cycle facilities; growing turnover and amount of transferred nuclear materials; variety of nuclear reactors, including fast breeder reactors (FBRs); expanding area of technological application of nuclear reactors; introduction of reprocessing and recycling of nuclear fuel in the nuclear fuel cycle; and increasing amount of radioactive waste.

Such systemic analysis should underpin recommendations on specific measures to tighten nonproliferation regime. Obviously, the recommendations will be the result of a compromise, but they may identify the promising concepts of nuclear energy development that will be less proliferation-sensitive. By the way, to find the right balance between energy security and nonproliferation, the international community requires a set of comparable quantitative criteria that will facilitate the decisionmaking process. At present, mostly qualitative criteria formulated 40 years ago are employed, but remember that they are based on the outdated levels of nuclear technologies, their costs and accessibility, let alone the bias caused by the bipolar system of international affairs that existed then.

Nuclear technology development has made them more affordable – from the point of price and from the point of decreasing secrecy. The emergence of some technologies, such as centrifuges for uranium enrichment, has had revolutionary impact on the balance of proliferation risks. Therefore, relative degree of proliferation risk of various nuclear technologies and even types of nuclear materials should be monitored and re-estimated on permanent basis by international experts, while their recommendations on counter-proliferation should be regularly updated.

One should strive for establishing the methodology of quantitative risk assessment using the system of terms similar to those formulated in the 1970–1980s with respect to nuclear and radiation safety of nuclear plants. In fact, the latter is an efficient tool of comparative evaluation and selection of power plants in accordance with their safety parameters.

Nonetheless, nonproliferation risk assessment is impeded with the political component, which makes them subject to speculations or hostage of political decisions of the past (taken in a different situation and at a different level of nuclear technology development).

QUANTITATIVE ANALYSIS: WAYS AND MEANS

Some time ago we suggested a method of quantitative risk assessment based on statistical data processing based on opinions of the expert community. Such method enabled us to evaluate the risks of secret nuclear weapon production in case of unauthorized diversion of different types of nuclear materials and to identify the weak points of the existing nonproliferation regime.

It would be reasonable to implement a similar project and work out the methodology of risk assessment for the proliferation of nuclear materials and technologies in the conditions of

expanding geography, application areas and variety of customers, as well as emerging innovative reactor and fuel cycle technologies.

The final product would be a realistic tool required to prepare institutional decisions aimed at tightening nonproliferation and to evaluate innovative projects of nuclear reactors and fuel cycles that may be proliferation-prone. Some recommendations can already be made even with the current level of knowledge:

- ❑ preventing the availability, production and consumption of low-enriched uranium (LEU), e.g. through shift to nuclear energy of high temperatures with higher efficiency of the NPP heat cycle;
- ❑ reprocessing of irradiated reactor fuel, so that mixed uranium-plutonium fuel may be manufactured and used;
- ❑ using thorium as a basic nuclear material that does not create direct proliferation risks;
- ❑ giving nuclear fuel some self-protection characteristics by integrating into it the fragments of fission.

Besides, such methodology of risk assessment may facilitate certain activities within the framework of large-scale nuclear energy development:

- ❑ development of the concept of international nuclear fuel cycle centers, which will reduce the proliferation risks by carrying out the most proliferation-sensitive fuel cycle operations under international control, i.e. uranium enrichment, LEU bank, fuel production and shipment, spent nuclear fuel storage and reprocessing, fuel recycling;
- ❑ future establishment of nuclear energy technological centers for fuel regeneration, burning of actinides and, perhaps, production of hydrogen with the help of nuclear reactors and its supplies to the states that are not ready for nuclear energy uses;
- ❑ leasing of nuclear fuel and nuclear power plants;
- ❑ introduction of innovative control and regulation mechanisms and monitoring techniques for nuclear materials, reactors and nuclear fuel cycle technologies;
- ❑ modernization of the international practice of regulation and control with the help of global distant monitoring of nuclear materials at all stages of declared nuclear activities;
- ❑ elaboration of scientific grounds for reducing the amount and curbing the circulation of hazardous nuclear materials at all stages of nuclear fuel cycle and reducing the amount of fissile materials in storage facilities separated or in bound state;
- ❑ categorization of nuclear materials and fuel cycle technologies from the point of their attractiveness;
- ❑ supervision of technologies that are proliferation-prone;
- ❑ assessment of the dirty bomb risks and regulations for the management of radioactive fission products and actinides;
- ❑ rules of supplying nuclear facilities with nonproliferation systems (physical protection, control and accounting, etc.) in-built in the design at the stage of project development;
- ❑ control of proliferation of knowledge in the area of nuclear technologies and other sensitive information;
- ❑ nuclear export control analysis based on quantitative assessment of proliferation risks;
- ❑ elaboration of the concept of unified nonproliferation regime based on the IAEA safeguards and multilateral approaches towards nuclear fuel cycle management.

Along with the development of nuclear technologies (that actually impedes nonproliferation activities), there emerge new methods of control over nuclear power plants and nuclear materials uses. Among them is the computer and TV distant monitoring, which enhances the efficiency of control and cuts down the costs. Various monitoring systems have already been tested in the field (e.g. in the course of the U.S.-Russian experiment involving the Kurchatov Institute).

Such global distant monitoring of nuclear materials should be integrated in the practice of international control and regulations. The mandatory use of such tools to monitor the amount and transfers of fissile and radioactive materials at all stages of fuel cycle may prevent the production and unauthorized use of nuclear materials, or their theft in the process of shipment.

As far as innovative reactor designs and nuclear fuel cycle technologies are concerned, the following primary tasks may be set forth:

- analysis of the structure and elements of nuclear energy and fuel cycle from the point of proliferation risks – ratio of fast breeder and slow reactors, closed fuel cycle with reprocessing, separation and recycling of actinides and fission products;
- expert assessment of proliferation risks related to the implementation of innovative projects and introduction of non-traditional nuclear energy technologies; requirements for innovative nuclear technologies, closed nuclear fuel cycle (reprocessing, separation, recycling, management and isolation of radioactive waste), nuclear plants for decentralized users;
- elaboration of ways to minimize the equilibrium amounts of radionuclides and amount of radioactive waste;
- analysis of the proliferation risks related to storage of spent nuclear fuel, management of radioactive fission products and actinides, disposal of radioactive waste;
- conditions and requirements for final isolation of radioactive waste;
- development of technologies and designs that would provide for inherent protection of hazardous nuclear materials, e.g. production of fuel with the lowered proliferation risks;
- computer system of control and accounting of nuclear materials based on their monitoring and detection.

Appropriate research in these areas aimed at reducing the proliferation risks is an essential component for the promotion of secure large-scale nuclear energy development along with the nuclear and radiation safety measures.