WORLD NUCLEAR ASSOCIATION

Swaps in the International Nuclear Fuel Market

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Executive Summary

Trade in nuclear fuel materials and services takes place between producers and consumers spread across a range of countries worldwide. To carry out such trade efficiently often requires that quantities of nuclear materials are exchanged, or 'swapped'. This avoids the need to transport materials from place to place as they go through the various processing stages in the nuclear fuel cycle.

The trade in nuclear materials is subject to government restrictions and controls; some of these are designed to ensure non-proliferation of nuclear materials, while others are intended to achieve political, economic or strategic objectives. These restrictions are usually contained in bilateral agreements between the major countries involved in nuclear trade, resulting in a complex web of requirements and restrictions. Thus, another reason for swapping nuclear materials is to simplify the administration of fuel management by avoiding quantities of fuel becoming subject to the requirements of several different bilateral agreements.

Although simple in principle, swaps of nuclear material can be complicated by the various physical and legal characteristics of the nuclear fuel, including the isotopic composition, location, mining and customs origins, safeguards obligations, ownership, *etc*. There are also several different types of swap, depending on which of these characteristics is to be exchanged; these include ownership swaps, obligation swaps, location swaps and swaps between different forms of uranium.

This report describes the purpose and the operation of the various types of swap transaction, and the government restrictions and controls which affect them. It finds that some of the potential benefits of swaps (particularly obligation swaps) are not being achieved, due to sometimes cumbersome and unpredictable consent procedures. The ability to carry out such swaps more easily would in no way weaken the international non-proliferation regime, but would allow improved efficiency in nuclear fuel management.

1 Introduction

Exchanges of nuclear materials, or 'swaps' as they are normally referred to in the industry, are transactions carried out frequently in nuclear fuel management in the context of an international market. In most cases, exchanging nuclear materials avoids the need to physically transfer them from one location to another, allowing market participants to meet their processing and utilisation needs while reducing transportation costs and saving time. In addition, safety is improved by eliminating transportation risks, minimal though they may be. The administration of nuclear material controls is also simplified.

This report describes the specific characteristics of nuclear fuel and the trade in nuclear materials, and explains how the need for swaps arises from a conjunction of two factors: the requirements that governments have placed on wide aspects of nuclear trade, and the operational needs of utilities as they evolve according to the demands of reactor operation and the complex nature of the fuel cycle. As a result of these constraints, utilities frequently need to adjust the composition of their fuel holdings.

In the 1980s, the issues affecting swaps were essentially dictated by political and non-proliferation concerns. Political changes which have taken place in some regions since that time have served to reduce these concerns in many cases. However, since the early 1990s, the swapping of nuclear materials of certain origins[1] has been curtailed by import restrictions introduced by the European Union (EU) and the USA.

Some parties with large inventories have been prepared to loan part of their nuclear material against the payment of interest based on its market value. Such transactions have frequently been associated with swaps and other transactions (*e.g.* the material returned has different characteristics to the material loaned), and therefore they have been subjected to the same restrictions.

Swaps are often combined with other transactions; for example, if a utility swaps natural uranium concentrate for enriched uranium, the transaction comprises a swap together with a purchase of enrichment and conversion.

It should be noted that for many swaps, the same result could be achieved by a matching pair of buy and sell transactions between the two parties, plus in some cases transportation of the materials. The advantages of swaps are that they are administratively simpler, and avoid the need for transportation.

[1] Currently this only applies to material with Russian origin.

2 Specific Aspects of Nuclear Fuel Trade

Three aspects of trade in nuclear material are particularly relevant in the context of swaps. The first is that although both production and consumption are widely distributed internationally, the flow of material is concentrated by processing in a relatively small number of countries. Conversion services are available at plants in five countries (Canada, China, France, Russia, USA), and commercial enrichment services are provided at plants in seven countries (China, England, France, Germany, Netherlands, Russia, USA). Fabrication, however, is more widely distributed, with local plants in many nuclear generating nations.

Secondly, uranium is a fungible commodity, *i.e.* one quantity may be replaced by another meeting the same definition or specification. This fungibility aspect applies to both U_3O_8 and natural UF_6. That is, all U_3O_8 is fungible with all other U_3O_8 and all natural UF_6 is fungible with all other natural UF_6, providing of course that the materials all meet the relevant ASTM specifications.

Thirdly, material supplied to conversion, enrichment and reprocessing plants is not separately tracked through the facility. Batches of material supplied by different owners are co-mingled inside the plant before processing, according to operational demands. An equivalent amount of the plant's output is then allocated to particular customers on an accounting (bookkeeping) basis, not according to the actual material supplied. This is analogous to a bank account, where bank notes and coins paid out to a customer making a withdrawal are not physically the same as those previously deposited by the same customer.

3 Nuclear Fuel Characteristics

The following characteristics of nuclear fuel are relevant to its trading and, in particular, to the restrictions imposed on swaps:

- Physical/chemical form.
- Isotopic composition.
- Physical location.
- Time at which the material was contracted or held.
- Mining origin of U_3O_8.
- Origin of the enrichment (for enriched uranium products).
- Place of production or major transformation (*i.e.* conversion, enrichment, fabrication or reprocessing).
- Customs origin.
- Safeguards obligations.
- Title of ownership.

3.1 Uranium Origin

Two separate origin concepts must be distinguished: *mining* (or geographic) origin, and *customs* origin. The mining or geographic origin is simply defined as the country where the uranium oxide (normally U_3O_8) was originally mined and milled.

Customs origin is determined by the legal customs authorities in a particular jurisdiction, taking into account the place of mining and milling, and any place of substantial transformation; it is used to implement government requirements. Rules of customs origin, in accordance with strict regulations, vary between countries. The determining factor is normally the extent of processing in a third country. The origin of the enrichment component, in the case of enriched uranium, has also been an issue, particularly in relation to Russian enrichment and the enrichment in the EU of natural uranium originating in Russia and in various other countries of the former Soviet Union.

To take an example, if U_3O_8 which was mined and milled in Namibia is converted to UF_6 in France, it may be considered French-origin UF_6 for customs purposes. However, some countries, such as Canada, do not recognize conversion as a substantial transformation, and will consider this material as Namibian origin for customs purposes. If the material is subsequently enriched in the UK, it becomes UK-origin enriched uranium product for the purposes of customs origin.

In general, enrichment is considered a substantial transformation. Annex 2 gives the rules of customs origin of some of the major governmental authorities. It should be noted that a change in customs origin does not result in a change in mining origin, which is usually trade restricted or banned.

3.2 Safeguards Obligations

Safeguards obligations on nuclear material are conditions on the use of the material assumed by importing governments in accordance with the requirements of the governments of supplying countries, under the terms of intergovernmental nuclear co-operation agreements or understandings. They are not part of the international safeguards system and the IAEA is not involved in their enforcement, nor in procedures for possible obligation swaps.

Obligations can be thought of as ‘flags’ attached to the nuclear material indicating the governments whose conditions are imposed on the material. As material crosses national barriers on its path through the fuel cycle, it can collect a series of cumulative obligations which are the concern solely of the relevant governments, and of the Euratom authorities in the EU.

One aspect of obligations, which should be emphasised in view of confusion which has been reported outside the industry, is that the origin of the material (mining or customs) is not determined by the obligations pertaining to the fuel. It follows that exchanges of obligations between quantities of nuclear fuel do not imply the exchange of origin. Indeed, rules of customs origin are such that exchanges of origin between quantities of nuclear fuel are not possible in general. However, referring to Section 5.4, the equivalent of an origin swap can be achieved by an ownership swap followed by an obligation swap if the materials are at the same location.

It should be noted that the importance of the origin (mining or customs) and safeguards obligations characteristics is directly related to the existence of government requirements. If there were no trade restrictions and there was a universally-agreed safeguards and non-proliferation regime, then these characteristics would have little relevance except for utilities enforcing a specific origin diversification procurement policy.

3.3 Other Characteristics

The physical characteristics of nuclear fuel are straightforward. Uranium in the nuclear fuel cycle can exist in various physical/chemical forms: natural U_3O_8, natural UF_6, enriched UF_6, UO_2 or uranium metal, fuel assemblies, spent fuel, or reprocessed uranium. The principles of equivalence and proportionality[2] allow comparison of quantities of uranium in different forms.

The isotopic composition (or enrichment assay in the case of enriched uranium) determines the material category relevant to safeguards, *i.e.* depleted uranium, natural uranium, low enriched uranium and high enriched uranium[3]. Stocks can be held at various locations: at mines/mills, converters, enrichers, fabricators, nuclear power plants, or reprocessing plants. From a safeguards standpoint, once uranium has reached the UF_6 stage, material balance areas (MBAs) are the relevant points of location. Within an MBA, material is fully fungible, and thus the question of swaps is not relevant. The time at which the material was contracted or held is relevant for the application of certain regimes or legislation; if a contract pre-dates the introduction of particular regulations it may be exempt from complying with them (this is referred to as 'grandfathering').

[2] In accordance with the principle of equivalence, when batches of material lose their identity through processing, equivalent quantities of material are regarded as being subject to particular obligations on an accounting basis. The proportionality principle allows safeguards obligations to be allocated on the basis of the mass of the isotope of significance (normally U-235 in the case of uranium).

[3] Depleted uranium has a U-235 content less than 0.711%. Natural uranium contains 0.711% U-235. Low enriched uranium (LEU) has a U-235 content between 0.711% and 20% (with two categories being considered in some cases: 0.711% to 5%, and 5% to 20%). High enriched uranium (HEU) has a U-235 content greater than 20%.

4 The Need for Swaps and Loans

In utilities' attempts to optimise their total fuel costs they have to take into account not only operational factors but also the various governmental and commercial constraints throughout the fuel cycle. As reactor performance and burn-up vary, so in turn does the demand for fresh fuel, fabrication, enrichment, conversion and natural uranium. These variations in demand have implications in terms of desired fuel characteristics, not only for form, location and time but also for obligations.

This can be better illustrated through examples.

Example 1: Utility A has deliveries of its natural uranium at an EU converter and an enrichment contract with a US enricher while utility B has a contract for natural uranium with a north American converter but enrichment contracts in the EU. By swapping the ownership of the natural uranium, utilities A and B avoid the transatlantic transportation of the natural uranium to serve the enrichment contracts.

Example 2: A utility does not have enough uranium to fabricate a batch of fuel assemblies with the same safeguards obligation. In order to avoid the administrative burden of having to account for fuel assemblies with different types of obligations within the same reactor reload, the utility exchanges the obligations with other participants in the fuel cycle in order to achieve uniformity. This is also important for reprocessing as reprocessors request that fuel bundles delivered should contain material subject to only one set of obligations.

Example 3: A utility which built up considerable inventories of uranium in different forms for which it has to pay storage charges, loans the material to a trader or a fabricator which may require a working stock (for example, to provide for fabrication losses while scrapped material is being recovered). The utility receives the payment of interest based on the market value of the material and avoids storage and other insurance charges.

It should be noted that the need for obligation swaps (as opposed to other types of swaps), which also exists for all other market participants such as traders or intermediaries, results from different safeguards obligations being imposed by the governments of producer countries and the countries where the material was transformed, or where it was simply stored or in transit. If these differences did not exist the need for obligation swaps would not arise.

5 Types of Swaps and Loans

The following types of swaps are relevant to nuclear trade. The transactions are normally carried out without physical movement of the materials unless otherwise stated.

5.1 Ownership Swaps

An ownership swap (or title swap) is a mutual change of ownership of two quantities of nuclear material, with all other characteristics of the material remaining unchanged (see Figure 1). It is also strictly equivalent to two matching buy and sell transactions (party A acquires the material belonging to B and party B acquires the material belonging to A). The ownership swap is typically accomplished through a book transfer between the accounts of the parties at the facility or facilities where the material is located.

	Party 1	Party 2
Before	Location A Origin X Obligation K	Location B Origin Y Obligation L
After	Location B Origin Y Obligation L	Location A Origin X Obligation K

Figure 1. An ownership swap, which is equivalent to two matching buy and sell transactions.

The motivation for this type of transaction is to acquire material at a different location (see Example 1 in Section 4) and/or to obtain material of different origin and/or obligation. Depending on the exact circumstances, fees may or may not be charged.

Normally ownership swaps involve material of the same chemical form and category[4] but other types are also possible:

- UF_6 for U_3O_8 resulting in purchase of the conversion component of the material by the party receiving the UF_6.
- Enriched uranium for U_3O_8 or natural UF_6 (feed component) resulting in the purchase of the enrichment component (and conversion component in the case of exchange against U_3O_8) by the party receiving the enriched uranium.

Within the EU, the Euratom Supply Agency (ESA) has an exclusive right to conclude contracts for ownership swaps entered between one EU end-user and a third party in accordance with Article 52 of the Euratom Treaty.

5.2 Obligation Swaps

5.2.1 Internal Obligation Swaps

An internal obligation swap (also known as 'internal swap of safeguards obligations', 'domestic obligation exchange', 'flag swap', 'code swap'[5] or 'substitution') is defined as an exchange of obligations between quantities of material located at two different safeguards material balance areas[6] (MBAs) in the same country or jurisdiction (under the Euratom Treaty, the European Union (EU) is a single jurisdiction for nuclear material). The ownership, origin and physical location of the materials remain unchanged (see Figure 2).

	Party 1	Party 2
Before	Location A Origin X Obligation K	Location B Origin Y Obligation L
After	Location A Origin X Obligation L	Location B Origin Y Obligation K

Figure 2. An obligation swap; in an internal obligation swap the materials are located within the same country or jurisdiction, while in an international obligation swap the materials are in different jurisdictions.

Internal obligation swaps are frequent transactions, although they may require approval on a case-by-case basis. In general, swaps of nuclear material of identical quantity, chemical form and isotopic composition present no problem. In other cases they are subjected to the principle that swaps may not result in a degradation of the non-proliferation regime.

Such swaps of course require the permission of the authority responsible

[4] In the case of enriched uranium of different isotopic compositions (assays), comparisons of the batches of materials to be exchanged are made on the basis of the natural uranium feed component and the separative work (enrichment) component.

[5] The 'code swap' designation is used within Euratom where obligations are associated with particular letters or 'codes'.

[6] Within a single MBA material is fully fungible, provided that the materials are in the same category and that the enrichments are within certain limits.

for the tracking of material to which the obligations apply, which is usually the national government or Euratom. Whether they also require the permission of the governments whose obligations are attached to the material depends on the terms of the agreement creating such obligations and the respective administrative arrangements. In practice, the three countries imposing the important obligations in nuclear trade, the USA, Canada, and Australia, have in the terms of their bilateral co-operation agreements given permission for internal obligation swaps in the USA and the EU.

In the United States, there is no published procedure for obligation swaps; however it is understood that no advance approval is needed for domestic obligation exchanges concerning natural uranium or enriched uranium of identical enrichment. In such cases, obligation exchanges are reported routinely to the Nuclear Regulatory Commission (NRC) after completion. However, obligation exchanges involving different enrichments require advance approval by the NRC.

In the EU, an obligation swap performed within a material balance area does not require prior consent from the ESA. An obligation swap performed between two material balance areas needs a prior approval from the ESA. The ESA then will liaise with the Euratom Safeguards Directorate in Luxembourg.

5.2.2 International Obligation Swaps

An international obligation swap (also known as 'international exchange of safeguards obligations' or 'international flag swap') is defined as an exchange of obligations between equivalent quantities of material located in different countries or jurisdictions. The ownership and physical location of the materials remain unchanged (see Figure 2).

Although this kind of exchange does not involve physical movement of material, it requires prior consent by the safeguards authorities for both locations. Prior consent is also required from the countries to which the material is obligated.

International obligation swaps are very rare transactions. Among suppliers, Australia[7], Canada and the USA are prepared to give consent for international obligation swaps only after prior review on a case-by-case basis. However, the stated US criteria are very general and open to interpretation, most notably that the swap should not "facilitate a transaction of proliferation concern"; Canada follows a similar policy. Euratom procedures also require prior case-by-case consent.

International obligation swaps require a lengthy procedure; probably due to this fact, together with the lack of experience and the perceived uncertainty, few such swaps have ever been requested. As a result of the lack of demand for such transactions, the authorities in suppliers' countries have not made efforts to streamline the procedures.

Annex 3 sets out more fully for both internal and international swaps the complex requirements and criteria applied by the major governments involved. Once all necessary permissions to effect a swap have been obtained, then execution takes place simply by notifying the authorities that the swap has taken place in order that the obligation accounting records may be revised accordingly.

5.3 Location Swaps

A location swap is a combination of an ownership swap and an obligation swap concerning two batches of material of identical physical characteristics and origin. The origin and the physical location of the material remain unchanged (see Figure 3). The relevant safeguards authorities must be informed of the transaction; in the case of Euratom, the Euratom Supply Agency (ESA) must also give its approval.

[7] Australia has revised its position of not permitting any international swaps involving Australian obligated material, and has agreed that such swaps may take place under certain conditions.

	Party 1	Party 2
Before	Location A Origin X Obligation K	Location B Origin X Obligation L
After	Location B Origin X Obligation K	Location A Origin X Obligation L

Figure 3. A location swap, which is a combination of an ownership swap and an obligation swap with materials of the same origin.

5.4 Origin Swaps

In general the relevant authorities do not permit origin swaps (*i.e.* where the ownership, the safeguards obligation and physical location of the materials remain unchanged). These include swapping the mining origin of natural uranium, and swapping the origin of the uranium feed and/or the enrichment components of enriched uranium product. However, it is possible to achieve the equivalent of an origin swap by an ownership swap followed by an obligation swap, if the materials are at the same location; otherwise transportation of the materials is required to reverse their location. As mentioned before, obligation swaps do not change the mining or customs origin of the materials.

5.5 Loans and Loan-Exchanges

A loan is defined as a transaction whereby the owner of the material transfers the ownership and/or the right of use and consumption of the material to another party, and later receives an equivalent amount of material with the same characteristics. A loan achieves essentially the same effect as a sale and future buy-back transaction between the same parties. Normally there is an economic benefit to the owner derived from the party which uses the material during the period of the loan.

Loans can be used to reconcile the time characteristic of fuel holdings. Loans of excess inventories permit the adjustment of the time characteristic (*i.e.* time of delivery/utilisation of the material), reducing the storage, financing and insurance costs.

A loan-exchange is defined as a loan where the material subsequently returned to the owner has different characteristics to the material loaned. The difference between a loan-exchange and an ownership swap is the time between the transfer of the material by party A to party B and the return of the material by party B to party A. Normally the parallel transactions in a swap are almost simultaneous, while in a loan-exchange they may be separated by months or years. However, there is no clear cut distinction based on the time between transactions.

6 Government Requirements and Policies

6.1 Non-Proliferation and Safeguards Obligations

Governments impose requirements on nuclear trade for a number of reasons, the first of which is non-proliferation. Proliferation-related requirements are of three types: those imposed through the international safeguards system operated by the International Atomic Energy Agency (IAEA) and Euratom; those required as conditions of intergovernmental nuclear co-operation agreements (‘bilaterals’); and those required by governments as part of their national nuclear accounting systems. The requirements in bilaterals are the important ones in consideration of swaps.

The international safeguards operated by the IAEA and complemented by NRC and National Nuclear Security Administration (NNSA) safeguards in the USA and Euratom safeguards in EU countries are designed to prevent against proliferation by providing timely notification of diversion of nuclear material. They are implemented through three procedures: ‘material accounting’ of inventories and movements of nuclear material; ‘containment and surveillance’ of facilities to restrict or control access to nuclear material; and ‘inspection’ to verify the validity of information held by the safeguards authorities. The nuclear fuel industry has always given and continues to give its full support to the international safeguards system. Also, it of course co-operates fully with all national regulatory authorities.

A number of supplier nations have imposed, through intergovernmental nuclear co-operation agreements, additional requirements beyond those in the international safeguards system. Among suppliers of uranium and fuel cycle services, these additional requirements are imposed in particular by Australia, Canada, and the United States; in addition, under the Canada-Euratom and US-Euratom Agreements, Euratom may also impose its own obligations on the nuclear materials it exports to those countries. The individual bilateral agreements incorporate the actual requirements, which vary significantly. Annex 1 summarises the features of the agreements of the major nuclear suppliers.

Some supplier nations have required case-by-case prior consent for the use of fuel or material supplied by them, particularly as regards reprocessing. However, in general, ‘programmatic approval’ has been given for reprocessing in the EU. Some exporting nations have also imposed the requirement for prior consent either on permanent or temporary re-transfers (*e.g.* for further processing). The delays and problems in re-transferring fuel can cause considerable difficulty for utilities in the planning of fuel cycle activities. This situation has been significantly improved in the current US-Euratom Agreement, but there is still room for further improvement.

Some utilities regard it as unacceptable to have supplier nations making judgements on their fuel policy, and as a result will, as far as possible, avoid the use of material subject to bilateral obligations.

The USA and Russia signed a bilateral agreement in May 2008 permitting exports of US nuclear material and equipment to Russia. In the USA also, the 1992 Russian Suspension Agreement (RSA) was amended in 2008 to allow for the direct sale of a limited quantity of Russian enriched uranium product (EUP) to US utilities through 2020 when the RSA expires and Russian-origin uranium products and services can be sold into the USA without any restrictions. The amendment was codified into law via the 2008 Domenici Amendment.

Bilateral agreements can hinder normal nuclear trade by imposing requirements on operators which divert management time, reduce flexibility and increase uncertainty. The international and complex nature of the fuel cycle can lead to 'multiple labelling', where a quantity of fuel becomes subject to the jurisdiction of several bilaterals; as requirements are loaded on top of other requirements, the associated costs mount in a similar way. In response, utilities structure their fuel portfolios so as to reduce the burden of bilateral agreements – but at the cost of following a less than optimal procurement strategy.

6.2 Political, Economic and Strategic Policies

Nuclear trade is also subject to other governmental requirements, from time to time, for political, economic or strategic reasons.

For example, in the early 1990s, large quantities of natural uranium and enrichment services originating in Russia and some of the former Soviet Union countries became available in international markets at relatively low prices. In response, restrictive measures were introduced in the EU and the USA to limit the market access of this uranium and enrichment. In the EU these took the form of 'reasonable limitations' (sometimes referred to as 'entitlements' or 'informal quotas'), while in the USA they were in the form of anti-dumping determinations and suspension agreements. The imposition of these restrictions has limited significantly the trading of nuclear materials of certain origins. As noted in Section 6.1, the Russian Suspension Agreement (RSA) was put into place in 1992 that essentially eliminated any direct sales of Russian-origin uranium or enrichment into the USA. The amendment to the RSA in 2008 allows for direct sales of Russian-origin EUP into the USA from 2008-2020 at about 20% of the US market. In 2020, the RSA expires and Russian-origin uranium products and services can be sold into the USA without any restrictions.

The ESA treats Russian origin uranium acquired as a result of swaps for consumption by utilities in the EU in the same way as direct purchases of Russian-origin material; thus, swap transactions are subject to the same 'reasonable limitations' as purchase contracts. In the USA, anti-circumvention measures taken in the context of the anti-dumping investigation and subsequent determination and suspension agreements, prevent indirect imports of Russian material following swaps with other origins[8].

[8] The Russian Suspension Agreement (RSA) was promulgated in 1992. It suspended the antidumping investigation being conducted by the US Department of Commerce on uranium products from Russia and a number of newly independent states. The RSA was amended in 2008 to allow Russia to sell a certain quota of EUP directly into the USA. The RSA expires in 2020. Under a US suspension agreement, exchanges of materials through swap type procedures are considered to be circumvention of the agreement and are not allowed.

7 Conclusion

The above description of the purpose and workings of swaps and loans makes it clear that they can be beneficial transactions for both industry and society. However, current government procedures relating in particular to obligation swaps are such that some of the potential benefits are not being realised.

Obligation swaps are carried out to fulfil a real industrial need, not to circumvent non-proliferation requirements. They can be described as a method of reconciling the actual and desired characteristics of a utility's fuel inventory, at the lowest cost to industry and with the smallest demands on the safeguards system. The effectiveness of non-proliferation controls is not diminished by obligation swaps; an equivalent amount of nuclear material remains obligated to supplier countries after a swap has taken place. Obligations are transferred between quantities of material, not reduced.

The World Nuclear Association has in a number of publications stated that the ideal regime governing international nuclear trade would be a single international set of agreed non-proliferation and safeguards rules. However, absence of the consensus among governments necessary to attain such a regime means that the network of bilaterals remains a major factor affecting nuclear trade.

One effect of over-restrictive obligations imposed by some bilaterals is that some users will avoid procuring material subject to those obligations, as they are not prepared to accept the administrative burden and the unpredictable limitations on the circulation and use of the materials. This can serve to distort the normal workings of the market, causing utilities to adopt less than optimal fuel procurement policies.

The governments of the United States, Canada and Australia, and the Euratom authorities, all require that potential international obligation swap transactions be subject to prior consent on a case-by-case basis. The need to obtain case-by-case consent makes fuel management planning difficult for utilities. The nuclear fuel industry cannot operate efficiently under a case-by-case consent regime; many possible swap transactions have not been conducted because utilities were not prepared to arrange them without knowing whether or when consent was likely to be forthcoming. Improving the consent process for swaps would be to the advantage of the industry, governments and the public, by reducing the burden that bilaterals place on fuel users' operations, while maintaining the same amount of material subject to specific obligations.

The nuclear fuel industry recognizes and shares governments' concern for non-proliferation objectives. However, this concern should not prevent industry from undertaking swap transactions which do not threaten non-proliferation objectives. The way to achieve this is for clearer rules to be established as to the basis on which consent for swaps would be granted or denied. With a more consistent and predictable consent process, the industry would be able to make wider use of swaps.

It is for governments to formulate the guidelines to be used for approving swap proposals. However, certain criteria can be suggested as both responding to legitimate proliferation concerns and likely to result in the increased use of swaps by the industry. One such criterion, similar to one currently used in the EU, is that obligation swaps would not be approved if they decreased the quantity or quality of material subject to the most restrictive obligations.

A second criterion of general applicability is that consent should automatically be given for swap transactions where exactly the same result could be achieved by other means acceptable to the competent authority, *e.g.* by a combination of ownership exchange and transport. This criterion makes obvious sense; where the only difference between two routes is the cost of transport and physical protection, no non-proliferation purpose can be served by disallowing the preferable route of achieving the result by a swap.

Annex 1 | Principal Requirements of Supplier Countries

This annex summarises the principal requirements imposed through bilateral agreements of the major supplier nations.

Australia

Australia's policy is implemented through bilateral agreements with countries wishing to import Australian U_3O_8. The obligations on importers are essentially the same in each case, although the precise drafting varies from agreement to agreement. Each agreement expressly forbids the use of Australian nuclear material for the development or the manufacture of nuclear weapons or other nuclear explosive devices, and for other military uses (including naval propulsion).

Each agreement requires that Australian-obligated nuclear material must be covered by IAEA safeguards while within the jurisdiction of a bilateral partner, whether for use in a reactor or for processing. For a non-nuclear weapons state, these must be full-scope safeguards and an Additional Protocol to that country's safeguards agreement with IAEA; for a nuclear weapons state, the material must be covered by safeguards pursuant to the 'voluntary offer' made by that state.

Provision is made in each bilateral agreement for the introduction of fall back safeguards should the present IAEA safeguards arrangements cease to exist.

Each bilateral partner is obliged to seek prior Australian consent for reprocessing of spent fuel containing Australian-obligated nuclear material, for re-transfer of material to a third party, and for enrichment of uranium beyond 20% U-235.

Subject to rules of proportionality, nuclear material produced using Australian material also carries an Australian obligation. In the case of Switzerland, Euratom and Japan, a programmatic approach has been adopted regarding the prior consent provisions for reprocessing and any necessary re-transfers. The programmatic approach requires that reprocessing must be either for energy use (*i.e.* recycling) or for the proper management of materials contained in the spent fuel, and that the storage and use of any recovered plutonium must be under IAEA safeguards and take place within the nuclear fuel cycle programme delineated in the bilateral agreement.

Each bilateral agreement obliges the recipient country to provide adequate physical protection in accordance with internationally recognized standards.

In the event of non-compliance with the stipulated conditions by a recipient country, each bilateral agreement provides for the suspension or cancellation of further transfers of Australian-origin nuclear material. Similar provisions exist where a recipient country has failed to comply with its IAEA safeguards obligations.

Canada

Canada's bilateral agreements require an assurance that nuclear material, equipment and technology supplied will not be used for any nuclear explosive purpose.

Canada requires that material under Canadian obligation be exported under IAEA safeguards, for a non-weapon state full-scope safeguards and for a weapon state safeguards pursuant to the 'voluntary offer' made by that state. Provision is also made in each of Canada's bilaterals for the implementation of fall back safeguards in the event the above safeguards arrangements cease to be carried out.

The country's nuclear partners are required to undertake to ensure minimum levels of physical protection.

Canada requires prior consent over the retransfer of items supplied, over the reprocessing of spent fuel and the subsequent storage and use of the separated plutonium and over enrichment to 20% U-235 or more. These requirements are also applied to items derived from those directly supplied and thus specifically apply to nuclear material produced as a result of the use of Canadian obligated items.

Canada has signed an agreement with Euratom facilitating the application of Canada's prior consent right over transfers, and is seeking to reach similar agreements with other partners. Canada has reached agreement with Euratom and with Japan on a programmatic approach to the application of its prior consent right over the reprocessing of spent fuel.

Canada's requirements on uranium exports do not apply to material imported into Canada for toll conversion and re-export. Thus conversion in Canada does not of itself add Canadian obligations.

United States

US policy is that nuclear materials can only be exported with a licence to countries which have a nuclear co-operation agreement with the USA. The criteria for granting an export licence for source and special nuclear material are as follows:

- Export of source material may be approved under an agreement for co-operation or upon a determination by the US Department of Energy (DoE) that such activity will not be inimical to the interest of the USA.
- Export of special nuclear material (SNM), except for Pu-238 and quantities exempted under the Atomic Energy Act, must be under an agreement for co-operation and a determination made by the Executive Branch that such activity would not be inimical to the common defence and security.
- IAEA safeguards must apply to past and currently exported materials and to any SNM produced through the use thereof.
- Export of SNM produced must not be for use in a nuclear explosive device or for research on or development of a nuclear explosive device.
- Adequate physical security measures must be maintained on materials.
- Prior US consent is required for all reprocessing, enrichment and alteration, as well as for all re-transfers of source or SNM exported or produced through the use thereof. The third party also must agree to original export criteria, and in the retransfer of SNM, an agreement for co-operation between the USA and the third party must exist.
- Exports to non-nuclear-weapon states require IAEA safeguards over all their peaceful nuclear activities ('full-scope' safeguards).

Consideration is also given as to whether consent would materially advance US non-proliferation policy, or whether disapproval would be seriously prejudicial to US non-proliferation objectives.

The terms of the 1995 US-Euratom agreement, which entered into force in April 1996 and which expires in April 2026, give generic consent for reprocessing within Euratom and re-transfers of materials to most of the major trading partners of the USA and the EU. Re-transfers to other countries not included in the agreed list require case-by-case prior consent. The US-Japan agreement gives Japan generic consent for an agreed programme of transfers and reprocessing.

US policy is that toll conversion, enrichment and fabrication bring material under the terms of the relevant bilateral nuclear co-operation agreement.

Russia

Export of nuclear materials from Russia is possible only under an export licence issued by Federal Service for Technical and Export Control (FSTEC), which is assisted by Russian intelligence, security and other state authorities.

To obtain the licence for export to a non-nuclear-weapon state, the exporter has to provide to FSTEC assurances from the authorized governmental agency of the recipient country that the received nuclear materials:

- Will not be used for production of nuclear weapons and other nuclear explosive devices or for any military purpose.
- Will be subject to the IAEA safeguards.
- Will be physically protected in accordance with the IAEA requirements.
- Will be re-exported or transferred beyond the jurisdiction of the recipient country to any other country only on the aforementioned conditions.

Assurances can be provided to FSTEC on an ad-hoc basis or by reference to the respective provisions of a bilateral (usually nuclear cooperation) agreement between Russia and the recipient country.

Nuclear export to a non-nuclear-weapon state not having a comprehensive safeguards agreement with the IAEA can be effected if:

- It is contemplated by a specific decision of the Russian government.
- It complies with Russia's international obligations.
- Assurances from the government of the recipient state that nuclear materials will not be used in a way that might lead to construction of a nuclear explosive device are received.
- Such nuclear materials will be used exclusively for safe operation of existing nuclear installations that are subject to the IAEA safeguards.

Russian exporters which obtained licences are obliged to immediately inform FSTEC of any infringements of assurances.

Additionally, a commercial contract of the Russian exporter with any foreign party for transfer of nuclear materials should have a specific provision that requires the foreign party not to use these materials for construction of any weapon of mass destruction or its delivery system.

Other Nuclear Suppliers

Other nuclear suppliers generally supply under the terms of the Non-Proliferation Treaty (NPT) and the Nuclear Suppliers Group (NSG)[9] guidelines for transfers of nuclear materials with the materials subject to assurances of peaceful use and application of IAEA safeguards.

[9] The Nuclear Suppliers Group is a group of nuclear supplier countries that seeks to contribute to the nonproliferation of nuclear weapons through the implementation of two sets of Guidelines for nuclear exports and nuclear-related exports. The NSG first met in November 1975 in London, and is thus popularly referred to as the 'London Club' (*Club de Londres*). The first set of NSG Guidelines governs the export of items that are especially designed or prepared for nuclear use. These include: (i) nuclear material; (ii) nuclear reactors and equipment; (iii) non-nuclear material for reactors; (iv) plant and equipment for the reprocessing, enrichment, and conversion of nuclear material and for fuel fabrication and heavy water production; and (v) technology associated with each of the above items. The second set of NSG guidelines governs the export of nuclear-related dual-use items and technologies (items that have both nuclear and non-nuclear applications), which could make a significant contribution to an unsafeguarded nuclear fuel cycle or nuclear explosive activity. (Source: Nuclear Threat Initiative).

Annex 2 Rules of Customs Origin

United States

Under US Customs Service regulations, absent a statutory exemption every imported article of foreign origin must bear a conspicuous mark of origin. The Customs Service defines this as the country which manufactures, produces or grows the article. Further work or material added to an article in another country must effect a 'substantial transformation' in order to render such country the country of origin.

There is no litmus test for 'substantial transformation'; each case is decided on the facts. The Customs Service and the courts have traditionally used a three-part test: whether the transformation process produces an article with: i) a distinctive name, ii) character, or iii) use, different from the original article.

In 1986, the US Treasury Department has ruled that UF_6 is a 'substantially transformed' product and has been supported in this by the NRC. The question of enrichment and fabrication has not been addressed, but it appears likely that these would also be regarded as substantial transformations.

Thus for U_3O_8 imported into the USA, the customs origin is the same as the geographic origin. For UF_6, the customs origin is the country where the uranium was converted.

Canada

Canada does not recognize conversion to UF_6 as constituting a substantial transformation; it regards enrichment as the first stage at which transformation takes place. Thus for both U_3O_8 and possible imports of UF_6 into Canada, the customs origin is the geographic origin, the country where the uranium was mined and milled. For enriched and fabricated material, the country of origin is the country where these processes take place.

European Union

The EU recognizes the principle of substantial transformation. Conversion, and in practice, enrichment and fabrication are all regarded as substantial transformations. The customs origin is thus that where the most recent transformation took place.

Russia

Russia also recognizes the principle of substantial transformation for determination of customs origin. Conversion does not constitute substantial transformation, while enrichment and fabrication do.

Annex 3 | Consent Procedures Concerning Obligation Swaps

Internal Swaps

Australia

Under the terms of Australia's bilateral agreements, internal obligation swaps involving the exchange of obligations between quantities of nuclear material are permitted within the jurisdiction of each bilateral partner, including the EU and the USA. These terms permit internal swaps without prior consent subject to the following conditions:

- The two quantities must be equivalent.
- There must be operational reasons for the exchange.
- The exchange must not result in reducing the quality of the material subject to Australian safeguards (*e.g.* swapping obligations between HEU and LEU, or LEU and natural uranium).

Canada

Canada permits internal obligation swaps of Canadian material within the EU without prior consent, according to the terms of the Canada-Euratom agreement. Canada satisfies itself that its obligations have been respected by means of annual reports by Euratom of the inventory of Canadian-obligated material. The situation is the same for internal swaps of Canadian material within the USA.

European Union

Proposed internal swaps between two or more different Material balance Areas require case-by-case approval by both the Euratom Supply Agency in Brussels (on the contractual and supply aspects involved) and the Euratom Safeguards Directorate in Luxembourg.

In addition to the principles of equivalence and proportionality, the following are also applied in deciding on the acceptability of a transaction:

- The proposed swap must facilitate efficient operation of the nuclear industry (economic/ industrial justification).
- All international undertakings made by the EU must be complied with (includes an analysis of the political aspects).
- The contractual situation of the materials proposed for the swap must be in order.
- In the case of enriched uranium, the enrichment of the batches proposed for exchange of obligations must be within certain limits.
- The swap must not have the effect of diminishing the quantity of material subject to the most restrictive safeguards undertakings.

United States

Internal swaps within the EU are permitted without prior consent, in accordance with the terms of the 1996 US-Euratom agreement that runs for 30 years. Within the USA, no prior approval is required for swaps concerning natural uranium or enriched uranium of identical enrichment; such swaps are reported routinely after completion. However, proposed 'non-equivalent' internal swaps involving different quantities of material or uranium in different physical forms or enrichment require prior approval by the NRC. Exchanges of obligations on plutonium, HEU or U-233 are considered on an individual basis.

Russia

Normally Russia's consent is not required for internal swaps.

International Swaps

International exchanges of obligations are always subject to the consent of the supplier(s) to whom the materials involved are obligated and the jurisdiction(s) in which they are located.

All the major government authorities recognize the principle of equivalence in evaluating swap proposals. The principle treats quantities of uranium of different proportions as equivalent on the basis of the numbers of atoms of fissile isotopes. In the case of plutonium, all isotopes are treated equally, that is equivalence is on the basis of grams of plutonium. However the principle is normally applied only to materials of the same category and, in the case of enriched uranium, the enrichment assays must be within a certain band.

Australia

Following lengthy negotiations, Australia and Euratom agreed in 1993 on a framework and the procedure to be followed for international swaps on a case-by-case basis. The procedure defines the information which needs to be submitted by the parties.

United States

The USA is prepared to consider international obligation swaps only when the objectives of a swap cannot be met by ownership exchange or internal swaps. consent for international swaps is given on a case-by-case basis. The main criteria examined in the consent process are:

- The transaction must not result in a diminution of US non-proliferation controls on nuclear material.
- The transaction must not result in a degradation of the non-proliferation situation in a particular country or facilitate a transaction of non-proliferation concern.
- The transaction must result in a situation of equivalency of quantity and isotopic composition subject to the US non-proliferation controls.
- The transaction must be consistent with the US export licensing process, the US subsequent arrangement consent process and all other US legal requirements and US government commitments (*e.g.* co-operation agreements).
- The transaction would have been approved if the physical movement of material had been proposed.

Canada

Canada is prepared to allow international obligation swaps subject to prior consent on a case-by-case basis.

European Union

The EU is prepared to allow international obligation swaps subject to prior consent on a case-by-case basis. The criteria for consent are similar to those used for internal swaps.

Russia

Russia's consent is usually required for an international swap where the Russian material involved is subject to a nuclear cooperation agreement between Russia and the country where such material is located.

World Nuclear Association
Tower House
10 Southampton Street
London WC2E 7HA
United Kingdom

+44 (0)20 7451 1520
www.world-nuclear.org
info@world-nuclear.org

The World Nuclear Association's Law Working Group was established to raise awareness on the legal issues facing the nuclear industry, as well as to assist other Working Groups on ways to respond to specific legal challenges.

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