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CONF-980733-

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39th Annual Meeting, Institute of Nuclear Materials Management
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Abstract
In September, 1997, nine of the world’s plutonium-using countries agreed to a set of guidelines for international plutonium management, with acceptances to be submitted to the International Atomic Energy Agency on December 1. Following three years of discussion, the guidelines provide a unified package of accepted rules for the storage, handling, and transportation of civil plutonium as well as military plutonium that has been declared as no longer required for defense purposes. New requirements include a formal declaration of national plutonium strategies, which will recognize the environmental, economic, and proliferation concerns and the consequent importance of balancing plutonium supply and demand. Nations will also make annual declarations of their non-military stockpiles of unirradiated plutonium, together with estimates of the plutonium content in spent reactor fuel. These guidelines represent the first formally accepted recognition of the need for plutonium management of this scope and could thus provide a partial basis for future monitoring and policy regimes.

Background and Introduction
The nine-nation plutonium talks were first convened in the fall of 1994 by Dr. Hans Blix, then Director-General of the International Atomic Energy Agency (IAEA). It was recognized that, with the rapidly growing global stockpiles of separated civil plutonium, there was a need for international agreement on procedures for the separation, stockpiling, storage, and transportation of plutonium. Concerns included economic questions, environmental protection, and prevention of nuclear proliferation. Although the IAEA Director-General was personally responsible for the convening of the talks, and the IAEA provided facilities at the Vienna International Centre for their conduct, they did not constitute an official IAEA activity. Rather, the nine nations involved were those who, as signatories of the Nuclear Non-Proliferation Treaty (NPT) and as users or processors of plutonium, had special interests in the development of mutually acceptable guidelines for plutonium management. They included the five nuclear weapons states (China, France, the Russian Federation, the United Kingdom, and the United States), plus Belgium, Germany, Japan, and Switzerland. The talks convened under the chairmanship of Peter Agrell, U.K. Ministry of Trade, who chaired the talks through their completion in 1997.
Meetings of the nine delegations were held quarterly in Vienna. The U.S. delegation was headed by Fred McGoldrick of the Office of Nuclear Energy in the State Department, or by Alex Burkart from the same office. One of the three authors represented the Department of Energy on the delegation at each meeting. The Arms Control and Disarmament Agency and the Department of Defense were represented less frequently.

The International Plutonium Management guidelines resulting from these talks were adopted in September, 1997. It was agreed that official letters of acceptance would follow on or about December 1, 1997. The guidelines do not have the legal force of a treaty and did not require formal ratification. Their acceptance was formalized in each case by a note verbale, or official communication from the Permanent Mission of each country to the Director-General of the IAEA, who was requested to issue the guidelines and accompanying notes in the form of an INFCIRC. This was accomplished in March of 1998 (Ref. 1).

Issues

The majority of the guidelines' text was relatively non-contentious. Many of the principles and even some specific language exist in already-agreed documents such as the "Principles and Objectives for Nuclear Non-Proliferation and Disarmament," adopted at the 1995 NPT renewal conference, as well as various IAEA documents. However, there were several issues that did require attention and discussion as representing new or different kinds of national commitment.

The initial focus of the talks was on the storage and transportation of civil plutonium. It was observed early in the discussions, however, that stockpiles of plutonium that have become surplus to weapons programs constitute an inseparable part of the effective non-military global plutonium supply. Thus, it was decided at an early stage that the subject of discussion would include not only plutonium stockpiles derived from civil nuclear power programs, but former weapons material that has been declared as "no longer required for defense purposes." Alternative formulations such as "excess" or "surplus" weapons material turned out to have connotative implications that were unacceptable to some states, so the lengthier terminology was used throughout. As has been the case in virtually all international nuclear materials agreements, certain categories of material were excluded: Pu-238 such as is frequently used in thermoelectric power supplies; gram-sized or smaller quantities of plutonium as might be used in instrumentation, smoke detectors, etc.; and plutonium that is in such diluted form that otherwise-applicable IAEA safeguards do not apply or have been terminated. From the outset, it was agreed that plutonium as a component of spent fuel would not be covered by the guidelines.

Perhaps the most contentious issue -- more one of differing emphasis than of substantive differences -- concerned the importance of the quantity of separated plutonium in civil stockpiles. On the one hand, there was a general acceptance that in the interests of nonproliferation, other things being equal, unnecessarily large stockpiles of plutonium should generally be avoided. On the other hand, some nations do rely on the closing of the nuclear fuel cycle for reasons of energy supply, economics, and/or environmental protection, and these nations do not wish to have themselves
therefore seen as proliferation threats. After discussions of alternative wording that covered several quarterly sessions, there was agreement on compromise language (see below) emphasizing the importance of bringing plutonium supply and demand into balance, while maintaining a respect for the other considerations noted.

There was agreement from all parties that the guidelines would call for annual declarations of the quantities of separated plutonium held by each nation (excluding, of course, materials still required for defense purposes). There was some disagreement, however, regarding a parallel condition that would require an estimate of the amount of plutonium included in spent reactor fuel. This was an unusual sort of “requirement,” in that some saw the declaration as being in the interests of the country doing the declaring: the plutonium content of spent fuel worldwide is very much greater than the amount of separated civil plutonium, so its declaration could be visualized as having the effect of depreciating the still-large, but much smaller separated plutonium stockpiles. Some nations, though, insisted that since the guidelines explicitly excluded spent fuel as a topic for international management, it would be inappropriate to require any declarations pertaining to spent fuel. The resolution was to make the spent-fuel declaration essentially optional. Forms for it would be included with the guidelines, but with the understanding that not all nations would choose to submit them.

A very sensitive issue concerned the placement of plutonium under the IAEA’s international safeguards. This was of course not a concern for the non-weapons states, who as NPT signatories already have such a commitment, but did present a variety of problems for the weapons states. The prompt placement under safeguards of material no longer required for defense purposes could present security and legal concerns (because some such material might still be in the form of classified weapons components that must not be revealed to other countries) as well as economic concerns (because of the cost of isolating, dismantling, and desensitizing the components). Because concerns differed from state to state, the safeguarding commitment was made in the *notes verbale* rather than in the guidelines themselves. The commitment to put former weapons materials under safeguards -- already made in the NPT “Principles and Objectives” document -- was only on an “as soon as practical” basis; and there was no uniform commitment (see below) by the weapons states to put other plutonium under safeguards at all. (This provision was of importance to some states that would have difficulty separating their civil from military facilities.) Two states, Russia and the U.S., are already beginning discussions with the IAEA on provisions for some kind of inspection regime associated with former weapons materials, and special note was made of this consideration in their *notes verbale*.

Some nations, objecting to guidelines that seemed to give overly exclusive emphasis to plutonium without comparable attention to highly enriched uranium (HEU), wanted to see specific inclusion of HEU as a material similarly demanding of international controls. Among the arguments against that was that there is a legitimate interest, depending on the nuclear fuel cycle being used, in plutonium as a fuel for commercial nuclear power, where no comparable interest exists for HEU. The solution
was to include an agreement by most of the nations present to explore the possibility of developing a comparable set of guidelines for HEU in the future.

**The Guidelines**
The International Plutonium Management guidelines consist of 15 numbered sections, of less than a page each. They are specifically to be read in conjunction with the accompanying *notes verbale*, which as already noted include some of the substantive commitments. Specific content is as follows:

1. Each country has the right to adhere to its own nuclear energy policies but has an obligation for responsible plutonium management. Similar obligations apply to spent fuel and to HEU, but those topics are not covered here.

2. “Plutonium” includes that which is separated, included in mixed-oxide (MOX) fuel, or in unirradiated fabricated form.

3. Plutonium designated as no longer required for defense purposes is covered.

4. Pu-238, plutonium in gram quantities or as a sensing component in instruments, and plutonium exempted from IAEA safeguards by INFCIRC/153 are not covered.

5. Commitments under the NPT, Euratom agreements, IAEA Safeguards Agreements, and other nonproliferation commitments are reaffirmed.

6. International safety standards (the IAEA’s Basic Standards of Radiological Protection, the IAEA’s Fundamentals of Nuclear Safety, and the International Convention on Nuclear Safety) are reaffirmed.

7. Physical protection standards will follow those in the Convention on the Physical Protection of Nuclear Material and the recommendations of the IAEA’s INFCIRC/225 on Physical Protection of Nuclear Material. These requirements are attached to the guidelines as an appendix. They call for controlled-access use and storage areas and pre-arranged supplier-recipient agreements for quantities between 15 and 500 grams; additionally for constantly-guarded use and storage for quantities between 500 and 2000 grams; and additionally for guarded, restricted-entry use and storage areas and escorted transportation, with provision for calling on response forces, when quantities exceed two kilograms.

8. Separated plutonium holdings above 15 grams will be stored only at reprocessing plants, fabricating plants, or a small number of sites that have been specifically authorized by the government for plutonium storage.
9. Effective accountancy and control provisions will be in place, including material balance areas as defined in the IAEA’s INFCIRC/153. These will include measurement systems to identify inventories and their accuracies, shipper-receiver difference identification, inventory procedures, record and report procedures, and verification procedures.

10. International transfers (if exceeding 50 grams in a year) will require assurances of peaceful use, permanent application of IAEA safeguards regulations, maintenance of effective physical protection, and non-subsequent transfer without consent.

11. Recipients of international transfer will provide itineraries for transport and plans for ultimate use.

12. International transfers will acknowledge all obligations for plutonium management.

13. States are committed to develop plutonium management strategies that recognize proliferation risks, the need for environmental protection, the resource value of the material, cost-benefit considerations, and the importance of balancing supply and demand (including demand for reasonable working stocks).

14. States will publish occasional statements explaining plutonium management strategies; annual statements of plutonium holdings covered by the guidelines; and annual estimates of the plutonium content of spent civil reactor fuel.

15. States will exchange experiences in guideline implementation and will review the guidelines within five years of their proclamation.

The Notes VerbaIe
While most of the substantive commitments -- those included in the guidelines themselves -- are common to the nine participating states, there are others that differ from state to state and were accordingly included in individual notes verbale. There was agreement among the participants on the general form of the note verbale, which constitutes the official transmission vehicle for acceptance of the guidelines, but with an understanding that country-specific differences would exist. It is easiest to understand the notes verbale by observing a kind of “canonical form” that is common to most of the notes, and then observing the exceptions. The canonical form includes the following provisions:

- States accept the guidelines and certify their intentions to abide by them.

- States reiterate their NPT obligations, Safeguards agreements with IAEA (and Euratom where applicable), and the NPT Principles and Objectives.
Weapons states agree to voluntary placement of civil plutonium, and plutonium no longer required for defense purposes, under IAEA safeguards as soon as practical.

States agree to consult on the possibility of similar guidelines for HEU.

States express the hope for adoption of similar policies by other states that separate, hold, process, or use plutonium.

The exceptions include the following nation-specific conditions:

China declines to publish estimates of its spent fuel holdings; will publish its holdings of separated plutonium only after materials are transferred from military to civilian usage; will not publish amounts of purely civil materials; and will not commit to consideration of possible HEU guidelines.

Russia will publish its holdings of separated plutonium only after materials are transferred from military to civilian usage; and will not commit to consideration of possible HEU guidelines.

Russia and the United States further commit to undertake with the IAEA discussion of verification measures that can be applied to plutonium designated as no longer required for defense purposes.

The collection of notes verbale along with their attachments -- the guidelines themselves, the national statements of plutonium management strategies, and the first annual declarations of plutonium holdings -- were published by the IAEA as INFCIRC/549 on March 16, 1998.

National Plutonium Management Strategies
Statements regarding national strategies for plutonium management had been received, at the time of this writing, from seven of the nine nations. As would be expected in view of the diverse national policies, the length and detail of the statements differed substantially from one country to another.

Belgium emphasized its need for peaceful nuclear power to reduce dependence on imported oil. Seven pressurized-water reactors are now active. A mix of private and public companies provide fuel cycle services, including Synatom (fuel procurement and spent fuel management), FBFC International (fuel fabrication), Belgonucleaire (MOX fuel fabrication), and ONDRAF/NIRAS (radioactive waste disposal). Early (pre-1990) plans for reprocessing and recycling are being followed in some cases, but more recent strategies call for developing direct disposal options, and new reprocessing contracts are not being executed or negotiated. Spent fuel storage licenses at reactor sites will be effective well beyond 2000, by which time disposal strategies are expected to be in place. Stringent regulations ensuring safeguards and international transparency are in place. There are no plans for explosive use of plutonium, and reprocessed plutonium is to be used as MOX fuel as quickly as possible.
France has nearly 60 MW of nuclear capacity, producing some 77% of the country’s electricity. It sees nuclear power as a principal focus of national energy policy. Spent fuel, after cooling, is reprocessed at the Hague facility, which also devotes half its capacity to reprocessing of foreign spent fuels. Plutonium and uranium are separated completely for recycling into MOX or uranium oxide fuels, with plutonium recycling rates dictated by the number of reactors that can use MOX. Fission products and minor actinides are vitrified for temporary storage. A parliamentary decision is anticipated in 2006 regarding ultimate disposition of long-term highly radioactive waste.

Germany has 20 nuclear plants in or near operation, covering a third of its electricity demand. Germany has operational enrichment and fuel fabrication facilities. Spent fuel is either reprocessed (in France or the U.K.), or is sent to a repository in Germany, at the discretion of the utility. Two interim repositories exist and a third is under development. Plans for domestic reprocessing have been canceled. A pilot facility is under construction to demonstrate conditioning for disposal of spent fuel and other radioactive waste, with earliest anticipated operation in 2011.

Japan supports reprocessing of spent nuclear fuel as a means of guaranteeing energy supply and for environmental reasons. Reprocessing is done in the U.K. and France at present, with one domestic plant currently shut down and a second still under construction. Operation of the new plant is expected in 2003. Plutonium will be used in the form of MOX fuel. By 2010 it is planned that 16 to 18 plants will be using MOX, including one advanced boiling-water reactor with a full MOX core. Research and development is continuing toward fast breeder reactors, although operation of a prototype has been stopped because of an accident. Japan adheres to a principle of “no surplus plutonium,” holding only the amount necessary for its energy program. In the interests of international transparency, published reports provide projections of plutonium holdings. All materials are subject to IAEA safeguards as well as a state system of accounting and control.

Switzerland has five reactors supplying 45% of its electrical energy, and relies entirely on foreign suppliers for fuel cycle services. Enrichment and/or fuel fabrication is done in ten different countries. Spent fuel is reprocessed in the U.K. and France for fabrication into MOX fuel. Two reactors now routinely use MOX fuel supplies. Radioactive waste is legally required to be disposed in Switzerland, and this may in the future include unprocessed spent fuel. Storage is at interim facilities pending completion of geologic repository studies. Research and development is being done on increased-burnup cycles and transmutation in fast reactors or accelerator-based systems. All material is subject to full-scope IAEA safeguards. There is no intent for any explosive use of plutonium.

The United Kingdom has 16 power stations with 35 operating reactors, supplying 25% of the UK power demand. Six reactors are being decommissioned, and for economic reasons no new ones are now planned. There is still some public ownership, but with recent and planned privatization the entire supply market is expected to be competitive within a year. The government-owned British Nuclear Fuels (BNFL) supplies enrichment, fabrication, reprocessing, and waste management
services. Decisions regarding reprocessing of spent fuel and on siting for dry stores are left to the commercial judgment of the fuel owners. However, older Magnox fuel must be reprocessed for technical reasons. BNFL has reprocessing contracts with many foreign as well as domestic utilities. MOX fuel has been delivered to Swiss and German utilities, and its use is under study by some British utilities. There are extensive holdings of plutonium in the U.K. on behalf of foreign customers, as well as domestic operators. All civil plutonium is securely stored under relevant regulations, including international safeguards inspections. For 11 years data have been published on plutonium inventories and shipments. Considerable detail on reprocessing contracts, transportation procedures, stockpiling, and safeguarding is included in the U.K. paper.

The United States does not encourage civil use of plutonium and engages in no reprocessing, believing that such programs are not economical and raise proliferation concerns incommensurate with any benefits. It does, however, honor its existing commitments regarding civil programs in Europe and Japan. U.S. power generation uses once-through fuel cycles with low-enriched uranium in light-water reactors, with eventual permanent disposal of spent fuel. A permanent geological depository is now under evaluation. The U.S. supports research into advanced once-through light-water reactors for improved safety, reliability, and cost-effectiveness. In addition to plutonium in spent fuel, the U.S. has over 50 tons of formerly military plutonium that has been declared excess to defense needs, and will ultimately place all of it under IAEA safeguards. Parallel programs are being pursued for disposal of excess plutonium either by burning already-separated plutonium as MOX fuel in domestic reactors (with controls to avoid encouraging subsequent civil use of plutonium), or by direct disposal through vitrification and geologic-site burial.

**Annual Declarations**

At this writing, seven of the nine countries had submitted their first declarations of plutonium quantities. The following table summarizes the total declared holdings. (Submitted tables further identify forms in which the plutonium is held.)

<table>
<thead>
<tr>
<th>Country</th>
<th>Unirradiated Pu (tons)</th>
<th>Est. Pu in spent fuel (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>2.7</td>
<td>12</td>
</tr>
<tr>
<td>China</td>
<td>0</td>
<td>Not declared</td>
</tr>
<tr>
<td>France</td>
<td>65.4</td>
<td>153</td>
</tr>
<tr>
<td>Japan</td>
<td>5.0</td>
<td>49</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.7</td>
<td>6</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>54.8</td>
<td>47</td>
</tr>
<tr>
<td>United States</td>
<td>45.0</td>
<td>285</td>
</tr>
</tbody>
</table>

Note that plutonium is identified by location, not by ownership, and separate declarations are made of ownership-location differences in unirradiated plutonium. The largest such examples: 30 tons of plutonium in France is owned by other countries, and Japan owns 15.1 tons of plutonium that is held in other countries.
Plutonium holdings are declared as of December 31 of each year. It is expected that annual declarations will be sent to the Director-General of the IAEA about the middle of the subsequent year.

Acknowledgments
The authors appreciate updated information regarding continuing activities in International Plutonium Management provided by Fred McGoldrick, until recently at the U.S. Department of State, Office of Nuclear Energy; and Erich Pieper, U.S. Department of Energy, International Policy and Analysis Division.

This paper has been prepared under the auspices of the U.S. Department of Energy by the Los Alamos National Laboratory under Contract W-7405-ENG-36 with the University of California. Views expressed in the paper are those of the authors alone and do not represent official positions of the U.S. government nor of the University of California.

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