

Multilateral Approaches to the Nuclear Fuel Cycle

Preliminary Views of the IAEA Secretariat for the Proposed Study

This non-paper was prepared by the Agency's Office of External Relations and Policy Coordination to provide a historical context to this issue and to raise preliminary questions. It does not represent the views of the Agency nor of the Experts Group.

The Issues

- 1) With the continuing spread of nuclear technology, controlling access to nuclear materials, equipment and information that may be relevant for the development of a nuclear-weapon programme has grown increasingly difficult. Throughout the past five decades, concerns and questions have been raised regarding the adequacy of international safeguards to detect, and thereby deter, the misuse of nationally controlled nuclear fuel cycle facilities for proscribed military purposes. This has been compounded by the fact that national controls over access to nuclear technology appear to be lacking. Moreover, some events have underscored the possibility that a State engaged in declared enrichment and reprocessing activities for peaceful purposes, could potentially misuse the nuclear materials, technology or know-how for the development of a nuclear-weapon programme. One possibility in this regard could be the renunciation by a State of its nuclear non-proliferation commitments undertaken pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), nuclear-weapon-free zone (NWFZ) treaties, or other legally binding non-proliferation agreements. Today, several non-nuclear-weapon States (NNWS) party to comprehensive safeguards agreements (CSA) operate enrichment or reprocessing plants in connection with peaceful nuclear development for energy production, and the future energy demands, as well as energy security concerns, could further stimulate countries to possess needed technologies. In this connection, concerns have also been expressed that the possible abrogation of treaty commitments can have a negative impact on the transfer of civilian nuclear technology to NNWS and thereby also impede the peaceful uses of nuclear energy.
- 2) Nuclear power's potential for a substantial role in long term sustainable energy development is well recognized. Continuing nuclear expansion can raise concerns about the possibility that some countries will be tempted to use nuclear technologies for non-peaceful purposes. Although in the context of nuclear proliferation it is the front end of the nuclear fuel cycle that is of the most immediate concern, associated with these concerns is a resurgent recognition of the need to address the accumulation, storage and disposal of separated plutonium and spent nuclear fuel and nuclear waste. In this regard, the international management of the storage and disposal of spent fuel and radioactive waste may also have non-proliferation benefits and provide economic benefits to countries with small nuclear fuel cycles. In addition, an initiative of this kind will allow for the further access of developing countries to the benefits of nuclear power.
- 3) The IAEA Director General, in an invited editorial in *The Economist* of 16 October 2003, in his statement to the 58th regular Session of the UN General Assembly on 3 November 2003 and in other forums, has highlighted these challenges to the international non-proliferation regime and proposed exploring new measures to meet them. The Director General suggested three concepts for further exploration:

- a. In light of the increasing risk of nuclear proliferation, both by States and by terrorists, an idea worth serious consideration is the advisability of limiting the processing of weapon-usable nuclear material (separated plutonium and high-enriched uranium) in civilian nuclear programmes — as well as the *production* of new weapon-usable nuclear material through reprocessing and enrichment - by agreeing to restrict these operations exclusively to facilities under multinational control¹. These limitations would need to be accompanied by appropriate rules for assurance of nuclear fuel supply to would-be users;
- b. Second, new nuclear energy systems should be deployed that, by design, avoid the use of materials that may be applied directly to making nuclear weapons. These systems should have built-in design features that would prevent countries diverting nuclear material to weapons production; prevent the misuse of the facilities and equipment for clandestine manufacture of such materials; and facilitate efficient oversight to ensure continued peaceful use. As much of the technology for proliferation-resistant nuclear-energy systems has already been developed or actively being researched, the implementation of these proposals is not merely a futuristic dream.
- c. Third, multinational approaches should be considered for the management and disposal of spent fuel and radioactive waste. Over 50 countries currently have spent fuel stored in temporary locations, awaiting reprocessing or disposal. Not all countries have the appropriate geological conditions for such disposal - and, for many countries with small nuclear programmes, the financial and human resources required for the construction and operation of a geological disposal facility are daunting.

Taken together, these measures could have the potential to provide enhanced assurance to the international community that the sensitive portions of the civilian nuclear fuel cycle are less vulnerable to misuse for proliferation purposes. At the same time, it is of obvious importance that such a venture not be used to justify otherwise unnecessary investment in proliferation-sensitive technology. Nonetheless, if implemented, these measures may also have the potential to facilitate the continued use of nuclear energy for peaceful purposes and enhance the prospects for the safe and environmentally sound storage and disposal of spent fuel and radioactive waste.

Outline of the Proposed Study

- 4) More than three decades have passed since initiatives on multilateral arrangements for sensitive nuclear fuel cycle facilities and technologies associated with weapon-usable nuclear material were first examined. The concept of multi-lateralising the storage and disposition of spent fuel and radioactive waste, too, has an established history. Annex II of this paper briefly recalls certain concepts and suggestions that were considered in previous decades in this regard. Much of the rationale, as well as many of the concerns and questions, remain the same and continue to shape the scope of the options through which they may be addressed. But much has changed as well, and a re-examination and re-assessment

¹ At this early stage, the use of the term “multilateral” (or ‘multinational’) shall be understood to refer to any approaches to the management of the nuclear fuel cycle that go beyond purely national control

of these ideas is warranted in light of evolving proliferation concerns and technology spread, as well as developmental and environmental priorities and evolving technologies.

- 5) The Secretariat of the Agency recommends that a study be carried out with the objective of preparing a report on “Multilateral Approaches to Nuclear Fuel Cycles”. This study would be geared towards identifying how such approaches might be developed and implemented in such a way as to strengthen the international nuclear non-proliferation regime, thereby facilitating the contribution of the peaceful use of nuclear energy to the economic development of interested countries, and to attract the adherence from all countries that is necessary for successful implementation.
- 6) The Secretariat proposes convening an ad hoc independent group of approximately fifteen experts (both governmental and non-governmental), designated by the Director General, which would identify the key issues to be addressed. Its composition would be best determined by core competencies² and would be heedful of the need to strike an appropriate regional and technological balance. The life of this ad hoc group would be limited to the production of a general report and its mandate would be to provide, inter alia:
 - a. An overview of the political, legal, security, economic and technological incentives and disincentives for co-operation in multilateral arrangements for the relevant parts of the nuclear fuel cycle;
 - b. A brief review of the relevant experience and analyses, as well as an assessment of recent and prospective developments, that could also identify new opportunities for future multilateral approaches;
 - c. The identification of the most promising institutional and technological approaches; and
 - d. Approaches or mechanisms that could be designed to attract the necessary financial investments (public, private, or public/private partnerships), both initially and in the longer term, to sustain the operations of multilaterally managed parts of the nuclear fuel cycle.
- 7) Several key questions would need to be considered, and the study itself would identify and consider a comprehensive list of relevant questions. Annex I of this paper contains an indicative list of questions, which does not purport to be comprehensive or definitive, but is designed to serve as a possible starting point.
- 8) From this review and assessment, the Group should be able to identify the most promising institutional and technological possibilities to be examined at a later stage. The suggested guidelines should cover both assessments of near-term and long-term acceptance and effectiveness and should recognize how alternatives may have to evolve in the future to assure continuing acceptance and effectiveness of proposed multilateral approaches to the nuclear fuel cycle. They should also take into account the different circumstances and perspectives of countries with existing fuel cycle capabilities and existing progress in national

² Core competencies could include inter alia: enrichment; reprocessing; spent fuel management; nuclear transport; nuclear security; nuclear law; nuclear non-proliferation; utilities; uranium mining; fuel fabrication; and communications and outreach.

efforts on geological repositories. In sum, the Group should provide guidance as to the way that offers the greatest promise of eventually leading to a strengthened non-proliferation regime while not creating unnecessary obstacles for nuclear power's contribution to economic development in interested countries.

- 9) The work of the Group should provide a solid basis for the subsequent review of the implications of both retaining the status quo and developing innovative multilateral approaches to the nuclear fuel cycle - with respect to both non-proliferation objectives and the objective of facilitating nuclear power's contribution to economic development in interested countries.
- 10) The proposed study is intended to make use of, but not duplicate, results from other initiatives that address the development of proliferation-resistant nuclear fuel cycles and technologies, such as the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and the Generation IV International Forum (GIF).
- 11) In proposing the study outlined here, the IAEA recognizes that while it may play a role in bringing interested States and other interested parties together, they themselves must judge whether proposed arrangements for multilateral approaches would be potentially beneficial from non-proliferation, political, technical, economic and legal perspectives.

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ANNEX I

Indicative List³ of Questions to be considered

- a. How would “multilateral” be defined for the purposes of the study?
- b. What is the scope? Is it for future installations? What might be the locations of those installations? Should it cover existing facilities in terms of transforming national into multi-lateral operations?
- c. How would multilateral managerial control or ownership affect the NPT regime - specifically in terms of Article IV of the Treaty?
- d. What is the feasibility of bringing non-NPT States into such a project?
- e. Would this approach benefit from being linked with the negotiations for a Fissile Material (Cut-Off) Treaty (FM(C)T)?
- f. How might physical security of the facilities in question be affected by such arrangements?
- g. What might be the cost sharing arrangements?
- h. What would be the risks of the transfer, or operation, of proliferation sensitive technology as a result of multilateral management, and how might they be controlled or foreclosed?
- i. How would assurances of supply be formulated, implemented and guaranteed?
- j. What would be the criteria for measuring the effectiveness of multilateral arrangements for enrichment, reprocessing, and spent fuel management and disposition, in terms of technological, economic and political solutions?
- k. Is the establishment of ‘nuclear energy parks’ for geographically adjacent States feasible?
- l. Can there be generic solutions, or should they be tailored to the region or other circumstances? Would regional arrangements for the production and supply of nuclear reactor fuel and waste management be both technically feasible and politically acceptable?
- m. How might consideration of multilateral options for the management of spent nuclear fuel impact on current national efforts or projects?
- n. How might multilateral management of spent fuel influence future nuclear fuel cycle choices?
- o. What would be the role of the NPT nuclear-weapon-States, and other States reportedly possessing nuclear weapons, in possible multilateral arrangements?
- p. What would be the organizational arrangements, allocation of ownership shares, financial obligations and degree of restraint imposed on participants regarding parallel national nuclear fuel cycle activities? Should there be conditions placed upon non-nuclear-weapon States who would benefit from this scheme, such as foreswearing national reprocessing and enrichment, or the implementation of an Additional Protocol?
- q. Will there also exist agreed arrangements with countries to ship back spent fuel to the countries of origin or to future multilateral spent fuel repositories?
- r. What are the existing models for multilateral operation of elements of the nuclear fuel cycle?
- s. What are the merits of multilateral ownership vis-à-vis multilateral operation?
- t. Is there a reasonable consensus among the States to go ahead with the consideration of institutional arrangements?
- u. How might international consensus be achieved to support multilateral approaches to the front- and back-ends of the nuclear fuel cycle?

³ This is an “indicative” not an “exhaustive” list of possible questions to be addressed. The experts group could supplement this list with additional questions’.

ANNEX II

Multinational Approaches to Nuclear Fuel-Cycles - A Brief Historical Context

- 1) At the very outset of the nuclear age, it was recognised that the atom had a dual nature: it could be used both for nuclear weapons and for peaceful purposes. The drive to cage the military atom and to free the peaceful atom has, over the years, led to the evolution of a delicately poised regime anchored in the NPT and its associated IAEA safeguards system.
- 2) The earliest and most far reaching proposal for multilateral institutional arrangements regarding sensitive fuel cycle facilities was the Baruch Plan launched in 1946. In it the USA proposed that States should transfer national ownership and control over dangerous nuclear activities and nuclear materials to an international atomic development agency. This plan failed because it was inconsistent with the then-prevailing political realities in the world.
- 3) In 1953, US President Eisenhower's Atoms for Peace proposal introduced an era of international co-operation in the peaceful uses of nuclear energy and this, in 1957, led to the establishment of the IAEA. The Atoms for Peace proposal, in contrast with the Baruch Plan's strategy to curtail the spread of national fuel cycle facilities, envisioned the spread of nuclear fuel cycle facilities while placing the emphasis on policy commitments regarding peaceful uses and non-proliferation, and a system of international safeguards to verify compliance with the relevant peaceful use undertakings.
- 4) The Atoms for Peace programme led to a large-scale, world-wide transfer of nuclear technology for peaceful purposes initially from the United States followed by France, the United Kingdom, the USSR and others. Under this programme, research reactors fuelled by highly enriched uranium were transferred to many non-nuclear-weapon States (NNWS) around the world. The technology, equipment and material transfers, combined with the associated training, helped nuclear scientists in many countries to acquire knowledge and expertise on nuclear fission and its various uses.
- 5) Consequently, large nuclear fuel cycles developed in North America, Western Europe and Japan, and nuclear technology spread to many countries. In parallel, the USSR facilitated the peaceful uses of nuclear energy in Central and Eastern Europe. With the spread of nuclear knowledge and technology, international concern heightened regarding the importance of controlling its spread and preventing its misuse for non-peaceful purposes. By 1961, the UN General Assembly had reached consensus on an Irish-sponsored resolution on nuclear non-proliferation - and this eventually led to the conclusion of the NPT in 1968.
- 6) It is significant that the early drafts of the NPT focused on non-proliferation and verification. However, in order to win the crucial support of NNWS with advanced nuclear programmes or with ambitions to use nuclear energy for peaceful purposes, the drafters included treaty provisions on co-operation in the peaceful uses of nuclear energy and on nuclear disarmament.
- 7) The NPT, which entered into force in 1970, arrested the further proliferation of nuclear-weapon States (NWS) by capping their number, for the purposes of the treaty, permanently at five. The treaty, while it entrenched the NWS' obligation ultimately to disarm,

also cemented the concept of the “inalienable right” of all parties to the NPT to exploit nuclear energy for peaceful purposes without discrimination and in conformity with the non-proliferation objectives of the Treaty. For all practical purposes this bargain has been set in stone and attempts to alter it always ran the risk of bringing down the entire edifice of the NPT regime.

- 8) Concomitant with the drive to establish a global nuclear non-proliferation regime were efforts to promote and assure peaceful uses. One set of concepts explored earlier pertained to proposals for the consideration of technical approaches, e.g., by identifying “proliferation resistant” fuel cycles which might avoid or limit access to sensitive nuclear materials such as high enriched uranium (HEU) and plutonium (Pu). The efforts towards developing a proliferation-resistant fuel cycle assume a given national context, seek to enhance non-proliferation efforts by a technical or physical modification of the fuel-cycle itself but do not transcend the perceived inviolability of State sovereignty in this area. Related proposals have been examined e.g., in the framework of the International Nuclear Fuel Cycle Evaluation (INFCE) in the late 1970’s and resulted in the general conclusion that, while worth pursuing, technical measures alone would not compensate for weaknesses of the international regime designed to safeguard sensitive nuclear materials and facilities. Notwithstanding the experience gained in the INFCE process, work is currently underway in the framework of the Agency’s project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and the Generation IV Initiative (GIF) of the USA to, inter alia, explore technical approaches for improving the proliferation resistance of the nuclear fuel cycle.
- 9) In addition to the above, in the 1970s, a number of proposals and concepts were advanced, pursued and eventually surrendered under pressure from competing interests driven by the dynamics of the Cold War, nationalism, economics, mistrust and limits of technology. These included initiatives on: multilateral fuel cycle centres - proposed for a limited number of States pooling their resources in a single centre to provide fuel cycle services⁴ multinational spent fuel centres - proposed as an alternative to reprocessing or storage of separated plutonium but which were not considered politically realistic; an international nuclear fuel authority - proposed in order to guarantee the supply of nuclear power plant fuel to NPT NNWS that had renounced national reprocessing or enrichment plants, but which failed to materialize, partly because of over-supply of natural and enriched uranium, and partly because States were not prepared to give up national development and operation of such technologies; and international plutonium storage intended to implement Article XII. A.5 of the IAEA Statute, but which did not result in any agreement.
- 10) The concept of addressing nuclear proliferation by making changes to the managerial aspects of the nuclear fuel cycle is one that has been explored in the late 1970s and early 1980s. The more explicit discussion on multinational institutional arrangements began within the IAEA itself in June 1980, when the Agency’s Committee on Assurances of Supply (CAS) was convened. In tandem with its consideration of international cooperation with respect to the supply of nuclear materials, equipment and technology, CAS also discussed the feasibility of multinational fuel centres. After having held 21 sessions (between 1980 and 1987), CAS found itself unable to reach a consensus, and went into formal abeyance. Nonetheless, a precedent for in-depth discussion of the issue of multi-nationalisation of the fuel cycle has been firmly established.

⁴ In the second half of the 1970s, the IAEA carried out a detailed study of the concept that showed the obvious advantages of cost, safety and of reducing the number of weapon-usable material production facilities, but no State came forward with a concrete proposal

- 11) The 1980 the UN General Assembly adopted a resolution for the convening of a United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy (UNPICPUNE). In keeping with the controversy that had been part of similar initiatives, disagreements over its objective prevented UNPICPUNE from meeting until 1987. While the conference that was eventually held ultimately reaffirmed the need for international cooperation on these issues, the more radical notion of multi-nationalising the fuel cycle itself - which had been openly addressed by the IAEA's CAS - was for the most part absent. Nonetheless, this initiative also revealed awareness that the future peaceful applications of nuclear technology could benefit from being discussed in an international context.
- 12) The concept of multi-nationalisation of the management, storage and disposition of spent nuclear fuel can be traced to Article XII A.5 of the IAEA Statute. This provides for the possible acquisition of excess fissionable materials by the Agency. Proposals for International Spent Fuel Storage have been discussed since the late 1970s and early 1980, both internationally and under the auspices of the IAEA. The use of nuclear power as a global energy source is resulting in the discharge of large quantities of spent fuel, containing significant amounts of unseparated plutonium. Authoritative estimates project that between 1960 and 2004, approximately [225,000] metric tons of spent fuel are expected to be discharged from the world's nuclear power reactors. By 2010, it is estimated that more than 320,000 metric tons of spent fuel is likely to be discharged from nuclear power reactors. This fuel would contain, in turn, approximately 2,100 tons of unseparated plutonium.
- 13) Several international agreements contain standards and guidelines to assist States to ensure the secure, safe, environmentally sound storage, shipment, and disposition of nuclear materials, including spent fuel. The Convention on the Physical Protection of Nuclear Material (CPPNM) applies to nuclear material intended for peaceful use while in international transport. It obliges parties to ensure that certain basic levels of physical protection are in place prior to exporting or importing nuclear materials. Proposals have been developed to extend the scope of the CPPNM to cover nuclear materials under national jurisdiction. The Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management applies to materials derived from civilian activities and obliges the parties to take appropriate steps to ensure safe spent fuel management and waste management. It covers all stages of spent fuel and waste management, operation, and disposal.