WNA Report

Ensuring Security of Supply in the International Nuclear Fuel Cycle

World Nuclear Association

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From the Director General

12 May 2006

Dr. Mohamed Elbaradei
Director General
International Atomic Energy Agency
Vienna
Austria

SUBJECT: WNA Report on Security of the International Nuclear Fuel Cycle

Dear Dr Elbaradei

As we have discussed, the world nuclear industry applauds your efforts to provide leadership in shaping an international system of nuclear commerce that will support an expanding global use of nuclear power in the 21st century while fortifying reliable barriers against the misuse of nuclear knowledge.

As a means of developing and articulating a broad-based industry point of view on the commercial and diplomatic elements of such a system, the World Nuclear Association established a Working Group on the Security of the International Nuclear Fuel Cycle.

The accompanying WNA Report offers the Working Group's initial perspectives on these matters. I transmit it to you on behalf of our worldwide membership of enterprises that compose the global nuclear industry. Through the Working Group, we stand ready to particpate actively and constructively in pursuit of the valuable objectives you have envisaged.

With warms regards,

John B Ritch

World Nuclear Association • Carlton House • 22a St. James's Square • London SW1Y 4JH • UK
Website: www.world-nuclear.org • Email: info@world-nuclear.org
Tel: +44(0)20 7451 1520 • Fax: +44(0)20 7839 1501
Incorporated in England No 1215741 • VAT Reg No GB 340 2373 93

Introduction

In 2004 the IAEA Director General established an Expert Group on Multilateral Approaches for the Nuclear Fuel Cycle. The Expert Group report, issued in early 2005, outlined the elements of a potential strategy aimed at "increasing non-proliferation assurances concerning the civilian nuclear fuel cycles, while preserving assurances of supply and services around the world". A key element of such a strategy would be to limit the spread of sensitive nuclear technologies by providing additional assurances of supply to countries that volunteer to forego the development of indigenous capabilities.

To contribute an industry response to the IAEA's important initiative, in August 2005 the World Nuclear Association established a Working Group on Security of the International Nuclear Fuel Cycle. Membership and Terms of Reference of the Working Group are given in Appendix 1.

This Working Group met formally on three occasions (in September 2005 and in January and April 2006). At the first meeting, it was agreed to establish three Sub-Groups (on the Front-End, on the Back-End, and on Customer Perspectives).

The three Sub-Groups reported to the main Working Group at the January 2006 meeting, and this final report was agreed in April 2006. The reports from the Sub-Groups are contained in Appendices 2, 3 and 4.

The WNA Working Group will continue to act as an industry sounding board as international deliberation on this topic evolves.

General Findings

The Working Group recognized and welcomed the objective of avoiding the spread of sensitive technologies and facilities through a credible assurance of access to enrichment and reprocessing/recycling services and, in the longer term, through the establishment of multilateral nuclear fuel cycle centres. Achieving this objective means ensuring that any State embarking on a programme of building nuclear power plants should be able to obtain a reliable guarantee of attractively affordable supply through existing market players.

Any action in fulfillment of such a guarantee would, of course, depend on the State being in full compliance with all international safeguards requirements, as determined and verified by the IAEA.

Customer Perspectives

The Sub-Group on Customer Perspectives brought together views from within the WNA membership as to how existing customers perceive the security of current supply arrangements, and considered how these might be strengthened.

The Sub-Group noted from the outset that existing world market arrangements offer a very high standard of security of supply in all aspects of the nuclear fuel industry. Indeed, in the history of the industry, there has never been a disruption of supply that has led to a loss of electricity generation. Several instances of major discontinuities in recent years have all been resolved with conventional market mechanisms.

The effectiveness of market mechanisms is enhanced by the common practice of utilities in following strategies that incorporate inventory, diversity of supply and contractual flexibilities. These strategies would be exercisable in the event of supply disruptions.

The current IAEA and Euratom safeguards regimes are effective and deserve a higher public profile. It is essential to nuclear commerce that customers be in full compliance with these safeguards regimes, and a more clear-cut penalty system for non-compliance should be agreed internationally at inter-governmental level.

Any approach to strengthening security of supply should be consistent with the continued effective operation of the competitive world market. Moreover, any arrangements for emergency or backup or guarantee supply arrangements should be used only as a last resort if existing market arrangements have failed, and not as a substitute for market supplies. Similarly, there should be no price discrimination against supplies from the normal market, and hence no price subsidies for the emergency or backup or guarantee supply arrangements.

The triggering of emergency or backup or guarantee supply arrangements should occur only in the event of a political disruption of the normal market for a reason other than a non-proliferation issue. Such triggering should not result from a technical or economic disruption. Experience has shown that any technical or economic disruption can be dealt with by normal operation of the existing world market, and this should continue to hold true.

As a final backup, the availability of former weapons HEU held as a stockpile would be helpful, as this would not remove material from the normal supply process. To be seen as adding significantly to security of supply, any such stockpile material would, of course, need to be controlled by a widely accepted international body, presumably the IAEA.

Front-end Views

To supplement existing market mechanisms in enrichment services, a reinforced guarantee of supply for enrichment services should be established through a joint commitment by existing uranium enrichment companies ("enrichers") supported by the IAEA and national governments.

This proposed supply assurance concept would be a "guarantee-in-depth" analogous to "defence-in-depth" in reactor safety. It would consist of three layers of guarantees:

- Level I: Basic supply security provided by the existing world market
- Level II: Collective guarantees by enrichers supported by governmental and IAEA commitments
- Level III: Government stocks of enriched uranium product (EUP)

The initial level of guarantee, from the existing world enrichment market (Level I), is based on the strong multi-year performance record of the international SWU market.

The second level of guarantee (Level II) would be invoked in the event of a disruption of normal commercial supplies for bilateral political reasons between an enricher and a customer State.

Level III – Government EUP Stocks – would be used as a last resort in the unlikely event that enrichers could not meet their backup supply commitments as embodied in Level II.

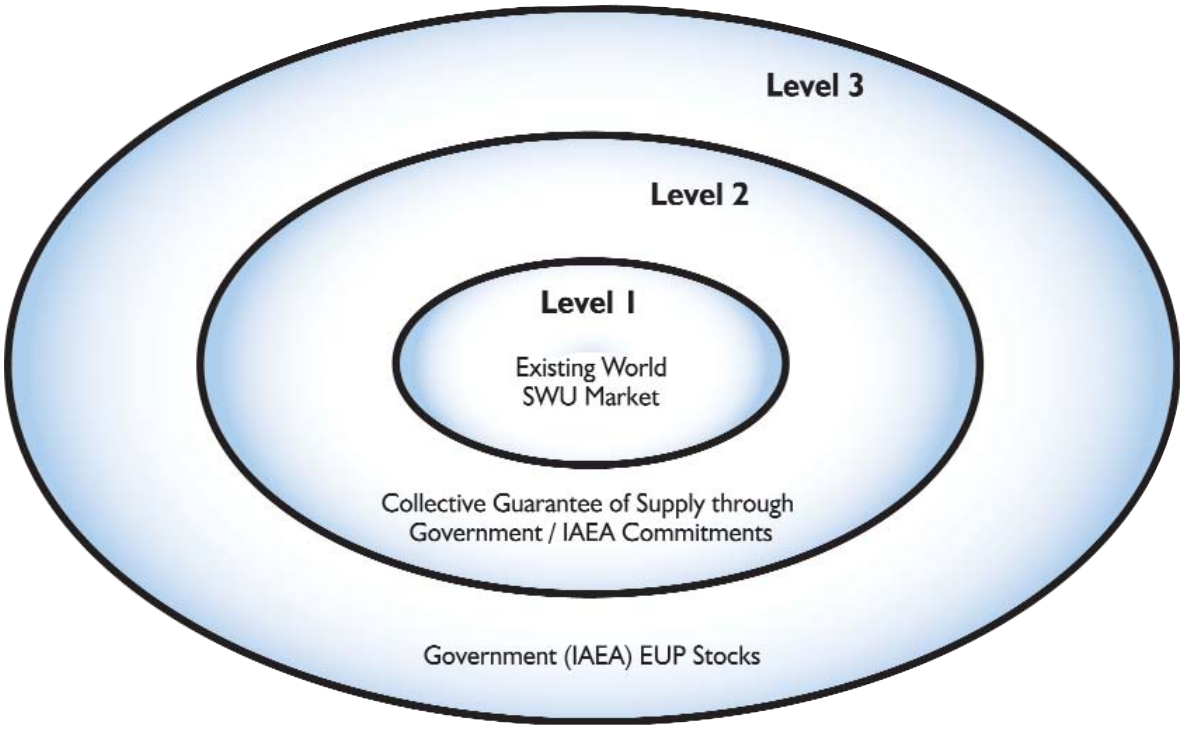

FIGURE 1: Multi-Layered and Multilateral Guarantee of Supply (see Appendix 3)

This multi-level guarantee mechanism would operate in case of a contract suspension for political reasons. Upon notification by the concerned enricher or customer, the IAEA would determine the legitimacy of the customer's claim in light of pre-defined criteria pertaining to its compliance with safeguards requirements and the events leading to the contract suspension. The Agency would thereupon notify the other (remaining) enrichers to implement their obligations.

Under the Level II backup supply arrangements, the other enrichers would at this point be committed to supply. To ensure that no single enricher is unfairly burdened with the responsibility of providing backup supply, the other enrichers would supply the contracted enrichment in equal shares under terms previously specified between the IAEA and the enrichers. (A standard backup supply clause would be included in commercial contracts between enrichers and customers eligible for such backup.)

Designing a similar mechanism for fuel fabrication would be more complex. Because fuel design is specific to each reactor design, an effective mechanism would require stockpiling of different fuel types/designs. The cost of such a mechanism could thus be substantial. It should be noted, however, that uranium fuel fabrication per se does not present a proliferation risk.

Back-end Views

Current declared recycling strategies do not, in the short term, necessitate new reprocessing facilities for fuel from light water reactors. Thus, existing reprocessing/recycling capacities are sufficient to meet foreseeable demand. Any State that does not produce an annual used fuel discharge sufficient to justify its own national reprocessing/recycling facility should be able to obtain adequate guarantees of supply through existing market players.

In future, however, a situation might arise in which a significant number of States, anticipating a large expansion in their use of nuclear power, choose a recycling strategy to ensure the sustainable long-term management of their resources. This could lead to a call for increased capacities in existing facilities or new builds.

In light of the robust nuclear energy initiatives now under way in many countries, concepts of international reprocessing/recycling centres are worth pursuing and deserve further, more detailed review. Effectively implemented, probably on a regional basis, such a concept could enhance guaranteed access to recycling services for countries wishing to close their fuel cycle.

To limit the spread of such technologies worldwide, countries already possessing these technologies should be encouraged to offer their services to meet such demand. The goal should be to achieve a situation in which countries without back-end fuel cycle facilities have a clear-cut option of having their spent fuel reprocessed and MOX fuel manufactured, at affordable prices, at national or multinational back-end facilities located in countries with expertise and a high level of industrial development in this area. Establishing such arrangements would require the negotiation of inter-governmental agreements.

Conclusions

The current world market provides a considerable degree of security of supply, and has never to date failed to ensure continued operation of nuclear energy generation worldwide.

Starting from this premise, the industry recognizes that there are ways to strengthen security of supply through the provision of explicit guarantees that would be implemented by the IAEA under provisions established by multilateral agreement.

The nuclear industry recognizes and accepts the responsibility to work with governments and the IAEA to achieve the aim of increased security of supply on the foundation of a well-established and successfully functioning world market.

APPENDICES:

1. Working Group Membership and Terms of Reference
2. Views of the Customer Perspectives Sub-group
3. The Concept of Security of Enrichment Supply
4. Back-End Multilateral Nuclear Approaches: The Industry's Non-Proliferation Viewpoint

May 2006

Appendix 1
SECURITY OF THE INTERNATIONAL NUCLEAR FUEL CYCLE WG

Terms of Reference

The WNA Board agreed at its meeting on 12 April 2005 to establish a Working Group to monitor, report on developments, and guide WNA contributions to the evolving policy debate on the security of the international nuclear fuel cycle.

In establishing the Working Group, the Board took note of recent proposals, emanating primarily from the IAEA, aimed at enhancing nuclear security and strengthening the non-proliferation regime. These proposals relate to uranium enrichment, reprocessing of spent nuclear fuel, and storage and disposal of spent nuclear fuel. These proposals have potentially significant implications for the nuclear industry, both commercially and in terms of public perception.

It is in the interest of a sound public debate that the nuclear industry contribute its unique analysis and perspective, born of decades of operational experience. By assembling practical knowledge and expertise in this area, the WG can formulate, and guide the WNA in expressing, an industry viewpoint that brings valuable realism to the analysis of future public policy options.

The Security of the International Nuclear Fuel Cycle WG will:

- Monitor and assess developments within its remit.
- Seek to develop a coordinated industry view as to how nuclear security and non-proliferation objectives can best be implemented in a manner consistent with commercial realities in an expanding global industry.
- Make recommendations on actions that should be taken or facilitated by the WNA.

The Working Group will support and guide WNA engagement with the IAEA to ensure that the industry's analysis contributes effectively to the consideration of future policy options.

WG Membership

Pat Upson, Urenco Enrichment Co, *Chairman*
Reggie Bell, Westinghouse UAM
Clark Beyer, Rio Tinto Uranium
Jeff Combs, Ux Consulting Company
Malcolm Critchley, Westinghouse Electric Company
Jack Edlow, Edlow International
Ali Etemad, Vattenfall Braensle AB
Chaitanyamoy Ganguly, IAEA
James A. Glasgow, Moran Lewis
John Guselle, Cameco Corporation
Roger Howsley, BNFL
James A Israel, Itochu
Caroline Jorant, AREVA
Alexey Lebedev, Techsnabexport
John Luke, British Energy plc
Ruthanne Neely, Ux Consulting Company
Yuichiro Matsuo, Japan Nuclear Fuel Limited
Charles McCombie, Arius
Tariq Mehmood, Pakistan Atomic Energy Commission
Lawrence Mercier, AREVA NP
Arthur de Montalembert, AREVA
Naomi Ohno, Mitsui & Co
Gerard Pauluis, Synatom SA
Khalil Ahmed Qureshi, Pakistan Atomic Energy Commission
Sergei Ruchkin,Techsnabexport
Yoram Sadan, Israel Atomic Energy Commission
Robert Van Namen, USEC
Jussi Vihanta, Euratom Supply Agency

Irina Borysova, WNA Secretariat

Customer Perspectives Sub-Group
John Luke, British Energy plc, *Coordinator*
James A. Glasgow, Moran Lewis
John Guselle, Cameco Corporation
Walt Wolf, WOLFCO Inc
Jeff Combs, Ux Consulting Company
Melissa Mann, Ux Consulting Company
Lawrence Mercier, AREVA NP
Khalil Ahmed Qureshi, Pakistan Atomic Energy Commission
Gerard Pauluis, Synatom SA
Yoram Sadan, Israel Atomic Energy Commission
James A Israel, Itochu

Front-End Sub-Group
Robert Van Namen, USEC, *Coordinator*
Clark Beyer, Rio Tinto Uranium
Malcolm Critchley, Westinghouse Electric Company
Ali Etemad, Vattenfall Braensle AB
John Guselle, Cameco Corporation
Caroline Jorant, AREVA
Tariq Mehmood, Pakistan Atomic Energy Commission
Naomi Ohno, Mitsui & Co
Sergei Ruchkin, Techsnabexport
Yuichiro Matsuo, Japan Nuclear Fuel Limited

Back-End Sub-Group
Caroline Jorant, AREVA, *Coordinator*
Jack Edlow, Edlow International
Gerard Pauluis, Synatom SA
Alexey Lebedev, Tekhsnabexport
Roger Howsley, BNFL
Charles McCombie, Arius

Appendix 2
VIEWS OF THE CUSTOMER PERSPECTIVES SUB-GROUP

The Track Record

The uranics and nuclear fuel fabrication industries have historically maintained high standards of security of supply. Indeed, since the introduction of nuclear power there has never been a disruption to supply which has led to a loss of electricity generation. Moreover, nuclear fuel is easy to stockpile at licensed facilities, and there are many other mechanisms embodied in the market which promote security of supply.

The strength and flexibility of the existing supply system has been demonstrated in recent years by four major discontinuities: hex conversion supply disruptions, a fire at a major Australian producer's plant, a flood at a major mine in Canada, and adverse weather conditions which impacted on export of Russian supplies. All these have been resolved by the use of conventional market mechanisms.

Existing Measures to Promote Supply Security

It is well established practice that utilities maintain stocks of finished fuel and intermediate products down the manufacturing chain to natural uranium, while suppliers also maintain stockpiles to cover risks of supply disruption. Such stockpiling is facilitated by the low cost of nuclear fuel in relation to the costs of electricity generation and by the relatively small physical volumes involved.

Most utilities follow strategies that incorporate diversity of supply and rolling procurement programmes. These strategies emphasize working with suppliers with good credentials and a track record of high reliability. In addition, many supply contracts provide flexibilities that can be exercised in the event of supply disruptions.

Key Objectives of Any New Security of Supply Initiative

Any new arrangements should be based on the strengths of the existing arrangements that provide supply security and use international safeguards to prevent diversion of materials. Emergency arrangements should be deployed as a last resort and not as a substitute for market mechanisms. The need for such arrangements should be subject to periodic review.

New arrangements should be designed to minimize the impact on normal commercial mechanisms, and any stockpiles or guarantees established should not remove material from the normal supply process. Equally, such mechanisms should be used as a backup to existing supply, and not as a replacement. Finally, there should be no price discrimination against supplies from normal market mechanisms, i.e. the arrangements should not involve price subsidies. The use of material previously employed in the military cycle would minimize disruptions to conventional market mechanisms; former military HEU stocks would be a suitable vehicle for providing such assurance.

Access to New Security Arrangements

Criteria for the receipt of emergency supplies should be defined and formalized in advance. They should be triggered by a failure of normal commercial supply for an end user with a verified commitment to nuclear non-proliferation. The most likely reasons for supply disruptions will be political rather than technical, and control of emergency stockpiles should therefore be placed with an independent international body, presumably the IAEA. The mechanism for emergency stockpiles should be transparent and market-neutral.

Measures to Strengthen Public Confidence in the Existing International Safeguards Regime

There has never been a diversion of materials from nuclear reactors that are under IAEA safeguards, and the effectiveness of existing IAEA/Euratom safeguards regimes should be given higher public profile. Universal ratification of the Additional Protocol to traditional IAEA safeguards agreements would strengthen public confidence. A more clear-cut penalty system for non-compliance should be agreed internationally at an inter-governmental level.

Conclusions

- Full NPT compliance must be a prerequisite for access to supply.
- Existing market mechanisms have been proven to work well in dealing with supply disruptions.
- New approaches to addressing security issues should be consistent with continued successful operation of the competitive market.
- The criteria for access to the guarantee mechanism should be defined in advance.
- Emergency supply arrangements should be used as a last resort and not as a substitute for market supplies.
- The use of former weapons HEU would lessen the impact on the market.

Appendix 3
THE CONCEPT OF SECURITY OF ENRICHMENT SUPPLY

Introduction

To address concerns relating to security of supply, a guarantee of supply of enrichment services should be established through a joint commitment by existing uranium enrichment companies ("enrichers") in an IAEA-supported mechanism established by multilateral agreements.

This supply assurance concept would be a "guarantee-in-depth" analogous to defence-in-depth in reactor safety. It would consist of three layers of guarantees:

- Level I: Basic supply security provided by the existing world market
- Level II: Collective guarantees by enrichers supported by governmental and IAEA commitments
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The second level of guarantee (Level II) would be invoked in the event of a disruption of normal commercial supplies for bilateral political reasons between an enricher and a customer State.

Level III – Government EUP Stocks – would be used as a last resort in the unlikely event that enrichers could not meet their backup supply commitments as embodied in Level II.

A Multilateral Approach by Existing Enrichers to a Guarantee of Supply (Level II)

The guarantee mechanism must have a number of essential characteristics:

- To be eligibile, a customer State must have made a commitment to forego the development of, or the building or operation of, enrichment facilities.
- The IAEA must certify that the customer (and the host nation) are, and are expected to remain, in full compliance with international safeguards.
- The enrichers must be compensated for any cost of providing the Level II guarantee (e.g. dedication of inventory, construction of facilities, and actual supply necessary to fulfil this commitment).
- The basic commercial contract must have been suspended for political reasons not related to non-proliferation issues. Commercial issues or capacity planning problems at the supplier would not trigger the Level II guarantee.
- The mechanism must be market neutral and must not modify normal commercial market practices in enrichment. Contracts would continue to be negotiated on an individual and confidential basis, but would include a commonly agreed standard clause providing where it would apply (see below).

As stated above, the mechanism would apply in the case of a contract suspension for political reasons. The IAEA would intervene, following notification by the concerned enricher or customer. It would determine the customer's eligibility in light of its and its country's compliance with non-proliferation and safeguards obligations, certify that the events leading to the contract suspension had met pre-defined criteria for invoking the supply assurance, and then notify the other (remaining) enrichers that their commitment to implement the Level II backup supply had been triggered.

A standard backup supply clause would be included in the base commercial contracts between enrichers and customers eligible for such backup. To ensure that no single enricher is unfairly burdened with the responsibility of providing backup supply, the other (remaining) enrichers would then supply the contracted enrichment in equal shares under terms agreed between the IAEA and the enrichers.

To ensure proper execution of the supply guarantee, an international framework would be required:

- All IAEA members would be committed not to initiate commercial or financial retaliation measures against the interests of the enrichment suppliers if and when the IAEA had triggered the implementation of the Level II guaranteed supply.
- The IAEA would be assigned the responsibility to determine the eligibility of customers and to trigger implementation of the guarantee.
- Enrichment supplier countries should undertake a formal commitment to allow the export of enriched uranium to countries in compliance with the above commitments, if and when the IAEA had triggered the implementation of this Level II guaranteed supply.
- Enrichers would be compensated for any costs associated with providing the supply assurance.

Once agreed, the multilateral mechanism would be defined and formalized in an IAEA Information Circular (INFCIRC). Each enricher would agree to terms with the IAEA following confirmation from its home government that the backup arrangement is consistent with applicable laws and regulations.

Appendix 4
BACK-END MULTILATERAL NUCLEAR APPROACHES: THE INDUSTRY'S NON-PROLIFERATION VIEWPOINT

The imminent worldwide expansion of the civil nuclear industry can be expected to lead to an increasing number of States seeking assurances of supply in materials, services and technologies. In anticipation of this, different ideas have recently emerged as to how these demands could be met on a global scale while further reducing potential proliferation risks.

One such idea is that of Multilateral Nuclear Approaches, or MNAs, as presented in the IAEA's Expert Group report (INFCIRC/640) in February 2005. The options proposed therein fall into three general categories: assurances of services not involving facility ownership, conversion of existing national facilities to multinational facilities, and construction of new joint facilities.

The present text details the industry's position concerning the non-proliferation aspects of MNAs at the back-end of the fuel cycle; that is, reprocessing and recycling of spent fuel, and final waste disposal.

Reprocessing and recycling

As stated in INFCIRC/640, many of the existing reprocessing and recycling facilities are essentially State-owned, implying that any assurance of service from a supplier would be based on the implicit or explicit agreement of the corresponding government. A choice of suppliers of reprocessing services is also important to potential user countries. Current declared recycling strategies worldwide do not require the creation of new reprocessing facilities (national or multinational) for spent fuel from light water reactors in the short term. However, a State anticipating a significant expansion in its use of nuclear power in the near future may well choose a reprocessing-recycling strategy in order to ensure a sustainable long-term management of its resources, including the optimization of its ultimate waste management. Although it may be argued that under certain economic conditions a once-through fuel cycle is attractive, particularly if there are no plans for long-term nuclear development, a constant growth of uranium prices on the world market and a continuation of the current excess of demand over supply, as well as resource conservation arguments, could favour the choice of a closed cycle.

Reprocessing, MOX fuel fabrication, and recycling of MOX fuel in a reactor, performed in a timely manner with appropriate safeguards, can actually decrease the quality and quantity of plutonium and offer an upgrade of the spent fuel standard, while minimizing the risk of diversion of fissile material. A State that has entered into comprehensive safeguards agreements with the IAEA (in the case of non-nuclear weapon States), that wishes to pursue a reprocessing-recycling strategy, and that possesses a sufficiently large nuclear fleet, should thus not be prohibited from acquiring its own reprocessing and recycling facility. On the other hand, the spread of such technologies worldwide should be avoided in order to limit the risks of diversion of the technology for non-peaceful purposes. Therefore, countries already possessing these technologies and officially pursuing the strategy of a closed nuclear fuel cycle should offer their services in reprocessing and MOX-fuel fabrication to other States, giving them the opportunity to resolve the issue of spent fuel management and to transfer MOX fuel under appropriate safeguards. Should a State not wish to reuse its separated fissile materials as MOX fuel, the timely use of the MOX fuel by a utility in a third party with appropriate non-proliferation credentials should be encouraged. In the absence of such a possibility, the fissile material could be immobilized as final waste.

Final waste disposal

If, for a given State, spent fuel is considered as a final waste form to be disposed of, then the existence of regional or international repositories must be favoured from a global non-proliferation viewpoint in order to limit in the long-term the dissemination of "plutonium mines", and to reduce and optimize international safeguards resources.

On the other hand, waste immobilized via vitrification following reprocessing does not pose any risk of proliferation, although close control by the national authorities of the highly radioactive waste will still be necessary for security reasons. Since a repository for vitrified wastes does not require safeguards by the IAEA standards, it may be feasible to implement such a facility in any State possessing a suitable geological site and industrial facilities. The development of international waste repositories not requiring safeguards (i.e. specifically for vitrified HLW) could be an incentive for certain countries to choose reprocessing if associated services for waste disposal were offered. Such a system should allow the fuel user to make the choice of disposal destination.

Fuel leasing/take-back options

A leasing/take-back approach should also be envisaged for any country that uses or wishes to use nuclear power, but may not be in a position to implement safe and secure disposal. This approach could be employed on a wider basis once a final repository for ultimate waste exists on an international and non-discriminatory basis. While eventually there may be a few States prepared to host an international repository, this will probably prove politically feasible only after several of national repositories are fully operational.

In summary, the concerns and objectives of the industry in relation to multilateral approaches to the back-end of the fuel cycle are:

- To offer a range of viable solutions for the management of spent fuel and waste. Should a State choose to reprocess its spent fuel, a guarantee of access to reprocessing and waste management services should be secured, provided that the route foreseen for the subsequent management of the separated fissile material is appropriate from a non-proliferation viewpoint.
- To encourage States with already existing back-end facilities to service foreign regional customers (under long-term contracts or with appropriate capital shareholding) in order to avoid the spread of sensitive nuclear technologies worldwide. From the non-proliferation perspective, the establishment of multilateral nuclear fuel cycle centres operating full IAEA safeguards is a promising long-term approach.
- To encourage competition within a multilateral nuclear approach. If political or technical barriers prevent a State from disposing of its own final waste, a genuinely international and non-discriminatory solution should be available.
- To encourage national efforts and international collaboration on the research and development of advanced nuclear reactor and fuel cycle reprocessing technologies that further increase proliferation resistance (for instance, by not separating plutonium) and minimize the waste to be disposed of.
- To support pragmatic approaches. Promoting ideal but politically infeasible solutions may only postpone decisions that are needed to afford predictability in an industry where rapid and effective development is needed to meet human and environmental needs.

The World Nuclear Association is the international private-sector organization **supporting the people, technology, and enterprises** that comprise the global nuclear energy industry.

WNA members include the full range of enterprises involved in producing nuclear power – from uranium miners to equipment suppliers to generators of electricity.

With a secretariat headquartered in London, the **WNA serves as a global forum** for industry experts and as an authoritative information resource on nuclear energy worldwide.

World Nuclear Association

Carlton House • 22a St. James's Square • London SW1Y 4JH • UK

tel: +44(0)20 7451 1520 • fax: +44(0)20 7839 1501

www.world-nuclear.org • info@world-nuclear.org