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January 2021

Supplement Analysis for the Disposition of Fast Critical Assembly Plutonium

National Nuclear Security Administration

ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
EIS	Environmental Impact Statement
FCA	Fast Critical Assembly
FONSI	Finding of No Significant Impact
HLW	High-level radioactive waste
JAEA	Japan Atomic Energy Agency
LCF	Latent Cancer Fatality
MOX	Mixed Oxide
MT	Metric Ton
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Administration
ROD	Record of Decision
SA	Supplement Analysis
SEIS	Supplemental Environmental Impact Statement
SPD	Surplus Plutonium Disposition
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant

INTRODUCTION

The National Nuclear Security Administration (NNSA), a semi-autonomous agency within the Department of Energy (DOE), has prepared this supplement analysis (SA) to evaluate an environmental impact statement (EIS) (see below) in light of changes that could have bearing on the potential environmental impacts previously analyzed. The Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations direct agencies to prepare a supplement to either a draft or final EIS if the "agency makes substantial changes in the proposed action that are relevant to environmental concerns" or there are "significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts" (40 CFR 1502.9(c)(1)(i)-(ii). DOE's NEPA regulations state that when it "is unclear whether or not an EIS supplement is required, DOE shall prepare a Supplement Analysis" (10 CFR 1021.314(c)). This SA provides sufficient information for NNSA to determine whether (1) to supplement an existing EIS, (2) prepare a new EIS, or (3) no further NEPA documentation is required (10 CFR 1021.314(c)(2)(i)-(ii)).

Existing EIS evaluated in this SA:

DOE, 2015. *Surplus Plutonium Disposition Supplemental Environmental Impact Statement*, DOE/EIS-0283-S2, National Nuclear Security Administration, Washington, DC, April. Access at: https://www.energy.gov/nepa/downloads/eis-0283-s2-final-supplemental-environmental-impact-statement.

PROPOSED CHANGE OR NEW INFORMATION

NNSA evaluated alternatives for disposition of plutonium in the Surplus Plutonium Disposition Supplemental Environmental Impact Statement (SPD Supplemental EIS, DOE 2015a). The SPD Supplemental EIS analysis included alternatives for disposition of up to 13.1 metric tons (MT) of surplus plutonium (6 MT of non-pit material and 7.1 MT of pit metal). The 6 MT included 900 kilograms (kg) of Gap Material Plutonium. Following completion of the SPD Supplemental EIS, NNSA documented its decision to disposition 6 of the 13.1 MT using the Waste Isolation Pilot Plant (WIPP) Alternative (81 *Federal Register* 19588, April 5, 2016). Now, NNSA proposes to change the disposition method for up to 350 kg of the 900 kg of gap material plutonium that was included in the 6 MT. The 350 kg is stainless-steel clad plutonium from Japan's Fast Critical Assembly (FCA) reactor and represents less than 6 percent of the 6 MT. Rather than using the WIPP Alternative, NNSA proposes to use the H-Canyon/HB-Line to Defense Waste Processing Facility (DWPF) Alternative, as evaluated in the SPD Supplemental EIS, to dispose of the FCA plutonium (FCA fuel).

BACKGROUND

In the SPD Supplemental EIS, NNSA evaluated disposition options for 13.1 MT of surplus plutonium consisting of 6 MT of non-pit material and 7.1 MT of pit metal. As discussed in Chapter 1, Section 1.5.2, of the SPD Supplemental EIS, the 6 MT of surplus non-pit plutonium included 0.9 MT (900 kg) of excess capacity to allow for the possibility that NNSA might identify additional quantities of surplus plutonium that could be processed for disposition using the facilities and capabilities analyzed in the SPD Supplemental EIS.

NNSA assessed the impacts of shipment, receipt, treatment, storage, and disposition of up to 900 kilograms (kg) of foreign Gap Material Plutonium, of which the FCA fuel is a subset, in an Environmental Assessment (EA) for Gap Material Plutonium – Transport, Receipt, and Processing (DOE/EA-2024, December 2015), with a subsequent Finding of No Significant Impact (FONSI)[1]. In the 2015 EA, NNSA noted that up to 375 kg of the Gap Material Plutonium may require stabilization prior to disposition. NNSA further stated that interim storage and disposition of the Gap Material Plutonium would be in accordance with decisions made for disposition of U.S. surplus plutonium in the SPD Supplemental EIS (DOE 2015a).

In a 2016 ROD (81 *Federal Register* 19588, April 5, 2016), NNSA announced its decision to implement the preferred alternative, the Waste Isolation Pilot Plant (WIPP) (Dilute and Dispose) Alternative, for disposition of 6 MT of surplus, weapons-usable, non-pit plutonium. In the 2016 ROD, NNSA refers specifically to the 2015 Gap Material Plutonium EA. In the SPD Supplemental EIS, NNSA evaluated five alternatives for disposition of 6 MT of plutonium, which includes the 900 kg of Gap Material Plutonium, including the H-Canyon/HB-Line to DWPF Alternative and WIPP (Dilute and Dispose) Alternative. Disposition of surplus plutonium is described in Sections 2.2.3 (H-Canyon/HB-Line Alternative) and 2.2.4 (WIPP Disposal Alternative). Impacts from implementation are described in Chapter 4 by resource area for each alternative (e.g., Section 4.1.2.1.5 for impacts of the WIPP alternative on human health).

The five alternatives evaluated by NNSA in the SPD Supplemental EIS are:

1) No Action;
2) Immobilization to DWPF (immobilization in a can and subsequent vitrification with high level waste at DWPF);
3) Mixed Oxide (MOX) Fuel (fabrication into MOX fuel. Approximately 4 of the 6 MT could meet the MOX specification requirements but FCA fuel would not);
4) H-Canyon/HB-Line to DWPF (dissolution in H-Canyon/HB-Line and transfer via the waste tanks to DWPF for vitrification and storage pending disposition in a geologic repository); and
5) WIPP (downblending the plutonium and disposing of it as transuranic waste).

As part of an international agreement between Japan and the US NNSA, the Japan Atomic Energy Agency (JAEA) is providing funding to NNSA to disposition FCA fuel. The United States has received the FCA fuel and it is currently stored at SRS awaiting further processing for final disposition.

The FCA fuel is different from the rest of the 6 MT because the plutonium is clad in stainless steel. The cladding must be removed prior to processing the plutonium using any of the action alternatives evaluated in the SPD Supplemental EIS. The majority of the 6 MT is not clad in stainless steel and processes currently available at SRS could be used to cost-effectively prepare it for disposition using any of the action alternatives described in the SPD Supplemental EIS. Initial plans for the FCA fuel, as described in the 2015 EA (DOE 2015b), were to separate the material

[1] In 2010, NNSA prepared an SA (DOE, 2010a) that addressed receipt and storage of gap material-plutonium.

from its stainless-steel cladding and convert it to an oxide form[2] for downblending at SRS to meet the waste acceptance criteria (WAC) for disposal at WIPP near Carlsbad, New Mexico. Because of the cost to install and operate a decladding and oxide conversion process, NNSA initiated an evaluation of alternative processing technologies in a 2017 Savannah River Nuclear Solutions (SRNS) feasibility study (SRNS 2017). Following completion of the 2017 study, SRNS developed recommendations for further technology maturation of four of the top ranked disposition options. Development studies and experiments on oxidation, chemical dissolution, electrolytic dissolution, and actinide alloying were completed by the Savannah River National Laboratory (SRNL). SRNS completed a second feasibility study (SRNS 2018a) to update the 2017 evaluation with the additional input from the SRNL technology maturation activities.

Based on results of the 2017 (SRNS 2017) and 2018 (SRNS 2018a) studies, NNSA is proposing to change the disposition path for only the FCA fuel. Using the H-Canyon to DWPF Alternative would be much less costly than decladding and downblending for disposal at WIPP. In addition, the H-Canyon/HB-Line to DWPF Alternative would make use of available processes and facilities. Both alternatives would fulfill NNSA's need to safely disposition surplus weapons-usable plutonium. Instead of decladding and downblending for disposal at WIPP, the FCA fuel would undergo electrolytic dissolution in H-Canyon, followed by immobilization at DWPF and storage at the Glass Waste Storage Building pending shipment to a geologic repository once it is available.[3] The remainder of the 6 MT would be disposed using the WIPP Alternative consistent with the 2016 Record of Decision.

PROPOSED ACTION

NNSA proposes to disposition FCA fuel by dissolving it in H-Canyon and sending the plutonium-bearing solution to the high-level radioactive waste (HLW) tanks and then to the DWPF for vitrification. Vitrified waste would be stored at SRS in the Glass Waste Storage Building pending the availability of a geologic repository. The H-Canyon to DWPF Alternative evaluated in the SPD SEIS (DOE 2015a) would use chemical dissolution. Instead, the Proposed Action would use electrolytic dissolution.

The material will be dissolved using an electrolytic dissolver in H-Canyon. The DOE Office of Environmental Management (DOE/EM) categorically excluded replacement of a failed electrolytic dissolution unit in H-Canyon with a spare electrolytic dissolution unit.[4] The FCA fuel would be transported from K-Area to H-Canyon for charging to (placing in) the electrolytic dissolver. Containers of the FCA fuel would be removed from the shipping packages and placed

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[2] The majority of FCA fuel is stainless-steel clad alloy and requires conversion to an oxide prior to dilution. A small portion of the FCA fuel is stainless-steel clad oxide and, therefore, would not require conversion prior to dilution. This SA applies to both the stainless-steel clad alloy and the stainless-steel clad oxide.

[3] Immobilized HLW is safely stored in the Glass Waste Storage Building at SRS pending shipment to a geologic repository when one is designed and operational.

[4] In accordance with DOE regulations at 10 CFR 1021.410 DOE determined that replacement of the dissolver was categorically excluded from further NEPA review (OBU-H-2019-0006, January 14, 2019). Access at https://www.energy.gov/nepa/downloads/cx-019585-electrolytic-dissolution-fast-critical-assembly-material.

in or attached to a charging device for transfer to the dissolver. After preparing the electrolytic dissolver with a cold chemical solution of nitric acid, the cans would be charged to the dissolver. Electrical power would be applied to the dissolver resulting in the dissolution of the FCA cladding and fuel. NNSA estimates that dissolution would be complete in less than 24 hours per charge. After each dissolution cycle is complete, solution samples would be obtained to ensure complete dissolution of the FCA fuel. If necessary, a subsequent heating step would be performed to complete the dissolution process. Additional charges would be run to complete a batch. NNSA estimates that 18 batches would be required to complete processing of the FCA fuel. After completion of each batch, the material would be transferred to an accountability tank in H-Canyon and then to a canyon vessel for storage and eventual transfer to the H-Tank Farm. Immobilization and storage of the material would occur at DWPF and the Glass Waste Storage Building pending disposal in a geologic repository. Hazardous and radioactive wastes would be managed using existing SRS facilities and processes and are discussed in the Environmental Impacts section. NNSA estimates that vitrification of the FCA fuel along with HLW associated with the dissolution process at DWPF would require three waste canisters, or less than one-tenth of one percent of the estimated 8,170 canisters that will be produced at DWPF.

To ensure safe and secure operations, NNSA, in conjunction with DOE/EM which owns the facilities, would review and revise, as needed, safety basis documents for all involved facilities at SRS.

RESOURCE AREAS NOT ANALYZED IN THIS SA

The following resource areas will not be affected by the proposed change or new information (DOE 2015a, Table 2-3, pp. 2-29 to 2-39) and, therefore, are not analyzed in this SA:

- Land Use and Aesthetics: No impacts to the current land use would result from operations for the proposed action.
- Geology and Soils: No impacts to the geology and soils would result from operations for the proposed action. There is no associated construction with the proposed action.
- Water Resources: No increase or difference in impacts to water resources would result from operations for the proposed action.
- Air quality: Air emissions would be approximately the same for the proposed action (H-Canyon/HB-Line Alternative) and the WIPP Alternative.
- Ecological Resources: No increase or difference in impacts to ecological resources would result from the proposed action. There is no associated construction, lighting, or additional noise different from regular H-Canyon operations that would impact ecological resources.
- Cultural and Paleontological Resources: No increase or difference in impacts to cultural and paleontological resources would result from the proposed action. There is no associated construction, lighting, or additional noise different from regular H-Canyon operations that would impact cultural or paleontological resources.
- Infrastructure: No changes to the would-be existing infrastructure is required for the proposed action. Electrical use for the proposed action is described below.

- Noise and Vibration: No impacts from noise and vibration would result from the proposed action. All noise and vibration would be consistent with regular H-Canyon operations.
- Traffic: No impacts to traffic volume or patterns would result from the proposed action. The proposed action would not result in hiring of new employees so traffic volume and patterns would remain unchanged.
- Socioeconomics: No impacts to local or regional socioeconomics would result from the proposed action. Operators and support staff would be drawn from existing SRS forces.
- Environmental Justice: No impacts to minority or low-income populations would result from the proposed action.

RESOURCE AREAS ANALYZED IN THIS SA

The following resource areas could be affected by the proposed change or new information:

- Waste and Spent Nuclear Fuel Management
- Human Health- Normal Operations
- Electrical Use

ENVIRONMENTAL IMPACTS

In the SPD Supplemental EIS, NNSA evaluated disposition of 6 MT of plutonium using both the H-Canyon/HB-Line to DWPF Alternative and the WIPP Alternative. The impact assessment of both alternatives includes up to 350 kg of FCA fuel that is the subject of this SA. Table 1 compares the impacts of processing 350 kg of FCA fuel using both alternatives. The data are based on multiplying the data presented in the SPD SEIS by 6 percent, the approximate amount of FCA fuelup to 350kg) compared to 6 MT. Data were taken from Tables 2-3 and 4-3 of the SPD Supplemental EIS. NNSA structured the alternatives in the SPD SEIS to include the MOX Fuel Alternative in each of the other action alternatives. Therefore, the estimates provided in Table 1 are bounding estimates.

Table 1. Comparison of Potential Environmental Impacts

Resource Area	**Summary of Potential Impacts, Proposed Action: H-Canyon/HB-Line Alternative**	**Summary of Potential Impacts, WIPP Alternative**	**Difference in Potential Impacts**
Waste and Spent Nuclear Fuel Management	<u>Waste Generation</u> HLW- 0 DWPF canisters - 3	<u>Waste Generation</u> HLW – 0 DWPF canisters - 0	<u>Waste Generation</u> HLW – no difference[5]

[5] Neither alternative would result in generation of HLW. However, incorporating plutonium in DWPF canisters would require a few additional canisters to ensure criticality safety.

Table 1. Comparison of Potential Environmental Impacts			
Resource Area	**Summary of Potential Impacts, Proposed Action: H-Canyon/HB-Line Alternative**	**Summary of Potential Impacts, WIPP Alternative**	**Difference in Potential Impacts**
	CH-TRU waste - 324 to 420 m^3 MLLW - 0 m^3 LLW - 660 to 1,200 m^3 Hazardous - 0.42 to 0.48 m^3 Non-hazardous (solid) - 900 to 2,160 m^3 Waste treatment, storage, and disposal capacities are sufficient to manage these waste streams. Source: DOE 2015a, Table 2-3, p. 2-33	CH-TRU waste – 1440 to 1,500 m^3 MLLW – 0 m^3 LLW – 582 to 1,140 m^3 Hazardous – 0.30 to 0.36 m^3 Non-hazardous (solid) – 780 to 1,920 m^3 Waste treatment, storage, and disposal capacities are sufficient to manage these waste streams. Source: DOE 2015a, Table 2-3, p. 2-33	Less CH-TRU waste would be generated using the H-Canyon/HB-Line Alternative because WIPP Alternative processing results in TRU waste for Disposal at WIPP. There would be little or no differences in waste generation between chemical and electrolytic dissolution.
Human Health – Normal Operations	<u>Worker and Public Health</u> Annual Population Dose (person-rem) - 0.04 to 0.06 Annual Population LCFs - 0 ($2x10^{-5}$ to $4x10^{-5}$) Project Total Population LCFs - 0 ($4x10^{-4}$ to $6x10^{-4}$) Annual MEI dose (mrem) - 0.0005 to 0.0006 Annual MEI LCF Risk - 0 ($3x10^{-10}$ to $4x10^{-10}$)	<u>Worker and Public Health</u> Annual Population Dose (person-rem) - 0.04 to 0.06 Annual Population LCFs - 0 ($2x10^{-5}$ to $4x10^{-5}$) Project Total Population LCFs - 0 ($5x10^{-4}$ to $6x10^{-4}$) Annual MEI dose (mrem) - 0.0005 to 0.0006 Annual MEI LCF Risk - 0 ($3x10^{-10}$ to $4x10^{-10}$)	<u>Worker and Public Health</u> All differences are minor. In the case of electrolytic dissolution, worker dose would be lower than the H-Canyon/HB-Line chemical dissolution and WIPP alternatives. Both would require handling and de-cladding of the fuel prior to processing,

Table 1. Comparison of Potential Environmental Impacts			
Resource Area	**Summary of Potential Impacts, Proposed Action: H-Canyon/HB-Line Alternative**	**Summary of Potential Impacts, WIPP Alternative**	**Difference in Potential Impacts**
	Project Total MEI LCF Risk - 0 ($4x10^{-9}$ to $6x10^{-9}$) Average Annual Worker Dose (mrem) - 14 Worker LCF Risk from Average Annual Dose (mrem) - 0 ($6x10^{-6}$) Project Total Worker LCF Risk - 0 ($1x10^{-4}$) Source: DOE 2015a, Table 2-3, p. 2-30, and Table 4-3, p. 4-18	Project Total MEI LCF Risk - 0 ($5x10^{-9}$ to $6x10^{-9}$) Average Annual Worker Dose (mrem) - 16 Worker LCF Risk from Average Annual Dose (mrem) - 0 ($1x10^{-5}$) Project Total Worker LCF Risk - 0 ($2x10^{-4}$) Source: DOE 2015a, Table 2-3, p. 2-30, and Table 4-3, p. 4-18	whereas electrolytic dissolution would not.
Electric Use	10,200 to 16,200 MWhr Source: DOE 2015a, Table 2-3, p. 2-39	10,200 to 16,200 MWhr Source: DOE 2015a, Table 2-3, p. 2-39	Expected electric use is 680 MWhr, a subset of both of the previously evaluated alternatives. NNSA expects no difference in electric use between the H-Canyon/HB-Line Alternative and the WIPP alternative. Electrolytic dissolution may require slightly more electricity than chemical dissolution.

The electrolytic dissolution process would be similar to the H-Canyon dissolution process as described in Appendix B, section B.1.3, of the SPD Supplemental EIS (DOE 2015a). From a process standpoint, the only substantive difference is the application of electric current to the acid solution to dissolve the stainless-steel clad plutonium.[6] NNSA would use a 50 percent nitric acid solution for electrolytic dissolution which is the same solution used for chemical dissolution. Dissolved material would be similar to that resulting from chemical dissolution and compatible with transfer to the H-Area Tank Farm pending immobilization in DWPF. Electric use for the FCA dissolution would be an estimated 680-megawatt hours (MWhr). Electrolytic dissolution would result in use of less than half the steam required for chemical dissolution for the same quantity of plutonium. This is because chemical dissolution occurs in a steam heated process whereas electrolytic dissolution only utilizes steam to chemically dissolve residual plutonium remaining at the end of the electrolytic dissolution process. The only process waste from the electrolytic dissolution process is the transfer of the dissolved material to the waste tanks and DWPF. Air emissions from electrolytic processing would be the same as those from chemical processing. The off gas would be processed through the same system used for chemical dissolution.

Operations to carry out the proposed action would take place in existing, operating facilities with current staff, properly trained to operate the electrolytic dissolver and associated equipment. The processing schedule would be integrated with the H-Canyon mission schedule and with the DWPF processing schedule. NNSA estimates that processing in H-Canyon and transfer to the waste tanks would take about five years. About one year would be required for dissolution and four years for discard. Discard would not be continuous. Dissolved material would be discarded to sludge batches being prepared for vitrification in DWPF. If the FCA fuel was decladded, processing times for chemical and electrolytic dissolution would be similar. Operations would be scheduled in conjunction with other H-Canyon operations and coordinated with tank farm and DWPF operations.

In the SPD Supplemental EIS (DOE 2015a, Tables 4-3 and 4-4), NNSA estimated radiation doses and impacts, in terms of latent cancer fatalities (LCFs), from operations for the H-Canyon/HB-Line Alternative (including the material evaluated in this SA) to workers and the public. Worker doses were estimated to be less than the SRS administrative limit of 500 millirem (mrem) per year, resulting in no LCFs on an annual basis. Over the life of the H-Canyon/HB-Line to DWPF Alternative (13 years), NNSA estimated that operations could result in an estimated 2 LCFs to involved workers and none to members of the public or the maximally exposed individual. However, the proposed action is a small subset of the overall H-Canyon/HB-Line Alternative. No LCFs in addition to those NNSA previously estimated would result from implementation of the proposed action.

Vitrification of the FCA fuel in DWPF would result in an estimated 3 HLW glass canisters (SRNS 2018b). In the SPD Supplemental EIS (DOE 2015a, Section 4.1.4.4, p. 4-68), NNSA estimated that vitrification of 6 MT of surplus non-pit plutonium using the H-Canyon/HB-Line Alternative (including the material evaluated in this SA) would result in 20 (using gadolinium as a neutron poison) to 48 HLW glass canisters.

[6] SRS operated an electrolytic dissolver in H-Canyon between 1969 and 1980 to dissolve stainless-steel clad material.

NNSA, in conjunction with DOE/EM, which owns the facilities, would ensure that safety documentation is updated as required prior to operation of the electrolytic dissolution process. Electrolytic dissolution would not introduce new accident scenarios for H-Canyon or DWPF operations.

MITIGATION

The proposed action would not require mitigation beyond standard engineering and environmental protection practices.

DETERMINATION

The impacts from activities related to the disposition of FCA fuel have been evaluated in the SPD Supplemental EIS (DOE 2015a). There are no substantial differences in environmental impacts between using the electrolytic dissolver and the standard H-Canyon dissolver for this amount of material (up to 350 kg). All processes downstream of the dissolver are the same as those analyzed in the H-Canyon/HB-Line to DWPF Alternative. NNSA concludes that the proposed change and new information are not a substantial change relevant to environmental concerns. No further NEPA review is required to implement disposition of the FCA fuel via electrolytic dissolution in H-Canyon, subsequent immobilization at DWPF, and storage at the Glass Waste Storage Building pending shipment to a geologic repository. NNSA will issue an amended ROD if it decides to implement the H-Canyon/HB-Line Alternative as the disposition path for FCA fuel.

NNSA Headquarters Concurrence:

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