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Policies On Fissile Materials:

The Cutoff Treaty and Excess Stocks

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These are not the easiest of times for making progress on nuclear arms control. The problems go well beyond a fissile material cutoff treaty (FMCT), which presently awaits negotiation. It is therefore important to begin on a positive note by recalling how much has been achieved in the past five to 10 years. The gloomier predictions about the post–Cold War world have not come to pass. There has been no return to the confrontational use of nuclear weapons in the relations between great powers, deep cuts in nuclear armaments have been undertaken, and there has not been the rush to acquire nuclear weapons that some anticipated, despite recent events in South Asia.

Instead, this has been a period in which the norms, measures, and institutions of nuclear arms control have been greatly strengthened. The Nuclear Non-Proliferation Treaty (NPT) has been extended and has achieved near universality. The United Nations

has become involved in, amongst other things, the dismantling of Iraq's nuclear weapon program. The denuclearization of the new states formed out of the relics of the Soviet Union has been successfully completed. A Comprehensive Nuclear Test Ban Treaty has been concluded. And so on.

Having said this, a great distance still has to be traveled. This is especially true in regard to the control and disposition of plutonium and highly enriched uranium (HEU). But even in this context, there is nothing insurmountable about the problems that confront us, provided that they are approached with clear-sightedness, determination, and political realism.

Two Inventories

The fissile material agenda can seem very complicated and confusing. But it is also simple if one casts an eye over the broad aggregates. Since 1945, a little over 3,000 tonnes (metric tons; one metric ton = 2,200 pounds) of fissile material (plutonium plus HEU) have been produced. This quantity can be divided into two inventories. The first, which I shall term Inventory A, accounts for approximately one-third of the total, or 1,000 tonnes. It comprises material produced for, used in, and discharged from civil reactors and fuel-cycle facilities. The remaining two-thirds, or 2,000 tonnes (Inventory B), comprises the fissile material produced for, used in, and extracted from nuclear warheads.

A number of important distinctions can be drawn between these two inventories:

Types of fissile material. The 1,000 tonnes in Inventory A consist almost entirely of "reactor-grade" plutonium, containing relatively large concentrations of the higher-numbered isotopes of plutonium which are very radioactive and heat-emitting. Although this material can be used in weapons, it is not ideal for the purpose. In contrast, seven-eighths of the 2,000 tonnes in Inventory B is HEU, and one-eighth is plutonium. Nearly all of these materials are weapon-grade.

Forms. Inventory A is held in a relatively small number of

forms, usually at well-known locations. Three-quarters of it is contained in unreprocessed spent fuel, usually held in storage ponds at power reactor sites. Much of the remainder is stored as separated plutonium oxide, is encased in unirradiated fuel elements, or is distributed in various types of waste. There are some troublesome bits of this inventory, such as the HEU associated with research reactors, but otherwise it is rather homogeneous and technically unproblematic.

The same cannot be said about Inventory B. It is held in a multiplicity of forms: in warhead components (operational, reserve, and dismantled); in the forms used in, or residue from, warhead production processes; in fuel elements for naval propulsion reactors, and in the associated fuel-fabrication industry; in contaminated machinery and pipe-work; and in

Table 2.1

U.S., Russian Excess Weapon-Grade Plutonium and Highly Enriched Uranium (in tonnes)

	Total inventory, end of 1994 (central estimates)	Declared excess by U.S., Russian governments	Estimated excess stocks*
Plutonium			
United States	85	38	49
Russia	130	50	95
WGU-eq**			
United States	645	100	480
Russia	1,050	500	890
Total	**1,911**	**600**	**1,514**

* Illustrative estimate, based on the assumption that one significant quantity (SQ) of plutonium (8 kilograms) and weapon-grade uranium equivalent (WGU-eq) (25 kilograms) is allocated per strategic warhead maintained in operation after START II reductions (and that the United States and Russia each maintain 1,000 tactical weapons); and that a stock of 50 tonnes of WGU-eq will be needed by each country for naval requirements. As most modern designs of nuclear warheads contain considerably less than a significant quantity of plutonium and WGU-eq, the estimates in this column should be regarded as upper bounds even after allowances are made for materials held in the production "pipeline." See *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies*, pp. 441–443.

** WGU-eq is used to allow direct comparisons. The amount declared excess by the United States is 174 tonnes, which is the equivalent of 100 kilograms of weapon-grade uranium. A small fraction of the excess U.S. and Russian HEU has been blended down to LEU since 1994. (See Table 1.4 and Appendix 5.)

scraps and wastes of many kinds. The delineation of this inventory, and of its various parts, is inherently complex. Matters are not helped by slack record-keeping, especially in the early years of the Cold War.

The error margins attached to estimates of Inventory B are therefore much higher than those attached to Inventory A. Among the declared nuclear weapon states, the United States and Britain have reported their inventories of plutonium and HEU produced for military purposes, and both have promised to provide additional information about these stocks. But even there, many uncertainties remain, especially in regard to the quantities and grades of HEU.

Safeguards. The majority (around 60 percent) of Inventory A is under full international safeguards. This includes all fissile materials in the NPT's non-nuclear weapon states (one trusts), and civil materials in Britain and France which are subject to Euratom and, to some degree, International Atomic Energy Agency (IAEA) safeguards. The remaining 40 percent is largely held in the United States and Russia, including the substantial stock of plutonium separated from power reactor fuels that is held in store at the reprocessing site near Chelyabinsk.

Of the 2,000 tonnes of plutonium and HEU in Inventory B, only a tiny proportion—well under five percent—is currently under international safeguards. Inventory B is thus largely outside the purview of the multilateral safeguards system. The quantities under safeguards, however, will increase as excess materials are declared and brought under IAEA verification.

Geographical distribution. Inventory A is quite widely distributed across the industrial nations with nuclear power programs. A large proportion is held in spent fuel ponds in Canada, Germany, Japan, Russia, and the United States, and in separated and unseparated forms at the reprocessing sites in Britain, France, and Russia.

The great majority of Inventory B (more than 95 percent) is owned by the United States and Russia, reflecting the massive

scale of their military commitments during the Cold War (see Table 1.3, page 11). However, the quantities in China, France, and the United Kingdom are still substantial, and there are politically and strategically important quantities in India, Israel, North Korea, and Pakistan, albeit quantities that are measured in kilograms rather than tonnes.

Infrastructure. The world's inventories of fissile materials are the result of huge investments in capital facilities, notably reactors and reprocessing plants (plutonium) and enrichment plants (HEU). The facilities that have produced Inventory A are largely under international safeguards (the RT-1 reprocessing plant in Russia being a notable exception), and most are operating today. The facilities responsible for Inventory B are mainly unsafeguarded, although a significant number have ceased operating in recent years.

Four conclusions that have a bearing upon policy can be drawn from this brief survey:

First, although Inventory A has its problems, the great political, managerial, and regulatory challenges rest with Inventory B and its associated production facilities.

Second, because Inventory B is so large, because it contains materials in so many forms, because full records were not kept, and because military facilities were not generally designed to be safeguarded, meeting this challenge will require time, patience, and money. Various technical issues also need to be addressed, the solutions to which are not immediately apparent.

Third, 10 years ago the 2,000 tonnes in Inventory B were almost entirely dedicated to serving the huge nuclear arsenals of the time together with the needs of naval reactors. Our estimate is that around 400 tonnes will be required, at maximum, by the nuclear weapon states, assuming that the United States and Russia implement the START II arms reductions (see table 1.1, page 6). This inventory would be sufficient to serve both weapon arsenals and naval reactors for decades to come. As further arms reductions seem likely, the required quantity will

probably fall well below 400 tonnes, the corresponding excess growing beyond 1,500 tonnes.

Of the 2,000 tonnes of fissile material that have hitherto been tied to military applications, four-fifths or more is therefore no longer needed for those purposes. Of the 3,000 tonnes that comprise the world's total inventory of plutonium and HEU, only 10 to 15 percent are likely to remain relevant to military needs. The corollary is that 85 to 90 percent will be "non-military," compared to as little as 25 percent a decade ago.

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The important implication is that the requirements for verifying and controlling fissile material stocks and infrastructures are today very little different from the requirements that would have to be faced in conditions of complete nuclear disarmament. Of course, the politics are different, but the requirements are very similar. To quote from the final chapter of *Plutonium and Highly Enriched Uranium 1996*, "for both practical and political reasons, the regulatory situation in all countries, including the NWS [declared nuclear weapon states], should be approached *as if the world is preparing for total nuclear disarmament*, whether or not that is a desirable or realistic prospect."[2]

Fourth, the distinctions between the status and safeguarding of Inventories A and B raise, as we are all aware, profound issues of equity. This inequality is real and cannot be ignored. It is aggravated by the common perception that parts of Inventory B now pose the greatest threat to national and international security, and are thus most in need of increased regulation.

Four Essential Policy Agendas

Very large inventories and associated infrastructures are still ill-defined, under-protected and under-regulated. Everyone's security will be threatened as long as this is allowed to continue. Four policy agendas have to be, and in varying degrees are being, developed. In no particular order of importance, they are:

- The ban on the future production of fissile material for weapon purposes (a fissile material cutoff treaty, or FMCT);
- The extension of multilateral controls and the strengthening of national measures, including physical security, over excess stocks of fissile materials;
- The disposition of excess stocks of fissile materials, so that the amounts that are available for misuse are steadily reduced; and
- The detection of undeclared programs dedicated to the production or use of fissile materials for weapon purposes.

The third and fourth of these agendas will not be discussed here, although they are considered at length in our book and in Chapter III of this report. However, it must be emphasized that all of these agendas have to be pursued vigorously. None is optional. They form a package that is politically and instrumentally indivisible.

The Fissile Material Cutoff Treaty

An FMCT is as essential as the other agendas. Some have argued that it is inessential, on the grounds that production of fissile materials for weapons has halted in four out of five nuclear weapon states, and that an FMCT would bring insufficient benefits to justify its bureaucratic and regulatory costs. In addition, they argue that the treaty's only importance, and the only justification for incurring those costs, lies in capping plutonium and HEU production in India, Israel, and Pakistan.

Those holding these opinions are seriously undervaluing the FMCT. Why is it so important? There are four main reasons:

A new international norm. A universal and verified ban on the production of plutonium and HEU for weapons purposes would add another barrier to the acquisition of nuclear weapons. It would also be a necessary component in any eventual disarmament regime.

A policy driver. An FMCT would focus attention on the establishment of an effective web of controls in countries with extant weapon programs, and one that justifies international confidence. An FMCT would thus help to drive the internal

and external search for, and development and implementation of, effective controls on the large parts of Inventory B and its associated infrastructures that are excess to military requirements. Although inherited stocks should be left outside its purview (see below), an FMCT would require attention to be given to a range of issues, with appropriate measures developed accordingly. They include:

The status and content of safeguards agreements. Should voluntary offer agreements between the IAEA and individual nuclear weapon states be retained, and if so should they be recast and harmonized?

The scope of international verification. Which materials and facilities should be brought under international safeguards or other forms of verification?

Rights of withdrawal from safeguards. Should those rights be removed or their scope substantially narrowed? How would the provision of fuels for naval or tritium production reactors be handled under an FMCT?

Transfers. Should transfers of unsafeguarded fissile material between nuclear weapon states be allowed under an FMCT?

Material accounting systems. How could accounting systems be improved and extended, and brought up to the best international standards?

Safeguardability of production facilities. How can adequate confidence be attained in regard to enrichment and production facilities which were not designed to be safeguarded, and which may be unable to meet standard safeguards criteria even after re-engineering?

Safeguards culture. Which steps (including training) are required to establish an international safeguards culture in states where little or none has developed to date?

Detection of undeclared facilities and activities. Which of the measures adopted by the IAEA to strengthen safeguards, particularly to help detect undeclared activities, should be applied in order to verify compliance with the FMCT?

Capping production in the de facto nuclear weapon states. A universal FMCT would have to embrace production capabilities in Israel, India, and Pakistan. There is broad agreement that the FMCT would be a valuable confidence-building measure in the Middle East. It also would help to stabilize the security situation in South Asia.

NPT Principles and Objectives. The commitment to negotiate an FMCT is an integral part of the NPT Principles and Objectives, which were agreed in 1995. To abandon or defer negotiations would injure the prestige of this document. By extension, it could impede progress on other aspects of nonproliferation and disarmament since other commitments might also come to be regarded as optional or open to deferment.

Excess Stocks

The proposed FMCT's main focus is on ending the production of fissile materials for nuclear weapons, as is made clear in the Shannon mandate (see Appendix 2). Because the treaty must be verifiable, its negotiation and implementation will act as an important policy driver in the ways already indicated.

While the focus is therefore on production and on *future* outputs, the stocks inherited from *past* production cannot be ignored. We have already noted their huge scale; that their management, regulation, and disposition is bound to be vital to any nonproliferation and disarmament policy in the short, medium, and long terms; and that their exclusion from multilateral systems of control would offend against perceptions of equity and universality. It should also be recognized that this excess stock could act as a surrogate production system if left unattended. States would not need to produce new stocks of material for weapons if they could simply dip into old stocks.

However, we do *not* favor bringing these inherited stocks into the FMCT negotiations, for two reasons. The first is that inclusion of these stocks would greatly complicate an already complicated task. The FMCT's objectives should be kept sim-

ple and unambiguous. The second reason is that we do not believe that a universal cutoff treaty that embraces past stocks is negotiable at the present time. Among the three de facto nuclear weapon states, and in China and France, there is reluctance to admit that excess stocks exist, let alone that they deserve to be verified by international agencies. This does not mean that these states will indefinitely oppose consideration of stocks, nor that we should accept their claims, but that time and progress on other fronts may be required before they will bring their excess stocks to the negotiating table.

There are two options. One is to address the issues relating to stocks once the FMCT has been concluded—to address production and stocks sequentially. The other option is to address them in parallel. Both options deserve serious consideration. Our own preference is to establish a parallel process, but one that should be largely independent of the FMCT negotiations (total independence is probably unrealistic). It might begin with the negotiation of formal agreements or treaties between the United States and Russia, which have by far the largest holdings of excess plutonium and HEU, and which have already taken some steps towards a common program of action. Essentially, their governments would deepen, energize, and build upon the transparency and irreversibility agreements that are already in place. These negotiations might be carried out in close consultation with other governments and with the international safeguards agencies. Upon achievement of the new agreements or treaties, they could be opened for accession by other states.

Essentially, these agreements would commit the parties to transparency and to the acceptance of specific regulations in regard to their excess stocks. We have suggested elsewhere the kinds of declarations that such agreements might entail (none would entail the release of sensitive information on weapon designs)[3]:

- Declarations of the best available estimates of total inventories of weapon-grade plutonium and HEU, and of fuel- and

reactor-grade plutonium, and of the steps that are being taken to establish confidence in those estimates. As knowledge improves, the estimates would be progressively refined;

- Declarations of the quantities of plutonium and HEU that are being assigned to weapon purposes (after implementation of agreed arms reductions where applicable), and of the quantities of HEU assigned to naval propulsion, and the grounds upon which those quantities have been chosen. These quantities would be reduced upon the announcement of further arms reduction and dismantlement programs;
- Declarations of the resulting excess of plutonium and HEU over military requirements, and of the forms in which it is held and the manner in which it is stored; and
- Declarations of the steps that will be taken to submit excess plutonium and HEU to international verification.

In conclusion, the four policy agendas (cutoff, stocks, disposition, detection) all need to be pursued with equal vigor. None is optional. Despite the current difficulties in Geneva and elsewhere, we are convinced that these agendas can and will be taken forward. Their development is vital to international security, and to the further marginalization of nuclear weapons whether or not complete nuclear disarmament lies at the end of the road.

1. Based on a presentation given at the Workshop on the Fissile Material Cutoff Treaty sponsored by the Institute for Science and International Security (ISIS), Washington, D.C., the Science Policy Research Unit (SPRU), University of Sussex, and the University of St. Andrews at the U.N. Conference on Disarmament, Geneva, February 14, 1997. The presentation draws upon *Plutonium and Highly Enriched Uranium* 1996: *World Inventories, Capabilities, and Policies,* esp. chapters 14 and 15. It represents the views of the joint authors.
2. *Plutonium and Highly Enriched Uranium* 1996, p. 436.
3. Ibid., p. 456.