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REQUEST FOR APPROVAL TO DISPOSE OF 11(E)2 BYPRODUCT MATERIAL AT THE NEVADA TEST SITE

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MEMORANDUM

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United States Government

Department of Energy

Fernald Field Office

memorandum

Feb 11 1994

DATE: DOE-0846-94

REPLY TO ATTN OF: FN:Allen

SUBJECT: **REQUEST FOR APPROVAL TO DISPOSE OF 11(e)2 BYPRODUCT MATERIAL AT THE NEVADA TEST SITE**

TO: Nick C. Aquilina, Manager, Nevada Operations Office

SUMMARY

In accordance with DOE Order 5820.2A, "Radioactive Waste Management," the Fernald Environmental Management Project (FEMP) requests your approval for disposal, after treatment, of the 11(e)2 byproduct material contained in Fernald's K-65 and cold metal oxide silos at the Nevada Test Site (NTS). The leading remedial alternative for material treatment is vitrification.

The K-65 and cold metal oxide silos (Silos 1, 2 and 3) contain approximately 14,000 cu yds of uranium ore residues and cold metal oxides (estimated to be less than 6,000 cu yd after vitrification) classified under the Atomic Energy Act as 11(e)2 byproduct material. DOE Order 5820.2A provides for disposal of small volumes of 11(e)2 byproduct material at DOE low-level waste sites with approval of the appropriate field organization. FEMPs interpretation of the intent of the "small volume" requirement in DOE Order 5820.2A was to preclude disposal of the large volume of uranium tailings from throughout the complex at low-level waste disposal facilities. As described below, the 11(e)2 byproduct material in the silos meets the description of a small volume and therefore may be disposed at NTS. The Manager of the Nevada Operations Office is the appropriate approval authority.

We seek your approval on whether this 11(e)2 byproduct material can be disposed at the NTS pursuant to DOE Order 5820.2A, Chapter IV, and, if approved, that Fernald can pursue qualification of the vitrified silo residues as an approved waste stream in the regular manner under NVO-325, the NTS waste acceptance criteria document.

DISPOSAL OF BYPRODUCT MATERIAL AS LLW

The FEMP's silo residues meet the definition of byproduct material in section 11(e)2 of the Atomic Energy Act, in that they are ". . .tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content" (the Attachment to this memorandum provides information specific to the FEMP residues as to their origin and processing prior to placement in the silos). DOE Order 5820.2A, "Radioactive Waste Management," dated September 26, 1988, Chapter III, provides for the disposal of low-level

radioactive waste (LLW) at DOE sites pursuant to certain requirements, but the definition of LLW specifically excludes 11(e)2 byproduct material. However, Chapter IV of the Order sets forth the policy that "small volumes of DOE waste containing 11(e)2 byproduct material...may be managed as low-level waste in accordance with the requirements of Chapter III of this Order."

As stated above, the reference to "small volumes" is intended to prevent the disposal of large volumes of uranium mill tailings (millions of cubic yards) from consuming the limited resources of LLW disposal facilities at DOE sites. Moreover, Chapter IV also states, "Waste covered under this chapter in quantities too large for acceptance at DOE low-level waste disposal sites shall be...disposed of at specially designated DOE sites or tailing disposal sites established under the Uranium Mill Tailings Radiation Control Act of 1978."

The test for "small volumes", therefore, is defined by the FEMP to be quantities that are not "too large for acceptance at DOE low-level waste disposal sites." The current volume of the FEMP silo residues is approximately 14,000 cu yd. Vitrification is expected to reduce this volume to less than 6,000 cu yd. The latter represents only 15 to 20 percent of the LLW disposed of annually at the NTS in recent years. In addition, exhumation and treatment, and therefore shipment of the residues is currently scheduled to occur over a three year period.

Documentation meeting the requirements of the National Environmental Policy Act for the remediation of the silos, and the vitrification, packaging, and shipment of the silo residues, is contained in our Operable Unit 4 Feasibility Study/Proposed Plan-Environmental Impact Statement.

Your approval of this request will enable us to develop a waste application which will support implementation of the preferred remedial alternative identified in the Proposed Plan for Operable Unit 4, and assist in gaining the required Environmental Protection Agency approval. The Feasibility Study and Proposed Plan are scheduled for final approval by the United States Environmental Protection Agency (Region V) on January 26, 1994. Approval of the Feasibility Study and Proposed Plan will be followed by a public review period beginning March 7, 1994, at which time the public has an opportunity to comment on the preferred remedial alternative. Following the public review period, the Record of Decision will be completed which will address public input on the remediation plans and identify the selected alternative for Operable Unit 4. Therefore, to support the next step in the remediation of Operable Unit 4, we request your completed evaluation by March 4, 1994, before the Public Comment period begins.

While your approval to dispose of these 11(e)2 byproduct materials at the NTS is not alone sufficient authorization to begin shipments, it is a necessary step toward that objective. Prior to shipment of these waste materials to the NTS for disposal, DOE-FN and its operating contractor will, in the regular, prescribed manner, apply for DOE-NV approval of the silo residues as a waste stream under NVO-325 waste acceptance criteria. These criteria include, among other things, prohibitions of certain constituents, limits on surface radiation dose rates, packaging and

certification requirements—all of which are familiar to the FEMP due to our successful program of adherence to NVO-325 in the management of our LLW shipped to Nevada for disposal. Your organization's approval of this waste stream under NVO-325 will be required before shipments can begin.

Once the NVO-325 criteria are successfully met and demonstrated, we will work closely with your office and your operating contractor to determine the appropriate material handling requirements and disposal configuration for these residues.

An attachment is provided for additional information related to the remedial plans for the silo residues. Items in the attachment include background on the history of the silos and silo residue characteristics; description of the Operable Unit 4 preferred remedial alternative and basis for selection; description of the vitrification process; characteristics of the vitrified product for disposal; and the schedule for remediation activities.

This letter was coordinated with Wendy Griffin of your staff, and her comments have been incorporated.

ACTION

We are seeking your approval by March 4, 1994, to dispose of the FEMP 11(e) 2 byproduct material, after treatment, at NTS.

J. Phil Hamric
Manager

Attachment: As Stated

APPROVED:

Nick C. Aquilina, Manager
Nevada Operations Office

Date

cc w/att:

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ATTACHMENT

BACKGROUND

History of the silos and silo residues

The silo residues have been stored at the FEMP in Silos 1, 2, and 3 since the early 1950's. The residues were generated by the processing of pitchblende ores and uranium concentrated ores at the FEMP and other DOE facilities for their uranium content. The resultant uranium metal was used in direct support of the United States defense programs. Silos 1 and 2, also known as the K-65 silos, contain "hot" raffinates, also known as K-65 residues. The residues were termed "hot" raffinates because they contain elevated concentrations of gamma emitting progeny from the radium-226 decay series. Silo 3 contains metal oxides, also known as "cold" metal oxides because they contain comparatively lower concentrations of gamma emitting progeny from the same decay series than the K-65 residues. Silos 1, 2, and 3 along with the empty Silo 4 are part of Operable Unit 4.

Silo 1 and 2 contain residues generated from the extraction of uranium from pitchblende ores at the Mallinckrodt Chemical Works (MCW) in St. Louis, Missouri and the FEMP. The majority of these ores originated from the Shinkolobwe Mine in the Belgian Congo with the balance coming from the Rum Jungle Mine and Radium Hill Mine in Australia. As generation of the residues continued at MCW, storage became a problem. Therefore, the K-65 residues were initially sent to Lake Ontario Ordnance Works (LOOW) near Niagara Falls, New York for storage. Some of these drums were emptied into a tower at LOOW and the remaining drums were sent to the FEMP. Later, the residues were sent directly from MCW to the FEMP.

At the FEMP, the drums were transferred into Silos 1 and 2 via the K-65 Drum Handling Building. In the Drum Handling Building, the drums were emptied in a tank and mixed with water. The resultant slurry was pumped into Silos 1 and 2, where the solid and liquid separated. The liquid was decanted into the Decant Sump Tank via ports on the silos' sides leaving behind the wet solid which remains in Silos 1 and 2 today. The Decant Sump Tank also contains K-65 sludges which were generated as solids settled or precipitated from the decanted Silos 1 and 2 liquids.

Silo 3 contains residues known as "cold" metal oxides. These residues were generated only at the FEMP. Before being placed into Silo 3 the residues were processed through a spray calciner or a rotating dryer. At the spray calciner, liquids were evaporated at a temperature of approximately 510°C (950°F). At the rotating dryer, some liquids were removed by centrifugal force, and the remaining liquids were evaporated in a rotary calciner operating at approximately 650°C (1200°F) to 820°C (1500°F). During the calcining, the metal nitrates were converted to metal oxides. Finally, the fine metal oxide powder resulting from the calcining was pneumatically transferred to Silo 3.

Characteristics of the untreated silo residues

The primary chemical contents of the K-65 residues are a mixture of hydroxides, carbonates and sulfates. The radionuclides in the K-65 residues include uranium (U)-238 and progeny [including U-234, thorium (Th)-230, radium (Ra)-226, lead (Pb)-210, and polonium (Po)-210]; U-235 and progeny [including protactinium (Pa-231) and actinium (Ac)-227]; and Th-232 and progeny (including Th-228). Of these radionuclides, those with the relative highest concentrations are Ra-226 (400000 pCi/g), Po-210 (194000 pCi/g), and Pb-210 (156000 pCi/g). Due to the high Ra-226 concentrations the K-65 residues emanate radon-222 at a rate of approximately 4500 pCi/m^2/s. The predominant inorganic constituents are lead (66200 mg/kg), calcium (17000 mg/kg), iron (15500 mg/kg), and barium (9450 mg/kg). Twenty-five organic constituents were detected with only tributyl phosphate (22 mg/kg), Aroclor-1254 (7.0 mg/kg) and Aroclor-1260 (2.0 mg/kg) exceeding a mean of greater than 1 ppm.

The volume of the K-65 residues in Silo 1 is approximately 4293 yd^3, and Silo 2 contains approximately 3719 yd^3. In 1991, a removal action was performed which added a layer of bentonite clay to Silos 1 and 2. This was done to reduce the radon-222 emissions from the silos. A total of 878 yd^3 of bentonite clay was added bringing the total volume of material for treatment and disposal in Silos 1 and 2 to approximately 8890 yd^3.

The primary chemical contents of the byproduct material in Silo 3 are a mixture of oxides. The radionuclides in the Silo 3 residues include U-238 and progeny (including U-234, Th-230, Ra-226, and Pb-210); U-235 and progeny (including Pa-231 and Ac-227); and Th-232 and progeny (including Ra-228, Th-228, and Ra-224). Of these radionuclides, those with the highest concentrations are Th-230 (51200 pCi/g), Ra-226 (2970 pCi/g), and Pb-210 (2620 pCi/g). The predominant inorganic constituents are magnesium (58600 mg/kg), iron (37800 mg/kg), sodium (36100 mg/kg), calcium (29400 mg/kg), aluminum (17200 mg/kg), and potassium (7260 mg/kg). Although no analytical data is available for the organic constituents in Silo 3, their existence in the oxides is unlikely due to the high temperatures of the calcining performed during generation. The total volume of the residues in Silo 3 is approximately 5088 yd^3.

As part of the Operable Unit 4 Remedial Investigation, samples from the silos were tested via the Toxicity Characteristic Leaching Procedure (TCLP) and Extraction Procedure (EP) Toxicity test for Toxicity Characteristic (TC) metals. These results indicate that lead (570 mg/L) exceeded the RCRA regulatory limits for the K-65 residues and that arsenic (9.4 mg/L), chromium (5.1 mg/L), and selenium (2.7 mg/L) exceeded the regulatory limits for the metal oxides. Although the untreated silo residues exceed the RCRA regulatory limits for these toxicity characteristic metals, they do not meet the definition of a RCRA hazardous waste. The residues are defined as byproduct material under the Atomic Energy Act and are therefore excluded from the definition of hazardous waste under RCRA. Despite this exclusion, the silo residues will be stabilized through vitrification. This treatment effectively reduces the leachability of the toxicity characteristic metals below RCRA limits and is described in the following section.

ATTACHMENT

PLANNED REMEDIATION

Selection of the preferred remedial alternative

As part of the CERCLA RI/FS process, numerous alternatives were developed for remediation of Operable Unit 4. These alternatives were screened to eliminate those that were impractical to implement or ineffective at addressing the hazards associated with the silo residues. The alternatives which passed this screening process were then subjected to a detailed analysis to examine the merits of each at addressing the concerns associated with the silo residues. The results of this detailed analysis were then compared for each of the alternatives. Alternatives which were evaluated included no-action alternatives, in-situ alternatives, alternatives which included disposal with no treatment, and alternatives which included treatment through vitrification, cement stabilization, or chemical extraction and disposal at on-property or off-site facilities. Factors included in the detailed analysis included: overall protection of human health and the environment; compliance with ARARs; long-term and short-term effectiveness; reduction of the toxicity, mobility, and volume through treatment (vitrification- nearly a 60% reduction in volume; cementation- between 200-350% increase in volume); and implementability and cost.

Based on the results of the detailed analysis and the comparison of the detailed analysis a preferred alternative was selected. The preferred alternative demonstrated the best performance when compared to the other alternatives, with respect to the factors included in the detailed analysis. Components of the preferred alternative include stabilization of the silo residues through vitrification, packaging, and disposal at the Nevada Test Site.

The preferred alternative would achieve substantial risk reduction at the FEMP Operable Unit 4 boundary by removing the sources of contamination, treating the material from which exposures result in the highest risk, and shipping the treated residues off site for disposal. The preferred alternative both reduces the mobility of the hazardous constituents and results in a significant reduction in the volume of materials requiring disposal. DOE-FN believes the preferred alternative would be protective of human health and the environment; comply with ARARs; be cost effective; utilize permanent solutions to the maximum extent practical; and utilize treatment as a principle element of the response.

The vitrification process

Vitrification is a versatile process that can transform waste solutions, slurries, moist powders, and/or dry solids into a chemically durable glass. The vitrification process is performed by melting the residues at high temperatures (up to 1500°C) provided by an electric current from electrodes immersed in the melt. This process evaporates or destroys organic constituents and incorporates the inorganic constituents into the resultant glass.

The heart of the vitrification system is the melter, which is a refractory-lined cavity with submerged electrodes. After preheating the cavity and the initial charge, the melt becomes electrically conductive. At this time the molten glass is heated by an alternating current generated between pairs of electrodes immersed in the melt. Chemicals may be added to the residues, as required, to aid in achieving suitable durability or processability. The additives may include reagent grades of silicon oxide (SiO_2), alumina (Al_2O_3), boric acid (H_3BO_3), sodium carbonate (Na_2CO_3), and carbon. The molten glass may either be cast into monolithic shapes, formed into smaller shapes, or quenched to a frit.

Vitrification is not an innovative technology, however, the application of the vitrification technology to the treatment of hazardous and radioactive waste is innovative. Treatability studies and benchscale tests performed by Operable Unit 4 have shown that the silo residues are readily amenable to the vitrification technology. The K-65 residues, in particular, easily form a good glass without significant additives or process adjustments. The selection of vitrification as the preferred remedial treatment technology for Operable Unit 4 materials was based on a significant quantity of process knowledge and data accumulated from the extensive Operable Unit 4 vitrification treatability studies already completed.

Characteristics of the vitrified product

Materials to undergo vitrification include: the residues stored in Silos 1, 2, 3 and sludges in the Decant Sump Tank (estimated volume of sludge is 5 yd^3). If any soils are encountered during remediation of Operable Unit 4 which exhibit highly elevated direct radiation levels as a result of contamination from the silo residues, those soils will also be vitrified. The total volume of the residues prior to treatment will be approximately 14,000 yd^3. Information from laboratory scale treatability tests indicate that the vitrification process will reduce the volume of material for disposal to approximately 6000 yd^3. It is expected that the total volume of soils to be vitrified would not be significant in comparison with the total volume of the silo residues.

This treatment effectively reduces the leachability of toxicity characteristic metals below RCRA regulatory limits, and creates an overall more stable residue form which is more compatible for disposal. In particular it reduces radon emanations from the K-65 residues from approximately 4500 $pCi/m^2/s$ to less than 1 $pCi/m^2/s$.

Evaluations performed by Operable Unit 4 personnel in conjunction with the FEMP Waste Characterization group indicate that the vitrified residues would meet the "General Waste Form Criteria" as listed in Section 5.5.1.1 of NVO-325. However, after vitrification, the glass will be tested as confirmation that concentrations of RCRA metals no longer exceed the RCRA toxicity characteristic limits and that radionuclides are properly immobilized within the glass. Measurements will also be performed to indicate that the radon emanation rates are effectively attenuated. Goals for these levels will be driven by NTS waste acceptance criteria disposal requirements. Results of the analysis will be evaluated and forwarded to NTS, as required, prior

to shipment to NTS for disposal. In addition, all sampling and analysis will be performed per NVO-325 requirements, including quality assurance and use of standardized data reporting forms.

Remediation schedule

The scheduled date for beginning the removal and treatment of the residues is March 1997. Therefore, assuming a three month testing and evaluation period, shipments would begin in June 1997 and would continue on a regular basis until June 2000.