Multilateral Nuclear Approaches (MNAs), Factors and Issues Lessons from IAEA Study to Regional Cooperation
다자간 원자력 협력: 요소와 현안

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Abstract

In response to the increasing emphasis being placed on the importance of international cooperation as part of global efforts to cope with *growing non proliferation, and security* concerns in the nuclear field, the Director General of the International Atomic Energy Agency (IAEA), Mohamed ElBaradei, appointed an international group of experts to consider possible multilateral approaches to the nuclear fuel cycle.

The mandate of the Expert Group was three fold:

- To identify and provide an analysis of issues and options relevant to multilateral approaches to the front and back ends of the nuclear fuel cycle;
- To provide an overview of the policy, legal, security, economic, institutional and technological incentives and disincentives for cooperation in multilateral arrangements for the front and back ends of the nuclear fuel cycle; and
- To provide a brief review of the historical and current experiences and analyses relating to multilateral fuel cycle arrangements relevant to the work of the Expert Group.

The overall purpose was to assess MNAs in the framework of a double objective: *strengthening the international nuclear non proliferation regime and making the peaceful uses of nuclear energy more economical and attractive.* The Group identifies options for MNAs - options in terms of policy, institutional and legal factors - for those parts of the nuclear fuel cycle of greatest sensitivity from the point of view of proliferation risk. It also reflects the Groups deliberations on the corresponding benefits and disadvantages (pros and cons) of the various options and approaches.

Although the Expert Group was able to agree to forward the resulting report to the Director General, it is important to note that the report does not reflect agreement by all of the experts on any of the options, nor a consensus assessment of their respective value. It is intended only to present options for MNAs, and to reflect on the range of considerations which could impact on the desirability and feasibility of those options.

1 Foreword

Mandate

In his statement to the IAEA General Conference in September 2003, the Director General observed that international cooperation in the context of the design and operation of the nuclear fuel cycle was an important issue that had been discussed over the years, but which, in his view, now merited serious consideration as part of the global effort to cope with increasing non proliferation and security challenges. He stated that such consideration should include an evaluation of the merits of limiting the use of weapons usable material (plutonium and highly enriched uranium) in civilian nuclear programmes, by permitting it only under multilateral control, and that any exploration of this kind had to be accompanied by appropriate rules of transparency, control and, above all, assurance of supply. He emphasized that strengthened control of weapons usable material was key to efforts to strengthen non proliferation and to enhance security. These proposals were refined and reiterated in his October 2003 article published in The Economist. The Director General also referred to the need to consider as well the merits of multinational approaches to the management and disposal of spent fuel and radioactive waste. As he pointed out, not all countries have the appropriate conditions for geologic disposal and, for many countries with small nuclear programmes for electricity generation or for research, the financial and human resource investments required for research, construction and operation of a geologic disposal facility were daunting. Considerable economic, safety, security and non proliferation advantages may therefore accrue from international cooperation on the construction and operation of international waste repositories. In this statement, the Director General indicated that the merits and feasibility of these and other approaches to the design and management of the nuclear fuel cycle should be given in depth consideration, and referred to the convening of an Agency group of experts as a useful first step in this regard.In March 2004, in his statement to the Board of Governors, the Director General referred to the wide dissemination of the most proliferation sensitive parts of the nuclear fuel cycle - the production of new fuel, the processing of weapon usable material and the disposal of spent fuel and radioactive waste - as the possible "'Achilles' heel' of the nuclear non proliferation regime", and to the importance of tightening control over such operations. He indicated that this could be done by bringing them under some form of multilateral control, with appropriate checks and balances to preserve commercial competitiveness, to control the proliferation of sensitive information and to ensure the supply of fuel cycle services. To that end, the Director General announced his intention to appoint a group of experts to examine the feasibility of moving forward with such measures. In June 2004, the Director General informed the Board of Governors that he had appointed an international expert group, to be chaired by Mr. Bruno Pellaud, former Deputy Director General for Safeguards, to consider possible multilateral approaches to the front and back ends of the nuclear fuel cycle.

The mandate of the Expert Group as originally articulated was three fold:

① To identify and provide an analysis of issues and options relevant to multilateral approaches to the front and back ends of the nuclear fuel cycle;

① To provide an overview of the policy, legal, security, economic, institutional and technological incentives and disincentives for cooperation in multilateral arrangements for the front and back ends of the nuclear fuel cycle; and

① To provide a brief review of the historical and current experiences and analyses relating to multilateral fuel cycle arrangements relevant to the work of the Expert Group.

Speaking on the occasion of the first meeting of the Expert Group, the Director General asked the Group to address the issue in all of its various facets, and in particular to assess the potential for a positive impact on international security. He directed the group to take into account the perceptions and expectations of all interested stakeholders and stressed that, to be successful, new approaches must go beyond the outright denial of technology. The Director General noted the importance of examining multilateral options with respect to both the front end and the back end of the fuel cycle, noting that any solution must be inclusive and without reference to the status of particular countries. He asked the group to not confine itself to finding "one size fits all approaches": what works in one region may not be the most ideal approach in another. He also agreed that the concept of multilateral nuclear approaches (MNAs) could be placed in the broader context of the non proliferation regime as a whole, including the Treaty on the Non Proliferation of Nuclear Weapons (NPT) and other relevant agreements.

The Expert Group, which was convened in August 2004, and held a series of 4 one week meetings over the period August 2004 to February 2005, consisted of individuals selected by the Director General to represent a broad spectrum of experience and nationalities, all of whom had been associated with the nuclear field in one capacity or another for many years. The Expert Group was assisted in its efforts by Messrs. Lawrence Scheinman and Wilhelm Gmelin as resource persons, as well as a number of current and former staff members of the IAEA and external experts.

Although the Expert Group was able to agree to forward the resulting report to the Director General, it is important to note that the report does not reflect agreement by all of the experts on any of the options, nor a consensus assessment of their respective value. It is intended only to present options for MNAs, and to reflect on the range of factors which could influence the consideration of those options.

Preliminary Considerations

At the outset of its deliberations, the members of the Expert Group expressed the collective expectation that nuclear energy will play a significant role in supplying the world with energy, and that, given the dual nature of nuclear energy, reliable and effective arrangements are necessary to prevent the further proliferation of nuclear weapons. The Group felt that that, as a consequence, its purpose was to assess MNAs in the framework of a two pronged objective: strengthening the international nuclear non proliferation regime and making the peaceful uses of nuclear energy more economical and attractive. Recently, the nuclear non proliferation debate has been driven by new challenges to the non proliferation regime: the discovery of undeclared nuclear material and activities; the existence of clandestine markets for the acquisition of nuclear technology; the threat of "break out" by States within the regime. Two proposals, in particular, have been put forward - neither for the first time - with a view to ensuring that the nuclear non proliferation regime maintains its authority and credibility in the face of these very real challenges. One of these proposals calls for the denial of technology to non nuclear weapon States (NNWS) and reinterpretation of the provisions of the NPT concerning States' rights to develop the research, production and use of nuclear energy. The increasing unwillingness of many NNWS to accept additional restrictions on the development of peaceful nuclear technology suggests that the viability of this proposal is questionable. The other proposal is for multilateral approaches to the operation of those parts of the nuclear fuel cycle considered to be of the greatest sensitivity from the point of view of proliferation risk. It is the latter proposal that the Expert Group was asked to consider. First, a word about terminology. In the view of the Expert Group, a distinction should be made between the words "multilateral" (the broadest and most flexible term, referring simply to the participation of more than two actors), "multinational" (implying several actors from different States), "regional" (several actors from neighbouring States) and "international" (actors from different States and/or international organisations, such as the IAEA). The Group has been asked to address the broadest possible options, and has thus explored all multilateral options, whether multinational, regional or international. In addition, it was necessary to define what the Expert Group considered to be those parts of the nuclear fuel cycle of the greatest sensitivity from the point of view of proliferation risk. As can be seen from the structure of the report, the Group decided to address *enrichment, reprocessing and spent fuel disposal and storage*. In fulfilment of its mandate, the Expert Group addressed three elements:

a. **Current and historical experiences** with MNAs: *In other words: what has already been tried in this regard? How successfully?* It provides background on the mandate of the Expert Group and on the political and historical contexts of the issue of MNAs. In this context, the Group was able to benefit from accumulated experience with existing successful multilateral solutions, particularly in Europe. The Group was also able to take advantage of work carried out under the auspices of the IAEA, and in other fora, in the somewhat less successful investigations into MNAs previously carried out. In addition, there is a wealth of practical experience with multilateral approaches not only in the nuclear field, but in other fields of technology, such as aviation and space, to name only two.

b. **Factors, options, and incentives and disincentives**: It addresses, collectively and individually, policy, legal, security, economic and technological factors relevant to MNAs in connection with the four sectors of the nuclear fuel cycle identified above. It also discusses cross cutting factors and reflects the Experts Group's analysis of the factors specific to, and possible options associated with, each of those sectors and identifies the corresponding benefits and disadvantages (pros and cons) of the various options.

c. **Over arching considerations and recommendations**: It addresses overarching issues, primarily of a broad political nature, that may affect perceptions as to the feasibility and desirability of MNAs and reflects on the conclusions of the Expert Group and offers recommendations on possible ways forward with MNAs.

Drawing on historical experience with efforts to establish MNAs, and borrowing materials and concepts from the practical examples, the challenge of the Group was to reassess the issues and options in the context of the present.

2 Current Political Context

The global nuclear non proliferation regime has been successful in limiting, albeit not preventing, the spread of nuclear weapons. The vast majority of States have pledged to forego the manufacture and acquisition of nuclear weapons and have abided by that commitment. Nevertheless, the past few years have been a tumultuous and difficult period, during which new challenges to the international non proliferation system have surfaced.

The decades long nuclear non proliferation effort is under threat: from regional arms races; from treaty benders and breakers; from the manner in which export controls have been applied; from a burgeoning and alarmingly well organised illicit black market in nuclear trade; and the increasing risk of illicit acquisition by terrorist and other non State entities. In the meantime, the universality of the non proliferation regime continues to be challenged by three States that have stayed outside the treaty. And finally, there is the extraordinary situation of the Democratic People's Republic of Korea (DPRK), the first country to have, de facto or de jure, withdrawn from the NPT.

Further concerns include whether the NPT nuclear weapon States (NWS) are making sufficient progress in fulfilling their nuclear disarmament commitments under the NPT. While some progress has been made, shortfalls remain and continue to evoke sharp criticism from many NNWS, and are cited as a major disincentive for some States to support further non proliferation initiatives. The same applies to the continuing delay in the initiation of negotiations of a verifiable Fissile Material (Cut off) Treaty (FM(C)T), and in entry into force of the Comprehensive Nuclear Test Ban Treaty (CTBT). Further nuclear disarmament, and legally binding agreements banning the production of nuclear material for weapons purposes and the testing of nuclear explosive devices, would improve world security now, making it measurably more difficult for any new aspirants to nuclear weapons status to get started in the first place.

Yet there have been positive developments. Membership in the NPT now stands at 189 countries (including the DPRK). Supplier countries also now exercise greater vigilance in their export controls. Meanwhile, in response to the IAEA's uncovering of the Iraqi undeclared weapons programme in the early 1990's, the international community moved decisively to strengthen the IAEA's safeguards system, and adopt the Model Additional Protocol (INFCIRC/540 (Corr.)) as a standard feature of the IAEA safeguards system. These new arrangements are already having an impact in boosting the confidence level in the IAEA safeguards, and have led to proposals to make adherence to the Additional Protocol a condition for compliance with the requirement of NNWS party to the NPT to conclude safeguards agreements "in accordance with the safeguards system of the IAEA". International cooperation in peaceful nuclear energy has thus far been predicated on political commitments to use transferred nuclear material, equipment, facilities and technology exclusively for peaceful purposes, combined with an acceptance of international safeguards to verify compliance with such commitments. Efforts to create further nuclear weapon free zones are another positive signal.

Security Council Resolution 1540 (2004) has tackled trafficking by non State actors in weapons of mass destruction, including nuclear weapons, obliging all governments to adopt appropriate control systems to prevent such trafficking. International collaboration in the "*Megatons to Megawatts*" programme has seen large quantities of highly enriched uranium (HEU) released from dismantled Russian warheads downblended into low enriched uranium (LEU) for civilian use. In addition, a significant portion of the US supplied HEU research reactor fuel has now been recovered under US take back programmes. Similar actions are now also being taken with respect to Russian supplied HEU fuel as well.

More worrisome is the case of "breakout": a State party to the NPT invoking its right to master the nuclear fuel cycle, being able to do so unfettered, and then giving three months' notice to withdraw from the NPT and developing nuclear weapons capabilities, as the DPRK is reportedly doing. Such a scenario is without doubt unacceptable to the world community.

The foregoing positive and negative developments shape current assessments of the proliferation threat. A further significant factor is that the civilian nuclear industry appears to be poised for worldwide expansion. Rapidly growing global demand for electricity, the uncertainty of supply and price of natural gas, soaring prices for oil, concerns about air pollution, and the immense challenge of lowering greenhouse gas emissions, are all driving a fresh look at nuclear power. As the technical and organisational foundations of nuclear safety improve, there is increasing confidence in the safety of nuclear power plants. In light of existing, new and reawakened interest in many regions of the world, the prospect of new nuclear power stations on a large scale is real. As a consequence, the future will likely result in a greater number of States interested in developing nuclear know how; seeking assurances of supply in materials, services and technologies; and contemplating development of their own fuel cycle capabilities.

Notwithstanding, countries have sought such capabilities, and for a variety of reasons: to carry out entirely legitimate, peaceful programmes; to remove doubts about the reliability of fuel supply from foreign sources; to conserve nuclear fuel resources through reprocessing; to achieve the prestige of possessing advanced, sophisticated fuel cycle facilities; to sell enrichment or reprocessing services on the international market; and because the State considered it to be economically justifiable. A few States have also sought such technologies for the purpose of developing nuclear weapons or securing the option to do so.

The civilian nuclear fuel cycle has not been a significant proliferation factor. Those States that wanted nuclear weapons have gone straight for them, creating parallel weapons programmes. Clearly, however, it is not desirable that every State with nuclear research and/or nuclear energy programmes should establish its own enrichment and reprocessing facilities (even if such activities would be within the boundaries of Article IV of the NPT). In particular, in regions of high tension or conflict, such activities - even when pursued in good faith - could add to regional instability.

In the 1970s, the search for alternative approaches to complete national fuel cycles, fuelled by growing concerns regarding prospective "plutonium economies" and the 1974 explosion by India, led in turn to a number of international initiatives, which are the central elements of the historical perspective provided in the following chapter.

3. Cross-cutting factors

Consideration of multilateral approaches to the nuclear fuel cycle tends to involve the same few factors, whether one is dealing with enrichment, reprocessing or disposal. As foreseen in the Director General's mandate to the Expert Group, reach across the spectrum of technology, economics, assurances of supply, legal and institutional arrangements, and non-proliferation and security issues. These cross-cutting factors are discussed in this chapter.

Advances in nuclear technologies

This deals with a major proliferation factor and its impact on safeguards and verification: the degree to which new technologies and other scientific developments interact with each other to lower the threshold of accessibility for sensitive nuclear technologies while nonetheless permitting more effective and efficient verification.

Since the time of INFCE, nuclear technology has undergone significant developments, on the one hand in the production of direct use nuclear materials and related sensitive components, and on the other for the tools now available to the IAEA for verifying nuclear material and its use.

These developments include:

Information technology (IT). IT has changed dramatically since the 1970s, due to the introduction of faster, smaller, more versatile, low cost and more reliable computers and operating systems. For example, complex multi-group codes and hydrodynamic calculations that once took hours on the then largest computers (Cray-1) may now be performed on a €2000 personal computer in the same time or faster, especially when connected with other personal computers in a network.

However, the most significant IT development has been the appearance, spread and the usage of the internet, where, apart from making information widely available and thereby fostering knowledge, a wealth of sensitive nuclear data designs, methods and techniques can be retrieved worldwide with little difficulty (for example, detailed designs of nuclear weapons, early generations of production centrifuges, reprocessing flow sheets, including detailed descriptions of the radiochemistry involved).

Sensor technology, process engineering and miniaturisation. All kinds of sensors for physical parameters - such as optical (satellites), radiation, pressure and motion sensors - are now available at low cost. These processes have been both optimised and miniaturised and are now radiation-resistant and economical.

Material technology. Examples are the use of non-metallic components in enrichment and reprocessing processes. Dual-use materials have become ubiquitous.

Chemistry. Basic research has resulted in the development of new techniques for reprocessing, for example with pyrochemical processes with which large separation factors can be routinely achieved in small geometries. Analytical methods were further developed so that concentrations of smaller than 10E-12% (or 0.000000000001)Chemists claim that such low concentrations are equivalent to the concentration of a lump of sugar dissolved in a volume of water as large as the Baltic Sea. are routinely determined, developments particularly important for Agency verification.

Finally, the combination of all of these developments, has led to powerful synergies. These synergies resulted for example in the development and implementation of advanced automatic measurement stations for IAEA safeguards verifications, where motion sensors trigger non-destructive measurements and video films of objects moved through the space of interest and the automatic and encrypted transmission of these data to IAEA HQ, via the internet.For nuclear facilities, the spin-offs of these technical advances are that nuclear safety has been further enhanced, processes can be streamlined and the economics have improved. Due to these advances, however, concealment of non-peaceful uses at complex facilities that are part of the nuclear fuel cycle has become technically less difficult. On the other hand, these advances have also contributed to the development of innovative nuclear systems, deemed proliferation-resistant, safe and economical. Related work performed in the framework of the IAEA INPRO project and the multinational Generation IV projects thus have implications and likely implications for non-proliferation, safety and economics of nuclear energy as a whole.

Agency safeguards verification and other verification systems have benefited from most of these developments, in particular, in connection with material accountancy evaluation through information technology (IT), particle analysis, destructive and non-destructive measurements (chemistry) and surveillance (sensor technology and IT), to the point that real-time verification of most peaceful nuclear processes has now become a technical possibility and, indeed, a reality where governments have cooperated in their implementation.

An evaluation of the impact of these advances on a variety of aspects of the peaceful uses of nuclear energy, such as proliferation risks, safeguards, assurance of supply, energy planning security and economics, shows that:

a. Proliferation risks have increased markedly in recent decades with the easier accessibility of sensitive technologies peddled on the world market by irresponsible parties, and with the dissemination of weapons design information.

b. Safeguards: technological advances have had a strong and positive influence, leading to increased safeguards effectiveness and efficiency. There is disagreement, however, as to whether this positive factor compensates fully the higher proliferation risks brought about by modern technology.

c. Assurance of supply and energy planning security: advanced technologies, with their promises of small-scale facilities and lower costs, encourage the pursuit of national facilities or regional MNAs by making them more attractive for achieving domestic or regional self-sufficiency in the fuel cycle. For smaller countries, such facilities make the possibility of national independence at a reasonable cost a more likely achievable goal.

d. In terms of economics, technology has made it possible to build smaller facilities. That is, for a given throughput, a given size, the costs have decreased. Of course, economies of scale continue to apply; a multinational partnership at a higher throughput would provide even better economics.

On the production side, enrichment to weapon-grade uranium using early generations of ultra-centrifuges has become less difficult, since documents on design, materials and process control of these early machines are more readily available. The level of difficulty seems now to be comparable to that of constructing a medium-performance car engine. However, advanced designs to achieve a steady output at reasonable cost are still not available. Furthermore, the know-how and experience gained from some 20 years of development cannot be re-engineered in only a few years. As far as uranium conversion, to or from UO_2 to UF_6 is concerned, the know-how has become readily available; this process presents no greater difficulties than would, say, the production of hydrogen or ammonia.

Safeguards verification of the peaceful use of enrichment plants and associated conversion processes has become very effective as a consequence of the advances in chemistry and sensor technology referred to above. Real time verification of an enrichment facility can be achieved at a pro rata cost lower than one thousandth of the cost of producing one "separative work unit".

Large-scale reprocessing installations using wet chemistry are now coming under IAEA inspection. The IAEA has defined the verification approaches and criteria to be applied. Verification of modern reprocessing facilities with complex chemical processes requires a very complex network of advanced sensors. Such verification is therefore costly, with an impact on IAEA's financial and human resources. The safeguarding of advanced reprocessing techniques, such as those based on pyrochemical processes, will be a challenge. Simpler and cheaper verification might be achieved when such new plants are constructed with no separation of U, Pu and minor actinides, and possibly with no extraction of fission products .

With respect to fuel cycle facilities at the back end of the fuel cycle (spent fuel and related facilities), there are no major proliferation concerns, since technological advances allow for efficient IAEA safeguards using real time verification for MOX fuel fabrication, spent fuel storage and even disposal repositories. The widespread implementation of the Additional Protocol will further accelerate this development. Technological advances would benefit these activities by simplifying their verification.

Recent discoveries of undeclared nuclear activities have demonstrated that the proliferation of sensitive technologies is difficult to inhibit given the broad dissemination of knowledge. The improvement, standardization, and strict application of export controls, as well as the strict application of international safeguards will help prevent clandestine activities. The advanced technologies used in modern safeguards will contribute greatly towards that goal. In addition, fostering multinational cooperation will facilitate a worldwide reduction of commercial nuclear facilities in the sectors of uranium enrichment and spent fuel reprocessing. This, in turn, will help to reduce technology transfers that might be used for weapons programs.

Economics

This summarizes generic economic considerations relevant for all multinational nuclear fuel cycle facilities. Additional economic considerations specific to different technologies (enrichment, reprocessing, storage and disposal) are addressed.

History and logic suggest that the more profitable a proposal, the easier will it be to recruit partners and implement the proposal. Economies of scale exist for most facilities in the nuclear fuel cycle, and the expectation that multinational facilities will likely be larger than national facilities raises the possibility that economies of scale will generate simultaneous non-proliferation and economic benefits. The double incentive should make it easier to establish a multinational facility.

But economic benefits need not be a necessary condition. Countries spend substantial sums to improve national security and should be willing to spend on multinational facilities that cost-effectively improve their security by strengthening the non-proliferation regime.

Nor are economies of scale and economic benefits sufficient conditions for a multinational facility. Even where they exist, it can be very difficult, for the reasons below, to structure incentives to be attractive to all necessary partners. And a country bent on proliferation will not necessarily be dissuaded even by a very lucrative MNA alternative.

The economic attractiveness of an MNA may be vulnerable to economic upsets or major shifts, whether due to markets, politics, accidents, or natural disasters. If so, hedges and insurance arrangements may be needed to make its economic appeal more resilient.

An MNA's attractiveness must not be too dependent on the future development of nuclear power following a particular expansion (or contraction) path, globally or regionally.

Different parties sometimes have different motivations and different expectations of the future. A successful MNA must dovetail these differences in ways that attract the participants necessary to deliver the desired economic and non-proliferation benefits. The costs of start-up, operations, liabilities and needed accumulating funds (e.g. for eventual decommissioning) must be allocated efficiently and equitably in the eyes of the participants. Acceptable dispute resolutionprovisions must be included, and if universal, or very broad, participation is needed, compensation arrangements may be needed to assure that every party judges itself a net winner.

Assurances of supply

Currently, the commercial market satisfies the demand for fuel services. There is a diversity of commercial enrichment companies; enrichment capacity exceeds demand; and, based on current expansion plans, capacity is likely to comfortably keep abreast of projected increases in demand. There is no specific call by consumers for additional arrangements to assure supply. For other front end processes (concentration and purification of uranium, conversion and fabrication) the situation is similar. This equilibrium in the uranium market is likely to change only if the demand for nuclear power increases significantly.

However, some States with enriched uranium resources may freely cut off supplies to other States to gain leverage for reasons that have nothing to do withnon-proliferation. Against that possibility, a country needing enriched uranium for nuclear power plants may have an interest in alternative extra-market measures being in place to provide assurances of supply. Other than for the production of weapon nuclear materials, possible motivationsfor building a domestic enrichment capability are:

a. Reducing external dependence on foreign suppliers and achieving greater economic independence, e.g. when faced with a shortage of foreign currency or energy supplies,

b. Unfavourable experiences in the past and low confidence in existing suppliers,

c. National prestige and expected spin-offs for industrial and technological development.

For any given country, none, some or all of these may be relevant. Establishing a multinational arrangement that provides a fully credible international external assurance of supply is no guarantee that a State will not wish to pursue a domestic capability. Nevertheless, an international external assurance of supply would address the first two motivations in this list. Whatever the situation, a State that pursues a domestic capability may not necessarily be doing so to create the option of acquiring nuclear weapons.

Concerns about assurances of supply have existed since the 1960s, and is still a primary concern in 2005, a central element of national nuclear policies. The secure availability of nuclear energy rests on assurances of supply of nuclear material, equipment and services for those having nuclear plants. Domestic solutions, which are the privilege of a few States, are not available to others. And in an age of growing interdependence and globalisation, the drive for self-sufficiency is diminishing as a guide to national economic policies. In this perspective, MNAs may represent an effective alternative to national solutions, depending upon conditions of the assurances of supply of fuel and/or services that are credible and viewed by the potential clients as dependable, reliable and economical.

The fundamental conditions that potential MNA partners may demand are worthwhile restating:

a. Diversity of suppliers participating in the MNA;

b. The willingness of a sufficient numbers of suppliers to grant to the MNA generic consent for the transfer of the respective goods and services assuming of course that basic premises with be fulfilled (non-proliferation credentials, physical security, export controls and safety);

c. The availability from such suppliers of significant amounts of fissile material free of "flags" and free of prior consent rights from other parties;

d. Sufficient reserve capacity of the respective fuel and services to cover supply emergencies, in a setup equivalent to the mandatory national oil reserves held by OECD members under the auspices of the International Energy Program of the International Energy Agency;

e. A credible, timely and reliable decision-making mechanism for the release of replacement supply;

f. A pricing mechanism for the provision of substitute fuel and services in case of emergency that is deemed fair and that leads to prices not significantly higher than those set by the original supplier;

g. A neutral and fair process for determining whether a recipient that has lost its original supplier is in good standing with its non-proliferation commitments.

Legal and Institutional

The establishment and operation of an MNA needs to be founded on an appropriate legal base. Such a facility could have as its legal basis:

a. an international agreement alone (as exemplified by Eurochemic);

b. national legislation (as exemplified by EURODIF);

c. a combination of a and b (as exemplified by URENCO).

In practical terms, there is little difference between a legal basis consisting of an international agreement alone and one consisting of an international agreement and national legislation (although the difference between the two will vary depending on the extent to which the requirements of the agreement are expressed in general or specific terms: the more general the terms of the agreement, the greater the difference). This is so because, normally, national legislation is needed to implement the terms ofan international agreement. Two exceptions to this general rule are: for a State in which existing legislation is sufficient to enable the implementation of the treaty; for a State in which an international agreement automatically becomes part of national law upon its entry into force for that State. However, even in these two cases, regulations (which are a form of legislation) may be needed for full and effective implementation.

With respect to the second possible legal basis, that is, national legislation alone, a State could, of course, enact legislation for the establishment and operation of an MNA. However, while a State has jurisdiction to require that the legislation be observed by any person or entity making use of the services provided by the facility, that State has no jurisdiction to enforce the observance of such requirements outside its territory (without the consent of the State in whose territory the person or entity is located, or unless the person or entity has assets against which legal action can be taken in the territory of the legislating State). Further, in the absence of a binding international agreement, a State would be free to repeal or change such legislation.

If an international agreement were to form the, or part of the, legal basis, for an MNA, the following issues related to form and procedure would need to be addressed:

a. whether all States would be entitled to become parties to the agreement (i.e. a universal agreement) or only those States in a given region (or, for that matter, whether it could be bilateral); and in that context, whether regional agreements could be concluded and brought into force more quickly than a universal agreement;

b. how the agreement would enter into force: if the agreement were to be multilateral, whether it should enter into force upon adherence to it by the host State and one or more other State(s);

c. whether the agreement should refer only to existing facilities (e.g. all existing enrichment facilities in the States party to the MNA) or cover all existing and future facilities;

d. whether it would be feasible to have an approach based on an agreement between the States in which the relevant facilities are located, together with separate agreements between that group of States and each State in which persons or entities within the latter's territory are to receive the services of the facility or facilities.

The agreement(s) or national legislation would also have to address, among others, the following substantive issues:

a. what entities may participate in or benefit from the MNA (e.g. governments; governmental entities; private entities);

b. the conditions for participation in the MNA, including:

   i) the application of appropriate IAEA safeguards pursuant to an INFtype agreement or an INFCIRC/153-type agreement, and an additional protocol based on INFCIRC/540 (Corr.), in the territory of all recipients of the output (e.g. services, material) of the facility;

   ii) the application of appropriate safety and physical protection measures in the territory of all recipients of the output of the facility;

   iii) an undertaking by each State to prohibit within its territory any activity parallel to that of the facility (e.g. any other enrichment activities); and, if agreed by a State or group of States, restricting research and development on such technology to the MNA entity;

c. the prohibition of withdrawal from the arrangement;

d. the sanctions to be applied with respect to any breach of sub(b) and (c) above;

e. how joint decisions are to be taken with respect to the supply of material or services, and agreed circumstances justifying a denial of supply (e.g. for reasons unrelated to non-proliferation, such as failure to fulfil commercial conditions);

f. how disputes (commercial or otherwise) are to be settled, including issues of forum and jurisdiction);

g. whether the MNA should be treated as an independent international legal entity, and, if so, the nature and extent of any privileges and immunities that are to be accorded to it in the host State and in other participating States;

h. how and by whom decisions relating to the operation of the MNA are to be taken;

i. how and by whom the activities of the MNA are to be financed;

j. what provisions should be made in case of insolvency of the MNA.

While many, if not most, of the above substantive issues would also have to be addressed in commercial contracts, such contracts (which would be governed by national law) would be binding only on the parties thereto, and the parties would not normally include Governments.

With the above in mind, and based on the premise that, to be attractive for further consideration, an MNA should be designed to lessen nonproliferation, security and safety concerns while providing assurances of supply of nuclear fuel and sustaining technologies in return for restraints in the use of sensitive technology, the following three categories of options for multilateral approaches are considered and assessed:

(a) Options involving assurances of services not involving ownership of facilities

i: Additional assurances of supply by suppliers: These assurances could take different forms, such as longer-term contracts or contracts with more favourable incentives. This might require all supplier-States agreeing to amend any national legislation which impose prior consent conditions ii: International consortium of governments: This could take the form of a fuel bank to which governments would physically contribute material. Alternatively, supplier governments could physically hold the material, subject to an agreement on how it is to be distributed.

iii: IAEA-related arrangements: The IAEA could physically hold and distribute the material. Alternatively, the IAEA could simply direct the distribution of the material. The IAEA could either hold title to the material, or conclude an agreement with a State or States to provide the material or services at the direction of the IAEA. Countries most concerned with assurances of supply would likely prefer a role by the IAEA. However,it is not clear whether countries would wish to relinquish all prior consent rights to material provided to or by the Agency. In addition, the IAEA might decline to provide material in certain circumstances (such as non-compliance in safeguards, poor nuclear safety records, or insolvency).

(b) Options involving the conversion of national facilities to multinational facilities

This would entail the conversion of an existing national facility to one subject to international ownership and management. It could be based on an arrangement in which all partners share the technology or one in which access to the technology is limited to the technology holders.

(c) Options involving the construction of new facilities

i: The URENCO model: This could involve the sharing of technology with all partners involved in the construction of a new facility, or the construction of a facility in a non-technology holding State without providing that State with access to the technology.

ii: The EURODIF model: Although the partner(s) would all have a share in the ownership of the facility, the technology holder(s) would not give the non-technology holding partner(s) access to the technology nor permit them to participate in the operation of the facility.

Non-proliferation and security factors

Since non-proliferation concerns are the driving force behind the present interest in devising multilateral approaches, it is necessary to ensure that any models for such approaches strengthen, not weaken, the non-proliferation regime. The outright transfer of sensitive technologies should be ruled out or, at a minimum, extreme caution/restraint should be exercised in its transfer. Related issues to be resolved from a non-proliferation and security perspective might include: siting of the multilateral facilities or operations; security of materials, facilities and transport; handling and storage of wastes; take-back of spent nuclear fuel; timely supply of fresh fuel and timely removal of spent fuel; and common legally binding non-proliferation undertakings.

As an alternative to multilateral approaches to prohibit additional States from developing enrichment and/or reprocessing capabilities, some have called for strengthening the non-proliferation regime by altering the NPT itself, whether de facto or de jure. In particular, it has been suggested to reinterpret existing NPT language, which recognises and guarantees non-nuclear-weapon States the right to pursue nuclear technology exclusively for peaceful purposes if they forego nuclear weapons (Article II) and submit to IAEA safeguards (Article III). However, such an approach is probably unrealistic.

Safeguards implementation

The concerns evoked by clandestine supply networks, the availability of and increasing access to nuclear technology, and the possibilitythat some countries may be tempted to use such technology for non-peaceful purposes cannot be ignored, particularly given past evidence of that some countries have not fully complied with their safeguards obligations. Hence, the importance of the strengthened safeguards system, and of the intrusive Additional Protocol. There are fundamentally two risks: diversion of fissionable materials from declared facilities and construction of undeclared fuel cycle facilities built with technology transferred from the declared program. Diversion risks can be countered quite effectively when the additional protocol is in place.

Yet, with respect to MNAs, a question should be asked: Would safeguards implementation by the IAEA take into account the special positive nature of a multinational nuclear facility? The answer is yes. Participants whether private or governmental would be committed to transparency and openness through the continuous presence of a multinational staff. Flows of materials would be mostly between partners to the MNA. The MNA agreement could even be stronger in this respect. This additional layer of international oversight would be recognised by the IAEA, allowing thereby a reduction of the safeguards verification scope.

This situation was anticipated by the authors of the Model Safeguards Agreement agreed by the Board of Governors in 1971, a model that has been adopted for almost all safeguards agreements concluded since then. Paragraph 81 of the model safeguards agreement (INFCIRC/153) lists criteria to be used by the IAEA for determining the actual number, intensity, duration, timing and mode of routine inspections of any facility. Its paragraph (d) covers the following criterion: *"International interdependence, in particular, the extent to which nuclear material is received from or sent to other States for use or processing; any verification activity by the Agency in connection therewith; and the extent to which a State's nuclear activities are interrelated with those of other States…"*.

In its report to the Director General in May 2004, the Standing Advisory Group on Safeguards Implementation (SAGSI) referred to Para. 81 and noted that a large number of facilities receive nuclear materials from, and send nuclear materials to, other States, and also that many facilities employ multinational staff whose activities are interrelated with those of other States. SAGSI confirmed that the IAEA should give appropriate recognition to international interdependence under the so-called "State level approach", an approach that would include consideration of State-specific factors such as the level of cooperation with the IAEA on safeguards implementation in the State, including consideration of openness and transparency; and the presence of a supportiveand effective State System for Accounting and Control (SSAC). These comments are quite relevant for MNA joint facilities.

Security and physical protection

Besides non-proliferation and safeguards factors per se, the physical protection of nuclear materials and related facilities has always been a matter of great importance, and would continue to be so under an MNA. Nevertheless, no international treaty mandates States possessing nuclear material to enforce physical protection and security measures. The NPT requires safeguards on nuclear material in NNWS Parties and that necessitates the establishment of a SSAC, but physical protection is not an attendant requirement. In practice, SSAC's controls, Agency inspections and the Agency's review of national accounting help to some extent to provide physical security of the nuclear material under safeguards. However, Agency inspectors are not required explicitly to verify physical protection. When the IAEA system of safeguards for NNWS was established in 1971-1972, physical protection standards were only "recommended", and no agreement was possible among the States to make these standards mandatory.

The agreed and recommended standards were published in 1975 as INFCIRC/225, and have been since then regularly upgraded under IAEA auspices. The latest INFCIRC/225 document recommends that each State establish and periodically re-evaluate "design basis threats" for its facilities, as well as conduct exercises to test whether guards, sensors and other protection measures are adequate. The document includes detailed provisions on protecting from sabotage nuclear power reactors as well as stored nuclear materials.

The 1980 Convention on the Physical Protection of Nuclear Material (CPPNM) required physical protection standards but these apply only to nuclear materials for peaceful purposes that are in international transit or in temporary storage as part of international transport. Thus, the CPPNM applies only to civilian nuclear material and contains no verification provisions. The result is that there is a wide variation in physical protection standards from State to State. The mechanism of "peer reviews" is used to assess the implementation of the CPPNM standards. An attempt is underway to strengthen the CPPNM, but the proposed amendments do not cover nuclear material in military use or related military facilities.

The protection of weapon-usable plutonium and HEU against theft and sabotage will not be effective against diversions and thefts, unless adequate standards are applied to all sources of such materials globally and are made mandatory. A revision of the CPPNM could improve the situation. Short of such a revision, a way should be found to make INFCIRC/225 mandatory; adherence to and implementation of such guidelines and recommendations also needs to be improved.

Thus, from the security perspective, all multilateral nuclear fuel cycle approaches will face the requirement of being integrated within the existing international nuclear non-proliferation and security arrangements in order to elicit the confidence of participating and other States. The challenge will be to ensure that a multilateral nuclear arrangement can be established with high standards of physical security and of MPC&A (material protection, control and accounting).