A PROPOSAL FOR PLUTONIUM DISPOSITION*

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PROCESS WEAPONS-GRADE PLUTONIUM IN A VOLUMETRIC NEUTRON IRRADIATION FACILITY TO BUILD UP HIGHER ACTINIDES AND FISSION PRODUCTS SUFFICIENT TO DETER DIVERSION OR THEFT FOR WEAPONS PRODUCTION | 1/14.00.00

STORE THE IRRADIATED PLUTONIUM FOR EVENTUAL USE AS A FUEL IN COMMERCIAL NUCLEAR REACTORS | 2/08.03.01

* BASED ON A DESIGN STUDY PERFORMED BY A GEORGIA TECH NE&HP DESIGN TEAM AND PUBLISHED IN FUSION TECHNOLOGY, 27, 326, 1995.

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14 00 00 Comment Number 1

A fusion-induced neutron flux would not be available until 2015 as described in the comment. This timeframe would not be consistent with the purpose of and need for disposition of Pu to reduce proliferation. In addition, this technology is immature compared to existing fission reactor technology. Several other new reactor technologies were eliminated for similar reasons, as described in Chapter 2 of the PEIS.

08 03 01 Comment Number 2

The Department of Energy acknowledges the commentor's support for Pu disposition in reactors. Decisions on disposition will be made based upon environmental analyses, technical and economic studies, national policy considerations, and public input.

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IRRADIATION OF WEAPONS GRADE Pu TO 115 Mwd/kg (11% ^{240}Pu) IS SUFFICIENT TO DETER THEFT.

A VOLUMETRIC NEUTRON SOURCE CAPABLE OF PRODUCING 10^{21} n/s AND A FAST NEUTRON FLUX OF $2x10^{15}$ n/cm^{2}s OVER AN IRRADIATION VOLUME OF ~60m^3 CAN PROCESS ~10 TONNES PER YEAR OF Pu.

A FUSION NEUTRON SOURCE, BASED ON THE TECHNOLOGY THAT IS BEING DEVELOPED FOR ITER AND THE FUSION PHYSICS THAT WILL BE DEMONSTRATED IN ITER (2008-2015), CAN PRODUCE A DISTRIBUTED NEUTRON SOURCE OF 10^{21} n/s.

A CONCEPT FOR A ~60m^3 IRRADIATION FACILITY HAS BEEN DEVELOPED, BASED ON EXISTING NUCLEAR FUEL TECHNOLOGY, LIQUID LITHIUM COOLING AND A REFRACTORY METAL STRUCTURAL MATERIAL.

1/14.00.00 cont.

THE IRRADIATION FACILITY WOULD BREED THE NEEDED FUSION FUEL (TRITIUM) AND PRODUCE 2700 MW ELECTRICAL POWER.

A FUSION-BASED IRRADIATION FACILITY FOR Pu PROCESSING COULD BE BROUGHT ON LINE IN 2015-25, OR EARLIER WITH AN ACCELERATED PROGRAM.

THE IRRADIATION FACILITY AND THE TEMPORARY STORAGE FACILITY FOR THE PROCESSED Pu WOULD BE ON A GOVERNMENT SITE.

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A TRANSMUTATION FACILITY FOR WEAPONS-GRADE PLUTONIUM DISPOSITION BASED ON A TOKAMAK FUSION NEUTRON SOURCE

KEYWORDS: *plutonium disposal, plutonium transmutation, fusion transmutation facility*

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It is suggested that weapons-grade plutonium could be processed through a transmutation facility to build up sufficient actinide and fission product inventories to serve as a deterrent to diversion or theft during subsequent storage, pending eventual use as fuel in commercial nuclear reactors. A transmutation facility consisting of a tokamak fusion neutron source surrounded by fuel assemblies containing the weapons-grade plutonium in the form of PuO_2 pebbles in a lithium slurry is investigated. A design concept/operation scenario is developed for a facility that would be able to transmute the world's estimated surplus inventory of weapons-grade plutonium to 11% ^{240}Pu concentration in ~25 yr. The fusion neutron source would be based on plasma physics and plasma support technology being qualified in ongoing research and development (R&D) programs, and the plutonium fuel would be based on existing technology. A new R&D program would be required to qualify a refractory metal alloy structural material that would be needed to handle the high heat fluxes; otherwise, extensions of existing technologies and acceleration of existing R&D programs would seem to be adequate to qualify all required technologies. Such a facility might feasibly be deployed in 20 to 30 yr, or sooner with a crash program.

I. INTRODUCTION

It has been estimated that 100 to 260 tonnes of weapons-grade plutonium (>93% ^{239}Pu) exists in the form of nuclear warheads and in processing and storage systems.[1,2] An even larger quantity, ~1400 tonnes, of highly enriched weapons-grade uranium exists.[3] Under the conditions of the Strategic Arms Reduction Treaties I and II, ~90 tonnes of weapons-grade plutonium and 450 tonnes of highly enriched uranium in the United States and the former Soviet Union will become surplus to military needs as weapons are dismantled over the next decade.[2,3] There is a substantially larger civilian stockpile, ~780 tonnes, of reactor-grade (^{239}Pu admixed with large fractions of higher transuranics) plutonium[2] of which ~80% is in the form of spent fuel, although ~135 tonnes has been separated for reuse in fission reactors.[2]

The disposition of all of this plutonium and highly enriched uranium is a pressing international concern. The security of approximately one-half of the weapons-grade plutonium and uranium that was in the custody of the former Soviet Union is of particular concern; some 25 tonnes cannot be accounted for.[2] The threat of some of this material falling into the hands of unauthorized parties (terrorists groups or irresponsible governments) is quite palpable. Even if the security is improved substantially, these large stockpiles of highly enriched, weapons-grade materials would remain a tempting target for diversion or theft. For the uranium,

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