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Contingency Planning for Feedstock Splits Between the Immobilization and MOX Disposition Routes to Fissile Materials Disposition

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Contingency Planning for Feedstock Splits Between the Immobilization and MOX Disposition Routes to Fissile Materials Disposition

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ABSTRACT

In 1997, DOE issued a ROD endorsing a "dual-track" approach for dispositioning excess Pu so that it achieved the "spent-fuel standard." This assumed 35.6 tonnes of weapons-grade Pu, 7.4 tones of non-weapons-grade Pu plus 7 tonnes of weapons-grade Pu from future retirements would make up the feed stock. The Center for Strategic and International Studies Senior Policy Panel on the Safe, Timely, and Effective Disposition of Surplus U. S. and Russian Weapons-Grade Plutonium (CSIS) deemed this direction as well and soundly conceived. The DOE's Materials Disposition Program is presently on track to deploy both disposition routes. In this hybrid approach, MOX fuel irradiation route would be used for pure Pu. Immobilization would be used for mixtures that are less practicable to fabricate into fuel or could be used for the full 50 tonnes. Both routes must overcome their uncertainties and obstacles and come on-stream for the complete disposition of the U. S. excess weapons-useable plutonium. However, because these disposition plants are being designed primarily to accommodate the hybrid, not the dual option, they fall short of the glowing praise heaped upon the Disposition Program by the CSIS. However, fairly minor changes to the disposition plants would bring them much closer to the glowing praise of the CSIS. A major problem for the program is the constantly changing status of the feed stock. DOE/EM is tossing much greater quantities of Pu to WIPP than had been anticipated and DOE/NE is reserving tonnes of Pu as national assets that had not been anticipated. Due to the loss of tonnes of Pu feed, original assumptions may no longer hold and the feed acceptance criteria may have to be revised. Many groups are now advancing unsolicited contingency plans to carry out the disposition of excess plutonium. Though these unsolicited plans may save money, they all appear to be in conflict with national policy.

INTRODUCTION

On January 14, 1997, the U. S. DOE issued a Record of Decision endorsing a "dual-track" approach for dispositioning excess Pu (1) so that it achieved the "spent-fuel standard." Under the dual-track approach, one track would fabricate weapons-grade Pu into mixed-oxide (MOX) fuel to be irradiated in existing U. S. commercial light-water reactors. The second track would mix the weapons-useable Pu into a ceramic mineral matrix that would then be incased in high-level radioactive waste for eventual geologic disposal. The Center for Strategic and International Studies (CSIS) Senior Policy Panel on the Safe, Timely, and Effective Disposition of Surplus U. S. and Russian Weapons-Grade Pu (2) has deemed this DOE program direction as well and soundly conceived for several reasons. Among these reasons are:

- "…The pursuit by the U. S. of two avenues for achieving the spent fuel standard provides the nation with important insurance that it will have at least one credible route available for converting the U. S. excess stockpile to the spent-fuel standard on a timely basis. Because each route faces some uncertainties and obstacles, the U. S. is enhancing the prospects of success by building redundancy into the program…
- Russia views any weapons-grade plutonium that will be only immobilized as being easier to reincorporate into nuclear weapons of existing design without testing than will plutonium that has been irradiated in reactors…
- The use of a dual-track approach will be essential to assure that the U. S. Disposition Program receives the requisite support to succeed domestically and internationally. Because there strong proponents of each of the two options, it is doubtful that the pursuit by the U. S. of only one alternative is likely to gain the requisite broad political support the program will require over the next several years…"

This decision was a culminating point of work set in motion earlier. On September 27, 1993, President Clinton (1, 3) announced the establishment of a framework for United States efforts to prevent the proliferation of weapons of mass destruction. In response to the growing threat of nuclear proliferation, the President's Nonproliferation and Export Control Policy (4) stated:

"The United States does not encourage the civil use of plutonium and, accordingly, does not itself engage in plutonium reprocessing for either nuclear power or nuclear explosive purpose…"

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Further, in January 1994, President Clinton and Russia's President Yeltsin issued a Joint Statement (1, 4) between the United States and Russia on "Nonproliferation of Weapons of Mass Destruction and the Means of Their Delivery". In this statement the Presidents endorsed the goal of irreversibility of nuclear arms reductions. They also tasked their experts to jointly "study options for the long-term disposition of fissile materials, particularly of Pu, taking into account the issues of nonproliferation, environmental protection, safety, and technical and economic factors." In accordance with these policies, the focus of the U.S. nonproliferation efforts is five-fold (1):

1. to secure nuclear materials in the former Soviet Union;
2. to assure safe, secure, long-term storage and disposition of surplus weapons-usable fissile materials;
3. to establish transparent and irreversible nuclear arms reductions;
4. to strengthen the nuclear nonproliferation regime; and
5. To control nuclear exports.

To demonstrate the United States' commitment to these objectives, President Clinton (1, 5) announced on March 1, 1995, "that 200 tons of fissile material, enough for thousands of nuclear weapons, be permanently withdrawn from the United States nuclear stockpile. Two hundred tons of fissile material that will never again be used to build a nuclear weapon." Of these 200 tonnes of U.S.-origin weapons-usable fissile materials, 165 tonnes are HEU and 38 tonnes are weapons-grade Pu.

The Secretary of Energy's Openness Initiative (1, 6) announcement of February 6, 1996, stated that the U. S. has 213 tonnes of surplus fissile materials, including the 200 tonnes the President announced in March 1, 1995. Of the 213 tonnes of surplus materials, about 174.3 tonnes are HEU and about 38.2 tonnes are weapons-grade Pu. Additional quantities of Pu may be declared surplus in the future.

Another zenith occurred on September 2, 1998, when Presidents Clinton and Yeltsen signed (7) the "Joint statement of principles for Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes." In this joint statement the Presidents "affirm the intention of each country to remove by stages approximately 50 metric tons of Pu from the nuclear weapons programs, and to convert this material so that it can never be used in nuclear weapons…and…to ensure that these materials do not become a proliferation risk."

ORIGINAL PLANNING BASES

The National Security Council (8) performed a detailed review in conjunction with the DOE and the DOD of the Pu and HEU requirements to support the nuclear weapons program and other national security needs. Nuclear materials that are not required have been declared excess (See Table 1). Quantities listed are based on the evaluation of available records. Quantities may be updated after re-evaluation of the original records.

Table 1. Weapons-grade Material Declared Excess by the National Security Council

Site	Weapon-grade Pu (Tonnes)
Pantex Site plus planned dismantlements	21.3
Rocky Flats Environmental Technology Site	11.9
Hanford Site	1.7
Los Alamos National Laboratory	1.5
Savannah River Site	1.3
Idaho National Engineering Laboratory Site	0.4
Other sites (includes Government and non-Government sites, DOE contractors, research institutes, and universities	0.1
TOTALS (may be affected by rounding)	38.2

In February 1994, then-Under Secretary Charles B. Curtis (9) launched the Materials in Inventory (MIN) Initiative. For the purposes of the MIN Initiative, the Department defined "materials in inventory" as all materials in storage at DOE-owned facilities:

- That are not currently in use,
- Materials that have not been designated as waste, and
- Materials that have not been set aside by the Nuclear Weapons Council.

For the MIN Initiative, the Department defines “not currently in use” as materials that have not been used during the past year and are not reasonably expected to be used in the coming year.

The Department currently manages approximately 52.6 tonnes of Pu not in weapons:

1. Approximately 73 percent (38.2 tonnes) of the 52.6 tonnes reported is weapons-grade Pu. Most of this material (27.8 tonnes) is in metal form; the remaining 10.4 tonnes comprise oxides, spent nuclear fuel, unirradiated fuel, and other forms.
2. Approximately 27 percent [14.3 tonnes] of the Department's Pu inventory is reactor or fuel grade. Pu contained in spent nuclear fuel accounts for the largest portion of this material, representing 6.9 tonnes; the remaining 7.4 tonnes comprises all other forms.

Assumptions had to be made to begin the Disposition Program (10). The base assumptions were:

- That all of the approximately 38.2 tonnes of weapons-grade material declared excess by the National Security Council would come to the Disposition Program; with the following exceptions:
  (a) Approximately 2 tonnes would not be of sufficient purity to merit disposition and would therefore be disposed of as waste in the Waste Isolation Pilot Plant (WIPP).
  (b) The irradiated material would be disposed of as irradiated fuel in the National Repository.
- The non-weapons-grade materials that the Secretary of Energy announced as excess would come to the Disposition Program as immobilization feed.
- The Actinide Packaging and Storage Facility (APST) would be built and usable.
- The difference between the amount available and 50 tonnes would be made up be later retirements as START II and START III takes effect.
- The 94-1 stabilization Program would be carried out and the lesser purity feeds would be processed in a fashion to increase the Pu concentration.

The Office of Materials Disposition (MD) published these assumptions, summarized in Table 2, in April 1997 as its feed materials planning bases (10). The report noted "Bases on current plans and assumptions about how the Pu forms will be stabilized for safe storage, approximately 9.5 MT of the Pu listed in Table 2 is considered sufficiently unattractive for use in weapons that is not considered to be weapons-usable. This includes 7.5 MT of Pu in irradiated fuel and another approximately 2.0 MT of low-concentration materials in "other forms" for which extraction of Pu would not be practical and which are expected to be processed and repackaged for disposal as TRU waste…"

Table 2. Surplus Plutonium

Category	Weapons-Grade Pu	Non-Weapons-Grade Pu	Total Surplus Pu
Metal	27.9	1.0	28.9
Oxide	3.1	1.3	4.4
Reactor Fuel	0.2	4.4	4.6
Irradiated Fuel	0.6	6.9	7.5
Other forms	6.4	0.7	7.1
Total Surplus Pu	38.2	14.3	52.5
Assumed non-weapons-usable	2.6	6.9	8.9
Assumed weapons-Usable	35.6	7.4	43.0
Pu assumed declared surplus in future	7.0		7.0
Weapons-Usable Pu Post-Stabilization	42.6	7.4	50.0

Immobilization looked at both a 17 tonne and an 18 tonne case. A further breakdown of possible Immobilization feed stock for these two cases is given in Table 3. These two cases give the feed source prior to the stabilization program. It was assumed that the 94-1 stabilization Program would be carried out as written and the lesser purity feeds would be processed in a fashion to increase the Pu concentration. For instance, it was assumed that the chloride salts would be process such that at lease 15 of the 16 tonnes of chloride salts would be removed from the "chloride-oxide" residues leaving about 1 tonne of Pu oxide slightly contaminated with chloride salt.

Table 3: Plutonium Feedstock For The 17 & 18 Tonnes Base Cases For Immobilization

Feed	Stream	MT Pu Feed	MT Pu feed
1	Pure Metal Converted to Oxide	To MOX	To MOX
2	Hanford Pure Oxides	1.7	1.7
3	Hanford Off Spec Metal-Oxides	3.4	3.4
4	Pu Alloys	1.0	1.0
5	Hanford & RF Impure Oxides	3.481	3.481
6	FFTF & Other Oxide Fuel	1.3	1.3
7	RF Oxides at Hanford (in 5)		
8	Chlorinated Oxides	1.04	1.04
9	Ash	0.131	
10	Ash Heels	0.003	
11	ZPPR (Alloy) Fuel	3.5	3.5
12	ER Salts (NaCl/KCl)	0.326	
13	ER Salts (CaCl2)	0.326	
14	DOR Salts	0.13	
15	MSE Salts (CaCl2)	0.203	
16	MSE Salts (NaCl/KCl)	0.203	
17	Anode Heels	0.558	0.558
18	Pu/U Oxides	0.9	0.9
	Total	18.201	16.88

FLOW SHEET BASED UPON ORIGINAL PLANNING BASES

Based upon the assumed feed stock, flow sheets were laid out to receive the following feed stocks:

- FFTF fuel assemblies and pins
- ZPPR fuel plates and pins
- Chloride salt contaminated plutonium oxide
- Alloys
- Clean plutonium metal,
- Impure plutonium metal
- Oxide fuel pellets
- Clean plutonium oxide
- Impure plutonium oxide
- Mixed Pu/U oxides

Each of these would be received into the head-end operation and transform them into acceptable oxide powder feed stock for conversion to the immobilized form. (See Figure 1) These residues were left in place when the weapons production complex was shutdown at the end of the “Cold War.” These residues have a wide range of impurity contents, typically from a few parts per million to > 90 wt. %.

Plutonium in these prepared oxide residues would be blended (approximately 75 kg total mass per blend batch) to levelize the impurities, Pu content, Pu isotopics, and U content. . The blender batch will be fully characterized. If the blend batch meets specifications, it will be fed to the next step; otherwise it will be returned to the vault for further blending. By using the blending step to levelize the contents of the feed stocks, reprocessing of this Pu is avoided. The blended Pu feedstock will then be blended with additional DU oxide and with ceramic precursors. Reactive sintering at high temperature (about 1350˚C) to form titanate ceramic disks would then mineralize this blended Pu. The ceramic disks will then be stacked and sealed in stainless steel cans, which would be arrayed within large stainless steel canisters into which vitrified high-level waste (borosilicate glass) would be poured. The heavy weight, about 3 tons, and large size, about one meter high by 0.6 meter in diameter, of each stainless steel canister, together with the highly radioactive waste barrier, increases the proliferation resistance of the immobilized Pu. The “can-in-canister” approach will use vitrified, high-level waste from existing facilities at Savannah River (the DWPF facility). Subsequently, the canisters will be disposed of in the national geologic repository.

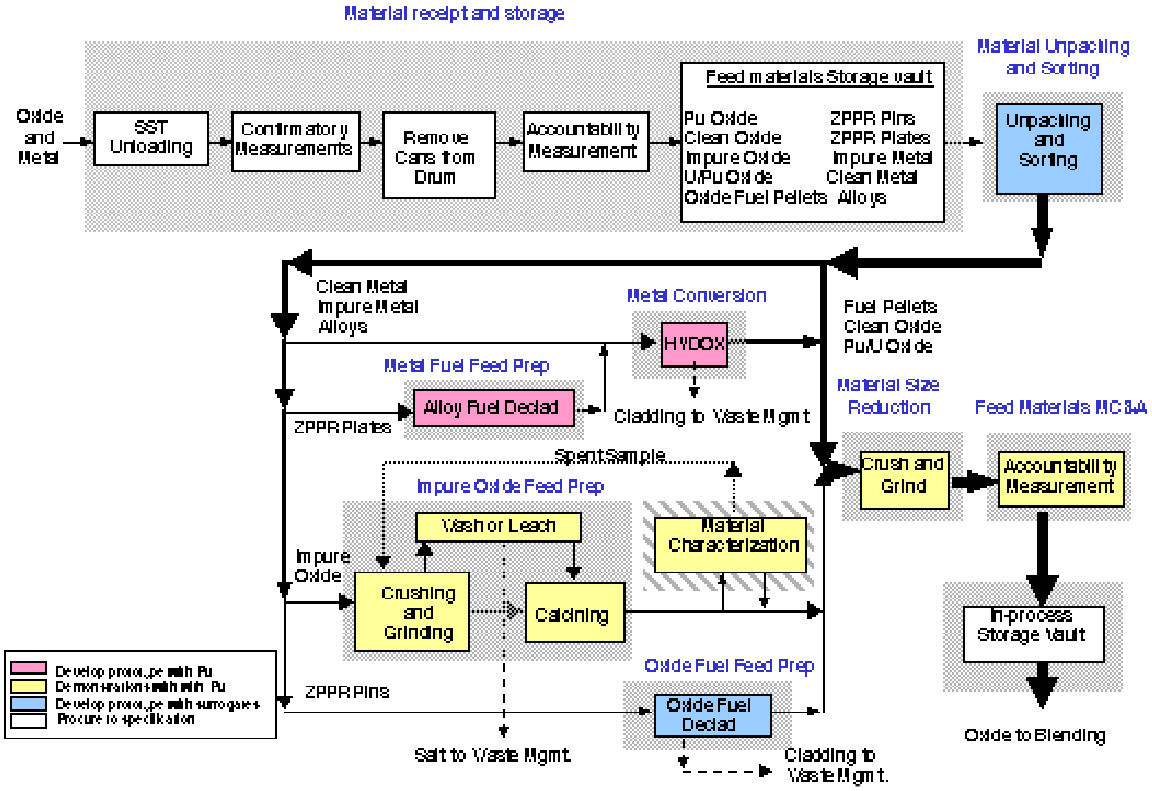

Figure 1. Original flow sheet for plutonium conversion.

REALITY VERSUS ASSUMPTIONS

The Rocky Flats Environmental Assessment (11) was devoid of references to the Waste Isolation Pilot Plant (WIPP) as an ultimate disposal site for wastes and residues from Rocky Flats. The EA "states clearly that the intent is to place residues in a condition allowing for safe interim (up to 20 years) storage irrespective of the disposition method selected in the future."

The First Record of Decision (12) stated "Up to approximately 6,587 kg of plutonium residues (containing up to approximately 351 kg of plutonium) will be processed at the Rocky Flats site and packaged in preparation for disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico."

The Second Record of Decision (13) stated: "Up to approximately 32,160 kg of plutonium residues (containing up to approximately 1,970 kg of plutonium) will be processed at Rocky Flats and packaged in preparation for disposal" at WIPP. The ROD further stated: "Most, and probably all, of the remaining approximately 727 kg of direct oxide reduction (DOR) salt residues (containing up to about 139 kg of plutonium) will be pyro-oxidixzed (if necessary) at Rocky Flats and repackaged in a manner that ensures that no package contains more than 10 percent plutonium, in preparation for disposal in WIPP."

In an amendment to the Second Record of Decision (14), DOE stated: "The Department of Energy (DOE) has decided to revise the approach to be used to dispose of approximately 3,360 kg of sand, slag and crucible plutonium residues (containing approximately 130 kg of plutonium) that is currently stored at the Rocky Flats Environmental technology Site…With the opening of the Waste Isolation Pilot Plant (WIPP) in New Mexico on March 26, 1999, DOE has now decided instead to prepare the sand, slag and crucible residues for direct shipment to the repository for disposal."

A January 6, 2000 memo from Deputy Assistant Secretary for Office of Site Closure (15) requested that Rocky Flats "suspend work on the baseline plan preparations to ship plutonium fluorides from Rocky Flats to the Savannah River Site (SRS) for stabilization. The current baseline does not appear to allow for shipment of the fluorides offsite in time to meet our closure schedule or the 94-1 milestone to ship fluorides by September 2000." How DOE/EM will resolve this with the congressional language in H. R. 2605 "Appropriations for Energy and Water Development for FY2000 Sec. 315" which states "*None of the funds may be used to dispose of transuranic waste in excess of 20 percent plutonium by weight for the*

aggregate of any material category" is unexplained. The total plutonium fluoride residues mass is 315.4 kg with a Pu content of 141.5 kg or 44.9 wt %..

The assumption that only 2,000 kg of Pu from all sites would be disposed of at WIPP has now been eclipsed by decisions that send about 2730 kg of Pu to WIPP from Rocky Flats alone.

August 18, 1999, Secretary of Energy Bill Richardson (16) announced that the DOE would conduct a National Environmental Policy Act (NEPA) review of the environmental impacts associated with the FFTF. This resulted in the removal of 711 kg of Pu that had previously been prepared either as full assemblies or as individual fuel rods but not yet assembled into fuel assemblies.

DOE/MD had assumed that PIP would disposition all of the ZPPR fuel. However, in November 1999, DOE/NE (17) has decided that the ZPPR fuel will be held by NE as a national asset; therefore, the approximately 3.5 tonnes of ZPPR fuel will not come into the PIP.

A variety of programs are assuming the use of Pu that has been declared excess to national defense needs. If funded, it is uncertain how much Pu would be removed from the disposition feedstock. It is assumed that approximately 2 to 3 tonnes of Pu will be necessary for these programs.

There have been a number of internal swaps of material. Whereas this may not affect the final total mass of Pu, it does change the mix of materials that would be feedstock to the Immobilization facility.

It now appears that the MOX facility will be assured of 25 tonnes of Pu metal and 1.2 tonnes of oxide feed. If DOD does give up an additional 7.0 tonnes of weapons pits, for the MOX system to have a feed stock of 33 tonnes, this material would also go to the MOX facility.

THE PRESENT IMMOBILIZATION FEED STOCK AND FLOW SHEET

With the FFTF and the ZPPR decisions made, the PIP has been directed to delete the equipment necessary to prepare these fuels for immobilization from the PIP design. This provides for a much less flexible PIP head-end. The revised flow sheet is given in Figure 2.

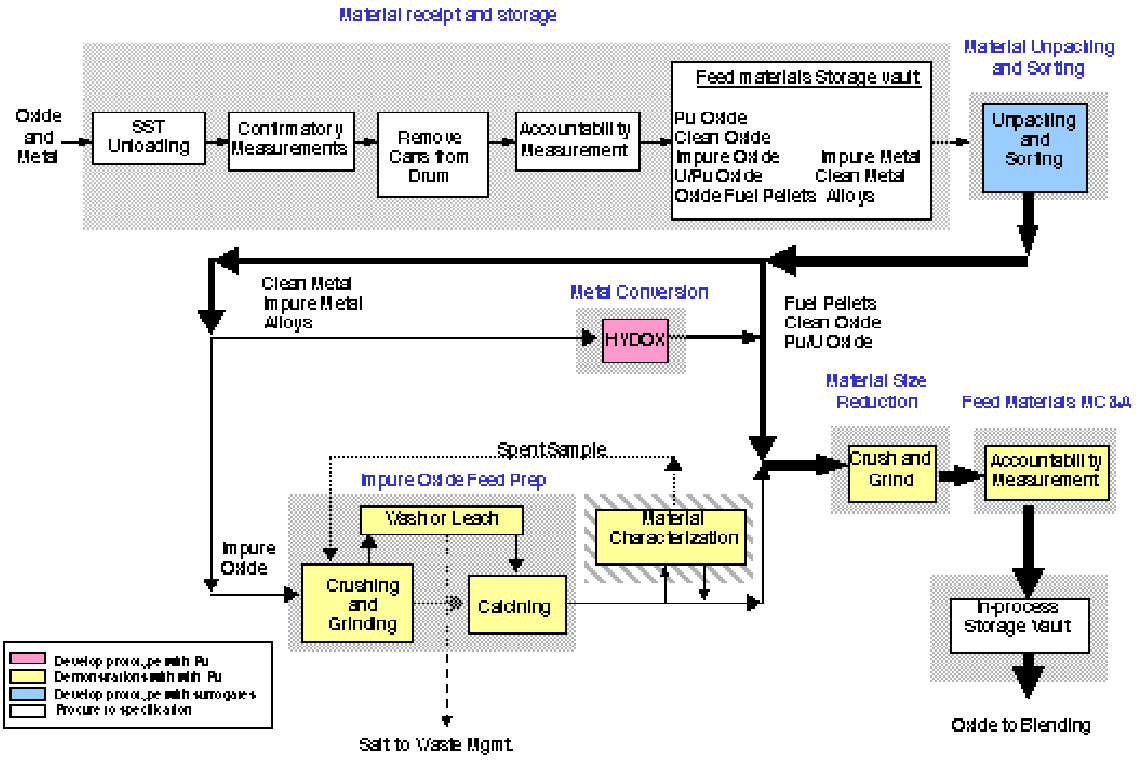

Figure 2. New flow sheet for plutonium conversion.

In the hybrid case, it appears that after the stabilization program is complete, PIP will have a maximum of 8.3 tonnes of weapons-grade feed (about 2.6 tonnes of impure metal and about 5.7 tonnes of impure oxide) and 3.2 tonnes of non-weapon-grade feed (metal and oxide). This gives a maximum feed of 11.5 tonnes of Pu to be fed to the front-end of the PIP. On the high end of the spectrum, the back-end of the PIP is being designed to accommodate the full 50 tonnes of excess Pu. This would allow all of the oxide assumed to be prepared for MOX under the hybrid concept to be blended with the materials assumed for PIP under the hybrid option and all the material immobilized.

ACCEPTANCE SPECIFICATIONS

Two feed types have been removed from the PIP planning bases:

- Engineered feeds with well know constituents (ZPPR and FFTF fuel),
- Low assay feeds that were to be processed by the 94-1 Program (20, 21) to yield clean oxide or metal for some of the feed stock and selective impurity removal for others.

The removal of approximately 6.5 tonnes of feed stock, leaves the PIP with about 11.5 tonnes of feed stock. The total amount of impurities coming into the PIP however, has changed very little. With purer feeds removed from the PIP feed stock, blending will be more difficult. The PIP must revisit the Materials Acceptance Specification in light of the removal of clean feed stocks.

It becomes even more important that the history of the feeds be maintained at the various sites and that the various sites not blend the feeds prior to transfer to the Savannah River Site for inclusion into the Immobilization Program. For the original 17 tonnes bases, computer modeling indicated that the required inline vault space for reblend cans doubled as the result the blending of chloride oxides by Rocky Flats during a 1980s program. Rocky Flats had generated approximately one tonne of residue containing about 700 kg of Pu from the electrorefining furnaces in Building 371. Rocky Flats shipped approximately one-half of the chloride oxide to Hanford. However, prior to shipment, some of the chloride oxide was blended with incinerator ash and perhaps other feeds. The result is not only additional vault space, but additional handling and hence addition radiation exposure for the operators.

The MOX plant is being designed to receive up to 33 tonnes of high purity Pu metal and oxides; its design will not allow it to receive the higher impurity level feed stocks. The present concept is to have all weapons pits and clean metal converted to oxide in the pit disassembly and conversion facility (PD&C) and then use Mediated Electrochemical Oxidation dissolution via Ag(II) to dissolve the Pu oxide. Using solvent extraction the Pu solution would be polished. This arrangement would allow the separation of americium and gallium but would not allow the separation of uranium or thorium. As it is being designed, the MOX plant could not accept approximately 11.5 tonnes of the U. S. surplus Pu. Additional solvent extraction would allow the processable feeds to be increased by about 8 tonnes if the MOX plant were licensed for greater than weapons-grade Pu. It is very doubtful that the MOX polishing system could be designed to handle the array of materials (enriched uranium, thorium, neptunium, etc.) in the remaining three tonnes

CONTINGENCY PLANNING

With all of the changes in the feed stock coming into the Disposition Program, it appears to be a good time to step back and take another look at what was planned and do some contingency planning. Also the “Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement” (18, 19) states that the DOE will use a hybrid approach and construct and operate three new facilities at its Savannah River Site. The hybrid approach allows for the immobilization of approximately 17 tonnes of surplus Pu and the use of up to 33 tonnes as mixed oxide fuel. The new Pu disposition facilities will provide pit disassembly, Pu conversion, immobilization, and MOX fuel fabrication services. Some have suggested that now that the facilities are known to be al at one site, DOE/MD should re-look at facility requirements and combine the facilities to save money.

These contingencies indeed may spread the cost out over more years and may actually reduce the overall cost of both the Disposition and Legacy Clean-up Programs. However serious consideration can be given to these contingencies only if they meet the test of treaties, policy, and law and a realization of the present conditions in Russia.

The old Soviet security system (26) for fissile material, which focused on the surveillance and control of those in contact with such material, was largely swept away with the collapse of the Soviet Union. [As of 1994, essentially no former Soviet nuclear facilities had effective portal monitors to sound an alarm if a worker were carrying out plutonium. Fences had holes or were overgrown with vegetation. The principal tamper indication devices were easily faked wax seals (most workers with access to Pu had the stamp needed to create a new seal). Most sites had no accurate, measured material inventories, and no accurate national accounting system or regulatory frameworks were in place.(27) Gone too is the economic security of nuclear workers, who may now be tempted or threatened by predatory criminal groups (26). Several kilograms of Pu are required to construct a nuclear weapon, with the quantity depending on the composition of the materials, type of weapon, and sophistication of the design (25). The biggest obstacle facing non-nuclear-weapons states or even terrorist groups interested in acquiring nuclear weapons, is lack of access to fissile material. Details aside, necessary amounts are very small

compared to the tonnes of Pu present in the FSU. Given the small quantities of Pu required for nuclear weapons, the quicker and more complete the removal of Pu from the hands of an unstable government the better for international security. The NAS termed this situation a “clear and present danger”(22) and argued that long-

term disposition of excess Pu should be carried out with all deliberate speed. In testimony before the Senate Governmental Affairs Committee, Curtis (28) quoted Senator Sam Nunn:

> *"Today, there is no greater threat to our nation's, or our world's, national security, than the illicit spread of weapons of mass destruction," and "the challenge facing the Russians, and the rest of the world, is to ensure that the former Soviet Union does not become a vast supermarket for the most deadly instruments and technology known to man."*

Curtis went on to say "That circumstance could greatly complicate U. S. strategic nuclear planning. It would aid rogue states and undercut nonproliferation prospects. And it could dramatically embolden subnational groups using violence and terrorism to pursue their aims. The Clinton Administration has made nonproliferation and the fight against terrorism two of its highest national security priorities." The goal of the U. S. government is to minimize the risks that Pu poses to the American people (29). It must be understood that the pace at which Russia moves to dispose of its Pu will be determined by that country's fiscal situation and by Russia's view of the U. S. progress in disposing of its surplus Pu (30). Therefore, any contingency that delays the start of the Disposition Program in the U. S. would also result in a delay in Russia. It is vital that excess Pu be safely and securely transformed as quickly as possible into forms much harder to use for weapons (31). The sooner the process of disposing of this Pu begins, the safer the world will be. Leaving tonnes of Pu in the hands of an unstable government poses continual risk both to American and global security.

The Disposition Program is undertaken in a manner that is consistent with the U. S. policy objectives (irreversibility of the nuclear disarmament process and discouraging the civilian use of plutonium) as well as nonproliferation considerations, and agreements with Russia and other nations. The U. S. does not currently plan to implement a unilateral program but does retain the option to begin certain disposition activities to encourage the Russian, to sever as an international nonproliferation and disarmament example and foster multilateral or bilateral disposition efforts and agreements. To this end, MD has announced that the disposition facilities would include:

- Government ownership and control at a DOE site;
- Use of the facilities only for the surplus plutonium disposition program.
- Subjection to the highest standards of safeguards and security throughout all aspects of storage, transportation, and processing, and will include appropriate International Atomic Energy Agency verification.

Building an integrated facility that is processing both classified and unclassified materials cannot both protect classified information and be open to IAEA inspectors. Neither could the U. S. serve as an international example if facilities built for disposition were then used to fabricate new weapons.

CONCLUSIONS

Since the end of the Cold War, tens of tonnes of Pu have become surplus to defense needs in both the U. S. and Russia. Weapons stockpiles are declining; arms reduction negotiations are proceeding; and weapons dismantlements are continuing. All of these actions increase the stockpiles of surplus Pu. Given the current political instability and worsening economic conditions prevailing in Russia, there is a very real threat that Pu could be stolen or diverted into the hands of terrorists or non-nuclear nations. Since Pu can be readily fabricated into crude nuclear weapons for use not only against other nations but also in the U. S. against Americans, preventing the flow of Pu to countries of proliferation concern and to terrorist groups is a major objective of U. S. national security policy. (24, 25) The MD Program (1) is, therefore, first and foremost a nonproliferation program; its in focus with the U.S. five-fold nonproliferation effort:

1) To secure nuclear materials in the former Soviet Union;
2) To assure safe, secure, long-term storage and disposition of surplus weapons-usable fissile materials;
3) To establish transparent and irreversible nuclear arms reductions;
4) To strengthen the nuclear nonproliferation regime; and
5) To control nuclear exports.

Under the dual-track approach, one track would fabricate weapons-grade Pu into mixed-oxide (MOX) fuel to be irradiated in existing U. S. commercial light-water reactors. The second track would mix the weapons-useable Pu into a ceramic mineral matrix that would then be incased high-level radioactive waste for eventual geologic disposal. Under Secretary Thomas Grumbley (21) stated that "pursuing both technical approaches in parallel thus provides important insurance for success. It allows each technology

to serve as a backup should unexpected obstacles (technical, schedule, cost or other problems) arise for the other."

However, the Pu is not under the control of MD. Defense Program once managed essentially all nuclear materials. Now numerous DOE Programs have a nuclear materials responsibility:

- Pu residues are under the control of the Office of Environmental Management (EM);
- Pits and some of the clean metal are under the control of the Office of Defense Programs , and
- Unirradiated fuels are under the control of the Office of Nuclear Energy Programs.

The decisions made by DOE Offices other than MD have a great effect on the Disposition Program. The blend program in the PIP was assuming about 3 to 4 tonnes of tramp impurities to blend over about 17 to 18 tonnes of Pu. That has changed to about the same amount of tramp impurities to blend over 8 to 11.5 tonnes of Pu.

Now that the decision has been made to locate the three disposition facilities at the Savannah River Site, numerous groups are attempting to do contingency planning for MD. Whereas some of these unsolicited contingency plans may save money or spreads out the cost over a greater number of years, for the most part all of them run against policy and on-going negotiations.

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