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Report on an International Workshop on the Future of Reprocessing, and Arrangements for the Storage and Disposition of Already-Separated Plutonium (Moscow, 14-16 December 1992), and an International Workshop on Nuclear Security Problems (Kiev, 17 December 1992)

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Moscow Workshop

The agenda a list of participants are attached as are copies of some articles written out of the meetings by Mark Hibbs of *Nuclear Fuel* and copies of most of the prepared papers. The following are some items of interest that emerged:

The Future of the Russian Plutonium-production Facilities

A key difference between this and previous workshops was the presence of environmental activists as observers. The Russian plutonium production facilities near Chelyabinsk ("Mayak"), Kransnoyarsk, and Tomsk have all spawned local environmental movements that would like to shut them down. Representatives from these movements as well as Valeri F. Menchikov, Deputy Chairman, and Eugene Nesterov, Chairman of the Subcommittee on Nuclear and Radiation Risks of the Supreme Soviet's Committee for Ecology and Rational Use of National Resources and Alexi Yablakov, President Yeltsin's environmental advisor, were invited to attend the workshop by co-organizer Lydia Popova, the nuclear fuel cycle specialist of the Socio-Ecological Union (a national umbrella group).

The conversion plans of the three plutonium-production facilities appear to be as follows:

- *CHELYABINSK-65.* Continued recovery of reactor-grade plutonium and the construction of new 800-MWe demonstration fast-neutron reactors. Chelyabinsk-65 shifted over its RT-1 reprocessing plant in 1976 from the recovery of military plutonium from the fuel of the 5 co-located production reactors to the reprocessing of the spent fuel from the first generation of Soviet light-water reactors (VVER-440s); research reactors; submarine and ice-breaker propulsion reactors; and two Soviet demonstration fast-neutron reactors (the BN-350 on the east coast of the Caspian Sea in Kazakhstan and BN-600 at Belyarskiy in the Urals). Thus far about 26 tonnes of reactor-grade plutonium have been separated at the Mayak combine at Chelyabinsk 65.

- *TOMSK-7.* The Russian Ministry of Atomic Energy has proposed Tomsk-7 as the site for a special facility for the storage of surplus fissile materials recovered from dismantled nuclear warheads. The facility is to be built with the assistance of the U.S. (Nunn-Lugar) funds. Two (out of five

original) military plutonium-production reactors are still operating at this site, producing weapon-grade plutonium which is being recovered in an underground military reprocessing facility. According to a 1989 commitment by Gorbachev, the production reactors are to be shut down by the year 2000. The justification given for their continued operation is the space heat and electricity that they supply.

- *KRASNOYARSK-26.* One (out of three original) military plutonium-production reactors is still operating and producing weapon-grade plutonium which is being recovered in an associated reprocessing facility. Here again the reactor is to be shut down by the year 2000 and the justification its continued operation is the byproduct space heat and electricity. Krasnoyask-26 is the site of a 30-40 percent completed RT-2 reprocessing plant for VVER-1000 (1000-megawatt light-water-reactor) fuel. VVER-1000 spent fuel is already being shipped for storage at a 6000 metric tonne uranium (MTU) spent-fuel storage pool at this facility which is currently only about 10-percent full. (However, more than half of the capacity of RT-2 was committed to the reprocessing of VVER-1000 spent fuel from the Ukraine and it is now very uncertain whether this fuel will continue to be shipped to Krasnoyarsk -- see notes from the Kiev workshop below.)

There are no current plans to reprocess the spent fuel from graphite-moderated (RBMK Chernobyl-type) reactors which constitute about 50 percent of the nuclear capacity of the former Soviet Union and whose spent fuel contains lower concentrations of both U-235 and plutonium than VVER spent fuel. The spent fuel from these reactors is accumulating in large cooling ponds at the nuclear-power plants from which it was discharged.

Spokesmen for these conversion plans were invited to the workshop by co-organizer, Professor Anatoli Diakov, Director of the Center for Arms Control, Energy and Environmental Studies of the Moscow Institute for Physics and Technology.

These spokesmen insisted that regardless of any past environmental sins,* their future activities will be models of containment.** They also argued

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* The Mayak facility has caused enormous radioactive contamination as a result of a number of deliberate and accidental releases of high-level waste into the surface environment. Currently, the problem of most urgent concern relates to the approximately 100 million Curies of Cs-137 (30 times the amount released into the atmosphere by the Chernobyl accident) that were dumped into a small depression ("Lake Karachay") which is currently being filled in. The contamination is spreading from the lake into the ground water. At Tomsk and Krasnoyarsk the greatest concern focuses on the huge quantities of fission products that have been injected into local deep aquifers between clay layers as a cheaper alternative to the immobilization of high-level wastes in glass prior to burial -- the practice at all other reprocessing plants worldwide.

** In discussing the proposed RT-2 reprocessing plant for VVER-1000 spent fuel at Kraznoyarsk, L.N. Lazarev of the St. Peterburg Radium Institute promised 99.98 percent recovery of plutonium; 95 percent capture of the volatile fission products Kr-85 and I-129; partitioning (99%) for separate treatment of the long-lived radionuclides, neptunium-237 (halflife 2 million years) and technicium-99 (halflife 200,000 years); zero discharges of contaminated water into the surface environment and deep injection of tritium contaminated water into an aquifer where the water has an "age" (since contact with surface waters) of 40,000 years. The final extraction of actinides neptunium and transuranic isotopes from the high-level waste of RT-2 would be carried out in the underground military reprocessing plant [L.N. Lazarev, "Reprocessing and the Environment," paper prepared for the workshop].

passionately that plutonium should not be buried either in spent fuel or mixed in with high-level vitrified waste.

This focus on the reduction of the longevity of the waste in exchange for highly-expensive chemical processing operations that are likely to result in the generation of more surface contamination than is ever likely to result from leakage from a carefully designed deep underground depository for spent fuel was puzzling to most of the foreign participants. In this connection, one Russian participant cited a 1983 U.S. article which predicts that, for each 100 tonnes of plutonium buried, 10 million cancer deaths will ultimately result. A review of that article* later revealed that the cited conclusion was obtained on the assumption that every atom buried or its decay products will eventually be ingested by humans. Because of the assumed relatively slow leaching and transport to the surface of the waste, the estimated hazard from Pu-239 (about 0.1 cancer death per gram) is dominantly due to its decay product, U-235, which has a half life of 0.7 billion years. The calculated deaths due to the burial of the Pu-239 would therefore occur over about a billion years. The same type of calculation would yield an astronomical number of deaths from the U-235 naturally in the earth's crust. It could also be used to prove that the net reduction of U-235 in the earth's crust by fission in the reactors used to produce the Pu^{239} will ultimately save many millions of lives.

Evgenii Dzekun, chief engineer of the Mayak reprocessing plant, argued for continued reprocessing of spent VVER-400 fuel there and the construction of three new 800-megawatt fast-neutron reactors at a nearby site. He put forward a scenario in which three such reactors would be brought on line in 1997, 1999 and 2001 and operated once-through at an 80-percent capacity factor. With these assumptions 6 tonnes of plutonium would be loaded into the reactors each year.**

This approach is not very useful as a way to deal with plutonium, however, since, as another table in Dzekun's paper showed, at most 0.6 net tonnes of plutonium would actually be fissioned annually in the three proposed reactors if their radial breeding blankets were removed. The net effect of operating the Mayak reprocessing facility and the three reactors would therefore be to convert plutonium in spent light-water-reactor fuel into plutonium in breeder reactor fuel. The expense would be enormous because of the huge operating costs of the reprocessing facility and the fact that the fast-neutron reactors would cost significantly more that light water reactors of the same capacity.***

One obvious motivation behind Dzekun's proposal was to continue to lay the basis for a plutonium-breeder economy in Russia some time in the future. However, that could be done with one demonstration breeder which could be

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* A. Haghighat and M.A. Robkin (University of Washington Department of Nuclear Engineering) "Actinide Hazarad Reduction by Partitioning and Transmutation in a Coupled Reactor System," *Nuclear Technology 61*, #3, June 1983, pp. 503-513.

** E.G. Dzekun, "Experience with the Management of Fissile Materials at 'Mayak'" (paper enclosed).

*** The usual assumption, based on French experience with the 1200-MWe Superphenix, is that the capital cost of a fast-neutron reactor would be twice that of an LWR of equivalent capacity. This is consistent with Japanese estimates of the cost of an 800-MWe fast-neutron reactor. However, Russian fast-neutron reactor advocates are somewhat more optimistic. Dzekun stated that the BN-800 is expected to cost about 30 percent more than an LWR of the same capacity.

fueled by already separated plutonium for many decades. Indeed, it is our understanding that the Soviet government had already decided in 1989 cut back the Soviet breeder-reactor program to at most one 800-MWe demonstration breeder reactor.

Dzekun indicated that the rate of reprocessing of VVER-400 fuel at Mayak has fallen off during the past two years as VVER-400 reactors outside Russia have stopped shipping their fuel to Mayak. Although the nominal annual reprocessing capacity of the RT-1 facility is 400 tonnes of VVER-440 fuel, only 160 tonnes were processed in 1991 and 120 tonnes in 1992. The reprocessing of one hundred twenty tonnes of fuel would yield only about 1 tonne of plutonium -- not the 2.44 tonnes a year projected in his his scenario through 2005.

The hopes for a future in commercial reprocessing at Krasnoyask-26 appear to be similarly unrealistic. As our German workshop participant, Klaus Janberg pointed out, the original movement toward reprocessing in West Europe were made in 1970-71 when the United Kingdom's Atomic Energy Authority offered reprocessing contracts at a price of $15 per kilogram heavy metal (kgHM).* The current price for new reprocessing contracts from the British and French reprocessing companies is about $1000/kgHM -- even though the capital costs of the reprocessing plants have been already paid off by prepayments on the first ten years of reprocessing contracts. As a result, the cost of separating and fabricating plutonium into reactor fuel is currently several times the cost of low-enriched uranium fuel.**

The British and French have earned foreign currency with their nuclear-fuel-reprocessing services. However, because of poor economics, this market appears to be drying up. The only potential customer for Russian reprocessing services that has shown interest is South Korea whose interest in plutonium the U.S. government is trying to discourage.*** The two biggest German electrical utilities (RWE Energie AG and VEBA AG) recently asked permission from the German government to abandon reprocessing and are considering cancelling already paid for reprocessing contracts.**** And Japan is suffering great embarrassment as plutonium is being separated in France from Japanese spent fuel under similar prepaid reprocessing contracts faster than the Japanese nuclear fuel cycle can reabsorb -- a problem that will be compounded if Britain starts up its new reprocessing plant which was also largely financed with prepaid Japanese contracts.

In short, the plutonium-production establishments at Chelyabinsk and Krasnoyask seem to be caught in a time warp with plans for their futures that are no longer viable.

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* The insistence of the U.S. Atomic Energy Commission on similarly low commercial reprocessing prices in the 1960s led to the short-lived and economically and environmentally disastrous U.S. Nuclear Fuel Services commercial reprocessing enterprise which reprocessed about 600 tonnes of fuel between 1966 and 1971 at its facility at West Valley, New York.

** The economic analysis is laid out in some detail in "Disposition of Separated Plutonium" by Frans Berkhout, Anatoli Diakov, Harold Feiveson, Helen Hunt, Edwin Lyman, Marvin Miller and Frank von Hippel, *Science & Global Security 3* (1992, in press, sent in a previous mailing).

*** See the story by Mark Hibbs enclosed.

**** See the enclosed articles by Hibbs enclosed.

In his talk, Dzekun seemed to hint that he was aware of this problem when he complained that it had proved impossible to even give away separated reactor-grade plutonium when it had been offered to governments that had sent delegations to visit Mayak.* He also stated that the cost of cleaning out Am-241 from the decay of 15-year halflife Pu-241 out of the aged reactor-grade plutonium would add about 30 percent to the reprocessing cost -- making its ecconomics still more unfavorable.

A few of us therefore raised with Dzekun over lunch the possibility of Western assistance to facilitate the transition of the workforce at the Mayak reprocessing plant to some other activity. We cited the successful conversion of the U.S. counterpart facility at Hanford from plutonium produciton to cleanup with a net increase in workforce.

Dzekun told us that the Mayak reprocessing plant employes 2500 poeple at an average salary of 1800 rubles per month. Including benefits this is about $1000 per person-year at the current ruble exhange rate -- i.e. a total payroll of $2.5 million/year. He also indicated that the current backlog of liquid high-level waste (HLW) would amount to about 10 year's work for the HLW-glassification plant. But he was not convinced that our proposed conversion approach would be successful at Mayak. In any case, he said he did not have authority to make such decisions. However, he said that he would pass on our ideas to those who do.

Dzekun said that the civilian plutonium recovered at Mayak is stored in standard stainless steel canisters containing 3kg of PuO_2 each and that these cannisters are stored in an "unfloodable" area on a shelf one meter above floor level. He said that the contents of these cannisters are weighed to an accuracy of 0.5 gms but that the uncertainties in the quantities of plutonium being extracted from the fuel are dominated by an 0.5 percent uncertainty in the volume of the reprocessing plant's fuel dissolver tank. He stated that every 3-4 months the plant is cleaned out and a plutonium input-output balance calculated. He said that less than one percent of the plutonium is lost to waste streams and that the next largest loss is to plateout in the plant's plumbing. The material unaccounted for (MUF) is typically 15 kilograms plutonium, which would be a few percent of the throughput during a 3-4 month period. If the MUF is larger than can be explained by measurement errors, a "special investigation" is carried out.**

Dzekun said that the area of "Lake Karachay," the depression into which approximately 100 million Curies of Cs-137 have been discharged has been reduced by filling from an original size of 0.42 square km to 0.18 square km and that the lake level is controlled by adding low-(< 10^{-4}-1 Ci/liter) and intermediate-level (10^{-4}-1 Ci/liter) liquid waste. (One serious contamination event resulted from the lake level being lowered by evaporation during a dry spell in 1967 when a wind storm blew contaminated duste from the exposed shores.)

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*The reactor uranium is reenriched to 2.4 percent U-235 for RBMK (graphite-moderated, water-cooled reactor) fuel.

**In his talk on safeguards at reprocessing plants, Marvin Miller pointed out that the trigger for such an investigation is usually set so that there will be both less than a 5 percent chance of a false alarm and a 95 percent chance of detecting the threshold diversion. This corresponds to a threshold diversion of 3.3 times the standard deviation of the summed measurement errors.

Storage of Surplus Military Fissile Materials

Vladlen Golozubov, (VNIPIET), S.Peterburg described progress in the design of the proposed long-term storage facility for surplus C.I.S. fissile material from dismantled nuclear warheads. A Russian-U.S. meeting had just been held at Los Alamos where a document "General Safety Criteria for the Russian Fissile Material Storage Facility" had been drafted.

According to Golozubov, the current design capacity of the storage facility is 40,000 fissile-material containers, half containing plutonium components and half containing highly-enriched-uranium components. This is down from the 45,000-container first-stage and 110,000-container second stage facility that was being discussed as recently as June 1992. Presumably this reflects in part the expectation that surplus weapons HEU will be sold to the U.S. for dilution to low-enriched power-reactor fuel rather than being stored.

The fissile-component containers are to be designed to withstand a fall of 9 meters, an 800 degress Centigrade fire for 30 minutes or immersion in water at up to 12 atmospheres pressure (corresponding to a depth of over 100 meters). The storage compartments would be cooled by natural convection if the air conditioning failed and would be sealed with hermetic doors. Golozubov estimated the construction cost of the facility at 330 million 1990 rubles or about $30 million at current exchange rates.

The city council of Tomsk has voted against hosting the storage facility. When Tom Cochran asked Golozubov about the possibility of a tradeoff, in which Tomsk would accept the storage facility in exchange for the shutdown of the reprocessing facility at Tomsk-7, Golozubov agreed that this was "the only possibility." Later Cochran gave an interview to Tomsk TV in which he argued that the exhange would result in a net reduction in environmental risk for the citizens of Tomsk.

In response to a question, Golozubov stated that the storage facility would be guarded by a special military guard and that no consideration was being given to storing civilian plutnonium in it.

There was some internal debate within the U.S. group about the desirability of the fissile-component storage facility. A secure central storage facility will provide important insurance against diversion. But the prevalent Minatom view that plutonium is a "national heritage" and must be preserved indefinitely made some of us nervous. In contrast, the predominant view in the U.S. government appears to be that surplus weapons plutonium is a waste that must be stored temporarily pending a determination of the best approach to imbedding it into more proliferation-resistant form -- most likely, spent fuel or vitrified high-level waste.

Disposition of Weapons Plutonium

The Breeder Alternative. V.M. Murogov, of the Obninsk Institute of Power Engineering discussed that Institute's proposal for the disposition of surplus weapons plutonium.*

Murogov acknowledged that the use of plutonium as a fuel in light-water reactors posed both safety and safeguards problems and suggested instead that the plutonium be used to fuel the cores of fast-neutron reactors located near Mayak and equipped with thorium instead of uranium blankets. The U-233 bred in the blankets would then be used after dilution with U-238 to fuel a new generation of safer light-water reactors.

Murogov stated that plutonium fuel has been tested in three fast-neutron reactors in the former Soviet Union: the BR-10 at Obninsk (an entire core containing 150 kg of plutonium) and the BN-350 on the Caspian Sea (350 kg of plutonium in 10 test fuel assemblies) and the BN-600 (an unspecified amount of fuel). In total, over 2000 MOX fuel rods had been fabricated at the pilot test facility "Paket" at Mayak and tested in the BN-350 and BN-600 up to a 10 percent burnup without leaks at a linear heat rate of 490 Watts/cm. He therefore proposed to use the weapons plutonium as fuel for the BN-600 and the proposed BN-800 reactor. The initial core of the BN-800 reactor would contain 2.3 tonnes of plutonium with annual reloads containing 1.6 tonnes. He stated that the associated fuel-fabrication facility (complex 300 at Mayak) was 50-percent complete.

In the longer term, Murogov argued for the development of a new metal or cermet fuel which would not contain uranium-238 in which the plutonium could be fissioned without generation of additional plutonium and a blanket of thorium in which U-233 would be bred to fuel a new generation of safer light-water reactors.

The Vitrification Alternative. The alternative of disposing of separated plutonium directly in high-level-waste (HLW) glass was discussed in a paper brought by the U.S. group.** The argument was made that this would be both a more secure method of disposal (because minimal processing and only one site would be involved) and at much lower cost. According to the summary table of the paper the disposition costs for 100 tonnes of plutonium would be roughly as follows:

Glassification with HLW	$ 0.1-0.75 billion
Conversion to fuel for light-water reactors	~$ 1 billion
Use as fuel for fast-neutron reactors	~$ 5 billion

The extra cost in the light-water-reactor case is due to the fact that the cost of fabricating fuel containing plutonium exceeds the full cost of the low-enriched uranium fuel that would otherwise be used. The extra cost in the fast-neutron-

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* V.M. Murogov, "Energy Conversion of Weapons Plutonium in an Ecological Acceptable Nuclear Fuel Cycle" (enclosed).

** "The Disposition of Separated Plutonium."

reactor case is largely due to the fact that fast-neutron reactors cost much more per unit of electrical generating capacity than light-water reactors.

Diakov presented a paper (enclosed) describing the vitrification plant at Mayak. He estimated the capital cost as $70 million with one half of the cost being due to the massive glass melter, which has to replaced after about 3 years use. According to Boris S. Zakharkin of the Institute of Inorganic Materials (VNIIM), Moscow, the phosphate glass currently being made at Chelyabinsk has a Curie content of 0.15 Curies per gram. Dzenkun stated that about 680 tonnes of glass had been vitrified thus far, containing about 100 million Curies of Sr-90, Cs-137 and their decay products. Dzekun stated that about 400 million Curies remained in Mayak's high-level-waste tanks.*

Miscellaneous

Mikhailov Now Chief Scientist at Arzamas-16. We were told that Victor Mikhailov, Russian Minister of Atomic Energy, has named himself to succeed Yuli Khariton as chief scientist of Russia's first nuclear weapons design laboratory.

Reciprocity. We were told that Yeltsin's administration was recently attacked by conservatives in the Parliament for selling out Russian security with "unequal agreements" in exchange for the $400 million Nunn-Lugar funds." The reference was apparently to certain conditions that the U.S. Congress had attached to its authorization of U.S. assistance for the elimination of C.I.S. warheads and other weapons. These conditions include the requirement that Russia unilaterally commit itself to forgoe any reuse in weapons of the fissile materials and other weapons components recovered from dismantled nuclear weapons and facilitate U.S. verification of its compliance with this requirement.

We were told that Victor Mikhailov, the Russian Minister of Atomic Energy responsible for negotiating the terms of the specific assistance responded in a speech to the Supreme Soviet that, in fact, he had obtained U.S. financing without accepting any verification conditions. Most of the U.S. assistance provided thus far has been for safe transport of C.I.S. warheads.

In a hearing before the Senate Armed Services Committee on 4 August, Assistant Secretaries from the U.S. Departments of Energy, Defense and State and the outgoing Assistant for Atomic Energy to the Secretary of Defense all insisted that their Russian counterparts had shown no concern about the U.S. refusal to offer reciprocal assurances as to the irreversibility of U.S. reductions.

The U.S. has committed to supply at least 10,000 containers at $5,000 apiece for the storage of fissile components from dismantled nuclear warheads and

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* The Russian convention for Curies seems to be to include both the Curies of 30-year halflife Cs-137 plus Sr-90 plus their shorter-lived decay products, Ba-137m and Y-90 but, because of language problems, we were still not able to nail this down to our satisfaction.

" See e.g. "Treaty of Unequals," *Sovietskaya Rossiya*, 8 December 1992. An interview with Iona Andronov, Deputy Chairman of the Committee of International Affairs and Foreign Economic Relations of the Russian Supreme Soviet and also with Georgi Kornienko, former Deputy Minister of the USSR Foreign Ministry.

has committed $15 million toward the design of a facility for the long-term storage of these fissile components (at least the plutonium components). The State Department has assured the Congress that it expects that the U.S. will be offered opportunities to verify that the materials stored in these containers and storage facility will not be reused in weapons.

To our knowledge, however, the U.S. has not been given information as to the storage locations of the many thousands of tactical warheads transported from the Belarus, Kazakhstan and the Ukraine that are to be dismantled and whose fissile material is to be disposed of for nonweapons purposes by agreement of these republics with Russia. Foreign Minister Kozyrev proposed reciprocal declarations of the U.S. and Russian nuclear warheads and fissile materials and their respective storage and production facilities but the Bush Administration did not respond.

Kiev Workshop
(17 December 1992)

Our host organization was the Scientific Center for International Policy of the Ukrainian "Znanie" (Knowledge) Society. This is the same organization that hosted our visit to Kiev a year ago. Arrangements for our visit to Kiev were made by the Russian Foreign Ministry. Since we did not have direct communication with the Ukrainians in advance of the workshop, we did not know the agenda until we arrived.

When we arrived, we found ourselves in sessions in which we were invited to ask questions about Ukraine's nuclear-energy and nuclear-weapons policy. The principal respondents were:

- Dr. Volodymyr B. Gryniov, Deputy Chairman of the Ukrainian Supreme Soviet, who met separately with us at the Ukranian Supreme Soviet;
- Colonel Valentin I. Astakhov, Department Head, Ukrainian General Staff and Vladimir Resnikov (civilian), Ukrainian General Staff; and
- Georgii A. Kopchinskii, First Deputy of the State Committee of Ukraine for Nuclear and Radiation Security.

We also had a private exchange at the Moscow workshop with Konstantin I. Grischenko, Head of the Arms Contol and Disarmament Department of the Ukrainian Ministry of Foreign Affairs.

Ukraine's Nuclear-weapons Policy

All the Ukranian officials insisted that the Ukraine fully intends to become a nonnuclear weapons state -- but that it will take several years and that assistance, assurance against nuclear threats, and a fair share in the value of the recovered uranium must be part of the deal.

Astakhov stated that the dismantlement of ICBMs will be conducted by the Ukrainian military -- after which the warheads will be handed over for transport to

Russia for dismantlement. When we suggested that the warheads could be removed to safe storage more quickly by removing them from the ICBMs before the ICBMs are removed from their silos, he cited both "political and ecological" problems" with this approach and also insisted that it would not be safe to remove the warheads from the missiles before the missiles were themselves dealt with because of the "integrated climate-control" systems of the missiles.

The scenario Astakhov laid out was therefore of the Ukrainian military removing ICBMs from their silos and dismantling them one by one over a period of several years. The shortest time in which he could imagine dismantlement being completed was 2-3 years. He stated that external assistance would be required and mentioned in particular the need for pumping equipment and tanks to store the toxic liquid fuel in the SS-19 ICBMs. He stated that the Ukraine does not have this type of equipment on the scale required to defuel the 130 SS-19. He also stated that the original 1994 deadline for denuclearization to which Ukraine had committed itself in the December 1991 Alma Ata accords had been unrealistic and complained that "we haven't seen anything but promises" of assistance yet "from the Americans."

Astakhov denied any interest on the part of the Ukrainian military in obtaining an ability to launch the ICBMS located on the republic's soil. However, Leonid Leschenko, a department head at the Ukrainian Institute of World Economics and International Relations who participated as an observer in both the Kiev and Moscow workshops stated his opinion that Ukraine should have a "technical capability" to block the launch of the ICBMs. (Currently the Ukrainian President has only the promise of consultation before launch.)

Astakhov stated that the ICBMs were being shifted to "cold-mode" alert levels in which they would not have a launch-on-warning capability. [At our workshop a year ago we were informed by a participant from the Russian General Staff that the ICBMs (or their warheads) had been disabled to the point where it would take weeks before they could be put back again into a functional state.]

Grischenko, when asked if the $175 million assistance package recently offered by the Bush Administration would be sufficient to cover the costs of the missile and silo elimination responded in the negative. In response to the same question, Gryniov said that he didn't know.

Gryniov stated that the Ukraine does not wish to become a nuclear-weapon state (he said that a decision to do so would be "catastrophic) . However, he said that the Ukraine needs an individualized guarantee against nuclear attack signed by both Russia and the U.S. He rejected as inadequate "psychological reassurance" to the Ukrainian population the Russian no-first-use declaration and the U.S. declaration that it will not attack with nuclear weapons an NPT signatory that is not allied with a nuclear-weapons state. Nevertheless, he also stated his personal view that Ukraine's parliament (the Rada) would ratify both the START and the NPT Treaties during February.

Nuclear-reactor Safety

Ukraine has inherited a large fraction of the nuclear-power capacity of the former Soviet Union. This capacity produced about 27 percent of Ukraine's

electricity in 1991 -- up to 40 percent during the winter months. However, as a result of the 1986 Chernobl accident, there is a strong anti-nuclear movement in the Ukraine. In October, the Rada voted to shut down the entire Chernobyl plant in 1993 but the officials that we met expressed considerable uncertainty as to whether this shutdown would occur in view of the dire shortage of electric power in the Ukraine. The proposal of the nuclear-safety organization is to replace the three remaining operable 1000-MWe graphite moderated reactors at Chernobyl with three 1000-MWe light-water reactors (VVERs) that are currently in a nearly complete but frozen state: Zaporozhe-6, Rovno-4 and Khmelnitski-2.

When we visited the Chernobyl site the next day we found two 1000-Mwe units operating with a third down because of a major fire in the turbine room that occurred last October. The spent fuel discharged by the Chernobyl RBMKs is being stored in large cooling ponds that are only about half full. The RBMKs are to be replaced by three VVER-1000s but new construction starts are "frozen" until 1995.

In addition to the Chernobyl reactors, the Ukraine possesses 2 operable VVER-440s and 10 VVER-1000s. In the past, spent fuel from these VVERs was sent to either Chelyabinsk-65 or Krasoyarsk-26. This system has broken down -- at least temporarily because of a vote by the Russian parliament to forbid the import of radioactive waste into Russia. This has created a problem since the VVER spent-fuel storage pools can contain only 1.5-2 years more discharged fuel. The plan is to add by 1996-97 central dry storage with sufficient capacity to store more than 4000 tonnes of heavy metal in spent fuel. However, this will not be soon enough to deal with the immediate problem. Kopchinski stressed that assistance from Russia is required to deal with this problem. He stated that Ukraine has no hard currency to buy dry storage casks from the West.

He also indicated that Ukraine is interested in obtaining both uranium-enrichment and fuel-fabrication technology. In the meantime, starting in 1993, the Ukraine will supply its own natural uranium for enrichment and fabrication into fuel in Russia. For the long term, "whether we have an open or closed fuel cycle is an open question."

Finally, Ukraine -- like every other country using nuclear power -- expects to have difficulty getting any community to accept an underground high-level-waste depository.

Enclosures

Agenda and Participants: Workshop on the Future of Reprocessing and Arrangements for the Storage & Disposition of Already Separated Plutonium (Moscow, 14-16 December 1992)

Mark Hibbs, "Russian Plutonium Program at the Crossroads: A Special Report," *Nuclear Fuel*, 4 January 1993, pp. 4-7;

-- "Chernobyl Resumes Operation as Regulators Run into Opposition," *Inside N.R.C.*, 28 December 1992; "Ukrainians Predict Chernobyl will Operate Past End of 1993, *Nuclear Fuel*, 31 December 1992, pp 11-12; "Chernobyl Management Aiming to Upgrade ECCS with G-7 Funds," *ibid*, pp. 12-13;

-- "Big German Utilities Propose Conditional Nuclear Phase-out," *Nuclear Fuel*, 10 December 1992 (special issue); "German Utilities Ready to Sacrifice Hanau MOX Fabrication Plant," *ibid*, 4 January 1993, pp. 7-9.

Thomas B. Cochran and Christopher Paine, "Chemical Separation Plants in Russia: Why Further Operations Should be Deferred"

Johan Swahn, "Direct Disposal of Spent Fuel: The Swedish KBS-3 Method"

Klaus Janberg, "Recyling of Plutonium in LWRs in Germany: Status in Nov. 1992"

Tatsujiro Suzuki, "Plutonium and Reprocessing in Japan -- Signs of Change?"

Eugene Dzekun, "Experience with the Management of Fissile Materials at 'Mayak'"

L.N. Lazarev, "Reprocessing and the Environment in Russia"

V.M. Murogov *et al*, "Energy Conversion of Weapon Plutonium in an Ecologically Acceptable Nuclear Fuel Cycle"

Anatoli Diakov, "~~Technical Possibilities for Inclusion of Plutonium in High-level Waste Glass~~" "Imbedding Russian Weapon Grade Plutonium into High-level-waste Glass: Technical Considerations"

David Hughes,"Arms Experts Fear Nuclear Blackmail", AVIATION WEEK, January 4, 1993 -- "U.S., Russia Bargin for Enriched Uranium", Ibid, January 11, 1993.

John-Thor Dahlburg, "Ex-Soviets' 'Loose Nukes' Sparking Security Alarms", Los Angeles Times, December 28, 1992.

Mark Hibbs, "Russian Plutonium at the Crossroads: A Special Report," Nuclear Fuel, January 18, 1993

Article in Russian on Plutonium, 1992

R. Jeffrey Smith,"Reporters Granted First Look at Texas Nuclear Weapons Facility", Washington Post, January 13, 1993.

AGENDA
(written papers are indicated by an *)

Workshop on the Future of Reprocessing and Arrangements for the Storage & Disposition of Already Separated Plutonium
(fifth in a series of international workshops)
Moscow, 14-16 December 1992

Cohosted by

The Russian Parliament Committee on Environmental Protection
The Socio-Ecological Union of Russia, and
The Center for Arms Control, Environment and Energy Studies of the Moscow Institute of Physics and Technology

Foreign Delegation Co-organized by the
Federation of American Scientists and the
Natural Resources Defense Council

Monday, December 14: THE FUTURE OF REPROCESSING

The Status of Reprocessing and the Future of the Nuclear Fuel Cycle in Russia
-- Boris Zakharkin (VNIIM, [Institute of Inorganic Materials, Moscow])

Reprocessing and the Environment in Russia*
-- Leonid Lazarev, Radium Institute, St. Petersburg

Chemical Separation Plants in Russia: Why Further Operations Should be Deferred*
-- Thomas B. Cochran and Christopher Paine (NRDC)

Direct Disposal of Spent Fuel: The Swedish KBS-3 Method*
-- Johan Swahn (Chalmers University of Technology, Sweden)

Recyling of Plutonium in LWRs in Germany: Status in Nov. 1992*
-- Klaus Janberg (Gesellschaft fur Nuklear Service, Germany)

Reprocessing and Plutonium Recycle in Western Europe
--Frans Berkhout (Princeton)

Plutonium and Reprocessing in Japan -- Signs of Change?*
--Tatsujiro Suzuki (MIT)

Problems of Plutonium Safeguards at Reprocessing and Plutonium-fuel Fabrication Plants
-- Marvin Miller (MIT)

DISCUSSION

Tuesday, 15 December: PLUTONIUM STORAGE

Design and Safe Operation of a Russian Storage Facility for Fissile Materials from Weapons
-- Vladlen Golozubov, (VNIPIET), S.Peterburg

Experience with the Management of Fissile Materials at "Mayak"*
-- Eugene Dzekun, (Majak), Chelyabinsk

International Arrangements to make Nuclear-weapons Reductions Irreversible
-- Frank von Hippel (Princeton)

Development of a U.S. Policy on the Storage and Disposition of Surplus Weapons Plutonium
-- Chris Paine

Japan's Plutonium Policies: Domestic and International Dimensions
-- Kumao Kaneko (Tokai University)

On the Application of IAEA Safeguards to Plutonium and Highly Enriched Uranium from Military Inventories*
-- Discussion of a paper by Tom Shea (IAEA)

DISCUSSION

Wednesday, 16 December: PLUTONIUM DISPOSITION

The Prospects for Use of Plutonium in Fuel in Russia
--Victor Orlov (NIIKET [Institute for Construction of Energy Devices]) Moscow

Alternative Approaches to Plutonium Use in Reactor or Accelerator Fuel
-- Marvin Miller (MIT)

Energy Conversion of Weapon Plutonium in an Ecologically Acceptable [Fast-neutron Reactor] Fuel Cycle*
--Victor Murogov et al (Institute of Physics and Power Engineering, Obninsk)

Technical Possibilities for Inclusion of Plutonium in High-level Waste Glass
-- Anatoli Diakov, Moscow Institute for Physics and Technology

Current State of Cross-Section and Radioactivity Data for Plutonium-239.
--Feliks Chukreev, Kurchatov Institute, Moscow
--Vasili Manohin, Institute of Physics and Power Engineering, Obninsk

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10 January 1993

To: Colleagues Concerned about Nuclear Warhead and Materials Controls

From: Frank von Hippel

Please find attached copies of the following:

Report on an International Workshop on the Future of Reprocessing, and Arrangements for the Storage and Disposition of Already-Separated Plutonium (Moscow, 14-16 December 1992), and an International Workshop on Nuclear Security Problems (Kiev, 17 December 1992). The foreign delegations to these workshops were co-sponsored by the Federation of American Scientists and the Natural Resources Defense Council (Thomas Cochran and Christoper Paine).

In the Moscow workshop, we learned of: the hopes at the Chelyabinsk-65 nuclear complex to continue reprocessing power-, research- and naval-reactor fuel and to use the recovered plutonium to fuel a new generation of fast-neutron reactors; the hopes at the Krasnoyarsk-26 complex to complete and operate the partially completed light-water-reactor fuel reprocessing plant there; and the hopes to build a U.S.-financed long-term storage facility for military plutonium and some highly-enriched uranium near Tomsk. We also heard from the local environmental groups who oppose each of these plans. In our turn, we gave presentations on the security risks associated with separated plutonium, its current negative economic value as a fuel, and the possibilities of disposing of surplus separated plutonium in glassified high-level waste.

We also learned of a conservative backlash in the Russian Parliament against the verification requirements of the Nunn-Lugar "Soviet Nuclear Threat Reduction Act of 1991" that requires that, in exchange for U.S. assistance for nuclear weapons transport and storage, Russia forgoe "any use of fissionable and other components of destroyed nuclear weapon in new nuclear weapons." The conservatives apparently regard this arrangement as "unequal" because the U.S. has not been willing to make the reciprocal assurances.

In the Kiev workshop, we learned of the Ukrainian government's proposed go-slow approach to the removal of the 1240 strategic warheads on the 176 silo-based ICBMs in that republic to Russia for dismantlement. Basically, the proposal is to remove the warheads from each missile only as a part of an operation that would dispose of the booster and its toxic fuel at the same time.

A journalist, Mark Hibbs, accompanied us. Some of his articles on Russian plutonium policy, Ukrainian nuclear-energy policy and German reprocessing policy are enclosed. He will have an additional set of articles from the workshops on Russian high-level-waste vitrification, plutonium storage, Chernobyl-reactor-type spent-fuel and the plutonium policy of the Russian Ministry of Atomic Energy in the 18 January issue of *Nuclear Fuel.*

In addition, some of the papers presented at the workshop are enclosed.*

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* Two other papers, "Disposition of Separated Plutonium" by Frans Berkhout, Anatoli Diakov, Harold Feiveson, Helen Hunt, Edwin Lyman, Marvin Miller and Frank von Hippel and "On the Application of IAEA Safeguards to Plutonium and Highly Enriched Uranium from Military Inventories" by Tom Shea (IAEA), were distributed in the 4 December mailing.

"Arms Experts Fear Nuclear Blackmail"* quotes David Kay as arguing that the smuggling of some plutonium or HEU out of Russia is "likely" during the next 5 years. The article also quotes me as arguing for international safeguards to reinforce Russian safeguards on surplus nuclear warheads and fissile materials.

"The Laboratories and the Former Soviet Union" describes a possible role for the U.S. nuclear-weapons labs in supporting and monitoring the establishment of such such reinforced safeguards by the Russian nuclear weapons laboratories as well as similar roles in the improvement of the safety of nuclear-power reactors in the former Soviet Union and the cleanup of the environmental legacy of Soviet plutonium production.

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* David Hughes, *Aviation Week & Space Technology*, 4 January 1993, pp. 61-62.