# APPENDIX B
# ENGINEERED ALTERNATIVE PASS LIST

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# ENGINEERED ALTERNATIVE PASS LIST

The following is a listing of Engineered Alternatives (EA) that passed the screening process. The listing includes the definition of the individual EA and the Engineered Alternatives Screening Working Group (EASWG) comments justifying assignment of the EA to the Pass List.

1 Supercompact Everything Except Sludges

All wastes except sludges are processed by first pre-compacting the waste into 35-gallon drums; the "pucks" are then supercompacted at forces in excess of 2,200 tons and packed for disposal in 55-gallon drums. The volume reduction is approximately 3:1.

The EASWG concluded that this EA met the definition and would be considered further. Off-the-shelf technology is available. Widely used for low-level waste (LLW). Transuranic (TRU) waste supercompacted at Rocky Flats Plant (RFP). Resource Conservation and Recovery Act (RCRA) Part B permitting in interim status at RFP.

2 Incinerate and Cement Solid Organic Waste

Solid organics are incinerated, and the resulting ash is cemented into an ash/cement matrix.

The EASWG concluded that this EA met the definition and would be considered further. Technology mature for hazardous constituents some engineering is still required for TRU waste. Commonly used for LLW—Japan, France, United States. No TRU waste incinerator operating. Permitted incinerators at Los Alamos National Laboratories for hazardous materials; moratorium on new hazardous materials incinerators; major effort required to permit future incinerators.

3 Shred and Vitrify Solid Organic Waste

Solid organics are incinerated and fused into a glass matrix by vitrifying. Vitrification melts/fuses the waste; silica may be added prior to melting.

The EASWG changed the title from "Incinerate and Vitrify" to "Shred and Vitrify" because the current vitrification technology does not require incineration, only shredding. The EASWG also concluded that this EA met the EA definition and would be considered further. Various vitrification technologies have been demonstrated related to plasma melting. France's (Marcoule Facility) is currently making radioactive glass logs. Not yet permitted for TRU waste.

4a Wet Oxidation and Cement Solid Organic Waste

Solid organics are oxidized into an ash residue. Wet oxidation involves the accelerated oxidation of waste in the presence of heated water, vapor, or steam, with the intent to chemically degraded the waste. The ash residue is cemented into an ash/cement matrix.

The EASWG concluded that wet oxidation alone did not meet the definition, because the resulting waste must be solidified to meet the Waste Acceptance Criteria (WAC). Two common solidification techniques were added to this EA to meet the definition. Wet oxidation technology demonstrated at bench scale, questions exist regarding ability to

handle all organic wastes. Currently used to treat non-radioactive organics in water. Technology never permitted but believed possible.

4b Wet Oxidation and Vitrify Solid Organic Waste

Solid organics are oxidized into an ash residue. Wet oxidation involves the accelerated oxidation of waste in the presence of heated water, vapor, or steam, with the intent to chemically degrade the waste. The ash residue is vitrified into a fused glass. Silica may be added to the residue prior to melting/fusing.

The EASWG concluded that wet oxidation alone did not meet the definition, because the resulting waste must be solidified to meet the WAC. Two common solidification techniques were added to this EA to meet the definition. Same technical and regulatory feasibility comments as EA #4a.

5 Shred and Bituminize Everything Except Sludges

All waste except sludges are mechanically shredded. A volume reduction ratio of 1.2:1 is assumed for shredding only. Bitumen is mixed into the waste, filling the void space in the waste drum.

The EASWG concluded that this EA met the definition and would be considered further. Technology is mature but not applied to TRU waste; development work required. Used in Japan for radioactive resins and sludges. This technology has not been permitted; however, the EASWG believes obtaining a permit is possible.

6 Shred and Compact Everything Except Sludges

All waste except sludges are mechanically shredded. A volume reduction ratio of 1.2:1 is assumed for shredding only. The shredded waste is compacted in the drum. Supercompaction is not used.

The EASWG concluded that this EA met the definition and would be considered further. (Not supercompaction—low pressure compaction.) Commercial nuclear plants routinely use compaction technology for LLW. Not currently being done for TRU nor demonstrated. Off-the-shelf equipment available. Permitted for LLW but not TRU, highly probable permit obtainable.

7 Shred and Cement Everything Except Sludges

All waste except sludges are mechanically shredded. A volume reduction ratio of 1.2:1 is assumed for shredding only. "Wet" cement is added to the waste creating a solid homogeneous waste/cement matrix.

The EASWG concluded that this EA met the definition and would be considered further. Grouting technology demonstrated at Hanford, believed used in German application for TRU type waste. Permitting of cementation of TRU sludges under interim status at U.S. Department of Energy (DOE) facilities. Permitting problems not expected by EASWG.

8 Shred and Cold Polymer Encapsulate Everything Except Sludges

All waste except sludges are mechanically shredded. A volume reduction ratio of 1.2:1 is assumed for shredding only. The shredded waste is encapsulated with a polymer.

The EASWG concluded that this EA met the definition and would be considered further. Commercial technology in use that polymerizes LLW. Not demonstrated for TRU waste. Technology is available off the shelf. Permitting problems are not expected by the EASWG.

9 Shred, add Salt and Compact Everything Except Sludges

All waste except sludges are mechanically shredded. A volume reduction ratio of 1.2:1 is assumed for shredding only. Shredded waste is mixed with crushed salt and compacted in the drum. Supercompaction is not used.

The EASWG concluded that this EA met the definition and would be considered further. Technology is available off the shelf; however, process not in use for TRU waste. Compaction of LLW currently permitted and performed. Permitting problems not expected by the EASWG.

10 Plasma Processing of All Waste

All waste is subjected to a high temperature plasma arc eliminating organics and melting metals and sludges into a solid form. The products of this process are vitrified glasses and solid metals.

The EASWG concluded that this EA met the definition and would be considered further. Centrifugal and fixed hearth technologies demonstrated with non-TRU materials, Centrifugal technology used to extract exotic metals in industrial applications. Pilot test completed for the Idaho National Engineering Laboratory (INEL) Pit 9 application with simulated waste. Design of a full-scale unit is approximately 90% complete at INEL (Lockheed) Research and development permitted. Not permitted for TRU waste. EASWG expects permit obtainable.

11a Melt Metals into TRU waste ingots

All metals are melted (sludges and combustibles are excluded) into an ingot and disposed of at the Waste Isolation Pilot Plant (WIPP). The size and weight of the final product are within transportation limits.

The EASWG decided to separate this EA into two categories: a) melt metals and emplace all at WIPP, and b) melt metals, partition radionuclides in slag and remove, cast metal, and dispose of as LLW. The EASWG determined that this separation allows for greater flexibilities in the analysis. The EASWG concluded that both EAs met the definition and would be considered further. Technology is mature but not applied to TRU wastes, development work required. EASWG believes technology is transferable to TRU waste uses. Technology not permitted for TRU waste, EASWG expects permits are obtainable.

11b Melt Metals with Frit to Partition Actinides

All metals are melted (sludges and combustibles are excluded). Glass Frit is added to the molten metal partitioning the radionuclides within the slag. The slag is removed, solidified, and disposed of at the WIPP. The metal is cast into ingots and disposed of as LLW at a LLW facility. The size and weight of the ingot are within transportation limits.

The EASWG decided to separate this EA into two categories: a) melt metals and emplace all at WIPP, and b) melt metals, partition radionuclides in slag and remove, cast metal, and dispose of as LLW. The EASWG determined that this separation allows for greater flexibilities in the analysis. The EASWG concluded that both EAs met the definition and would be considered further. Technology is mature but not applied to TRU wastes, development work required. EASWG believes technology is transferable to TRU waste uses. Potential to recycle waste containers/container materials. Technology not permitted for TRU waste; impacts LLW disposal facilities.

12 Salt Backfill Around Drums and Waste Stack

A crushed salt backfill is placed around and between the waste containers, filling the void space within the rooms. A 50% filling efficiency is assumed.

The EASWG concluded that this EA met the definition and would be considered further. The technology of pneumatic backfilling was demonstrated at WIPP. Can also be as simple as a pile of salt and a shovel. No regulatory concerns were noted. EASWG believes no permit is required for this technology.

15 Shred, Add Clay Based Material to Everything Except Sludges

All waste except sludges are mechanically shred. A volume reduction ratio of 1.2:1 is assumed for shredding only. Engineered clay grout is added to the shredded waste removing the void space within the waste drum. Two forms of clays are considered, swelling (smectites) and non-swelling (illite/kaolinite).

The EASWG decided to change the title of this EA to allow for various types of clays to be considered in the analysis. The EASWG concluded that this EA met the definition and would be considered further. Process is not being done for TRU waste. Equipment is available off-the-shelf. EASWG believes permits are obtainable.

16a Acid Digestion and Cementation of Solid Organics

Solid organics are dissolved in a strong acidic solution that is subsequently neutralized and precipitated, resulting in a reduced volume sludge waste form, which is solidified into a cement/precipitate matrix.

The EASWG concluded that acid digestion alone was not an EA; acid digestion must be followed by a stabilization process. Acid digestion was deleted and acid digestion with solidification was added. The EASWG determined that this EA meet the definition and should be considered further. This technology was used to process approximately 5,000 kg TRU waste between 1972 and 1980 at Hanford using sulfuric acid. Current bench-scale technology at Savanna River Site uses an acid process at 180°C and 15 psig. Belgium recovers Pu with sulfuric acid. Development of processes waste and residue stabilization systems, spent acid treatment, off-gas systems, is required. Cementation of resulting sludge has not been demonstrated. Technology not permitted. Permit issues associated with disposition of hazardous constituents. EASWG believed the technology may be permitted; however, not enough information is available to justify rejection.

16b Acid Digestion and Vitrification of Solid Organics

Solid organics are dissolved in a strongly acidic solution that is subsequently neutralized and precipitated, resulting in a reduced volume sludge waste form, which is vitrified into a fused glass. Silica may be added prior to vitrification.

The EASWG concluded that Acid Digestion alone was not an EA; acid digestion must be followed by a stabilization process. Acid digestion was deleted and acid digestion with solidification was added. The EASWG determined that this EA met the definition and should be considered further. The Technology and regulatory feasibility is identical to #16a with vitrification consideration #3.

19 Add Lime to Solid Organic Waste

Lime (CaO) is added to solid organics within a drum.

The EASWG changed the title of this EA from "Add Gas Getters" to "Add Lime to Solid Organic Waste". The new title was changed to better describe the EA. The EASWG concluded that this EA met the definition and would be considered further. This EA is a material handling process, no treatment technology is involved. Aluminum would have to be removed from the waste prior to the addition of lime. The EASWG concluded that a permit may not be required for this EA but potential WAC and U.S. Nuclear Regulatory Commission (NRC) Transuranic Package Transporter-II (TRUPACT-II) certification issues may be involved in implementing this EA.

22 Decontaminate Surface of Metallic Wastes for LLW Disposal.

Metals are sorted and decontaminated using freon or carbon dioxide. Filters are used to collect the radionuclides and are disposed of as TRU waste. Decontaminated metals are recycled or disposed of as LLW.

The EASWG concluded that this EA met the definition and would be considered further. The EASWG concluded that this technology was mature, and off-the-shelf technology is available. This technology was commonly used for alpha contaminated materials. The EASWG expects that a permit is obtainable if required.

29 Microwave Melt Sludges

Sludge waste is melted/fused into a fused glass. Silica may be added prior to vitrification.

The EASWG changed the title from "Vitrify Sludges" to "Microwave Melt Sludges" to better define the EA. The EASWG concluded that this EA met the definition and would be considered further. The microwave technology has been demonstrated for radioactive waste; however, the entire waste handling process has not been demonstrated. Completed systems with feed and off-gas processes must still be designed. Problems are expected with obtaining a permit because this is a thermal process however the EASWG believes a permit is obtainable.

33 Salt Plus Clay Backfill

Crushed salt is mixed with approximately 30% clay. The salt/clay backfill is placed around the drums filling the void space within the rooms. A 50% filling efficiency is assumed.

The EASWG determined that this EA met the definition of an EA and that it would be kept for further consideration. The EASWG changed the title to "Salt plus Clay Backfill" and described the alternative as a crushed salt backfill containing 30% clay. The technical and regulatory feasibility is identical to #12.

35 Salt Aggregate Grout Backfill Around Drums

Crushed salt is sifted and used as an aggregate in a brine based grout backfill (properties of Type 10 grout are assumed). The grout is pumped into the rooms, filling the void spaces within the rooms. A high filling efficiency is assumed.

The EASWG changed the title to specify a salt aggregate grout. The EASWG concluded that this EA met the definition and would be considered further. The technology is mature. Brine saturated grouts are commonly used in the petroleum and mining industries. Questions on gas generation potential may limit the effectiveness of this alternatives. The EASWG believed a permit would not be required—only DOE requirements need to be satisfied.

36 Bitumen Backfill

Bitumen is placed around the waste drums filling the void space within the disposal rooms.

The EASWG concluded that this EA met the definition and would be considered further. Material handling technology is mature. Bitumen backfill used in Germany. Off-the-shelf technology is available. May impact the no-migration permit; possible large increase in hazardous materials. Uncertainty in safety requirements due to combustible nature. The EASWG concluded that there is a large uncertainty in regulatory feasibility; however, not enough information is available to justify rejection.

38 Reduce Room Dimensions to Minimize Space Around Waste Stack

This alternative reduces the room dimensions to minimize space around the waste containers. Only minimal space around the waste containers is assumed after emplacement.

The EASWG concluded that this EA met the definition and would be considered further. The technology used to initially mine the rooms and panels can be used; the technology is mature. Equipment is available at the site, and the operation required to implement the EA is understood. Regulatory issues include site design validation process considerations with the State of New Mexico, the Consultation and Cooperation Agreement, and other coordination concerns with the state.

51 Change Mined Extraction Ratio

The mined extraction ratio is increased to increase the closure rate or the disposal rooms (i.e., leaving less supportive salt around the mined waste disposal rooms).

The EASWG concluded that this EA met the definition and would be considered further. The EASWG concluded that this technology is mature and understood. Equipment is available. Major analysis would be required to determine the design and the overall impact on the disposal system. Regulatory concerns include major considerations with respect to the site design validation process, State of New Mexico agreements, and Mine

Safety and Health Administration requirements. The EASWG concluded that no permit is required to implement this EA.

53 Seal Individual Rooms

Individual rooms are sealed instead of only sealing the panels. Communication between the rooms during an intrusion scenario is significantly reduced (gas, brine, and radionuclides).

The EASWG concluded that this EA met the definition and would be considered further. Technology is available off the shelf. Major analysis is required to determine seal design and performance parameters. No permitting problems were envisioned.

60 Depressurize Castile Reservoir

This alternative removes brine from the Castile Formation in sufficient quantities to remove the motive force that transports waste from the repository to the accessible environment in an intrusion event involving the Castile Formation.

The EASWG determined this EA met the definition of an EA and should be considered further. The EASWG changed the title from "Drain" to "Depressurize" stating that drain was not technically correct and was misleading. Technology is a standard oil industry practice (per Nelson Munsey of Yates Petroleum). Must dispose of brine—many options for disposal available. Technology has been permitted, minimal permitting problems anticipated. State permit required.

63 Change Waste Container Shape

Square waste or hexagonal packages are used to decrease the void space within the disposal room.

The EASWG concluded that this EA met the definition and would be considered further. Technology is mature and available. Off-the-shelf containers of different various shapes are available and may meet existing TRU waste container requirements. NRC TRUPACT-II certification modification required, and U.S. Department of Transportation certification required. These certifications have been obtained for TRU waste containers previously. Permits can be obtained.

64 Change Waste Container Material

Non-ferrous materials are used to construct the waste container. Nickel, stainless steel, copper and glass/ceramic are examples of materials that could be used.

The EASWG concluded that this EA met the definition and would be considered further. The technology is mature and available. Depending on the specific material, waste containers made of non-ferrous materials are available off-the-shelf that may meet the current TRU waste container requirements. Same regulatory feasibility comments as #63.

83 Salt backfill with CaO

Crushed salt and CaO (lime) are used to backfill around the drums and fill void space in the waste panel.

The EASWG concluded that this EA met the definition and would be considered further.

110 Enhanced Solidification of Sludges

Cementation of sludges is performed to provide a waste form with improved properties over sludges cemented with existing systems.

The EASWG determined that this EA met the definition and would be considered further. Technology of cementing sludges has been demonstrated. RFP has matured this technology. Some development work may be required. The regulatory issues include satisfying DOE requirements and RCRA permit or modification to permit.

111 Clay Based Backfill

Clay based backfill is placed around the drum, filling the void spaces within the room to hasten room closure and isolate the waste with a low permeability barrier. Two forms of clays are considered, swelling (smectites) and non-swelling (illite/kaolinite). Clay may be placed dry or water may be added and the material pumped into the rooms.

The EASWG determined that this EA met the definition and would be considered further. The Technology is mature for moist and dry clay emplacement. The EASWG believes that no permits are required and only DOE requirements must be met.

Note:

The combination EAs were derived from those used in the Engineered Alternatives Task Force (EATF) report and System Prioritization Methodology (SPM) program. The titles/descriptions have been changed to match the title of the discrete technologies. For example, the title "Nickel Alloy Container" was changed to "Change Waste Containers Material, #64" and "Rectangular Containers" was changed to "Change Waste Container Shape, #63". This was done to provide consistency throughout the analysis.

66 EATF Alternative 1—

Shred and cement organics and inorganics only, salt backfill.

The EASWG concluded that this EA met the definition and would be considered further.

67 EATF Alternative 2—

Enhanced cement sludges, shred and cement organics and inorganics, salt backfill.

The EASWG concluded that this EA met the definition and would be considered further.

68 EATF Alternative 3—

Enhanced cement sludges, shred and cement organics and inorganics, salt aggregate grout backfill.

The EASWG concluded that this EA met the definition and would be considered further.

69 EATF Alternative 4—

Enhanced cement sludges, incinerate and cement organics, shred and cement inorganics, salt backfill.

The EASWG concluded that this EA met the definition and would be considered further.

70 EATF Alternative 5—

Enhanced cement sludges, incinerate and cement organics, shred and cement inorganics, salt aggregate grout backfill.

The EASWG concluded that this EA met the definition and would be considered further.

71 EATF Alternative 6—
Vitrify sludges, shred and vitrify organics, melt metals into TRU waste ingots, salt backfill.
The EASWG concluded that this EA met the definition and would be considered further.

72 EATF Alternative 7—
Vitrify sludges, shred and vitrify organics, melt metals into TRU waste ingots, salt aggregate grout backfill.
The EASWG concluded that this EA met the definition and would be considered further.

73 EATF Alternative 8—
Vitrify sludges, shred and vitrify organics, melt metals with frit to partition actinides (metals are eliminated from the WIPP inventory), salt backfill, change waste container material.
The EASWG concluded that this EA met the definition and would be considered further.

74 EATF Alternative 9—
Vitrify sludges, shred and vitrify organics, melt metals with frit to partition actinides (metals are eliminated from the WIPP inventory), salt aggregate grout backfill, change waste container material.

The EASWG concluded that this EA met the definition and would be considered further.

75 EATF Alternative 10—
Decontaminate surface of metallic waste for LLW disposal, no backfill, change container material and shape, 10x31x188 rooms.
The EASWG concluded that this EA met the definition and would be considered further.

76 EATF Alternative 11—
Supercompact organics and inorganics, salt backfill, monolayer of 2,000 drums in a 6x33x300 room.
The EASWG concluded that this EA met the definition and would be considered further.

77 EATF Alternative 12—
Supercompact organics and inorganics, salt aggregate grout backfill, monolayer of 2,000 drums, in a 6x33x300 room.
The EASWG concluded that this EA met the definition and would be considered further.

78 EATF Alternative 13—
Vitrify sludges, shred and vitrify organics, melt metals with frit to partition actinides (metals are eliminated from the WIPP), no backfill, change waste container material and shape, minimize space around waste stack in a 10x31x188 room.
The EAWG concluded that this EA met the definition and would be considered further.

79 EATF Alternative 14—
Supercompact organics, and inorganics, salt backfill, seal individual rooms, 2,000 drums per room.
The EASWG concluded that this EA met the definition and would be considered further.

87 SPM IT-2

Enhanced cement sludges, shred and cement organics and inorganics, salt backfill, change waste container material.

The EASWG concluded that this EA met the definition and would be considered further.

88 SPM IT-3

Enhanced cement sludges, shred and cement organics and inorganics, salt aggregate grout backfill.

The EASWG concluded that this EA is a duplicate of #68, "EATF Alternative 3".

89 SPM IT-4

Enhanced cement sludges, shred and cement organics and inorganics, salt backfill with CaO.

The EASWG concluded that this EA met the definition and would be considered further.

90 SPM IT-5

Enhanced cement sludges, shred and compact organics and inorganics, salt backfill, 2,000 drum monolayer, 6x33x300 room.

The EASWG concluded that this EA met the definition and would be considered further.

92 SPM IT-7

Enhanced cement sludges, compact organics and inorganics, salt backfill with CaO, 2,000 drums monolayer, 6x33x300 room.

The EASWG concluded that this EA met the definition and would be considered further.

93 SPM IT-8

Enhanced cement sludges, shred and add clay based material to organics and inorganics, salt backfill.

The EASWG concluded that this EA met the definition and would be considered further.

94 SPM IT-9

Enhanced cement sludges, shred and add clay based materials to organics and inorganics, salt aggregate grout backfill.

The EASWG concluded that this EA met the definition and would be considered further.

95 SPM IT-10

Decontaminate surface of metallic waste for LLW disposal, change waste container material, salt aggregate grout backfill.

The EASWG concluded that this EA met the definition and would be considered further.