Department of Energy
Carlsbad Area Office
P. O. Box 3090
Carlsbad, New Mexico 88221

AUG 2 8 1995

Mr. Mark E. Weidler, Secretary
New Mexico Environment Department
P.O. Box 26110
Santa Fe, NM 87502

Dear Mr. Weidler:

Please find enclosed a copy of the Waste Isolation Pilot Plant Land Withdrawal Act Radioactive Waste Processing and Volume Reduction Technology Study, DOE/CAO-Draft-3102. This study is required under Section 19 of the Waste Isolation Pilot Plant Land Withdrawal Act (Public Law 102-579). This section requires the DOE to submit a study reviewing technologies that are available or are being developed for processing or reducing the volume of radioactive waste. The study will be submitted to members of Congress on October 30, 1995.

This document has undergone DOE review and is in the process of comment resolution and finalization. If you have any questions or concerns related to the study, please contact Mark Matthews of my staff at (505) 234-7467.

Sincerely,

George E. Dials
Manager

Enclosure

cc w/o enclosure:
P. Kilgore, CAO

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DOE/CAO-DRAFT-3102

Waste Isolation Pilot Plant Land Withdrawal Act Radioactive Waste Processing and Volume Reduction Technology Study

May 1995

U. S. Department of Energy
Carlsbad Area Office
Carlsbad, New Mexico

The Secretary of Energy
Washington, DC 20585

October 30, 1995

The Honorable Al Gore, Jr.
President of the Senate
Washington, DC 20510

Dear Mr. President:

Enclosed is the "Report to Congress in Response to Public Law 102-579, Waste Isolation Pilot Plant Land Withdrawal Act Radioactive Waste Processing and Volume Reduction Technology Study". The report is intended to satisfy the requirement promulgated in Section 19 of the Waste Isolation Pilot Plant Land Withdrawal Act.

The report reviews 216 processing technologies that may be applied to transuranic or mixed transuranic waste. These technologies physically stabilize the waste, reduce its volume, mitigate its hazardous properties, or mitigate its radioactive properties. The processes are analyzed according to the main mechanisms for achieving their objectives, applicable waste types, process maturity, and end waste forms.

The majority of processes apply to hazardous waste, or to the hazardous component of mixed waste. Few processes are at the commercial level for processing radioactive waste. Their development will depend on research funding, potential cost effectiveness, and their ability to comply with current and future environmental regulations. The Department of Energy will continue to support waste processing technology research and development through its technology development initiatives, commensurate with funding and applicability to DOE waste management applications.

Sincerely,

Hazel R. O'Leary

Enclosure

Abstract

This report reviews 216 processing technologies that are available for, or could be applicable to, transuranic and mixed transuranic waste. Thirty-six general categories of technologies are summarized. Each individual technology is also described; including process objective, process type, applicable waste types, process maturity, and end waste form. This report is in response to Section 19 of the Waste Isolation Pilot Plant Land Withdrawal Act, Public Law 102-579.

Acronym List

CAO - Carlsbad Area Office, of the Department of Energy
CH - Contact Handled
CFR - Code of Federal Regulations
DOE - Department of Energy
EPA - Environmental Protection Agency
ERDA - Energy Research and Defense Agency
FFCA - Federal Facilities Compliance Act
LWA - Land Withdrawal Act
MWIR - Mixed Waste Inventory Report
NAS - National Academy of Sciences
NTP - National TRU Program, of the Carlsbad Area Office
PEIS - Programmatic Environmental Impact Statement
RCRA - Resource Conservation and Recovery Act
RH - Remote Handled
SITE - Superfund Innovative Technology Evaluation
TRU - Transuranic
WIPP - Waste Isolation Pilot Plant

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I. Introduction.

This report is in response to the study requirement promulgated in Section 19 of the Waste Isolation Pilot Plant Land Withdrawal Act (LWA), Public Law 102-579, of October 30, 1992. This section reads:

> *"Within three years after the date of this Act, the Secretary shall submit to Congress a study reviewing the technologies that are available and that are being developed for the processing or reduction of volumes of radioactive wastes. The study shall include an identification of technologies involving the use of chemical, physical, and thermal (including plasma) processing techniques."*

The main body of the document contains background information, technology summaries, and trends. The appendices contain detailed descriptions of specific processing technologies. The report provides an overview of processes that are available for, or could be applicable to, transuranic (TRU) and mixed TRU waste. It does not review all processes that apply to radioactive, or hazardous waste.

Because the LWA was enacted for WIPP, the report also contains background information on regulations relevant to WIPP and waste management. These regulations have encouraged the development of many of the technologies described in the report. The reference section may be used when more detailed information is desired. Finally, the report provides technical information which the U. S. Department of Energy (DOE) is incorporating into the development of long term waste management policy and strategy.

A. WIPP Background.

The Waste Isolation Pilot Plant (WIPP) was created by the DOE as a research and development facility to demonstrate the safe disposal of transuranic radioactive waste materials generated by atomic energy defense activities. The WIPP is located 26 miles east of Carlsbad, in southeastern New Mexico. The underground portion of the facility is located 2150 ft (655 m) below the surface, near the center of a 2000 ft (655 m) thick, primarily salt bed known as the Salado Formation. The WIPP is designed to dispose of 6.2 million cubic feet of TRU and mixed TRU waste. These types of wastes are contaminated with radioactive elements heavier than uranium. They may also contain hazardous materials that are regulated under the Resource Conservation and Recovery Act (RCRA).

The WIPP is administered by the DOE's Carlsbad Area Office (CAO). One program under CAO's management is the National Transuranic Program (NTP) which coordinates the generation, characterization, treatment,

storage, transportation, and disposal of transuranic waste across the DOE complex. This report was prepared under the direction of the NTP.

The LWA requirement for this report was included in legislation specifically enacted to address the WIPP. As such, this report reflects WIPP's waste streams, and regulatory arena. It is a compendium of technologies for processing transuranic and mixed transuranic waste. Several assumptions were made in its development. They are:

1. This report is not intended to address all the technologies available to process low and high level radioactive waste or purely hazardous waste. The WIPP will accept only TRU and mixed TRU waste. The scope of this report is limited to processes that are, or could be, applicable to TRU and mixed TRU waste. No distinction is made between contact handled (CH) and remote handled (RH) waste. If a process is applicable to TRU, it is applicable to CH and RH TRU. A technology is included if it addresses low level or high level radioactive waste, low level or high level mixed waste or purely hazardous waste, only if it has a potential application to TRU and mixed TRU waste. This report focuses on processes in the United States.
2. The processes described have a desirable effect on a waste stream. The end result of a process could be reduced volume, physical stabilization, mitigation of hazardous properties, or mitigation of radioactive properties.
3. The report is a review and discussion of process technologies. The selection of a process for application is dependent upon several factors. These include: relevant state and federal regulations, the specific attributes of the desired outcome, the waste contaminants, the waste form, the storage container, the storage facility, disposal options, and resources. No recommendations of one process over another are made here. The DOE is developing specific recommendations for processing technologies applicable to each of its waste streams (mixed low-level and mixed TRU) at the generator sites. The results will be published in the DOE's Site Treatment Plans in accordance with the Federal Facilities Compliance Act (FFCA). This report is not intended to duplicate or supersede this effort. In addition, the DOE's Environmental Restoration and Waste Management Programmatic Environmental Impact Statement (PEIS) is the primary tool for making waste processing decisions. The PEIS addresses individual technologies, costs, and processing configurations in detail. This report does not attempt to provide the type of detailed analyses that can be found in the PEIS.
4. Due to the speed and magnitude of changes in the field of waste processing technologies, specific vendors of technologies are not mentioned. References for each technology are presented so that vendors may be identified.
5. Waste characterization lies outside the scope of this report because it does not modify the waste by reducing volume, physically stabilizing, or mitigating hazardous or radioactive properties.

6. Individual processing technologies are presented. Pre- and post-process waste preparation technologies are beyond the scope of this report.
7. Because WIPP will receive waste in drums and standard waste boxes, only those technologies for processing that lead to the production of contained waste are addressed. *In situ* processes fall under environmental remediation.

B. Regulatory and Legal Background.

The regulatory framework of WIPP is presented below, because this report meets a requirement of the LWA, which is WIPP specific. This information provides a legal view of the events leading to the creation of WIPP. Regulations applicable to radioactive, hazardous, and mixed waste are also discussed.

Since 1942, DOE and its predecessor agencies have generated radioactive waste in the course of developing, producing, testing and maintaining nuclear weapons. In 1957, the National Academy of Sciences (NAS) issued a report that concluded nuclear waste could be safely isolated from the public and the environment through in geologic repositories. The NAS recommended salt deposits because these formations are found in geologically stable areas with few earthquakes, lack moving groundwater that could transport radioactive materials to the surface, are easily mined, and they slowly move to seal any tunnels, shaft or cracks.

The Energy Research and Development Administration (ERDA) managed the nuclear weapons program from 1975 when the Atomic Energy Commission was dissolved until 1977 when DOE was created. At the invitation of the Governor of New Mexico and local officials, ERDA began site investigations in the Carlsbad area in 1975. Congress authorized funding for the research, development, and construction of the WIPP in Public Law 94-187 in 1976.

Lands owned by the United States and administered by the Bureau of Land Management are open to public use under mining and general land laws, unless legally withdrawn and reserved for a particular public purpose. Public lands may be withdrawn either by act of Congress or by the Secretary of the Interior. Land can be withdrawn permanently only through legislation. Therefore, in order to construct and operate the WIPP, land had to be withdrawn from the public lands and reserved for the purposes of the WIPP.

The Secretary of the Interior withdrew the WIPP site for DOE to perform its Site and Preliminary Design Validation Program on March 30,1982. On June 29,1983, the Secretary withdrew the same land for purposes of constructing the WIPP. Each withdrawal was for a period of eight years. Neither permitted the receipt, storage, or burial of any radioactive wastes at

the site. Early in 1991, the Interior Department issued another withdrawal that allowed operations involving radioactive waste at the site to begin .

The LWA permanently transferred jurisdiction over the withdrawal area to DOE. It also established other WIPP responsibilities. The Environmental Protection Agency (EPA) was formally identified as responsible for certifying WIPP's compliance with the disposal standards. The EPA was also tasked with developing criteria to guide its certification of WIPP. These criteria are included in the draft of 40 CFR 194. As stated above, Section 19 of the LWA required the development of this report.

The EPA is responsible for setting standards for protecting the environment from the escape of radioactive and hazardous materials from nuclear waste repositories. These standards, 40 CFR 191, are divided into two parts: standards for management and storage, and standards for disposal. The WIPP will be assessed against these requirements.

In 1984, Congress enacted the Hazardous and Solid Waste Amendments to the RCRA. These amendments established a stringent regulatory program to prohibit the land disposal of hazardous waste unless the waste is processed to meet land disposal standards, or the EPA determines that the Land Disposal Restrictions are not required in order to protect human health and the environment. If such a determination can be made, a No Migration Variance Petition is submitted to the EPA, and upon approval, a no migration variance is granted. In order to proceed with the disposal phase at WIPP, the DOE will seek a variance from the EPA for permanent disposal of mixed TRU waste.

C. The DOE TRU Waste Inventory

DOE TRU waste that is eligible for disposal at WIPP has been, and in some cases still is, generated by research and development activities, plutonium recovery, weapons manufacturing, environmental restoration, and decontamination and decommissioning projects. The great majority of the waste is solid, consisting of items such as personal clothing, paper trash, rags, glass, and tools and equipment that have been contaminated with TRU isotopes. Some of the TRU wastes are liquid (or sludges) produced during chemical processing for recovery of plutonium or other TRU elements.

Prior to 1970 TRU waste was typically disposed of on-site in shallow land burial configurations. Transuranic waste generated after 1970 has been segregated from other waste and placed in retrievable storage awaiting the opening of a deep geological repository for final disposal. The waste in retrievable storage is in a variety of containers. Metal drums (usually 55 gallon) and metal and wooden boxes are most commonly used. These containers are stored in earthen berms, concrete culverts, storage buildings, or some other type of facility.

Transuranic waste is subdivided into mixed and non-mixed categories. Mixed TRU waste is hazardous according to RCRA standards in addition to containing the radioisotopes that make it TRU. Non-mixed TRU waste does not contain materials that make it hazardous under RCRA. TRU waste is also subdivided into contact-handled (CH) and remote-handled (RH) categories based on whether or not the surface radiation dose rate of the final package prepared for disposal at WIPP is less than or greater than 200 mrem/hour. Because of the much higher dose rate from RH waste, these packages must be handled with special tools and equipment to protect workers. Processing technologies selected for specific TRU waste streams must be designed to protect workers from harmful radiation doses.

Over 200 separate waste streams have been identified for TRU waste intended for WIPP. The largest volume waste streams are those that make up the heterogeneous waste (primarily metal and other inorganic debris), solidified inorganics, combustible materials (primarily paper, rubber, and plastics), soil, and lead/cadmium metal waste matrix groups. While all waste technologies serve a purpose, those technologies that can make significant reduction in the final volume, decrease hazard levels, and/or increase the final waste form stability of these large volume waste streams can have an especially valuable positive impact. Since liquid wastes will not be disposed of at WIPP, technologies for converting organic and inorganic liquid wastes to a solid form are very important.

II. Report Development Approach.

The language in the LWA specifies several key information needs that must be addressed in this report. First and foremost, the LWA specifies that the DOE submit a study reviewing technologies. Given the precedent set by the FFCA, the request incorporated in the LWA has been interpreted for this report as a request for an inventory of technologies much like that submitted to Congress in accordance with the FFCA. As such, three primary activities, reference collection, database development, and document development, were undertaken to fulfill the requirements stated in the legislation.

References were collected from a wide variety of sources including published literature, DOE Site Treatment Plans, and private vendor submissions. Literature searches to identify published sources of technology descriptions were conducted. Several existing databases, maintained by the DOE, the EPA, and other agencies, contributed to this report. Postings were made to relevant Internet Usenet newsgroups soliciting identification of processes for further review. Other Internet information resources, such as the World Wide Web and Gopher servers, provided waste processing references. A solicitation for information was placed in the Commerce Business Daily requesting input to this

report. A complete listing of references is given at the end of this report, in Section V.

The LWA states that the study should provide a review of technologies. For this document, a technology is a scientific method applied to a waste for achieving a positive end result. The LWA also states that the study should review: 1) technologies that are available or are being developed; 2) technologies that process or reduce the volume of radioactive waste; and 3) and technologies that are either chemical, physical, or thermal. These key information needs identified in the LWA have been further delineated and defined as fields in a database that was developed to support this work. The field names in the database, shown in underlined type, are:

1. The Process Name is a unique way of referring to the technology.
2. The Process Objective describes the desired effect, or end result the process has on a waste form. More than one of these objectives may apply to a single process. The categories are:

   a. Reduce Volume: indicates that the technology creates a reduction in waste volume. Examples: compaction, dewatering.
   b. Physically Stabilize: indicates that the technology creates a waste form that is more resistant to physical and chemical forces. Examples: vitrification and macroencapsulation.
   c. Mitigate Hazardous Properties: indicates that the technology makes some or all of the waste non-hazardous or less hazardous by modifying or destroying the hazardous constituents, by stabilizing the hazardous constituents, or by removing and concentrating the hazardous constituents as separate, smaller waste streams. Examples: decontamination, dechlorination, amalgamation, deactivation, and chemical oxidation/reduction.
   d. Mitigate Radioactive Properties: indicates that the makes some or all of the waste non-radioactive or less radioactive by changing the nature of the radioactive constituents, by stabilizing the radioactive constituents, or by removing and concentrating the radioactive constituents as separate, smaller waste streams. Examples: transmutation, decontamination, encapsulation, and vitrification.

3. The Process Type reflects the main mechanism employed by the technology. A process can be described by a combination of any of the definitions. Additional descriptive information may also be included. The types are:

   a. Mechanical: caused by, or resulting from, or relating to a process that involves purely physical change. Examples: physical separation, compaction, carbon adsorption, filtration, shredding.
   b. Chemical: caused by, or resulting from, or relating to a process that involves purely chemical change. Examples: neutralization, oxidation, reduction, ion exchange.

c. Thermal: caused by, or resulting from, or relating to a process that uses heat as the primary agent to bring about change. Examples: plasma, incineration, evaporation, and pyrolysis.
d. Biological: caused by, or resulting from, or relating to a process that uses living organisms to cause change. Examples: microbial degradation, biodenitrification.
e. Electrokinetic: caused by, or resulting from, or relating to a process that uses a difference of electrical potential to create change. Examples: heavy metal migration and heavy metal precipitator.
f. Admixtures: caused by, or resulting from, or relating to a process that uses the addition of material to create a mixture with different properties. Examples: solidification in Portland cement, polymers, and asphalt.
g. Other: any process that does not fit into any of the categories listed above.

4. The Waste Type Application describes the categories of waste to which the technology has been applied, is proposed for application, or may be possible for application. The categories are:

a. Radioactive: waste containing radioactive materials that are not transuranic and containing no non-radioactive hazardous materials.
b. Radioactive-mixed: waste containing non-transuranic radioactive materials and non-radioactive hazardous material. Examples: contaminated with Uranium, solution of fission or activation products in an acid or flammable solvent.
c. Transuranic: waste containing alpha-emitting isotopes with an atomic number >92 and half lives >20 years, at concentrations greater than 100 nCi/g of waste. This waste type contains no non-radioactive hazardous materials. Example: Plutonium-oxide scrap.
d. TRU-mixed: transuranic waste which also contains non-radioactive hazardous material. Examples: pyrophoric Plutonium metal turnings, TRU solutions in flammable solvents or acid.
e. Hazardous: waste which contains no non-natural radioactivity but does contain material considered hazardous under RCRA or other applicable definitions. Examples: hydrochloric acid, acetone, chromate solution.

5. The Process Maturity indicates the maturity of the process for each application, or proposed application. Each application of technology is identified as conceptual, pilot/innovative, or commercial/proven. A single process may have different levels of process maturity when considered for application to different waste types.

a. Conceptual: the process has been proposed. The process is probably the subject of one or more written descriptions, but has not

been put into practice at either pilot or commercial scale. Laboratory trials may or may not have been conducted.

b. Pilot/Innovative: the process has been tested at a pilot scale. The technology may be unique or new.

c. Commercial/Proven: the process is commercially applied, or is proven and developed to the point where it could be applied at a commercial scale with little or no new development work if a customer existed.

6. The Matrix Type reflects the type of waste for which the process is applicable. Matrix type names and numbers are from the "US Department of Energy National Data Base System for the Final Mixed Waste Inventory Report Draft User's Guide", Appendix G, May 1994. (MWIR).
7. The End Waste Form reflects the residual waste at the end of the process.
8. References are given for the specific sources of information documented in the individual discussion. Some information may not have come from published sources, but may be the result of the authors' judgment.
9. The Process Description contains additional pertinent information about the technology. Included may be: the objective of the process, limitations, efficiency, safety and risks, energy requirements, scale of operations, equipment and facility needs, throughput, reliability, ease of maintenance, cost relative to other processes, residual waste streams, waste minimization aspects, and information about intellectual property rights. Due to the variability in references, not all process descriptions will address all of these attributes.

Document development paralleled the building of the database. The database was queried to identify trends in the information. The trends are presented in the following section.

III. Processing Technology Summaries

Trends are summarized for the 216 processes identified in the study. For each process objective (reduce volume, physically stabilize, mitigate hazardous properties, and mitigate radioactive properties), two sections summarize the technologies. The first section identifies the number of different processes that apply to a specific waste type. Within each waste type the maturity, or developmental stage, of the processes is also discussed. A single process can have more than one developmental stage, when applied to different waste types. For example, carbon adsorption is at the commercial stage for hazardous waste, and at the pilot/innovative stage for radioactive mixed waste.

The second section briefly summarizes the different types of processes. The waste technologies have been divided by their major features into 36 groups. Some technologies do not fit cleanly in one and only one group. The authors used their best technical judgment to place these in the group where they felt would be of most benefit to the reader. A few technologies so clearly fit in two groups that they are listed in both applicable groups. Complete discussions of individual processes are found in the appendices.

A. Volume Reduction Processes by Waste Type and Maturity.

The main objective of these 126 processes is a reduction in waste volume. See Figure 1.

1. TRU Waste.

Of the 216 process identified in this study, 104 address the reduction of volume of TRU waste. Of these, 62 are conceptual, 31 are pilot/innovative, and 11 are commercial/proven. At the conceptual stage are processes such as controlled air incineration, reactor based transmutation and fixed hearth plasma. At the pilot/innovative stage are processes such as dewatering, rotary drum dryer and abrasive particulate blasting. Commercially proven processes include compaction and direct heating.

2. Mixed TRU Waste.

Volume reduction processes for mixed TRU waste number 122. Eighty-four processes are conceptual, 28 are pilot/innovative, and 10 are commercial/proven. Included at the conceptual stage are: supercritical water oxidation, asbestos digestion, and batch steam distillation. At the pilot/innovative stage are processes such as catalytic oxidation and joule heated melter. Among commercially proven processes are compaction and shredding.

3. Radioactive Waste.

One hundred five processes were found that can reduce the volume of low level or high level radioactive waste, and potentially address TRU waste. At the conceptual level are 53 processes, 33 are pilot/innovative, and 19 are commercial/proven. At the conceptual level of development are reactor based transmutation, stirred glass melter and molten metal bath processes. At the pilot/innovative level fractional crystallization, high temperature melter, and cobalt dicarbollide extraction can be found. Shredding, beryllium and lithium removal, and molten sulfur are processes at the commercial/proven stage.

4. Mixed Radioactive Waste.

For low and high level mixed radioactive waste and possibly mixed TRU waste, 122 processes were reviewed. There were 68 conceptually mature processes, 36 pilot /innovative processes, and 18 commercial/proven processes. At the conceptual level are: silent discharge plasma and ultrasonically catalyzed precipitation. Included at the pilot/innovative stage are dewatering and freeze crystallization. Reverse osmosis and fluidized bed calcination are at the commercial/proven stage.

5. Hazardous Waste.

Numerous processes were identified for reducing the volume of hazardous waste, and possibly mixed TRU waste. Of the 112 processes, 25 are at the conceptual stage, 28 at pilot/commercial, and 59 at commercial/proven. At the conceptual stage are cobalt dicarbollide impregnated polymers, magnetically assisted separation, and negative pressure systems. Biocatalytic destruction, high salt tolerant bacteria, and electrodeposition are processes at the pilot/innovative stage. Commercially available, or proven, processes include flotation, electrochemical coprecipitation, and white rot fungi.

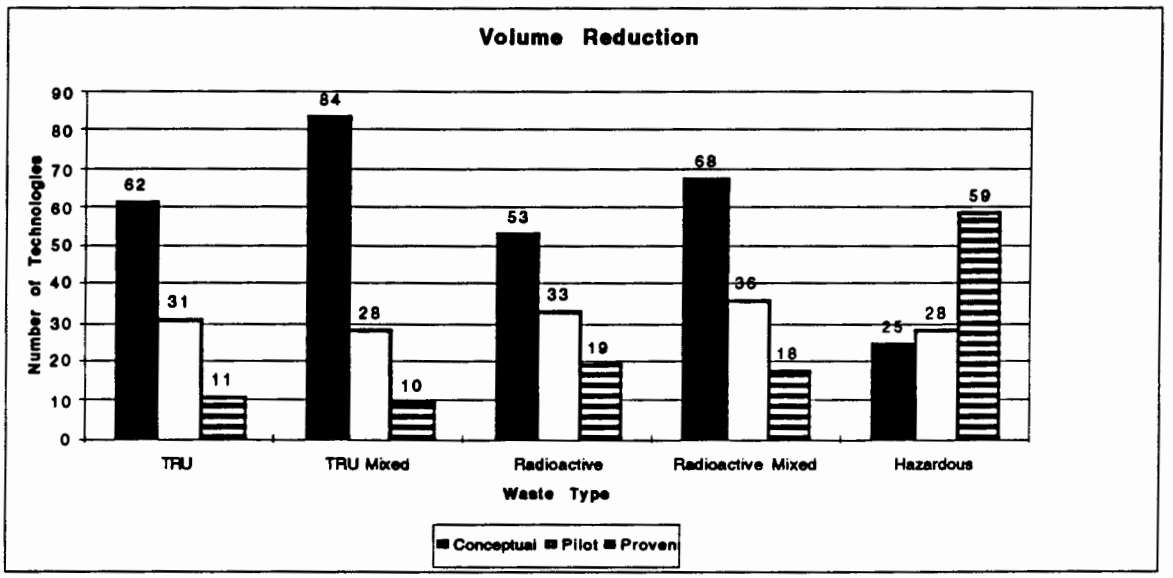

FIGURE 1. VOLUME REDUCTION TECHNOLOGIES BY PROCESS MATURITY.

B. Summaries of Processes Achieving Volume Reduction.

Adsorption/Absorption. Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by

organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group and are summarized below.

Air/Steam Stripping. Air and steam stripping technologies remove, or "strip" volatile compounds from contaminated water or aqueous waste streams by forcing air or steam through the waste. The volatile compounds evaporate into the air or steam and are carried away. Steam stripping may also be applied to non-aqueous solvents contaminated with nonvolatile impurities.

Biodegradation. This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorus, or nitrogen containing inorganic compounds to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

Calcination. Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the Appendices differ primarily in the design of the apparatus and the source of heat.

Complexation/Chelation. Chemical complexing and chelating agents are used to stabilize, concentrate, or collect specific constituents, usually from a liquid waste. Complexing agents are those which bond to atoms or molecules in the waste by the formation of a coordinate bond. Chelating agents are a class of organic compounds which form more than one coordinate bond with metal ions in solution. These agents are important because complexing or chelating agents can be selected based on their ability to bond to only specific species of interest in a solution. Thus they can be used to remove one, or a small group, of hazardous or radioactive ions from a solution containing other non-hazardous and non-radioactive ions. Many ion exchange materials are based on complexation or chelation reactions. These are considered separately in the ion exchange group below.

Deactivation. Deactivation is rendering a reactive material less hazardous by chemically reacting the material to convert it to a less hazardous compound or form. The methods in the appendices include several for oxidizing reactive metals such as sodium or uranium to their respective oxides by burning in air or reaction with water or some other oxidizing agent. Lithium hydroxide may be deactivated by reacting it with water. Deactivation also includes processes which destroy cyanide in solution by converting it into less hazardous compounds.

Decontamination. Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer either hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

Evaporation. Evaporation is the conversion of water, or some other liquid, to the gaseous state by the application of heat. This method is typically applied to reduce the volume of liquid waste streams.

Filtration/Centrifugation. Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due to density differences. These two techniques are combined in this report because they accomplish the same purpose.

Flocculation. Flocculation methods use a reagent (flocculant) in a dispersion of solids in a liquid to cause the solids to agglomerate and form a fluffy mass that typically floats on top of the liquid. This allows the flocculated solids to be easily separated from the liquid.

Incineration. Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion

chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources range from burning fossil fuels to electric arcs and plasmas.

Ion Exchange. Ion exchange is the removal of ionic species from waste (usually an aqueous solution) by using the reversible interchange of ions of like charge between an insoluble solid ion exchange medium and the solution. The ions in solution attach to the solid and are replaced, equivalent for equivalent, by other ions released from the solid. By proper selection of the ion exchanger and ion exchange conditions specific ions or groups of ions may be selectively removed from the solution. Ion exchange media are typically organic ion exchange resins, inorganic solids such as crystalline silico-titanates, or zeolites.

Leaching. Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Liquid-Liquid Extraction. In liquid-liquid extraction, also called solvent extraction, one or more species in one liquid phase transfer to a second, immiscible, liquid phase for which the species have a greater affinity. The two liquids must be brought into contact with each other for the extraction to take place. This can be done by mixing the two liquids in a separatory funnel, or in a more elaborate apparatus such as those using counter-current flow.

Metal Melting. Metal melting methods are those used to recover, clean, and/or compact metal waste by applying heat to melt the metal. The molten metal flows to form a compact mass, reducing waste volume, and can be poured off leaving other materials behind to separate the metal from other non-metal materials. The heat applied to melt the metal can also destroy many organic impurities in the waste.

Plasma Processes. A plasma is a completely ionized gas with nearly equal numbers of free positive and negative charges. Plasmas are generated by electric arcs or discharges, or electrical induction processes. Waste processing technologies use the very high temperatures generated in the plasma to destroy organic wastes or melt inorganic waste. Many of the plasma processes described in this report are included in more than one process groups, this plasma processes group, and another group such as vitrification or incineration.

Precipitation. Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving a new compound in the solution to provide ions that form an insoluble compound with other ions already present in the solution. For example, adding a soluble sulfate compound to a solution containing dissolved barium causes insoluble barium sulfate to precipitate. For this report, this group of processes also includes crystallization processes. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until salts in the solution becomes supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

Pyrolysis. Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other process or to further destroy the material.

Reverse Osmosis. Reverse osmosis is a technique in which pressure is applied to a solution a causing pure solvent (usually water) to pass through a semipermeable membrane. The result is pure water on one side of the membrane and a lower volume, more concentrated solution on the other side of the membrane.

Separation. Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, or radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

Size Reduction. Size reduction technologies are mechanical methods for making waste take up less space (volume reduction). These include compaction, which is using pressure to squeeze waste into a smaller volume, and shredding, which converts waste to similar sized pieces which pack more efficiently in containers.

Steam Reforming. Steam reforming is the process of converting organic waste to simpler compounds, typically mixtures of gases rich in hydrogen

and carbon monoxide. The gaseous products are sometimes burned as fuel.

Thermal Desorption. Thermal desorption processes use heat to drive adsorbed and absorbed volatile substances from solid waste. The volatilized substances are usually recondensed or otherwise collected for further processing and/or disposal.

Transmutation. Transmutation is the conversion of a radioisotope to a shorter-lived or stable isotope by bombarding it with nuclear particles such as neutrons or protons, usually in a nuclear reactor or a particle accelerator.

Vitrification. Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

Wet Air Oxidation. Wet air oxidation processes subject an aqueous phase containing dissolved or suspended organic substances to heat and pressure in the presence of air or oxygen. Under these conditions, the organics are converted to water, carbon dioxide, and biodegradable acids. The reaction is conducted at sub-critical temperatures and pressures (350-650 °F and 2-20 atm).

C. Physical Stabilization Processes by Waste Type and Maturity.

These 43 processes produce a waste form that is more resistant to physical and chemical forces. See Figure 2.

1. TRU Waste.

Of the 216 processes identified, 39 are applicable to TRU waste. Seventeen of the 39 are at the conceptual stage, 18 are pilot/innovative, and 4 are commercial/proven. Included in the conceptual group are metal refining and plasma centrifugation furnace. Phosphate bonded ceramics and sulfur polymer cement are among the 18 processes at the pilot/innovative stage. Compaction is in the group of four processes at the commercial/proven stage.

2. Mixed TRU Waste.

Forty-three processes are described which apply to mixed TRU waste. Twenty-four processes are conceptual, 15 are pilot/innovative, and four are commercial. Plasma arc furnace and pozzolanic binder are processes at the conceptual state of maturity. At the pilot/innovative stage can be found ceramic silicone foam and hydraulic cement. Only four processes, compaction and stabilization are at the commercial/proven stage.

3. Radioactive Waste.

Of the 39 processes applicable to radioactive waste and potentially TRU waste, 13 are conceptual, 19 are pilot/innovative, and seven are commercial/proven. Microwave melter and reactor based transmutation are among those processes at the conceptual stage. Included in the pilot/innovative stage are alkali slag cement and joule heated melter processes. Among commercial/proven processes are compaction and fluidized bed calcination processes.

4. Mixed Radioactive Waste.

Processes applicable to mixed radioactive and possibly mixed TRU waste number 43. Sixteen are at the conceptual stage, 20 are pilot/innovative, and seven are commercial. Plasma centrifuge furnace and sodium hypochlorite solutions are conceptually mature processes. Microencapsulation and pot calcination of solids are at the pilot/innovative stage. Molten salt calcination is an example of a process at the commercial/proven stage.

5. Hazardous Waste.

Forty-two processes address hazardous waste physical stabilization, and may address mixed TRU waste physical stabilization. Nine are conceptual, 16 pilot/innovative, and 17 are commercial. Heat spray is one of the conceptual processes. At the pilot/innovative stage are asphalt stabilization and electric air melting. High temperature melter and slag-and-kiln incineration are examples of processes that are commercially available.

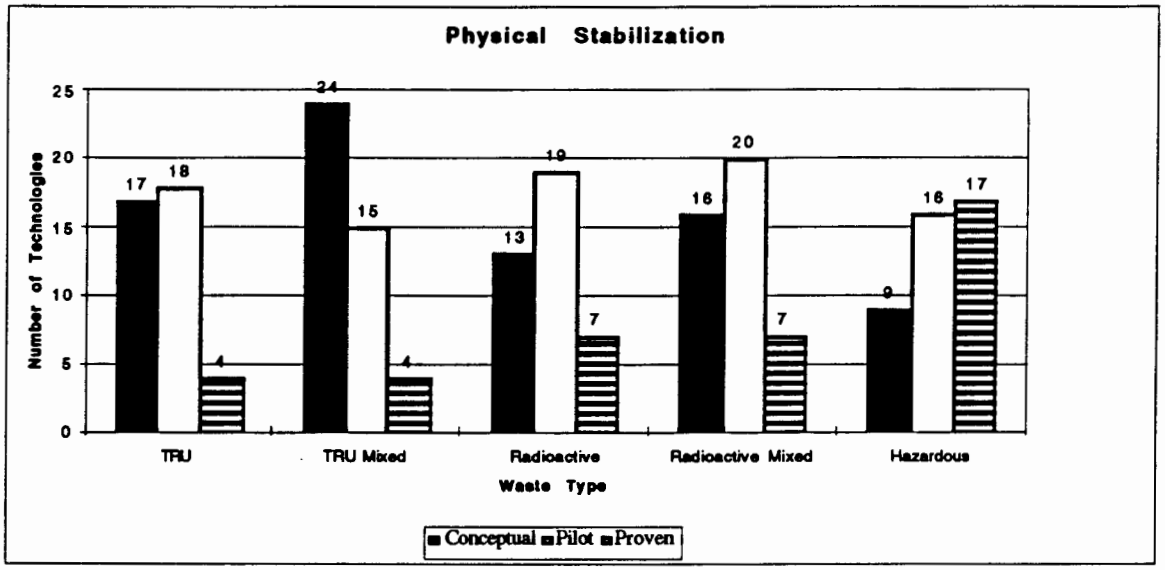

FIGURE 2. PHYSICAL STABILIZATION TECHNOLOGIES BY PROCESS MATURITY.

D. Summaries of Processes Achieving Physical Stabilization.

Actinide recovery. Actinides are elements with atomic numbers 89 (actinium) through 103 (lawrencium) and include the common fissile, source, and/or transuranic elements thorium, uranium, neptunium, plutonium, americium, and curium. Actinide recovery is the selective removal and capture of actinide elements from other materials in a waste stream. The volumes of TRU and TRU mixed wastes will be greatly reduced if actinides can be selectively removed and concentrated. The material left after actinide removal can probably be handled as low level waste or mixed low level waste. The technologies identified as actinide recovery technologies in this report are typically multi-stage chemical separation processes in which actinides are separated using successive dissolution, precipitation, and ion exchange steps.

Amalgamation. Amalgamation, as used in this report, is the mixing of waste metallic mercury with another metal or metals to form a solid alloy. By this process, liquid elemental mercury is converted to more a stable, solid form.

Biodegradation. This group includes methods in which living organisms are intentionally used metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorus, or nitrogen-containing inorganic compounds to simpler, less hazardous

compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

Calcination. Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the appendices differ primarily in the design of the apparatus and the source of heat.

Filtration/Centrifugation. Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due to density differences. These two techniques are combined in this report because they accomplish the same purpose.

Incineration. Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources range from burning fossil fuels to electric arcs and plasmas.

Metal Melting. Metal melting methods are those used to recover, clean, and/or compact metal waste by applying heat to melt the metal. The molten metal flows to form a compact mass, reducing waste volume, and can be poured off leaving other materials behind to separate the metal from other non-metal materials. The heat applied to melt the metal can also destroy many organic impurities in the waste.

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Size Reduction. Size reduction technologies are mechanical methods for making waste take up less space (volume reduction). These include compaction, which is using pressure to squeeze waste into a smaller volume, and shredding, which converts waste to similar sized pieces which pack more efficiently in containers.

Stabilization. Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert matrix material. Materials used for stabilizing waste include cements, grout, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens). Amalgamation of elemental mercury is a stabilization process, but for this report, amalgamation is broken out as a separate group.

Transmutation. Transmutation is the conversion of a radioisotope to a shorter-lived or stable isotope by bombarding it with nuclear particles such as neutrons or protons, usually in a nuclear reactor or a particle accelerator.

Vitrification. Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

E. Processes Mitigating Hazardous Characteristics by Waste Type and Maturity.

The main objective of these 188 processes is to make some or all of the waste non-hazardous or less hazardous. See Figure 3.

1. Mixed TRU Waste.

Out of the total number of processes reviewed, 184 apply to mixed TRU waste. One hundred forty two are conceptual, 34 are pilot/innovative, and eight are commercial processes. Among the conceptual processes are

carbon adsorption, fluidized bed redox, and plasma arc furnace. At the pilot stage can be found magnetic adsorption, rotary kiln incineration, and wet air oxidation. Direct heating evaporation and chemical precipitation are examples of the six commercially available processes.

2. Mixed Radioactive Waste.

For mixed radioactive waste, and possibly mixed TRU waste, there are 185 processes at various stages of maturity. At the conceptual level are 120, at the pilot level are 47, and at the commercial level are 18 technologies. Examples of conceptual processes are: potassium iodide leaching, sulfur impregnated carbon adsorption, and dechlorinization. At the pilot stage are: macroencapsulation, molten salt oxidation, and plasma reactor. Cementation with Portland cement and reactive metal combustion are examples of processes that are at the commercial stage of maturity.

3. Hazardous Waste.

Out of the 216 processes reviewed for this report, 184 apply to hazardous waste, and could possibly apply to mixed TRU waste. Forty-eight are at the conceptual stage, 55 at the pilot stage, and 81 are commercially available. At the conceptual stage are organic sponges and pozzolanic binders. Barium treatment, phosphate bounded ceramics, and ceramic silicone foam are examples of processes at the pilot stage. Commercially available processes include granular activated carbon, aerated slurry system, and controlled air incineration.

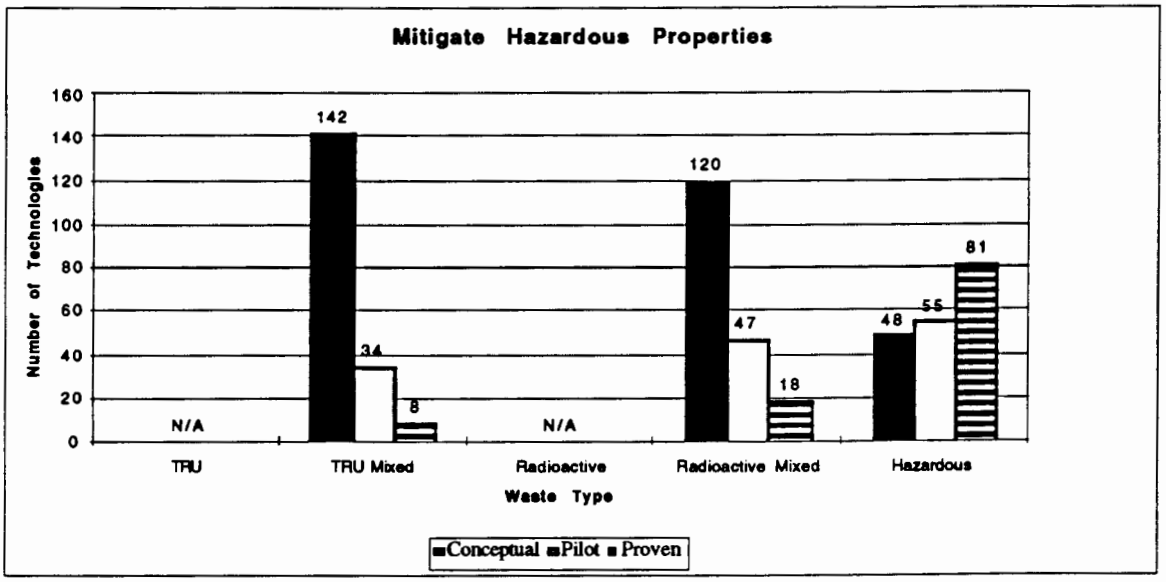

FIGURE 3. HAZARDOUS MITIGATION TECHNOLOGIES BY PROCESS MATURITY.

F. Summaries of Processes Mitigating Hazardous Characteristics.

Acid Digestion. Acid is used to break down the structure of solids in waste by dissolving some phases or by breaking all or some of the solids down to simpler forms. Heat may be used to speed up the action of the acid. If the hazardous component of the waste is either freed to go completely into the liquid acid phase, or stays completely in the remaining solid phase, separation of the liquid from the solid after digestion will result in the waste material being concentrated in a smaller volume of material. Waste concentrated in the liquid phase may be further concentrated by other methods such as precipitation.

Adsorption/Absorption. Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group and are summarized below.

Air/Steam Stripping. Air and steam stripping technologies remove, or "strip" volatile compounds from contaminated water or aqueous waste streams by forcing air or steam through the waste. The volatile compounds evaporate into the air or steam and are carried away. Steam stripping may also be applied to non-aqueous solvents contaminated with nonvolatile impurities.

Amalgamation. Amalgamation, as used in this report, is the mixing of waste metallic mercury with another metal or metals to form a solid alloy. By this process, liquid elemental mercury is converted to more a stable, solid form.

Biodegradation. This group includes methods in which living organisms are intentionally used metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorus, or nitrogen-containing inorganic compounds to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

Calcination. Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the appendices differ primarily in the design of the apparatus and the source of heat.

Complexation/Chelation. Chemical complexing and chelating agents are used to stabilize, concentrate, or collect specific constituents, usually from a liquid waste. Complexing agents are those which bond to atoms or molecules in the waste by formation of a coordinate bond. Chelating agents are a class of organic compounds which form more than one coordinate bond with metal ions in solution. These agents are important because complexing or chelating agents can be selected based on their ability to bond to only specific species of interest in a solution. Thus they can be used to pull one, or a small group, of hazardous or radioactive ions from a solution containing other non-hazardous and non-radioactive ions. Many ion exchange materials are based on complexation or chelation reactions. These are considered separately in the ion exchange group below.

Deactivation. Deactivation is rendering a reactive material less hazardous by chemically reacting the material to convert it to a less hazardous compound or form. The methods in the appendices include several for oxidizing reactive metals such as sodium or uranium to their respective oxides by burning in air or reaction with water or some other oxidizing agent. Lithium hydroxide may be deactivated by reacting it with water. Deactivation also includes processes which destroy cyanide in solution by converting it into less hazardous compounds.

Decontamination. Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer either hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

Dehalogenation. The goal of dehalogenation technologies is to convert hazardous halogenated compounds to simpler, less hazardous materials by

removing the halogen atoms from the compounds. Removal of chlorine from polychlorinated biphenyls or dioxins is one example of dehalogenation.

Evaporation. Evaporation is the conversion of water, or some other liquid, to the gaseous state by the application of heat. This method is typically applied to reduce the volume of liquid waste streams.

Filtration/Centrifugation. Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due to density differences. These two techniques are combined in this report because they accomplish the same purpose.

Flocculation. Flocculation methods use a reagent (flocculant) in a dispersion of solids in a liquid to cause the solids to agglomerate and form a fluffy mass that typically floats on top of the liquid. This allows the flocculated solids to be easily separated from the liquid.

Incineration. Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources range from burning fossil fuels to electric arcs and plasmas.

Ion Exchange. Ion exchange is the removal of ionic species from waste (usually an aqueous solution) by using the reversible interchange of ions of like charge between an insoluble solid ion exchange medium and the solution. The ions in solution attach to the solid and are replaced, equivalent for equivalent, by other ions released from the solid. By proper selection of the ion exchanger and ion exchange conditions specific ions or groups of ions may be selectively removed from the solution. Ion exchange media are typically organic ion exchange resins, inorganic solids such as crystalline silico-titanates, or zeolites.

Leaching. Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Liquid-Liquid Extraction. In liquid-liquid extraction, also called solvent extraction, one or more species in one liquid phase transfer to a second, immiscible, liquid phase for which the species have a greater affinity. The two liquids must be brought into contact with each other for the extraction to take place. This can be done by mixing the two liquids, in a separatory funnel, or in more elaborate systems such as those using counter current flow.

Metal Melting. Metal melting methods are those used to recover, clean, and/or compact metal waste by applying heat to melt the metal. The molten metal flows to form a compact mass, reducing waste volume, and can be poured off leaving other materials behind to separate the metal from other non-metal materials. The heat applied to melt the metal can also destroy many organic impurities in the waste.

Mercury Recovery. Mercury recovery methods include technologies designed to separate and collect mercury from other waste materials. The methods are generally thermal which take advantage of the volatile nature of mercury, or chemical methods in which an easily separated chemical compound of mercury is formed. Some of the chemical methods found in the appendices are potassium iodide leaching and retention with sulfur impregnated carbon.

Neutralization. Neutralization is a chemical process in which the pH of acid waste is increased (by adding a basic solution or substance) or the pH of basic waste is decreased (by adding an acid solution or substance) so that the product has a pH approaching 7. Corrosive wastes are considered to no longer have the hazardous characteristic of corrosivity if neutralized so the pH is between 2 and 12.5.

Oxidation/Reduction. Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other process which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

Plasma Processes. A plasma is a completely ionized gas with nearly equal numbers of free positive and negative charges. Plasmas are generated by electric arcs or discharges, or electrical induction processes. Waste

processing technologies use the very high temperatures generated in the plasma to destroy organic wastes or melt inorganic waste. Many of the plasma processes described in this report are included in more than one process groups, this plasma processes group, and another group such as vitrification or incineration.

Precipitation. Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compound in the solution to provide ions that form an insoluble compound with other ions already present in the solution. For example, adding a soluble sulfate compound to a solution containing dissolved barium causes insoluble barium sulfate to precipitate. For this report, this group of processes also includes crystallization processes. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until salts in the solution becomes supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

Pyrolysis. Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other process or to further destroy the material.

Radiolysis. Radiolysis processes use ionizing radiation to dissociate molecules. X-rays, gamma rays, and electrons are the types of ionizing radiation most commonly used in the methods in the appendices. Alpha particles, fission fragments, and other forms of ionizing radiation also produce radiolysis.

Reverse Osmosis. Reverse osmosis is a technique in which pressure is applied to a solution causing a pure solvent (usually water) to pass through a semipermeable membrane. The result is pure water on one side of the membrane and a lower volume, more concentrated solution on the other side of the membrane.

Separation. Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, or radioactive items from non-radioactive items and using magnetic properties

to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

Stabilization. Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert matrix material. Materials used for stabilizing waste include cements, grout, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens). Amalgamation of elemental mercury is a stabilization process, but for this report, amalgamation is broken out as a separate group.

Steam Reforming. Steam reforming is the process of converting organic waste to simpler compounds, typically mixtures of gases rich in hydrogen and carbon monoxide. The gaseous products are sometimes burned as fuel.

Thermal Desorption. Thermal desorption processes use heat to drive adsorbed and absorbed volatile substances from solid waste. The volatilized substances are usually recondensed or otherwise collected for further processing and/or disposal.

Vitrification. Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

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G. Processes Mitigating Radioactive Characteristics by Waste Type and Maturity.

There are 95 processes that make some or all of the waste non-radioactive or less radioactive. See Figure 4.

1. TRU Waste.

Ninety-one process were identified that address TRU waste. Fifty-three are at the conceptual stage, 31 at the pilot level, and 7 are commercial processes. Examples of conceptual processes are supercritical carbon dioxide and gel beads. Crystalline silico-titanate and microwave melter are at the pilot level. Manual separation and vacuum filtration are two commercially available processes for TRU waste.

2. Mixed TRU Waste.

Of the 95 processes reviewed for mixed TRU, 61 are conceptual, 28 pilot, and six commercial. Plasma centrifugal furnace and capacitative deionization are two processes at the conceptual level. At the pilot level are ceramic silicone foam and alkali slag cements. Commercially available technologies include vacuum filtration and pressure gradient.

3. Radioactive Waste.

For radioactive waste and potentially for TRU waste, 90 technologies were reviewed. Forty-six are conceptual, 34 are pilot, and 10 are commercial. Polymer solidification, physical membrane microfiltration, and acoustic barrier are processes at the conceptual stage. At the pilot level of maturity are induction melter and acid extraction. Resin in pulp is an example of a commercial technology.

4. Mixed Radioactive Waste.

There are 94 mixed radioactive waste treatments which may address Mixed TRU waste. At the conceptual stage can be found 52, at the pilot stage 33, and at the commercial stage 9. Included in the conceptual stage are supercritical carbon dioxide, synthetic detoxifier, and complexation. Examples of technologies at the pilot stage are titanium treated zeolites and calcine residue. Chemical precipitation and reverse osmosis are at the commercial stage.

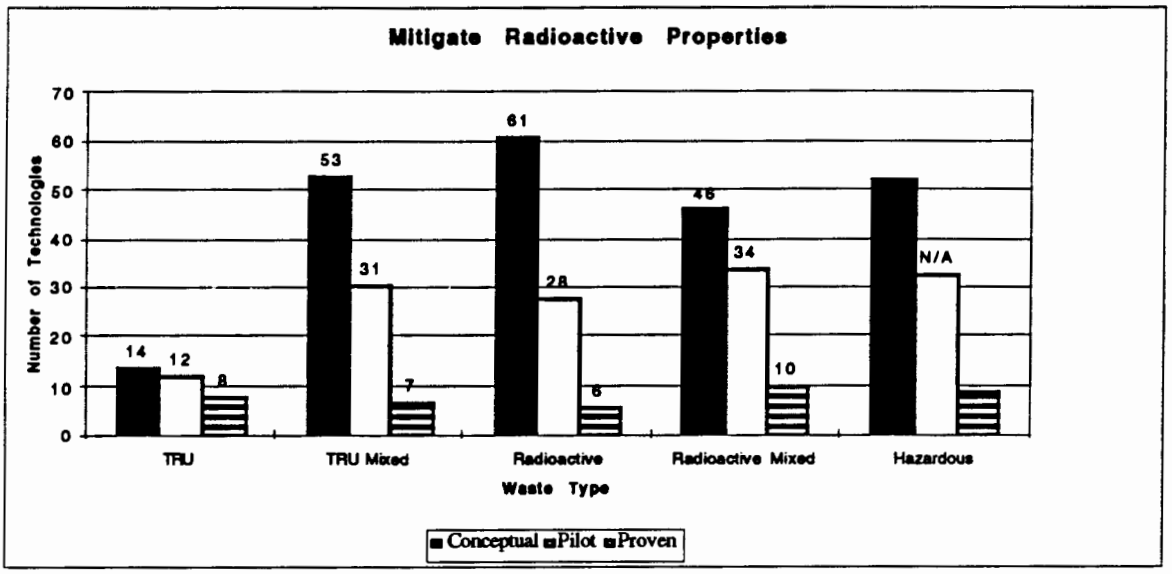

FIGURE 4. RADIATION MITIGATION TECHNOLOGIES BY PROCESS MATURITY.

H. Summaries of Processes Mitigating Radioactive Characteristics.

Acid Digestion. Acid is used to break down the structure of solids in waste by dissolving some phases or by breaking all or some of the solids down to simpler forms. Heat may be used to speed up the action of the acid. If the hazardous component of the waste is either freed to go completely into the liquid acid phase, or stays completely in the remaining solid phase, separation of the liquid from the solid after digestion will result in the waste material being concentrated in a smaller volume of material. Waste concentrated in the liquid phase may be further concentrated by other methods such as precipitation.

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Complexation/Chelation. Chemical complexing and chelating agents are used to stabilize, concentrate, or collect specific constituents, usually from a liquid waste. Complexing agents are those which bond to atoms or molecules in the waste by formation of a coordinate bond. Chelating agents are a class of organic compounds which form more than one coordinate bond with metal ions in solution. These agents are important because complexing or chelating agents can be selected based on their ability to bond to only specific species of interest in a solution. Thus they can be used to pull one, or a small group, of hazardous or radioactive ions from a solution containing other non-hazardous and non-radioactive ions. Many ion exchange materials are based on complexation or chelation reactions. These are considered separately in the ion exchange group below.

Deactivation. Deactivation is rendering a reactive material less hazardous by chemically reacting the material to convert it to a less hazardous compound or form. The methods in the appendices include several for oxidizing reactive metals such as sodium or uranium to their respective oxides by burning in air or reaction with water or some other oxidizing agent. Lithium hydroxide may be deactivated by reacting it with water. Deactivation also includes processes which destroy cyanide in solution by converting it into less hazardous compounds.

Decontamination. Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer either hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may

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Oxidation/Reduction. Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons loss) or decreased (reduced, electrons gain). Oxidation or reduction occurs in many

other process which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

Plasma Processes. A plasma is a completely ionized gas with nearly equal numbers of free positive and negative charges. Plasmas are generated by electric arcs or discharges, or electrical induction processes. Waste processing technologies use the very high temperatures generated in the plasma to destroy organic wastes or melt inorganic waste. Many of the plasma processes described in this report are included in more than one process groups, this plasma processes group, and another group such as vitrification or incineration.

Precipitation. Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compound in the solution to provide ions that form an insoluble compound with other ions already present in the solution. For example, adding a soluble sulfate compound to a solution containing dissolved barium causes insoluble barium sulfate to precipitate. For this report, this group of processes also includes crystallization processes. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until salts in the solution becomes supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

Reverse Osmosis. Reverse osmosis is a technique in which pressure is applied to a solution causing a pure solvent (usually water) to pass through a semipermeable membrane. The result is pure water on one side of the membrane and a lower volume, more concentrated solution on the other side of the membrane.

Separation. Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, or radioactive items from non-radioactive items and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

Stabilization. Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert matrix material. Materials used for stabilizing waste include cements, grout, sulfur cement,

thermoplastic or thermosetting polymers, and asphalt (bitumens). Amalgamation of elemental mercury is a stabilization process, but for this report, amalgamation is broken out as a separate group.

Transmutation. Transmutation is the conversion of a radioisotope to a shorter-lived or stable isotope by bombarding it with nuclear particles such as neutrons or protons, usually in a nuclear reactor or a particle accelerator.

Vitrification. Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

IV. Summary.

This report reviews technologies that are available for the processing of TRU and mixed TRU waste. In the appendices, each technology is categorized as achieving volume reduction, physical stabilization, or mitigating hazardous or radioactive properties. The majority of the technologies use mechanical, thermal, chemical, biological, or electrokinetic means; or the addition of admixtures to reach their process objectives. The applicability to radioactive, mixed radioactive, TRU, mixed TRU, and hazardous waste is stated. For each waste type, a technology was identified as being at the conceptual, pilot/innovative, or commercial/proven stage of maturity. Applicable waste types are further divided into specific categories such as wastewaters, organic process residues, or metal debris. The form of the waste after processing is also addressed.

Of all the processes reviewed, the vast majority apply to hazardous waste, or to the hazardous component of mixed waste. Very few processes are at the commercial level for processing radioactive waste. There are many processes at the conceptual or pilot stage that apply to radioactive waste, but their availability for future use is uncertain. Their development is dependent on research funding, potential cost effectiveness relative to other technologies, and their ability to comply with current and future environmental regulations.

The Office of Technology Development (EM 50) is the lead organization within DOE for carrying out a national program of applied research, development, testing, and evaluation for innovative waste management and processing technologies. The report provides input to EM 50's technology development

focus area of mixed waste characterization, treatment, and disposal. Site technology coordination groups at DOE operations offices compile, prioritize, and validate the specific needs at individual sites. These groups also foster technology transfer, and coordinate the technology development process with EM 50.

An awareness of these limitations is important when developing long term plans for managing radioactive waste. Resources may be applied to create new and further develop existing processing technologies, to construct and permit specially designed landfills and geologic repositories, or a combination of both. Risks associated with increased waste handling due to processing, the costs associated with processing versus disposal, and the time to construct and permit treatment facilities, or landfills and repositories, must be considered.

The report describes the processing options, including level of maturity, that are available for processing specific types of TRU and mixed TRU waste. Individual DOE facilities can use this document in conjunction with site treatment plans and agreements with the states in which the facilities reside to identify those applications of technologies which will be of most benefit. To comply with the Federal Facilities Compliance Act, each site has written a plan that contains detailed analyses of its individual facilities, waste streams, and future plans for any required processing.

Waste processing is one of the primary management alternatives for DOE TRU and mixed TRU waste. Many technologies reviewed in this report can be applied to the portion of TRU and mixed TRU waste that currently does not meet WIPP waste acceptance criteria. After processing, this type of waste would then be eligible for disposal at WIPP. Technologies with direct application to TRU and mixed TRU wastes are indicated in the individual process descriptions found in the appendices.

The report is not an endorsement of any technology or vendor. The determination of applicability, evaluation of effectiveness, and selection of a technology must be made on a case by case basis. Because waste management is a rapidly evolving field, many of the processes described here will improve, or be replaced, and new ones will be developed. The DOE will continue to support waste processing technology research and development through its technology development initiatives, commensurate with funding and applicability to DOE waste management applications.

V. References.

Appendix A1
Technologies Sorted by Process Objective

Process Objective: Reduce Volume

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Acid Digestion/Asbestos Digestion	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Actinide Recovery	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☐
Actinide Recovery/Uranium Removal	☒	☒	☐	☐	☒	☐	☐	☒	☒	☒	☒	☐
Adsorption/Algae Cell Walls	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Adsorption/Carbon in Pulp	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Adsorption/Cobalt Dicarbollide Impregnated Polymers	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Adsorption/Magnetic	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒
Adsorption/Synthesized Ligands	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Air-Steam Stripping/Batch Steam Distillation	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Air-Steam Stripping/Organics from Liquid Wastes	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Biodegradation/Biocatalytic Destruction	☐	☒	☐	☒	☒	☐	☐	☒	☒	☒	☒	☒
Biodegradation/High Salt Tolerant Bacteria	☐	☐	☐	☒	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Ceramic Sponge Fixation	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Fluidized Bed	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Heat Spray	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Molten Sulfur	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Plasma Arc	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Rotary Kiln	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Complexation/Decontamination	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒

Process Objective: Reduce Volume

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Complexation/ESI Products	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Abrasive Particulate Blasting	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Chemical	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/High Pressure Water	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Mechanical Vibration	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Soil Washing-Solvents	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Supercritical Carbon Dioxide	☒	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Ultrasonic	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Evaporation/APES	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Evaporation/Direct Heating	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Evaporation/Externally Fired Roaster	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Evaporation/Negative Pressure System	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Evaporation/Positive Pressure System	☒	☐	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Evaporation/Rotary Drum Dryer	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration /SemiPermeable Membrane	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Acoustic Barrier	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Belt Press	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Centrifugation	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Dewatering	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Gravity	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Physical Membrane Microfiltration	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒

Process Objective: Reduce Volume

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Filtration/Pressure Gradient	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Vacuum	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Vapor - Separation Membrane	☒	☐	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Flocculation/Flotation	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
Incineration/Controlled-Air Incinerator	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Fixed Hearth Plasma Process	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Fluidized Bed	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Liquid Injection	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Plasma Arc	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Rotary Kiln Incinerator	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Slagging Kiln	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Ion Exchange/Crystalline Silico-Titanate	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Ion Exchange/ReFIX Resin	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Ion Exchange/Reillex -HPQ	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Ion Exchange/Resin in Pulp	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Ion Exchange/Titanium-treated Zeolite	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Ion Exchange/Ultrasonically Catalyzed	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Acid Extraction	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Calcine Residue	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Cobalt Dicarbollide Extraction	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Leaching/CREP Soil Washer	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒

Process Objective: Reduce Volume

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Leaching/Dutch Association of Soil Treatment Companies	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Extraction of Organics from Soil	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Extraksol	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Heavy Organics, PCB's, Dioxins	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Soil Washing for Dioxins	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Soil Washing-Heap Leach Technology	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Superwetter II Nonionic Surfactant	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Tarra Met Heavy Metal Removal	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/TRU Containing Sludge	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Water-Based Soil Washing	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Liquid-Liquid Extraction/Aqueous Biphasic Separation	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Liquid-Liquid Extraction/Cobalt Dicarbollide	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Liquid-Liquid Extraction/PUREX	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Liquid-Liquid Extraction/SREX	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Liquid-Liquid Extraction/TRUEX	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Metal Melting/High Temperature Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Metal Melting/Induction Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Metal Melting/Metal Refining	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma Arc Furnace	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma Centrifugal Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma-Pyrolysis Reactor	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒

Process Objective: Reduce Volume

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Plasma Process/Silent Discharge Plasma	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Precipitation/Actinide Complexation	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Precipitation/Alternating Current Electrocoagulation	☐	☐	☐	☐	☒	☐	☐	☐	☒	☐	☒	☒
Precipitation/Chemical	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Precipitation/Electrochemical Coprecipitation	☐	☐	☐	☐	☒	☐	☐	☐	☒	☐	☒	☒
Precipitation/Enzymatic Transformation of Inorganics	☐	☒	☐	☒	☐	☐	☐	☒	☒	☒	☒	☒
Precipitation/Fractional Crystallization	☐	☐	☐	☐	☐	☐	☒	☒	☐	☐	☐	☐
Precipitation/Freeze Crystallization	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Precipitation/Iron Coprecipitation	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Precipitation/Microbial Coprecipitation	☐	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒	☒
Precipitation/Photocatalytic Removal	☐	☐	☐	☐	☐	☐	☒	☐	☒	☐	☒	☐
Precipitation/Ultrasonically Catalyzed	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒
Pyrolysis/Advanced Electronic Reactor	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Pyrolysis/Molten Metal Bath	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
ReDox/Catalytic Ozone	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/Evaporative Oxidation	☐	☒	☒	☐	☐	☐	☐	☐	☐	☐	☐	☒
ReDox/Supercritical Water Oxidation	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Reverse Osmosis	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Separation/Beryllium and Lithium removal	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☐
Separation/Capacitative Deionization	☐	☐	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒
Separation/Electrodeposition	☐	☐	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒

Process Objective: Reduce Volume

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Separation/Electrosorb	☐	☐	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒
Separation/Magnetic Barrier	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Separation/Magnetically Assisted	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒
Separation/Manual	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Separation/Particle Sizing	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Separation/TALSPEAK Process	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Size Reduction/Compaction	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Size Reduction/Shredding	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Steam Reforming/Catalytic Oxidation	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Steam Reforming/High Temperature Reactor	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☒
Thermal Desorption/Anaerobic Retorting	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Transmutation/Accelerator Based	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒
Transmutation/Reactor Based	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☐
Vitrification/Electric Arc Melting	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Fossil Fuel Fired Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/High Temperature Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Induction Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Joule Heated Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Microwave Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Plasma Arc Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Plasma Centrifuge Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒

Process Objective: Reduce Volume

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Vitrification/Stirred Glass Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Terra-Vit	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒

Appendix A2
Technologies Sorted by Process Objective

Process Objective: Physically Stablize

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Actinide Recovery/Polymers for Plutonium & Americium	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Amalgamation Treatment Process	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Calcination/Ceramic Sponge Fixation	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Fluidized Bed	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Heat Spray	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Molten Sulfur	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Plasma Arc	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Pot Calcination of Solids	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Rotary Kiln	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Deactivation/Sodium Hypochlorite Solutions	☐	☒	☐	☐	☐	☒	☐	☐	☒	☐	☒	☒
Filtration/Dewatering	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Slagging Kiln	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Metal Melting/High Temperature Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Metal Melting/Metal Refining	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma Arc Furnace	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma Centrifugal Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Pyrolysis/Chem Char Project	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Size Reduction/Compaction	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Stabilization/Alkali-Slag Cements	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒

Process Objective: Physically Stablize

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Stabilization/Asphalt	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Ceramic Silicone Foam	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Chemically Bonded Ceramics	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Hydraulic Cement	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Macroencapsulation	☒	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Stabilization/Phosphate-bonded Ceramics	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Polyethylene Encapsulation	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Polymer Solidification	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Portland Cement	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Pozzolanic Binder	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Sulfur Polymer Cement	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Vinyl Ester Styrene Encapsulation	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Transmutation/Reactor Based	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☐
Vitrification/Electric Arc Melting	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Fossil Fuel Fired Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/High Temperature Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Induction Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Joule Heated Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Microwave Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Plasma Arc Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Plasma Centrifuge Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒

Process Objective: Physically Stablize

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Vitrification/Stir-Melter, Inc.	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Stirred Glass Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Terra-Vit	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒

Appendix A3
Technologies Sorted by Process Objective

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Acid Digestion/Asbestos Digestion	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Acid Digestion/Phosphoric Acid	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Acid Digestion/Sulfuric Acid	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Actinide Recovery/Uranium Removal	☒	☒	☐	☐	☒	☐	☐	☒	☒	☒	☒	☐
Adsorption/Algae Cell Walls	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Adsorption/Carbon	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Adsorption/Carbon in Pulp	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Adsorption/Cobalt Dicarbollide Impregnated Polymers	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Adsorption/Gel Beads	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Adsorption/Granular Activated Carbon	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Adsorption/Impregnated Polymers	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Adsorption/Magnetic	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒
Adsorption/Organic Sponges	☒	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Adsorption/Sulfur-Impregnated Carbon	☒	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Adsorption/Synthesized Ligands	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Air-Steam Stripping/Batch Steam Distillation	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Air-Steam Stripping/Organics from Liquid Wastes	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Amalgamation Treatment Process	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Biodegradation/Aerated Slurry System	☐	☐	☐	☒	☐	☐	☐	☐	☒	☐	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Biodegradation/Biocatalytic Destruction	☐	☒	☐	☒	☒	☐	☐	☒	☒	☒	☒	☒
Biodegradation/Bioreactors	☐	☐	☐	☒	☐	☐	☐	☐	☒	☐	☒	☒
Biodegradation/High Salt Tolerant Bacteria	☐	☐	☐	☒	☐	☐	☐	☒	☒	☒	☒	☒
Biodegradation/Metal Free Environments	☐	☒	☐	☒	☐	☐	☐	☐	☒	☐	☒	☒
Biodegradation/Microbes for Dechlorination	☐	☐	☐	☒	☐	☐	☐	☐	☒	☐	☒	☒
Biodegradation/SBP Microorganisms	☐	☐	☐	☒	☐	☐	☐	☐	☒	☐	☒	☒
Biodegradation/Sewage Sludge Inocula	☐	☐	☐	☒	☐	☐	☐	☐	☒	☐	☒	☒
Biodegradation/Stromatolite Remediation	☐	☐	☐	☒	☐	☐	☐	☒	☒	☒	☒	☒
Biodegradation/Vacuum Extraction System	☒	☐	☐	☒	☐	☐	☐	☐	☒	☐	☒	☒
Biodegradation/White Rot Fungi	☐	☐	☐	☒	☐	☐	☐	☐	☒	☐	☒	☒
Calcination/Fluidized Bed	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Heat Spray	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Molten Sulfur	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Plasma Arc	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Pot Calcination of Solids	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Rotary Kiln	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Complexation/Decontamination	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Complexation/ESI Products	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Deactivation/Alkali Metals	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Deactivation/Oxidation with Water	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Deactivation/Reactive Metal Combustion	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Deactivation/Sodium Hypochlorite Solutions	☐	☒	☐	☐	☐	☒	☐	☐	☒	☐	☒	☒
Decontamination/Abrasive Particulate Blasting	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Chemical	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/High Pressure Water	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Mechanical Vibration	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Metals Recovery from Soil	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Soil Washing-Solvents	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Supercritical Carbon Dioxide	☒	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Decontamination/Ultrasonic	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Dehalogenation/APEG	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Dehalogenation/Dechlorinization	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Dehalogenation/Gamma-Ray Destruction of PCBs	☐	☐	☐	☐	☐	☐	☒	☐	☒	☐	☒	☒
Dehalogenation/Light Activated Reduction	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Evaporation/APES	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Evaporation/Direct Heating	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Evaporation/Externally Fired Roaster	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Evaporation/Negative Pressure System	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Evaporation/Positive Pressure System	☒	☐	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Filtration /SemiPermeable Membrane	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Acoustic Barrier	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Belt Press	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Filtration/Centrifugation	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Gravity	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Physical Membrane Microfiltration	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Pressure Gradient	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Vacuum	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Filtration/Vapor - Separation Membrane	☒	☐	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Flocculation/Flotation	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
Incineration/Controlled-Air Incinerator	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Fixed Hearth Plasma Process	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Fluidized Bed	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Liquid Injection	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Plasma Arc	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Rotary Kiln Incinerator	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Slagging Kiln	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Ion Exchange/Resin in Pulp	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Ion Exchange/Ultrasonically Catalyzed	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Acid Extraction	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Calcine Residue	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/CO2-Water Extraction	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Leaching/Cobalt Dicarbollide Extraction	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☐
Leaching/CREP Soil Washer	☒	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Leaching/Dutch Association of Soil Treatment Companies	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Extraction of Organics from Soil	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Extraksol	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Heavy Organics, PCB's, Dioxins	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Microbially Produced Acids	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Soil Washing for Dioxins	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Soil Washing-Heap Leach Technology	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Solvent Extraction of Dredged Sludges (SEDS)	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Leaching/Superwetter II Nonionic Surfactant	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Tarra Met Heavy Metal Removal	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/TRU Containing Sludge	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Leaching/Water-Based Soil Washing	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Liquid-Liquid Extraction/Membrane-assisted	☒	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Mercury Recovery/Distillation	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Mercury Recovery/Potassium Iodide Leaching	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Mercury Recovery/Retorting or Roasting	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Mercury Recovery/Sulfur Impregnated Carbon	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Metal Melting/High Temperature Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Metal Melting/Induction Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Metal Melting/Metal Refining	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Neutralization	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Plasma Process/High Energy Corona	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Plasma Process/Plasma Arc Furnace	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma Centrifugal Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma-Pyrolysis Reactor	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Plasma Process/Silent Discharge Plasma	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Precipitation/Alternating Current Electrocoagulation	☐	☐	☐	☐	☒	☐	☐	☐	☒	☐	☒	☒
Precipitation/Barium Treatment	☐	☒	☐	☐	☐	☒	☐	☐	☐	☐	☐	☒
Precipitation/Chemical	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Precipitation/Electrochemical Coprecipitation	☐	☐	☐	☐	☒	☐	☐	☐	☒	☐	☒	☒
Precipitation/Enzymatic Transformation of Inorganics	☐	☒	☐	☒	☐	☐	☐	☒	☒	☒	☒	☒
Precipitation/Freeze Crystallization	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Precipitation/Iron Coprecipitation	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Precipitation/Microbial Coprecipitation	☐	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒	☒
Precipitation/Ultrasonically Catalyzed	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒
Precipitation/UV & $KMNO_4$	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Pyrolysis/Advanced Electronic Reactor	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Pyrolysis/Chem Char Project	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Pyrolysis/Entrained-bed Gasification	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Pyrolysis/High Temperature Fluid Wall	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Pyrolysis/Molten Metal Bath	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Pyrolysis/Packed Bed Reactor	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Pyrolysis/Plasma Reactor	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Radiolysis/Electron Beam and X-rays	☐	☐	☐	☐	☐	☐	☒	☐	☒	☐	☒	☒
Radiolysis/Gamma-Ray Destruction of PCBs	☐	☐	☐	☐	☐	☐	☒	☐	☒	☐	☒	☒
Radiolysis/UV Extraction	☐	☒	☐	☐	☒	☐	☐	☐	☒	☐	☐	☐
Radiolysis/X-Ray and Gamma-Ray	☐	☐	☐	☐	☐	☐	☒	☐	☒	☐	☒	☒
ReDox/Catalytic Ozone	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/Catalyzed Electrochemical Product	☐	☒	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒
ReDox/Electrocatalytic Destruction	☐	☒	☐	☐	☒	☐	☐	☐	☒	☐	☒	☒
ReDox/Fluidized Bed	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/Mediated Electrochemical Oxidation	☐	☒	☐	☐	☒	☐	☐	☐	☒	☐	☒	☒
ReDox/Molten Salt Oxidation	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
ReDox/O_3 and H_20_2	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/Silent Discharge Plasma	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/Supercritical Water Oxidation	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/Ultrasonic Destruction	☐	☐	☐	☐	☐	☐	☒	☐	☒	☐	☒	☒
ReDox/UV, H_20_2, O_3	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/UV, H_2O_2	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/UV, H_2O_2,Catalyst	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/UV Laser	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
ReDox/UV, O_3	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Reverse Osmosis	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Separation/Beryllium and Lithium removal	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☐
Separation/Capacitative Deionization	☐	☐	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒
Separation/Electrodeposition	☐	☐	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒
Separation/Electrosorb	☐	☐	☐	☐	☒	☐	☐	☒	☒	☒	☒	☒
Separation/Magnetic Barrier	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Separation/Magnetically Assisted	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒
Separation/Manual	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Separation/Particle Sizing	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Separation/TALSPEAK Process	☐	☒	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Stabilization/Alkali-Slag Cements	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Asphalt	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Ceramic Silicone Foam	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Chemically Bonded Ceramics	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Hydraulic Cement	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Macroencapsulation	☒	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Stabilization/Phosphate-bonded Ceramics	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Polyethylene Encapsulation	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Polymer Solidification	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Portland Cement	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Pozzolanic Binder	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Vinyl Ester Styrene Encapsulation	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Steam Reforming/Catalytic Oxidation	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Steam Reforming/High Temperature Reactor	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☒
Steam Reforming/Steam Gasification Detoxifier	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Steam Reforming/Synthetic Detoxifier	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Thermal Desorption/Anaerobic Retorting	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Thermal Desorption/Counter Current Batch Washing	☒	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Thermal Desorption/Indirectly Heated Screw Conveyer	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Thermal Desorption/Infrared Heating	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Thermal Desorption/Thermal Distillation	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Thermal Desorption/Vacuum Enhanced	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Vitrification/Electric Arc Melting	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Fossil Fuel Fired Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/High Temperature Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Induction Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Joule Heated Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Microwave Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Plasma Arc Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Plasma Centrifuge Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Stir-Melter, Inc.	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Stirred Glass Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Wet Air Oxidation/DETOX Catalytic	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒

Process Objective: Mitigate Hazardous Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Wet Air Oxidation/General	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒

Appendix A4
Technologies Sorted by Process Objective

Process Objective: Mitigate Radioactive Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Actinide Recovery/Polymers for Plutonium & Americium	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Amalgamation Treatment Process	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒	☒
Calcination/Ceramic Sponge Fixation	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Fluidized Bed	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Heat Spray	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Molten Sulfur	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Plasma Arc	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Pot Calcination of Solids	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Calcination/Rotary Kiln	☐	☒	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Deactivation/Sodium Hypochlorite Solutions	☐	☒	☐	☐	☐	☒	☐	☐	☒	☐	☒	☒
Filtration/Dewatering	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Incineration/Slagging Kiln	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Metal Melting/High Temperature Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Metal Melting/Metal Refining	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma Arc Furnace	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Plasma Process/Plasma Centrifugal Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Pyrolysis/Chem Char Project	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Size Reduction/Compaction	☒	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
Stabilization/Alkali-Slag Cements	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒

Process Objective: Mitigate Radioactive Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Stabilization/Asphalt	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Ceramic Silicone Foam	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Chemically Bonded Ceramics	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Hydraulic Cement	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Macroencapsulation	☒	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒
Stabilization/Phosphate-bonded Ceramics	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Polyethylene Encapsulation	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Polymer Solidification	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Portland Cement	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Pozzolanic Binder	☐	☒	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Sulfur Polymer Cement	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Stabilization/Vinyl Ester Styrene Encapsulation	☐	☐	☐	☐	☐	☒	☐	☒	☒	☒	☒	☒
Transmutation/Reactor Based	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☐
Vitrification/Electric Arc Melting	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Fossil Fuel Fired Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/High Temperature Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Induction Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Joule Heated Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Microwave Melter	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Plasma Arc Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒
Vitrification/Plasma Centrifuge Furnace	☐	☐	☒	☐	☐	☒	☐	☒	☒	☒	☒	☒

Process Objective: Mitigate Radioactive Properties

Process Name	Process Type							Waste Type				
	Mech	Chem	Therm	Bio	Elec	Admix	Other	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Vitrification/Stir-Melter, Inc.	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Stirred Glass Melter	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒
Vitrification/Terra-Vit	☐	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	☒

Appendix B1
Technologies Sorted by Process Types

Process Type: Mechanical

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Actinide Recovery/Uranium Removal	☒	☐	☒	☒	☒	☒	☒	☒	☐
Adsorption/Carbon	☐	☐	☒	☒	☒	☒	☒	☒	☒
Adsorption/Gel Beads	☐	☐	☒	☒	☒	☒	☒	☒	☒
Adsorption/Granular Activated Carbon	☐	☐	☒	☒	☒	☒	☒	☒	☒
Adsorption/Organic Sponges	☐	☐	☒	☐	☐	☒	☐	☒	☒
Adsorption/Sulfur-Impregnated Carbon	☐	☐	☒	☐	☐	☒	☐	☒	☒
Biodegradation/Vacuum Extraction System	☐	☐	☒	☐	☐	☒	☐	☒	☒
Decontamination/Abrasive Particulate Blasting	☒	☐	☒	☒	☒	☒	☒	☒	☒
Decontamination/High Pressure Water	☒	☐	☒	☒	☒	☒	☒	☒	☒
Decontamination/Mechanical Vibration	☒	☐	☒	☒	☒	☒	☒	☒	☒
Decontamination/Metals Recovery from Soil	☐	☐	☒	☐	☒	☒	☒	☒	☒
Decontamination/Supercritical Carbon Dioxide	☒	☐	☒	☒	☒	☒	☒	☒	☒
Decontamination/Ultrasonic	☒	☐	☒	☒	☒	☒	☒	☒	☒
Evaporation/Negative Pressure System	☒	☐	☒	☐	☒	☒	☒	☒	☒
Evaporation/Positive Pressure System	☒	☐	☒	☐	☐	☒	☐	☒	☒
Filtration /SemiPermeable Membrane	☒	☐	☒	☒	☒	☒	☒	☒	☒
Filtration/Acoustic Barrier	☒	☐	☒	☒	☒	☒	☒	☒	☒
Filtration/Belt Press	☒	☐	☒	☒	☒	☒	☒	☒	☒
Filtration/Centrifugation	☒	☐	☒	☒	☒	☒	☒	☒	☒

Process Type: Mechanical

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Filtration/Dewatering	☒	☒	☐	☐	☒	☒	☒	☒	☒
Filtration/Gravity	☒	☐	☒	☒	☒	☒	☒	☒	☒
Filtration/Physical Membrane Microfiltration	☒	☐	☒	☒	☒	☒	☒	☒	☒
Filtration/Pressure Gradient	☒	☐	☒	☒	☒	☒	☒	☒	☒
Filtration/Vacuum	☒	☐	☒	☒	☒	☒	☒	☒	☒
Filtration/Vapor - Separation Membrane	☒	☐	☒	☐	☐	☒	☐	☒	☒
Flocculation/Flotation	☒	☐	☒	☐	☐	☐	☐	☐	☒
Ion Exchange/Ultrasonically Catalyzed	☒	☐	☒	☒	☒	☒	☒	☒	☒
Leaching/CREP Soil Washer	☒	☐	☒	☐	☒	☒	☒	☒	☒
Liquid-Liquid Extraction/Membrane-assisted Solvent	☐	☐	☒	☐	☐	☒	☐	☒	☒
Precipitation/Iron Coprecipitation	☒	☐	☒	☒	☒	☒	☒	☒	☒
Reverse Osmosis	☒	☐	☒	☒	☒	☒	☒	☒	☒
Separation/Magnetic Barrier	☒	☐	☒	☒	☒	☒	☒	☒	☒
Separation/Manual	☒	☐	☒	☒	☒	☒	☒	☒	☒
Separation/Particle Sizing	☒	☐	☒	☒	☒	☒	☒	☒	☒
Size Reduction/Compaction	☒	☒	☐	☐	☒	☒	☒	☒	☒
Size Reduction/Shredding	☒	☐	☐	☐	☒	☒	☒	☒	☒
Stabilization/Macroencapsulation	☐	☒	☒	☐	☐	☒	☐	☒	☒
Thermal Desorption/Counter Current Batch Washing	☐	☐	☒	☐	☐	☒	☐	☒	☒

Appendix B2
Technologies Sorted by Process Types

Process Type: Chemical

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Acid Digestion/Asbestos Digestion	☒	☐	☒	☐	☐	☒	☐	☒	☒
Acid Digestion/Phosphoric Acid	☐	☐	☒	☒	☒	☒	☒	☒	☒
Acid Digestion/Sulfuric Acid	☐	☐	☒	☐	☐	☒	☐	☒	☒
Actinide Recovery	☒	☐	☐	☒	☒	☒	☒	☒	☐
Actinide Recovery/Polymers for Plutonium & Americium	☐	☒	☐	☒	☒	☒	☒	☒	☒
Actinide Recovery/Uranium Removal	☒	☐	☒	☒	☒	☒	☒	☒	☐
Adsorption/Algae Cell Walls	☒	☐	☒	☐	☐	☒	☐	☒	☒
Adsorption/Carbon	☐	☐	☒	☒	☒	☒	☒	☒	☒
Adsorption/Carbon in Pulp	☒	☐	☒	☒	☒	☒	☒	☒	☒
Adsorption/Cobalt Dicarbollide Impregnated Polymers	☒	☐	☒	☒	☒	☒	☒	☒	☒
Adsorption/Granular Activated Carbon	☐	☐	☒	☒	☒	☒	☒	☒	☒
Adsorption/Impregnated Polymers	☐	☐	☒	☒	☒	☒	☒	☒	☒
Adsorption/Organic Sponges	☐	☐	☒	☐	☐	☒	☐	☒	☒
Adsorption/Sulfur-Impregnated Carbon	☐	☐	☒	☐	☐	☒	☐	☒	☒
Adsorption/Synthesized Ligands	☒	☐	☒	☒	☒	☒	☒	☒	☒
Air Steam Stripping/Supercritical Fluid Extraction (SCF)	☐	☐	☐	☐	☐	☐	☐	☐	☒
Amalgamation Treatment Process	☐	☒	☒	☐	☐	☒	☐	☒	☒
Biodegradation/Biocatalytic Destruction	☒	☐	☒	☒	☒	☒	☒	☒	☒
Biodegradation/Metal Free Environments	☐	☐	☒	☐	☐	☒	☐	☒	☒

Process Type: Chemical

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Calcination/Ceramic Sponge Fixation	☒	☒	☐	☐	☒	☒	☒	☒	☒
Calcination/Fluidized Bed	☒	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Heat Spray	☒	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Molten Sulfur	☒	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Plasma Arc	☒	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Pot Calcination of Solids	☐	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Rotary Kiln	☒	☒	☒	☐	☒	☒	☒	☒	☒
Complexation/Decontamination	☒	☐	☒	☒	☒	☒	☒	☒	☒
Complexation/ESI Products	☒	☐	☒	☒	☒	☒	☒	☒	☒
Complexation/Plutonium Removal	☐	☐	☐	☒	☐	☐	☒	☒	☐
Deactivation/Alkali Metals	☐	☐	☒	☐	☐	☒	☐	☒	☒
Deactivation/Oxidation with Water	☐	☐	☒	☐	☐	☒	☐	☒	☒
Deactivation/Sodium Hypochlorite Solutions	☐	☒	☒	☐	☐	☒	☐	☒	☒
Decontamination/Chemical	☒	☐	☒	☒	☒	☒	☒	☒	☒
Decontamination/High Pressure Water	☒	☐	☒	☒	☒	☒	☒	☒	☒
Decontamination/Mechanical Vibration	☒	☐	☒	☒	☒	☒	☒	☒	☒
Decontamination/Metals Recovery from Soil	☐	☐	☒	☐	☒	☒	☒	☒	☒
Decontamination/Soil Washing-Solvents	☒	☐	☒	☒	☒	☒	☒	☒	☒
Decontamination/Supercritical Carbon Dioxide	☒	☐	☒	☒	☒	☒	☒	☒	☒
Dehalogenation/APEG	☐	☐	☒	☐	☐	☒	☐	☒	☒
Dehalogenation/Dechlorinization	☐	☐	☒	☐	☐	☒	☐	☒	☒

Process Type: Chemical

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Dehalogenation/Light Activated Reduction	☐	☐	☒	☐	☐	☒	☐	☒	☒
Ion Exchange/Crystalline Silico-Titanate	☒	☐	☐	☒	☒	☒	☒	☒	☒
Ion Exchange/ReFIX Resin	☒	☐	☐	☒	☒	☒	☒	☒	☒
Ion Exchange/Reillex -HPQ	☒	☐	☐	☒	☒	☒	☒	☒	☒
Ion Exchange/Resin in Pulp	☒	☐	☒	☒	☒	☒	☒	☒	☒
Ion Exchange/Titanium-treated Zeolite	☒	☐	☐	☒	☒	☒	☒	☒	☐
Ion Exchange/Ultrasonically Catalyzed	☒	☐	☒	☒	☒	☒	☒	☒	☒
Leaching/Acid Extraction	☒	☐	☒	☒	☒	☒	☒	☒	☒
Leaching/Calcine Residue	☒	☐	☒	☒	☒	☒	☒	☒	☒
Leaching/CO2-Water Extraction	☐	☐	☒	☐	☐	☒	☐	☒	☒
Leaching/Cobalt Dicarbollide Extraction	☒	☐	☒	☒	☒	☒	☒	☒	☐
Leaching/CREP Soil Washer	☒	☐	☒	☐	☒	☒	☒	☒	☒
Leaching/Dutch Association of Soil Treatment Companies	☒	☐	☒	☐	☒	☒	☒	☒	☒
Leaching/Explosive Laden Sediments	☐	☐	☐	☐	☐	☐	☐	☐	☒
Leaching/Extraction of Organics from Soil	☒	☐	☒	☐	☒	☒	☒	☒	☒
Leaching/Extraksol	☒	☐	☒	☐	☒	☒	☒	☒	☒
Leaching/Heavy Organics, PCB's, Dioxins	☒	☐	☒	☐	☒	☒	☒	☒	☒
Leaching/Microbially Produced Acids	☐	☐	☒	☒	☒	☒	☒	☒	☒
Leaching/Soil Washing for Dioxins	☒	☐	☒	☐	☒	☒	☒	☒	☒
Leaching/Soil Washing-Heap Leach Technology	☒	☐	☒	☒	☒	☒	☒	☒	☒
Leaching/Solvent Extraction of Dredged Sludges (SEDS)	☐	☐	☒	☐	☐	☒	☐	☒	☒

Process Type: Chemical

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Leaching/Superwetter II Nonionic Surfactant	☒	☐	☒	☐	☒	☒	☒	☒	☒
Leaching/Tarra Met Heavy Metal Removal	☒	☐	☒	☐	☒	☒	☒	☒	☒
Leaching/TRU Containing Sludge	☒	☐	☒	☒	☒	☒	☒	☒	☒
Leaching/Water-Based Soil Washing	☒	☐	☒	☐	☒	☒	☒	☒	☒
Liquid-Liquid Extraction/Aqueous Biphasic Separation	☒	☐	☐	☒	☒	☒	☒	☒	☐
Liquid-Liquid Extraction/Cobalt Dicarbollide	☒	☐	☐	☒	☒	☒	☒	☒	☐
Liquid-Liquid Extraction/Membrane-assisted Solvent	☐	☐	☒	☐	☐	☒	☐	☒	☒
Liquid-Liquid Extraction/PUREX	☒	☐	☐	☒	☒	☒	☒	☒	☐
Liquid-Liquid Extraction/SREX	☒	☐	☐	☒	☒	☒	☒	☒	☐
Liquid-Liquid Extraction/TRUEX	☒	☐	☐	☒	☒	☒	☒	☒	☐
Mercury Recovery/Potassium Iodide Leaching	☐	☐	☒	☐	☐	☒	☐	☒	☒
Mercury Recovery/Sulfur Impregnated Carbon	☐	☐	☒	☐	☐	☒	☐	☒	☒
Neutralization	☐	☐	☒	☐	☐	☒	☐	☒	☒
Precipitation/Actinide Complexation	☒	☐	☐	☒	☒	☒	☒	☒	☐
Precipitation/Barium Treatment	☐	☐	☒	☐	☐	☐	☐	☐	☒
Precipitation/Chemical	☒	☐	☒	☒	☒	☒	☒	☒	☒
Precipitation/Enzymatic Transformation of Inorganics	☒	☐	☒	☒	☒	☒	☒	☒	☒
Precipitation/Ultrasonically Catalyzed	☒	☐	☒	☒	☒	☒	☒	☒	☒
Precipitation/UV & $KMNO_4$	☐	☐	☒	☐	☐	☒	☐	☒	☒
Radiolysis/UV Extraction	☐	☐	☒	☐	☐	☒	☐	☐	☐
ReDox/Catalytic Ozone	☒	☐	☒	☐	☐	☒	☐	☒	☒

Process Type: Chemical

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
ReDox/Catalyzed Electrochemical Product	☐	☐	☒	☐	☒	☒	☒	☒	☒
ReDox/Electrocatalytic Destruction	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/Evaporative Oxidation	☒	☐	☐	☐	☐	☐	☐	☐	☒
ReDox/Fluidized Bed	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/Mediated Electrochemical Oxidation	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/Molten Salt Oxidation	☐	☐	☒	☐	☒	☒	☒	☒	☒
ReDox/O_3 and H_20_2	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/Supercritical Water Oxidation	☒	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/UV, H_20_2, O_3	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/UV, H_2O_2	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/UV, H_2O_2,Catalyst	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/UV Laser	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/UV, O_3	☐	☐	☒	☐	☐	☒	☐	☒	☒
Separation/Beryllium and Lithium removal	☒	☐	☒	☒	☒	☒	☒	☒	☐
Separation/TALSPEAK Process	☒	☐	☒	☒	☒	☒	☒	☒	☒
Stabilization/Chemically Bonded Ceramics	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Phosphate-bonded Ceramics	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Pozzolanic Binder	☐	☒	☒	☒	☒	☒	☒	☒	☒
Steam Reforming/Catalytic Oxidation	☒	☐	☒	☐	☐	☒	☐	☒	☒
Steam Reforming/Steam Gasification Detoxifier	☐	☐	☒	☐	☐	☒	☐	☒	☒
Steam Reforming/Synthetic Detoxifier	☐	☐	☒	☒	☐	☒	☐	☒	☒

Process Type: Chemical

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Thermal Desorption/Infrared Heating	☐	☐	☒	☐	☐	☒	☐	☒	☒
Thermal Desorption/Vacuum Enhanced	☐	☐	☒	☐	☐	☒	☐	☒	☒
Wet Air Oxidation/DETOX Catalytic	☐	☐	☒	☐	☐	☒	☐	☒	☒
Wet Air Oxidation/General	☐	☐	☒	☐	☐	☒	☐	☒	☒

Appendix B3
Technologies Sorted by Process Types

Process Type: Thermal

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Actinide Recovery	☒	☐	☐	☒	☒	☒	☒	☒	☐
Air-Steam Stripping/Batch Steam Distillation	☒	☐	☒	☐	☐	☒	☐	☒	☒
Air-Steam Stripping/Organics from Liquid Wastes	☒	☐	☒	☐	☐	☒	☐	☒	☒
Calcination/Ceramic Sponge Fixation	☒	☒	☐	☐	☒	☒	☒	☒	☒
Calcination/Fluidized Bed	☒	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Heat Spray	☒	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Molten Sulfur	☒	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Plasma Arc	☒	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Pot Calcination of Solids	☐	☒	☒	☐	☒	☒	☒	☒	☒
Calcination/Rotary Kiln	☒	☒	☒	☐	☒	☒	☒	☒	☒
Deactivation/Alkali Metals	☐	☐	☒	☐	☐	☒	☐	☒	☒
Deactivation/Reactive Metal Combustion	☐	☐	☒	☐	☐	☒	☐	☒	☒
Decontamination/Supercritical Carbon Dioxide	☒	☐	☒	☒	☒	☒	☒	☒	☒
Dehalogenation/APEG	☐	☐	☒	☐	☐	☒	☐	☒	☒
Dehalogenation/Dechlorinization	☐	☐	☒	☐	☐	☒	☐	☒	☒
Evaporation/APES	☒	☐	☒	☐	☐	☒	☐	☒	☒
Evaporation/Direct Heating	☒	☐	☒	☐	☒	☒	☒	☒	☒
Evaporation/Externally Fired Roaster	☒	☐	☒	☐	☐	☒	☐	☒	☒
Evaporation/Rotary Drum Dryer	☒	☐	☐	☐	☒	☒	☒	☒	☒

Process Type: Thermal

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Incineration/Controlled-Air Incinerator	☒	☐	☒	☐	☒	☒	☒	☒	☒
Incineration/Fixed Hearth Plasma Process	☒	☐	☒	☐	☒	☒	☒	☒	☒
Incineration/Fluidized Bed	☒	☐	☒	☐	☒	☒	☒	☒	☒
Incineration/Liquid Injection	☒	☐	☒	☐	☒	☒	☒	☒	☒
Incineration/Plasma Arc	☒	☐	☒	☐	☒	☒	☒	☒	☒
Incineration/Rotary Kiln Incinerator	☒	☐	☒	☐	☒	☒	☒	☒	☒
Incineration/Slagging Kiln	☒	☒	☒	☐	☒	☒	☒	☒	☒
Leaching/Extraksol	☒	☐	☒	☐	☒	☒	☒	☒	☒
Mercury Recovery/Distillation	☐	☐	☒	☐	☐	☒	☐	☒	☒
Mercury Recovery/Retorting or Roasting	☐	☐	☒	☐	☐	☒	☐	☒	☒
Metal Melting/High Temperature Melter	☒	☒	☒	☐	☒	☒	☒	☒	☒
Metal Melting/Induction Melter	☒	☐	☒	☐	☒	☒	☒	☒	☒
Metal Melting/Metal Refining	☒	☒	☒	☒	☒	☒	☒	☒	☒
Plasma Process/High Energy Corona	☐	☐	☒	☐	☐	☒	☐	☒	☒
Plasma Process/Plasma Arc Furnace	☒	☒	☒	☒	☒	☒	☒	☒	☒
Plasma Process/Plasma Centrifugal Furnace	☒	☒	☒	☒	☒	☒	☒	☒	☒
Plasma Process/Plasma-Pyrolysis Reactor	☒	☐	☒	☐	☐	☒	☐	☒	☒
Plasma Process/Silent Discharge Plasma	☒	☐	☒	☐	☐	☒	☐	☒	☒
Precipitation/Freeze Crystallization	☒	☐	☒	☒	☒	☒	☒	☒	☒
Pyrolysis/Advanced Electronic Reactor	☒	☐	☒	☐	☐	☒	☐	☒	☒
Pyrolysis/Chem Char Project	☐	☒	☒	☐	☐	☒	☐	☒	☒

Process Type: Thermal

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Pyrolysis/Entrained-bed Gasification	☐	☐	☒	☐	☐	☒	☐	☒	☒
Pyrolysis/High Temperature Fluid Wall	☐	☐	☒	☐	☐	☒	☐	☒	☒
Pyrolysis/Molten Metal Bath	☒	☐	☒	☐	☒	☒	☒	☒	☒
Pyrolysis/Packed Bed Reactor	☐	☐	☒	☐	☐	☒	☐	☒	☒
Pyrolysis/Plasma Reactor	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/Evaporative Oxidation	☒	☐	☐	☐	☐	☐	☐	☐	☒
ReDox/Molten Salt Oxidation	☐	☐	☒	☐	☒	☒	☒	☒	☒
ReDox/Silent Discharge Plasma	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/Supercritical Water Oxidation	☒	☐	☒	☐	☐	☒	☐	☒	☒
Separation/Beryllium and Lithium removal	☒	☐	☒	☒	☒	☒	☒	☒	☐
Stabilization/Asphalt	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Macroencapsulation	☐	☒	☒	☐	☐	☒	☐	☒	☒
Steam Reforming/Catalytic Oxidation	☒	☐	☒	☐	☐	☒	☐	☒	☒
Steam Reforming/High Temperature Reactor	☒	☐	☒	☐	☐	☐	☐	☐	☒
Steam Reforming/Steam Gasification Detoxifier	☐	☐	☒	☐	☐	☒	☐	☒	☒
Steam Reforming/Synthetic Detoxifier	☐	☐	☒	☒	☐	☒	☐	☒	☒
Thermal Desorption/Anaerobic Retorting	☒	☐	☒	☐	☐	☒	☐	☒	☒
Thermal Desorption/Counter Current Batch Washing	☐	☐	☒	☐	☐	☒	☐	☒	☒
Thermal Desorption/Indirectly Heated Screw Conveyer	☐	☐	☒	☐	☐	☒	☐	☒	☒
Thermal Desorption/Infrared Heating	☐	☐	☒	☐	☐	☒	☐	☒	☒
Thermal Desorption/Thermal Distillation	☐	☐	☒	☐	☐	☒	☐	☒	☒

Process Type: Thermal

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Thermal Desorption/Vacuum Enhanced	☐	☐	☒	☐	☐	☒	☐	☒	☒
Vitrification/Electric Arc Melting	☒	☒	☒	☐	☒	☒	☒	☒	☒
Vitrification/Fossil Fuel Fired Melter	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/High Temperature Melter	☒	☒	☒	☐	☒	☒	☒	☒	☒
Vitrification/Induction Melter	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Joule Heated Melter	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Microwave Melter	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Plasma Arc Furnace	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Plasma Centrifuge Furnace	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Stir-Melter, Inc.	☐	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Stirred Glass Melter	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Terra-Vit	☒	☒	☐	☐	☒	☒	☒	☒	☒
Wet Air Oxidation/General	☐	☐	☒	☐	☐	☒	☐	☒	☒

Appendix B4
Technologies Sorted by Process Types

Process Type: Biological

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Biodegradation/Aerated Slurry System	☐	☐	☒	☐	☐	☒	☐	☒	☒
Biodegradation/Biocatalytic Destruction	☒	☐	☒	☒	☒	☒	☒	☒	☒
Biodegradation/Bioreactors	☐	☐	☒	☐	☐	☒	☐	☒	☒
Biodegradation/High Salt Tolerant Bacteria	☒	☐	☒	☒	☒	☒	☒	☒	☒
Biodegradation/Metal Free Environments	☐	☐	☒	☐	☐	☒	☐	☒	☒
Biodegradation/Microbes for Dechlorination	☐	☐	☒	☐	☐	☒	☐	☒	☒
Biodegradation/SBP Microorganisms	☐	☐	☒	☐	☐	☒	☐	☒	☒
Biodegradation/Sewage Sludge Inocula	☐	☐	☒	☐	☐	☒	☐	☒	☒
Biodegradation/Stromatolite Remediation	☐	☐	☒	☒	☒	☒	☒	☒	☒
Biodegradation/Vacuum Extraction System	☐	☐	☒	☐	☐	☒	☐	☒	☒
Biodegradation/White Rot Fungi	☐	☐	☒	☐	☐	☒	☐	☒	☒
Precipitation/Enzymatic Transformation of Inorganics	☒	☐	☒	☒	☒	☒	☒	☒	☒
Precipitation/Microbial Coprecipitation	☒	☐	☒	☒	☒	☒	☒	☒	☒

Appendix B5
Technologies Sorted by Process Types

Process Type: Electrokinetic

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Actinide Recovery/Uranium Removal	☒	☐	☒	☒	☒	☒	☒	☒	☐
Biodegradation/Biocatalytic Destruction	☒	☐	☒	☒	☒	☒	☒	☒	☒
Precipitation/Alternating Current Electrocoagulation	☒	☐	☒	☒	☐	☒	☐	☒	☒
Precipitation/Electrochemical Coprecipitation	☒	☐	☒	☒	☐	☒	☐	☒	☒
Radiolysis/UV Extraction	☐	☐	☒	☐	☐	☒	☐	☐	☐
ReDox/Catalyzed Electrochemical Product	☐	☐	☒	☐	☒	☒	☒	☒	☒
ReDox/Electrocatalytic Destruction	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/Mediated Electrochemical Oxidation	☐	☐	☒	☐	☐	☒	☐	☒	☒
Separation/Capacitative Deionization	☒	☐	☒	☒	☒	☒	☒	☒	☒
Separation/Electrodeposition	☒	☐	☒	☒	☒	☒	☒	☒	☒
Separation/Electrosorb	☒	☐	☒	☒	☒	☒	☒	☒	☒

Appendix B6
Technologies Sorted by Process Types

Process Type: Admixtures

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Actinide Recovery/Polymers for Plutonium & Americium	☐	☒	☐	☒	☒	☒	☒	☒	☒
Deactivation/Sodium Hypochlorite Solutions	☐	☒	☒	☐	☐	☒	☐	☒	☒
Plasma Process/Plasma Centrifugal Furnace	☒	☒	☒	☒	☒	☒	☒	☒	☒
Precipitation/Barium Treatment	☐	☐	☒	☐	☐	☐	☐	☐	☒
Stabilization/Alkali-Slag Cements	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Asphalt	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Ceramic Silicone Foam	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Chemically Bonded Ceramics	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Hydraulic Cement	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Phosphate-bonded Ceramics	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Polyethylene Encapsulation	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Polymer Solidification	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Portland Cement	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Pozzolanic Binder	☐	☒	☒	☒	☒	☒	☒	☒	☒
Stabilization/Sulfur Polymer Cement	☐	☒	☐	☐	☒	☒	☒	☒	☒
Stabilization/Vinyl Ester Styrene Encapsulation	☐	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Fossil Fuel Fired Melter	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Induction Melter	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Microwave Melter	☒	☒	☒	☒	☒	☒	☒	☒	☒

Process Type: Admixtures

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Vitrification/Plasma Arc Furnace	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vitrification/Plasma Centrifuge Furnace	☒	☒	☒	☒	☒	☒	☒	☒	☒

Appendix B7
Technologies Sorted by Process Types

Process Type: Other

Process Name	Process Objective				Waste Type				
	Reduce Volume	Physically Stablize	Mitigate Haz Prop	Mitigate Rad Prop	Rad	Rad Mixed	TRU	TRU-Mixed	Haz
Adsorption/Magnetic	☒	☐	☒	☒	☒	☒	☒	☒	☒
Dehalogenation/Gamma-Ray Destruction of PCBs	☐	☐	☒	☐	☐	☒	☐	☒	☒
Precipitation/Fractional Crystallization	☒	☐	☐	☐	☒	☐	☐	☐	☐
Precipitation/Microbial Coprecipitation	☒	☐	☒	☒	☒	☒	☒	☒	☒
Precipitation/Photocatalytic Removal	☒	☐	☐	☒	☐	☒	☐	☒	☐
Precipitation/Ultrasonically Catalyzed	☒	☐	☒	☒	☒	☒	☒	☒	☒
Radiolysis/Electron Beam and X-rays	☐	☐	☒	☐	☐	☒	☐	☒	☒
Radiolysis/Gamma-Ray Destruction of PCBs	☐	☐	☒	☐	☐	☒	☐	☒	☒
Radiolysis/X-Ray and Gamma-Ray	☐	☐	☒	☐	☐	☒	☐	☒	☒
ReDox/Ultrasonic Destruction	☐	☐	☒	☐	☐	☒	☐	☒	☒
Separation/Magnetically Assisted	☒	☐	☒	☒	☒	☒	☒	☒	☒
Transmutation/Accelerator Based	☒	☐	☐	☒	☒	☒	☒	☒	☒
Transmutation/Reactor Based	☒	☒	☐	☒	☒	☒	☒	☒	☐

Process Name
Adsorption/Carbon

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
VOICE (1989)

Process Name
Adsorption/Carbon

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

One of the most common forms of adsorption is carbon adsorption. Activated carbon is an excellent adsorbent due to the large degree of surface area contained within the carbon particle that is accessible for the adsorption process. In addition to the "outer" surface area on the carbon particle, "inner" cavities allow for significant surface area per mass of particle. The adsorption process consists of three steps: 1) diffusion of the contaminants through the fluid (gas or liquid phase) to the carbon particle; 2) diffusion of the contaminant through the "inner" cavities to the adsorption site; and 3) adsorption of the contaminant to the carbon particle. Carbon adsorption can be used for non-metallic inorganics, organo-metallic, and/or organic constituents in gases and liquids.

Process Name
Size Reduction/Compaction

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☐ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☒ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☒ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Murray, 1994, p.91

Process Name
Size Reduction/Compaction

Description
Size reduction technologies are mechanical methods for making waste take up less space (volume reduction). These include compaction, which is using pressure to squeeze waste into a smaller volume, and shredding which converts waste to similar sized pieces which pack more efficiently into containers.

Compaction is used to reduce the volume of waste and also produce a more stable structure for disposal. Different degrees of compaction are possible, depending on the force exerted by the compactor and the nature of the material. The typical compactor has a plate driven by a hydraulic press.

There are drum compactors that can either compact the contents of a 55-gallon drum or crush the drum and contents. Volume reduction factors of three are possible. A special compactor called the supercompactor can be used to apply pressures up to thousands of pounds per square inch.

Process Name
Evaporation/Direct Heating

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Considine, et. al., 1984, p. 366.

Process Name
Evaporation/Direct Heating

Description
Evaporation is the conversion of water, or some other liquid, to the gaseous state by the application of heat. This method is typically applied to reduce the volume of liquid waste streams.

Vaporization of a liquid from a solution or a slurry is used to concentrate the solution which is composed of a volatile solvent and a solute which is not appreciably volatile. Concentration is accomplished by driving off the solvent as a vapor. The direct application of heat will cause molecules to become thermally agitated and break through the surface tension of a liquid. Fossil fuels may be burned to create the heat source. Solar energy, as in the sun radiating on outdoor evaporation ponds, is also used as a heat source.

Process Name
ReDox/Fluidized Bed

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
FREEMAN ET., AL., ()

Process Name
ReDox/Fluidized Bed

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

The fluidized bed reactor consists of a vertical refractory lined vessel containing a bed of inert granular material. The bed is 'fluidized' by passing air, which serves as combustion air, through a perforated plate at the bottom of the vessel. Waste is fed to the hot bed for combustion where the high thermal mass and turbulent mixing action of the bed material rapidly transfers the heat to the waste. Auxiliary fuel is often used to maintain bed temperature. A secondary chamber may be required to ensure complete combustion for hazardous wastes. Limestone is usually added to the bed to provide capability for in-bed acid gas scrubbing capability (no scrubber required). Offgas particulate removal is required. A variation of fluidized bed technology is a circulating bed system where higher air velocities cause high carryover rates. The carryover material is recovered and returned to the system.

The fluidized bed incinerator is relatively simple in design as it has few moving parts. Its capital and maintenance costs are relatively low, and the incineration is long-lived. A fluidized bed incinerator is simple to operate, and has case of process control and high thermal efficiency. Lower operating temperatures lead to lower Nix formation and metal emission rates, and the capability for in-bed scrubbing eliminates the need for an offgas scrubber system. Fluidized bed incinerators are versatile in that they can accept solids, liquids, sludges, and gases.

Fluidized bed incinerators have a relatively low throughput capacity and it is difficult to remove residuals from the bed. Operating costs of fluidized bed incinerators are relatively high. Solid wastes will likely have to be pretreated (shredded or sized) prior to introduction. Residence times are non-uniform, and particulate entrainment rates are high. The vessel and related components are subject to erosion. Low melting point materials in the bed may cause the bed material to fuse.

Process Name
Stabilization/Macroencapsulation

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☒ Polymer	☐ Vitrified	

References
England, 1991, p.8.51-8.5.12

Process Name
Stabilization/Macroencapsulation

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Macroencapsulation is a process that can be applied to solid wastes to reduce surface exposure to potential leaching media. In the macroencapsulation process, solid wastes are surface coated with materials such as polymeric organics (e.g. resins and plastics) or with a jacket of inorganic materials. There is an EPA regulatory requirement to macroencapsulate radioactive lead solids. In one process at the DOE Savannah River Site, standard size lead blocks are lifted by their eyebolts to a series of heated tanks containing molten polymers. The lead is alternately dipped and cooled in the thermoplastic polymer until the desired thickness of coating is achieved. The end product is a block of lead covered in a polymer with an eyebolt out of the top, ready for final cooling, inspection and transport.

Process Name
Neutralization

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Ayers, et. al., (1994), p. 195.

Process Name
Neutralization

Description
Neutralization is a chemical process in which the pH of acid waste is increased (by adding basic solution or substance) or the pH of basic waste is decreased (by adding an acid solution or substance) so the product has a pH approaching 7. Corrosive wastes are considered to no longer have the hazardous characteristic of corrosivity if neutralized so that the pH is between 2 and 12.5.

Caustic (basic) wastes are generally neutralized by adding acid solutions or carbon dioxide. Acidic wastes are generally neutralized by adding lime, caustic soda, soda ash, or hydroxides such ammonium, magnesium, or ammonium hydroxide. In some cases, basic and acidic waste streams are both available and can be mixed together to produce a neutral product. Neutralization is normally performed by mixing the waste and the neutralizing agent in a reactor vessel.

Process Name
Precipitation/Chemical

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical _____
- ☒ Chemical _____
- ☐ Thermal _____
- ☐ Biological _____
- ☐ Electrokinetic _____
- ☐ Admixtures _____
- ☐ Other _____

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Chung (1989)

Process Name
Precipitation/Chemical

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

Chemical precipitation is a process where a reagent is added to a solution and the reagent reacts chemically with the ions in solution to form a precipitate. Insoluble precipitates can include: oxides, hydroxides, carbonates, sulfides, sulfates, chlorides, fluorides, or phosphates. The following reagents (or waste reagents) are typically used alone or in combination: 1) lime (i.e., containing oxides and/or hydroxides of calcium and/or magnesium); 2) caustic (i.e., sodium and/or potassium hydroxides); 3) soda ash (i.e., sodium carbonate); 4) sodium sulfide; 5) ferric sulfate or ferric chloride; 6) alum; or 7) sodium sulfate. Additional flocculating, coagulation or similar reagents/processes that enhance sludge dewatering characteristics are not precluded from use.

Process Name
Mercury Recovery/Retorting or Roasting

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☒ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
England, 1991, p.8.51-8.5.12

Process Name
Mercury Recovery/Retorting or Roasting

Description
Mercury recovery methods include technologies designed to separate and collect mercury from other waste materials. The methods are generally thermal (e.g., roasting or distillations) which take advantage of the volatile nature of mercury, or chemical methods in which an easily separated chemical compound of mercury is formed.

Mercury can be extracted from solid wastes by retorting or roasting. Retorting is a thermal process where by solid waste is heated in a furnace to affect a chemical change, in this case volatization of mercury. Subsequent to volatilization, the mercury is condensed and recovered as pure elemental mercury.

Process Name
Size Reduction/Shredding

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☒ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Tang, et. al., 1990, p.258.

Process Name
Size Reduction/Shredding

Description
Size reduction technologies are mechanical methods for making waste take up less space (volume reduction). These include compaction, which is using pressure to squeeze waste into a smaller volume, and shredding which converts waste to similar sized pieces which pack more efficiently into containers.

Size reduction by shredding is accomplished by taking nonhomogeneous material, such as that which may be found in drums, and mechanically ripping the material. Voids that may have been in the material can now be filled due to the smaller and more consistent size of the material. The volume reduction obtained is a result of eliminating much of the void space.

Process Name
Stabilization/Portland Cement

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Portland Cement
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☒ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☒ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Holden et al., (1989); Wiles (1989)

Process Name
Stabilization/Portland Cement

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Cement based stabilization/solidification is a process in which waste materials are mixed with Portland cement. Water is added to the mixture, if it is not already present in the waste material, to ensure the proper hydration reactions necessary for bonding the cement are present. The wastes are incorporated into the cement matrix and, in some cases, undergo physical and/or chemical changes that further reduce their mobility in the waste-cement matrix.

Process Name
Air-Steam Stripping/Organics from Liquid Wastes

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Boegel (1989)

Process Name
Air-Steam Stripping/Organics from Liquid Wastes

Description
Air and stream stripping technologies remove, or "strip" volatile compounds from contaminated water or aqueous waste streams by forcing air or steam through the waste. The volatile compounds evaporate into the air or steam and are carried away. Steam stripping may also be applied to non-aqueous solvents contaminated with nonvolatile impurities.

Volatile organic compounds can be removed from liquid wastes utilizing direct application of steam. Steam stripping units for liquids generally consist of a series of separation stages where the liquid contacts the steam, much like a distillation column. The steam exits the top of the column laden with the volatile organic contaminants. The waste water exits the bottom of the column relatively free of volatile organic compounds. The steam is condensed and must undergo either incineration, reuse as a fuel, or other recovery/reuse processes. The "cleaned" wastewater may need to undergo further treatment for other hazardous constituents.

Process Name
ReDox/Supercritical Water Oxidation

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — Supercritical Water
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Valentich et al, 1995

Process Name
ReDox/Supercritical Water Oxidation

Description

Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

Supercritical water oxidation (also called hydrothermal oxidation or HTO) begins when a mixture of waste and water is pressurized, heated, and injected into the reactor vessel. The temperature and pressure in the reactor are maintained above the critical pressure and temperature for water (greater then 374 degrees C and 2.21x10 (7) Pa) Oxygen is added to the reactor and the oxidation takes place. The reacted fluid is then removed from the reactor and cooled and depressurized. Both liquid and gaseous, and sometimes solid, phases are produced. These are sampled and tested for further processing, disposal or discharge.

Supercritical water has a high solubility for many organic compounds and a low solubility for most salts causing them to precipitate out. The process oxidizes organic wastes to carbon dioxide, water, nitrogen and other simple compounds.

Process Name
Ion Exchange/Crystalline Silico-Titanate

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P

Process Name
Ion Exchange/Crystalline Silico-Titanate

Description
Ion exchange is the removal of ionic species from waste (usually an aqueous solution) by using the reversible interchange of ions of like-charge between an insoluble solid ion exchange medium and the solution. The ions in solution attach to the solid and are replaced, equivalent for equivalent, by other ions released from the solid. By proper selection of the ions exchanger and ion exchange conditions (e.g., pH) specific ions or groups of ions may be selectively removed from the solution. Ion exchange media are typically organic ion exchange resins, inorganic solids (such as crystalline silico-titanates), or zeolites.

Crystalline silico-titanate (CST) is an inorganic ion exchange resin developed to remove various radionuclides from radioactive waste solutions. CST is stable in highly basic and acidic solutions and is highly resistant to radiation damage.

CST has been developed and optimized for removal of radio-cesium from highly alkaline wastes such as those at the DOE Hanford, WA site. Other CST formulations have the potential for removal of other radionuclides and non-radioactive metals. A Cooperative Research and Development Agreement is being negotiated to commercialize the material for use in ion-exchange and radionuclide waste treatment.

Process Name
Vitrification/Plasma Arc Furnace

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Additives sometimes used
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
Hamilton et al, 1995

Process Name
Vitrification/Plasma Arc Furnace

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

The basic concept of the KVS/EPI DC Plasma Arc Furnace is that the waste material, instead of burning, is put into a high temperature bath of liquid inorganic/metallic material. The organic material in the waste feed is disassociated at the high temperature into its component elements. The inorganic materials (silicon metals) form a molten bath. Since the organic material is disassociated at very high temperature, the efficiency of a melting system in the destruction of hazardous organic material is better than any other thermal treatment system.

Process Name
Adsorption/Magnetic

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Magnetic Swing Adsorption

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Adsorption/Magnetic

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

The Magnetic Swing Adsorption (MSA) process utilizes a column of magnetic adsorbent surrounded by a magnetic field to effect separation of certain metal species from solution. In this process, an electromagnet is simply energized for adsorption and shut-off for elution. During the adsorption mode, an effluent stream is produced that is depleted of certain metal species, whereas during the elution mode, an effluent stream is produced that is enriched in these same metal species. Both the magnetic field strength and relative flow rates during adsorption and elution control the degree of enrichment of the metal species. Magnetic adsorbents in various physical forms can be used in this MSA process for the removal of a variety of metal ions from waste water. A synergistic effect between a magnetic adsorbent material and an external magnetic field is thought to be responsible for the enhanced removal of metals from waste water. Results presented for the removal of plutonium and americium using a magnetic resin clearly demonstrate this synergy. These results also point the way for the development of a variety of new external field-enhanced separation processes.

Process Name
Mercury Recovery/Potassium Iodide Leaching

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — KI/I_2 leaching solutions
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Gates et al, (1995)

Process Name
Mercury Recovery/Potassium Iodide Leaching

Description
Mercury recovery methods include technologies designed to separate and collect mercury from other waste materials. The methods are generally thermal (e.g., roasting or distillations) which take advantage of the volatile nature of mercury, or chemical methods in which an easily separated chemical compound of mercury is formed.

Leaching is a chemical method that can be used to recover mercury from soils or sludges. To leach, the soil must be removed from the ground and mixed in a bath system with the leachate (a liquid solution that reacts with the mercury). In one set of experiments, a synthesized soil contaminated with mercury soil was leached with a solution of potassium iodide to reduce the mercury concentration. It was demonstrated that the mercury removal efficiency achieved with potassium iodide was independent of the mercury speciation or the initial concentration of mercury. Leaching of a simulated waste glass contaminated with mercury with potassium iodide, sodium and an acidic sodium bromide solution were also successful.

Process Name
Adsorption/Sulfur-Impregnated Carbon

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical — Mercury removal from liquid mixed waste.
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Gates et al, (1995)

Process Name
Adsorption/Sulfur-Impregnated Carbon

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

The adsorption process using sulfur-impregnated carbon is most typically implemented through the use of downward flowing pressure vessels installed between the well pump and the point of discharge (for liquid treatment), or an upward flowing pressure vessel between the source of off-gas and the point of emission (for air pollution control). Contaminants in the raw water or off-gas adsorb onto the sulfur-impregnated carbon. Laboratory work has been conducted to investigate the feasibility of using inexpensive sulfur-impregnated activated carbon beads for mercury removal from aqueous waste. Laboratory studies have shown that mercury can be removed to levels below the current Environmental Protection Agency toxic characteristics level (0.2 mg/L). When comparing the use of inexpensive carbon beads with a more expensive ion exchanger, carbon beads had favorable process economics.

Process Name
ReDox/Molten Salt Oxidation

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☒ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
U. S. DOE, November, 1992, May, 1993, October, 1993.

Process Name
ReDox/Molten Salt Oxidation

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

A combined thermal and chemical treatment in which waste and air are introduced into a ceramic-lined vessel containing a bed of molten (900-1000 degrees C) salt usually Na2 CO3. Waste is oxidized, but at lower temperatures than traditional combustion and with no flame. The process is very efficient and the molten salt neutralizes and retains acid gases produced and captures heavy metals and radionuclides.

Process Name
Incineration/Rotary Kiln Incinerator

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☒ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Freeman, 1989 and Dalton, February, 1993.

Process Name
Incineration/Rotary Kiln Incinerator

Description
Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources used range from burning fossil fuels to electric arcs and plasmas.

The rotary kiln is a cylindrical refractory-lined shell mounted on a slight incline. Rotation of the kiln provides for movement of waste through the kiln as well as for enhancement of waste mixing. Rotary kilns normally require a secondary combustion chamber to assure complete destruction of hazardous constituents. The primary chamber functions to pyrolyze or combust solid waste to gases. The gas-phase combustion reaction is completed in the secondary chamber. Both primary and secondary chambers are generally supplied with auxiliary fuel systems. An extensive off-gas system is generally required to control the high volume of emissions.

The rotary kiln incinerator is the most versatile type of conventional incinerator. It can handle a wide variety of solid and liquid waste types, and is capable of a wide range of physical waste feed configurations. Ash is removed continuously and does not interfere with waste oxidation. A rotary kiln incinerator can be operated at very high temperatures to handle difficult-to-destroy constituents, and has a good turndown ratio.

Rotary kiln incinerators have high capital costs for installation. High particulate loadings are often experienced. Drying of some aqueous sludge waste or melting or some solid wastes can result in clinker or ring information on refractory walls. Spherical or cylindrical objects may roll through the kiln before complete combustion. Rotary kiln incinerators are not thermally efficient, and cannot be thermally-cycled often (shutdown/startup cycle). The large volumes of air required for combustion give rise to large costly off-gas treatment systems.

Process Name
Pyrolysis/Plasma Reactor

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Dalton, February, 1993, p. C60-C61.and Freeman, 1989, p. 8.169-8.177.

Process Name
Pyrolysis/Plasma Reactor

Description
Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other processes or to further destroy the material.

In the plasma pyrolysis reactor, liquid waste molecules are pyrolyzed by passing through a thermal plasma plume. The plasma is generated in a horizontal reaction chamber where an electric charge passes through an atmospheric air stream. The gas molecules in the air stream are ionized and temperatures up to 18,000 degrees F are generated. As the liquid waste passes through the plasma, the organic constituents are decomposed into their elemental states. After passing through the plasma, the elements recombine to form hydrogen, carbon monoxide, hydrochloric acid, and particulate carbon. After off-gas scrubbing, the residual gases are electrically ignited in a flare stack.

The plasma pyrolysis reactor technology has a high throughput and can process highly toxic and refractory compounds, as well as wastes with low heating values. The technology can only be used to treat liquids with light particulate loading. The plasma pyrolysis reactor is a relatively small piece of equipment that can be transported from site of site. However, plasma pyrolysis reactors are energy intensive to operate.

Process Name
Wet Air Oxidation/General

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — Wet Air
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Dalton, February, 1993, DOE/MWIP p.2-4,2-5 and C45 - C46.

Process Name
Wet Air Oxidation/General

Description
Wet air oxidation processes subject an aqueous phase containing dissolved or suspended organic substances to heat and pressure in the presence of air or oxygen. Under these conditions, the organics are converted to water, carbon dioxide, and biodegradable acids. The reaction is conducted at sub-critical temperatures an pressures (e.g., 350-650 degrees F and 2 200 atmospheres).

In the continuous wet air oxidation process, the waste is mixed with compressed air and passed into a heat exchanger. From there it goes into the reactor where the oxidizable material in the waste reacts with oxygen in the mixture.

The wet air oxidation process is thermally self-sustaining. It is suited for non-incinerable dilute wastes, and requires small equipment volumes. Reaction times of 60 minutes or longer are typical. The process is not highly predictable. Wet air oxidation generally does not meet EPA treatment standards and thus is primarily used for pretreatment. Wastes which can be processed are limited to weak aqueous organic solutions. High pressure system hardware and off gas scrubbing are required. The wet air oxidation process is not effective on halogenated compounds.

Process Name
Adsorption/Granular Activated Carbon

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
EPA/540/2-91/024 October '91

Process Name
Adsorption/Granular Activated Carbon

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

Granular activated carbon (GAC) treatment is a physico-chemical process that removes a wide variety of contaminants by adsorbing them from liquid and gas streams. This treatment is most commonly used to separate organic contaminants from water or air; however, it can be used to remove a limited number of inorganic contaminants. In most cases, the contaminants are collected in concentrated form on the GAC, and further treatment is required.

Granular activated carbon (GAC) adsorption is most typically implemented through the use of downward flowing pressure vessels installed between the well pump and the point of discharge (for liquid treatment), or an upward flowing pressure vessel between the source of off-gas and the point of emission (for air pollution control).

Contaminants in the raw water or off-gas adsorb onto the GAC. The adsorptive capacity of the carbon varies with the nature and concentration of the contaminants. As the contaminant loading on the carbon reaches the adsorptive capacity of the carbon, the carbon is fully loaded with contaminants (i.e., at its adsorptive capacity). No further removal will take place and contaminants will begin to be found in the filter effluent. Effluent monitoring and estimates of the adsorptive capacity of the carbon enable the carbon in the filter to be replaced prior to occurrence of contaminant breakthrough.

Process Name
Biodegradation/Aerated Slurry System

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
EPA/540/2-90/016 Sept. '90

Process Name
Biodegradation/Aerated Slurry System

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous, or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

In a slurry biodegradation system, an aqueous slurry is created by combining soil or sludge with water. This slurry is then biodegraded aerobically using a self-contained reactor or in a lined lagoon. Thus, slurry biodegradation can be compared to an activated sludge process or an aerated lagoon, depending on the case.

Process Name
Dehalogenation/APEG

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
EPA/540/2-90/015

Process Name
Dehalogenation/APEG

Description
Dehalogenation is technologies whose goal is to convert hazardous halogenated compounds to simpler, less hazardous materials by removing the halogen atoms from the compounds. Removal of chlorine from PCBs or dioxins is one example of dehalogenation.

Alkaline metal hydroxide/polyethylene glycol (APEG) is a reagent which is capable of removing halogens from halogenated aromatic compounds. The products formed are a glycol ether and/or a hydroxylated compound and an alkali metal salt. These products are water soluble.

Process Name
Dehalogenation/Dechlorinization

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
Ayers et al, 1994

Process Name
Dehalogenation/Dechlorinization

Description
Dehalogenation is technologies whose goal is to convert hazardous halogenated compounds to simpler, less hazardous materials by removing the halogen atoms from the compounds. Removal of chlorine from PCBs or dioxins is one example of dehalogenation.

Potassium polyethylene glycol (KPEG) and alkali polyethylene glycol (APEG) have both been used to treat PCBs and dioxins. Removal efficiencies up to 99.5 percent have been demonstrated. Key factors in using the process are temperature of the material and contact time between the contaminant and the reagent. For soils, the moisture content is also a key factor.

Process Name
Biodegradation/Bioreactors

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Ayers et al, 1994

Process Name
Biodegradation/Bioreactors

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous, or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

Bioreactors have been the cornerstone of wastewater treatment processes for decades. The wastes are introduced to a biomass of microorganisms within the reactor which metabolize the soluble organic components. In most instances, additional nutrients and oxygen (aeration) must also be added.

Reactors may be either fixed film or slurry phase. Fixed film reactors are similar to the traditional trickling filters or rotating biological contractors (RBCs) of the wastewater industry. In either case the microorganisms are supported on the medium of the filter. The wastes are passed over the filter (or in the case of RBCs the filter is passed over the waste) allowing the microorganisms to come into contact with the wastes and breakdown the organic material. Slurry phase reactors are tanks into which the wastes, nutrients, and microorganisms are placed. The tank is mixed and may be aerated. In many instances, contaminated groundwater is used to create the waste slurry.

Both fixed film and slurry phase treatments are either batch or continuous mode. The effectiveness of the treatment depends on the: concentration of the wastes, contact (retention) time with the microorganisms, availability of oxygen in the system, and temperature within the reactor.

Process Name
Actinide Recovery/Uranium Removal

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DE-FC21-92MC28245

Process Name
Actinide Recovery/Uranium Removal

Description
Actinides are elements with atomic numbers 89 (Actinium) through 103 (Lawrencium) and include the common fissile, source, and/or transuranic (TRU) elements thorium, uranium, neptunium, plutonium, americium, and curium. Actinide recovery is the selective removal and capture of actinide elements from other materials in a waste stream. The volumes of TRU and TRU mixed wastes will be greatly reduced if actinides can be selectively removed and concentrated. The material left after actinide removal can probably be handled as Low Level Waste (LLW) or mixed LLW. The technologies identified as actinide recovery technologies in this report are typically multi-stage chemical separation processes in which actinides are separated using successive dissolution, precipitation, and ion exchange steps.

An integrated approach using in situ and ex situ soil treatment technology that includes several innovative techniques such as chelation-floatation, ultrasonic chemical leaching treatment by precipitation, ion scavenging, microfiltration and filter pressing operations. This technology is intended to remove uranium from soil to an acceptable residual level of less than 35 pCi/g. The process is designed to provide clean soil, dischargeable water and a concentrate that can be recovered and recycled or solidified for future disposal.

Process Name
Adsorption/Organic Sponges

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☒ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
DE-AC21-93MC29110

Process Name
Adsorption/Organic Sponges

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

This technology employs commercially available and inexpensive polymer sponges to remove CVOC vapors, such as methylene chloride, TCE, PCE, chloroform, and carbon tetrachloride. Contaminated air streams containing CVOC are directed past the organic sponges in a packed bed where the contaminants are selectively adsorbed on the sponges. After passing through the sponge bed, clean air is discharged from the sponge system. Regeneration of spent organic sponges may be accomplished either thermally or via aqueous desorption-biotreatment. The efficiency of the regeneration process is key to the overall cost effectiveness of this technology.

Process Name
Filtration/Dewatering

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☐ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Ayers et al, 1994

Process Name
Filtration/Dewatering

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

Dewatering is the process of removing or reducing the moisture content of a material, usually sludges or slurries prior to the application of another technology. By reducing the water content the ease of handling is greatly improved, the volume of the material is decreased, and the energy costs associated with thermal destruction can be significantly reduced since the liquids do not have to be evaporated. Dewatering is accomplished by: centrifuges, vacuum filters, pressure filters and lagoons.

Centrifuges operate on the principle of density separation accomplished by spinning the wastes and allowing the solids to disassociate from the liquids. Three types of centrifuges are commonly available: disc, basket, and scroll. Centrifuges produce sludges with solids concentrations ranging between 9 and 25 percent.

In vacuum filtration, a vacuum filter normally consists of a porous cylinder that is passed over a trough containing the sludge. A vacuum is applied to the inside of the cylinder, and the sludge is picked up as the cylinder rotates. The vacuum draws the water from the sludge which is then scraped from the cylinder. Vacuum filters produce solid concentrations of 20 to 40 percent.

Pressure filters are capable of dewatering sludges to wet solids between 30 and 45 percent. Compressing the filter plates forces the water from the sludge. Types of pressure filters include screwjack, hydraulic cylinder, and pressure leaf.

Lagoons work on the same principle as gravity thickeners and are used when larger volumes of waste require treatment. Their operation may be enhanced by the addition of vacuum-assisted underdrain systems.

Process Name
ReDox/Mediated Electrochemical Oxidation

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical Electrochemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic Electrochemical
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-4, p. 30

Process Name
ReDox/Mediated Electrochemical Oxidation

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

The Mediated Electrochemical Oxidation (MEO) process uses an electrochemical reactor to create a powerful oxidizer, or mediator, (e.g. silver II, Fe VI, or Co III) in an electrolyte (e.g. nitric acid). The oxidized mediator in turn oxidizes and destroys the organics in the electrolyte. End products are typically carbon dioxide and water. The mediator also renders radioactive components of the mixed waste soluble, making it possible for them to be removed from the solution by ion exchange. The process takes place at room temperature and low pressure, making it relatively safe to run.

Process Name
ReDox/Catalyzed Electrochemical Product

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — Electrochemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic — Electrochemical
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☒ Metal	☒ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-4, p. 30

Process Name
ReDox/Catalyzed Electrochemical Product

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

The Catalyzed Electrochemical Production Devices (CEPOD) system uses a powerful regenerated oxidative catalyst to dissolve, destroy, or decontaminate organic and inorganic media. CEPOD is applicable to the treatment of high concentration transuranics (TRU) in inorganic media (oxides and high-plutonium content ash); low concentration TRU in inorganic media (low-plutonium content ash, soil, and process sludges); contaminated combustible organic liquids; equipment and facility decontamination; and contaminated combustible solids.

Process Name
Precipitation/Barium Treatment

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☒ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☒ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Precipitation/Barium Treatment

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

Burning excess high explosives (HE) and mockups and flashing of equipment contaminated with HE forms sand and debris contaminated with barium oxide, barium carbonate, and barium nitrate, all of which are highly soluble in water. Mixing these wastes with gypsum causes a replacement reaction that generates nonsoluble barium sulfate and calcium hydroxide. The calcium hydroxide raises the pH of the treatment solution, which is lowered by adding sulfuric acid. Adding acid can decompose nitrates, generating NO_x that vents from the mixture. This only occurs if barium nitrate is present in the waste and very low pH is reached locally in the mixture.

Barium compounds are very heavy, and adequate mixing is a problem. Gypsum has advantages over more soluble sulfates in treating these wastes because it will settle with the barium, compensating for poor mixing. Using calcined calcium sulfate can prematurely solidify the waste.

Process Name
Incineration/Controlled-Air Incinerator

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical _____
- ☐ Chemical _____
- ☒ Thermal _____
- ☐ Biological _____
- ☐ Electrokinetic _____
- ☐ Admixtures _____
- ☐ Other _____

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Incineration/Controlled-Air Incinerator

Description
Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources used range from burning fossil fuels to electric arcs and plasmas.

A controlled-air incinerator (CAI) burns waste in a primary combustion chamber and uses a secondary combustion chamber as an afterburner. Off-gases are treated in a quench column, a high-energy venturi scrubber, an absorber column, two stages of high efficiency particulate air (HEPA) filters, an activated carbon adsorber, and a third-stage HEPA filter. The CAI has demonstrated 99.999999% destruction of organics, 99.9% removal of acid gases, and control of radioactive emissions to background levels.

The CAI is designed to burn up to 100 lb/h of solids or 200 lb/h of liquid, the rate limited by the 1.5 x 10 E6 Btu/h fired duty of the incinerator. Mixed phase liquids can be handled. Solids must be packaged in a 1-ft x 1-ft x 2-ft box and must be relatively free of noncombustibles such as glass and metals. Although built to handle transuranic-level alpha contaminated waste, the CAI can handle other isotopes in low concentrations. Carbon-14 and tritium are not captured in the gas cleanup train, and levels in the waste must be controlled to restrict release of these isotopes.

Process Name
Wet Air Oxidation/DETOX Catalytic

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Wet Air Oxidation/DETOX Catalytic

Description
Wet air oxidation processes subject an aqueous phase containing dissolved or suspended organic substances to heat and pressure in the presence of air or oxygen. Under these conditions, the organics are converted to water, carbon dioxide, and biodegradable acids. The reaction is conducted at sub-critical temperatures and pressures (e.g., 350-650 degrees F and 2-200 atmospheres).

The DETOX catalytic wet oxidation process is designed to destroy, by oxidation the organic components of liquid and solid wastes using oxygen and an acidic catalyst solution containing ferrous ions and hydrochloric acid. The catalyzed wet oxidation reaction occurs at the relatively low temperature of 50 degrees C to 250 degrees C and low pressure of 20-200 psig. The organic destruction efficiencies in bench-scale testing range from 99.0 to 99.9997%.

The equipment for the DETOX process is composed of a stirred vessel that may be operated in batch or continuous mode, a predetermined volume of catalyst solution is loaded into the reaction vessel and sealed. Oxygen is then introduced, and the system is brought to reaction conditions of temperature and pressure and stabilized before pump feeding the waste is initiated. Solid wastes must be slurried to continuously feed the pressurized reactor. The reaction gases composed of CO_2, water vapor, volatile organics (from waste or intermediate oxidation products)--are passed through a condenser, and condensate is recycled to the reaction vessel.

Process Name
Stabilization/Phosphate-bonded Ceramics

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Phosphate-bonding ceramics
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
Mixed Waste Treatment Technology Catalog

Process Name
Stabilization/Phosphate-bonded Ceramics

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Chemically-bonded phosphate ceramics can be used to stabilize mixed waste containing volatiles and pyrophorics. The technology treats solids and liquids (sludges) at room temperature. Waste forms are fabricated by acid-base reactions in which wastes are incorporated. Ashes, salts, and cement sludges are stabilized. The technology is inexpensive, does not produce secondary waste streams, and utilizes existing equipment from the cement industry. It is ideal for treatment of secondary waste streams from thermal treatments.

Process Name
Stabilization/Pozzolanic Binder

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Pozzolanic Binder
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☒ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☒ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Mixed Waste Treatment Technology Process

Process Name
Stabilization/Pozzolanic Binder

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Pozzolanic stabilization/solidification involves siliceous and alumnosilicate materials, which do not display cementing action alone, but form cementitous substances with lime ore cement and water. The primary containment mechanism is the physical entrapment of the contaminant in the pozzolan matrix. Examples of common pozzolans are fly ash, pumice and furnace slag. Pozzolans contain significant amount of silicates, which distinguishes them from the lime based materials. Pozzolanic reactions are generally much slower than cement reactions. Waste materials that have been stabilized with pozzolans include: oil sludges, plating sludges, waste acids, and creosote.

In one application, wastes are treated in a pozzolanic binder to reduce the toxicity of heavy metals. Chemical pretreatment includes oxidation/reduction of chromium, arsenic, and metal chelating agents. The wastes are spent solvents, Hg contaminated liquids, miscellaneous organic liquids (scintillation cocktails, rinse water, process residuals, etc.), ashes, environmental remediation soils, contaminated scrap metal, lab packs, waste water sludges, and explosive contaminated materials.

Process Name
Steam Reforming/Catalytic Oxidation

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Mixed Waste Treatment Technology Catalog

Process Name
Steam Reforming/Catalytic Oxidation

Description
Steam reforming is the process of converting organic wastes to simpler compounds, typically mixtures of gases rich in hydrogen and carbon monoxide. The gaseous products are sometimes burned as fuel.

High temperature steam is applied to liquid, solid, sludge or soil waste to volatilize organic contaminants and break them into lighter compounds. The vapor is passed through a catalytic oxidizer in a reaction chamber where the organics are further decomposed to carbon dioxide and water. Organics in the offgas are destroyed to a 99.99% DRE. If the waste has a high chlorine content, acid is formed as one of the waste products. Bench scale tests of this methods on radioactive wastes have been conducted and a field scale unit is under design . The method has been applied to medical wastes and has undergone a series of tests on DOE hazardous wastes at Hanford.

Process Name
Actinide Recovery

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
NTTC dB, General Laboratories Information

Process Name
Actinide Recovery

Description
Actinides are elements with atomic numbers 89 (Actinium) through 103 (Lawrencium) and include the common fissile, source, and/or transuranic (TRU) elements thorium, uranium, neptunium, plutonium, americium, and curium. Actinide recovery is the selective removal and capture of actinide elements from other materials in a waste stream. The volumes of TRU and TRU mixed wastes will be greatly reduced if actinides can be selectively removed and concentrated. The material left after actinide removal can probably be handled as Low Level Waste (LLW) or mixed LLW. The technologies identified as actinide recovery technologies in this report are typically multi-stage chemical separation processes in which actinides are separated using successive dissolution, precipitation, and ion exchange steps.

First, the plutonium is dissolved in nitric acid to separate it from the untreated scrap. Second, the acidic solution is introduced to a column filled with a resin that binds the plutonium, extracting it from the acidic solution. The bound plutonium is then washed from the resin, forming an eulate. In the third step, a chemical, or precipitant, added to the eulate causes the plutonium to precipitate out of the solution and form a solid cake. In some cases, the precipitant is added to the acidic solution without passing it through the resin column. Fourth, the plutonium cake is heated to drive off volatile components. The purified plutonium oxide that remains is then recovered. In the final step, evaporation is used to concentrate the remaining liquid waste to less than 5 percent of its original volume.

Process Name
Vitrification/Plasma Centrifuge Furnace

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Additives sometimes used
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
NTTC Database, General Laboratories Information

Process Name
Vitrification/Plasma Centrifuge Furnace

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

One vitrification method is the Plasma Centrifugal Furnace (PCF). Waste is fed to a rotating hearth such that the waste and molten material are held to the side through centrifugal force. During the rotation, the waste moves through plasma generated by a torch that does not rotate. To remove the molten material from the PCF, the rotation of the hearth is slowed, and the slag flows through a central bottom opening. The process will render hazardous and radioactive wastes and soils into a highly durable, glassy slag, with hazardous inorganic waste components being vitrified and stabilized into the slag.

Process Name
Liquid-Liquid Extraction/TRUEX

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
NTTC database

Process Name
Liquid-Liquid Extraction/TRUEX

Description
In liquid-liquid extraction, also called solvent extraction, one or more species in one liquid phase transfer to a second, immiscible, liquid phase for which the species have a greater affinity. The two liquids must be brought into contact with each other for the extraction to take place. This can be done by simply mixing the two liquids, for example, in a separatory funnel, or in a more elaborate apparatus such as those using counter-current flow.

TRUEX (transuranic extraction) is a process developed at Argonne National Laboratory for the removal of transuranic (TRU) elements from nuclear waste. The process is based on liquid-liquid extraction. A centrifugal contactor is used to mix the water-based waste solution with the TRUEX organic solvent to extract TRU elements. The machine spins the mixture and centrifugal force produces a clean separation of TRU containing solvent from wastewater. By repeatedly mixing and separating the two liquids, nearly all transuranic contamination is removed from the waste streams. After processing to recover plutonium and other TRU elements, the solvent may be eligible for near-surface disposal.

Process Name
Stabilization/Ceramic Silicone Foam

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Ceramic Silicone Foam
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☒ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☒ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
Internet DowVision 3/9/95

Process Name
Stabilization/Ceramic Silicone Foam

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

The ceramic silicone foam technology is a microencapsulation process in which the waste materials do not react chemically with the encapsulating material. In this technology, a ceramic silicone foam is used to bind the waste constituents into a stabilized/solidified mass. The foam surrounds the waste material and then hardens into a solid ceramic product. The ceramic silicone foam has been recommended by the Kurchatov Institute for Nuclear Physics for the encapsulation of the radioactive waste and debris from the Chernobyl nuclear disasters and other nuclear sites in the former Soviet Union.

Process Name
Decontamination/Supercritical Carbon Dioxide

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☒ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
Mixed Waste treatment technology catalog

Process Name
Decontamination/Supercritical Carbon Dioxide

Description
Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

Supercritical carbon dioxide is a dense fluid that exhibits good solubility for many organic materials. This process proposes to use supercritical carbon dioxide to remove oils, greases and solvents from solid waste. The desired result is that the cleaned items can then be treated as non-hazardous waste.

Process Name
Thermal Desorption/Vacuum Enhanced

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Mixed Waste Treatment Technology Catalog

Process Name
Thermal Desorption/Vacuum Enhanced

Description
Thermal desorption processes use heat to drive adsorbed and absorbed volatile substances from solid waste. The volatilized substances are usually recondensed or otherwise collected for further processing or disposal.

Thermal Enhanced Vapor Extraction (TEVES) is a technology that combines vacuum vapor extraction and soil heating to remove volatile organic compounds from soil. Basic scientific principles say that increasing the temperature of chemical constituents will increase the vapor pressure and evaporation rate. The TEVES is a conceptual process that requires pilot/bench scale development and field experience before full scale implementation.

Process Name
Adsorption/Gel Beads

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
NTTC Database - GLD5

Process Name
Adsorption/Gel Beads

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

A new type of gel bead developed at ORNL, uniquely suited for immobilizing various types of biocatalysts, provides an efficient means for removing trace amounts of strontium and other heavy metals, including isotopes, from wastewater streams. The beads may also be applied in systems that process fuels, pharmaceuticals, and other chemicals. Made from a mixture of propylene glycol alginate (PGA) and bone gelatin, the new beads provide a much more stable medium than those produced from alginate or carrageenan. They can maintain their integrity for a long time at temperatures of up to 100 (degree) C and in a pH range of 2 to 10. In addition, the beads themselves are chemically active and can adsorb strontium and cesium without added biocatalysts. Similar materials have been seen to adsorb other metals as well, including uranium, radium, cadmium, and copper. Because of this unexpected feature , they can provide an important new class of cheap, effective metal adsorbents. These beads can be used in a packed-bed column. The metal can be eluted later from the bed.

Process Name
Precipitation/Fractional Crystallization

Process Objective

- [x] Reduce Volume
- [ ] Mitigate Hazardous Properties
- [ ] Physically Stabilize
- [ ] Mitigate Radioactive Properties

Process Type

- [ ] Mechanical
- [ ] Chemical
- [ ] Thermal
- [ ] Biological
- [ ] Electrokinetic
- [ ] Admixtures
- [x] Other evaporation - fractional crystallization

Waste Type Application & Process Maturity

[x] Radioactive	[ ] Conceptual	[x] Pilot/Innovative	[ ] Commercial/Proven
[ ] Radioactive-Mixed	[ ] Conceptual	[ ] Pilot/Innovative	[ ] Commercial/Proven
[ ] TRU	[ ] Conceptual	[ ] Pilot/Innovative	[ ] Commercial/Proven
[ ] TRU-Mixed	[ ] Conceptual	[ ] Pilot/Innovative	[ ] Commercial/Proven
[ ] Hazardous	[ ] Conceptual	[ ] Pilot/Innovative	[ ] Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- [ ] 1100 Wastewaters
- [ ] 1200 Aqueous Slurries
- [ ] 2100 Aqueous/Organic Liquids
- [ ] 2200 Pure Organic Liquids
- [ ] 2900 Uncategorized Organic Liquids
- [x] 3100 Inorganic Process Residues
- [ ] 3150 Solidified Process Residues
- [ ] 3200 Organic Process Residues
- [ ] 4100 Contaminated Soils
- [ ] 4200 Contaminated Soil Debris
- [ ] 4900 Uncategorized Soils
- [ ] 5100 Metal Debris
- [ ] 5200 Inorganic Non-metal Debris
- [ ] 5300 Combustible Debris
- [ ] 5400 Heterogeneous Debris
- [ ] 6100 Lab Packs
- [ ] 6200 Reactive Metals
- [ ] 6300 Explosives/Propellants
- [ ] 6400 Compressed Gases/Aerosols
- [ ] 7100 Elemental Mercury
- [ ] 7200 Elemental Lead
- [ ] 7300 Beryllium Waste
- [ ] 7400 Batteries
- [ ] 8100 Unknown Liquids
- [ ] 8200 Unknown Solids
- [ ] 8900 Uncategorized Unknown

End Waste Form

[ ] Ash	[ ] Liquid	[ ] Sludge	[x] Other
[ ] Cement	[ ] Metal	[ ] Soil/Particulates	
[ ] Debris	[ ] Polymer	[ ] Vitrified	

References
NTTC Database - GLD5

Process Name
Precipitation/Fractional Crystallization

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

In the fractional crystallization process, a controlled evaporation process is used to slowly remove liquid from a liquid-ion solution. As the liquid is removed, a supersaturated solution forms. Eventually, a crystalline precipitate begins to form from the supersaturated solution. Generally, the precipitate is removed from the solution by filtration.

In one application, non-radioactive sodium is removed from salt cake using a fractional crystallization system. Water and nitric acid are combined with the salt cake to dissolve the waste, forming an aqueous solution. The solution is evaporated until the insoluble constituents begin to form a precipitate. The precipitate contains the radionuclides which can be removed and treated separately. The remaining solution can be stored as non-radioactive waste.

Process Name
Vitrification/Microwave Melter

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Additives sometimes used
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
EPA VISITT database 3.0; Dalton, February, 1993, p C78-C79; Lippold, July 2, 1993, p28.

Process Name
Vitrification/Microwave Melter

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

This is a thermal process to solidify inorganic wastes using microwave energy. The process produces a synthetic mineral matrix, incorporating hazardous or radioactive components of the waste in the crystal structure.

Sludges, soils, and other inorganic materials can be processed in the unit on a semi-continuous basis. The system is designed to accept any size of conventional drum or can be modified to accept nonstandard containers. The process operates by feeding waste material into the container using a standard screw feeder while applying the microwave energy. The molten waste is isolated in the container during the operation. This processing method offers advantages over other thermal processes including greater energy transfer efficiency by directly coupling the microwave energy to the waste, instantaneous energy control, high waste loadings, and high final product densities. Synthetic minerals also offer a leach resistant, stable matrix especially suited for hazardous and radioactive wastes. Also, the process equipment does not come in contact with high temperatures because the heat produced during operation is confined in the container which is insulated from the ancillary equipment.

The Microwaste (TM) process can treat sludges, soils,and other inorganic materials, contaminated with heavy metals. Additional off-gas equipment can be added so that wastes contaminated with a combination of metals and organics can be treated.

The Microwaste (TM) process was developed for use at the Rocky Flats Nuclear Weapons Plant in Golden, Colorado to treat hydroxide precipitation sludges contaminated with both radioactive and hazardous metals. The process was tested at the bench and pilot scales. A pilot scale process is currently being evaluated using simulated wastes at the Rocky Flats Plant.

Two bench scale systems were used to treat simulated and actual wastes. The actual waste was classified as mixed transuranic waste and contained plutonium, and characteristic and listed hazardous metals. The waste also contained elevated levels of nitrates.

Process Name
Evaporation/Rotary Drum Dryer

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
EPA VISITT database

Process Name
Evaporation/Rotary Drum Dryer

Description
Evaporation is the conversion of water, or some other liquid, to the gaseous state by the application of heat. This method is typically applied to reduce the volume of liquid waste streams.

Solvents may be removed from external solids by using a dryer such as a rotary drum dryer. As the waste is heated, it is tumbled to evenly distribute the heat. Residual solids from contaminated soils or dredgings can usually be returned to the source. Solids from other wastes may be stabilized, to fix heavy metals, and then landfilled. Residuals can be cleaned and stabilized to be sent to landfill or to be returned to the source depending upon regulatory requirement. The entire system is operated in a closed loop to minimize emissions of solvents to the atmosphere.

Process Name
Dehalogenation/Light Activated Reduction

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — Ultraviolet light
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☒ Metal	☒ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
EPA VISITT database

Process Name
Dehalogenation/Light Activated Reduction

Description
Dehalogenation is technologies whose goal is to convert hazardous halogenated compounds to simpler, less hazardous materials by removing the halogen atoms from the compounds. Removal of chlorine from PCBs or dioxins is one example of dehalogenation.

Light activated reduction of chemicals (LARC) can be used to dehalogenate chemicals. The process uses ultraviolet light and an optimized reducing environment. The method was developed for use on liquids, sludges, sediments, and solid wastes. For application to soils, sediments, and any other waste form into which ultraviolet light will not penetrate, the chlorinated compounds must first be extracted into a solvent which will transmit ultraviolet light.

The LARC process is patented.

Process Name
Separation/Capacitative Deionization

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Internet, Contact: Craig Sayoye (510)422-9919

Process Name
Separation/Capacitative Deionization

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

Capacitive Deionization (CDI) is a process that can be used to separate radionuclides and/or heavy metals anionic form from aqueous solutions. The CDI process is relatively simple. At the heart of the system are thin metal plates (electrodes) roughly six inches square and perforated by holes to facilitate stacking. A specialty material known as carbon aerogel is attached to the plates. The aqueous waste is pumped through electrochemical assemblies consisting of a stack of about 50 electrodes. When an electric charge is applied across the electrodes, the negatively and positively charged ions are absorbed into the carbon aerogel. By turning off the power, the trapped ions can be released into a relatively small stream of "rinse" water. Carbon aerogel is the reason that the CDI process, which is conceptually simple, has suddenly become viable. It is a highly porous and extremely light solid.

Process Name
Pyrolysis/Chem Char Project

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Mixed Waste Treatment Technology Catalog; DOE/MWIP-26 pg. 776--our record #245

Process Name
Pyrolysis/Chem Char Project

Description
Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other processes or to further destroy the material.

The Chem Char process was developed as a part of DOE research on technologies for coal gasification. The reaction chamber consists of a cylinder packed with a triple reverse burn char, which is a low grade activated carbon product. The process can treat wastes in the form of solids, liquids, sludges, and soils. Liquid wastes are adsorbed onto the char, contaminated soils are mixed with the char, and solid organic wastes are pulverized and mixed with the char. Waste constituents are converted to a combustible gas and to a dry inert carbonaceous solid. Radioactive and heavy metal constituents are retained in the char residue ash.

Process Name
ReDox/Evaporative Oxidation

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
ReDox/Evaporative Oxidation

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

The aqueous waste is concentrated in an evaporator by boiling off most of the water and the volatile compounds. Air or oxygen is added to the vaporized fraction and then forced through a fluidized catalyst bed, where the organic and inorganic compounds are oxidized. The off-gases, composed mainly of water and small amounts of acidic gases (from destruction of halogenated compounds) are passed through a scrubber and a condenser, then vented.

A proven evaporator design for this application is a single-stage forced-circulation evaporator. The liquid concentrate is heated by forcing it through a low-pressure steam heat exchanger and into the vapor body of the evaporator, where water and volatiles boil off at near-atmospheric pressure. This system can concentrate the nonvolatiles to 20 to 50 times the feed concentration level. The oxidizer is composed of a heater and a fluid bed catalytic reactor that operates at a temperature range of 900 degrees F to 1200 degrees F. The treated vapors are cooled in a heat exchanger, and the acidic gases are scrubbed off before the clean water vapors are condensed.

Process Name
Vitrification/Fossil Fuel Fired Melter

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Additives sometimes used
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
Vortec Corporation; 3770 Ridge Pike; Collegeville, PA ,19426; John Patten

Process Name
Vitrification/Fossil Fuel Fired Melter

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

Vortec has a patented vitrification technology that uses a counter-rotating vortex (CRV) combustor and a cyclone melter. It is being developed at the 25 ton/day scale to process contaminated soils.

Process Name
Stabilization/Alkali-Slag Cements

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Alkali-Slag Cements
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☒ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☒ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Wastewater Technology Centre; Ontario, Canada Caijun Shi; (905)336-4721

Process Name
Stabilization/Alkali-Slag Cements

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

In the alkali slag cement process, waste materials are mixed with a glassy slag and an alkaline activator to form a hardened alkali slag cement. The alkali slag cement has a lower porosity than ordinary Portland cement which prevents intrusion of leachates. The alkali slag cement is expected to be more durable than Portland cement and it has been shown to have a higher strength than Portland cement. It can be used to stabilize hazardous and radioactive wastes.

Process Name
Stabilization/Polymer Solidification

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Polymer Materials
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☒ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☒ Polymer	☐ Vitrified	

References
Westlich, July2, 1993, p.32.

Process Name
Stabilization/Polymer Solidification

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Organic polymerization stabilization/solidification relies on a polymer formation to immobilize the constituents of concern. Urea formaldehyde is the most commonly used organic polymer. It has been used primarily to stabilize/solidify radioactive wastes. It has been applied on a limited basis to hazardous wastes such as organic chlorides, phenols, cyanides and arsenic.

Low level, TRU and mixed wastes at the DOE Rocky Flats Plant are intended for polymer solidification where various thermosetting and thermoplastic polymers will be added to stabilize the waste. The goal is to treat the waste so that final waste forms meet EPA land disposal restriction treatment standards.

Process Name
Deactivation/Reactive Metal Combustion

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☒ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Westlich, July 2, 1993, p. 95.

Process Name
Deactivation/Reactive Metal Combustion

Description
Deactivation is chemically converting reactive material into a less hazardous material by chemically reacting the material to convert it to a more stable form. The methods include converting reactive materials to their oxides by burning in air or reaction with water or some other oxidizing agent. Deactivation also includes processes which destroy cyanide in solution by conveting it into less hazardous compounds.

This process is used at the Y-12 facility at Oak Ridge, TN, thermally oxidizes depleted and normal uranium chips to stable uranium oxide. The uranium oxide product can then be handled as non-hazardous solid low level radioactive waste.

Process Name
Deactivation/Alkali Metals

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☒ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Westlich, July 2, 1993.

Process Name
Deactivation/Alkali Metals

Description
Deactivation is chemically converting reactive material into a less hazardous material by chemically reacting the material to convert it to a more stable form. The methods include converting reactive materials to their oxides by burning in air or reaction with water or some other oxidizing agent. Deactivation also includes processes which destroy cyanide in solution by conveting it into less hazardous compounds.

In this process, reactive alkali metals such as sodium, potassium, and lithium are removed from containers by applying heat with electric heaters called burn trays. The metal is ignited with an oxyacetylene torch and burned in air. Steam is then added to finish reacting any unreacted metal. Water is added to dissolve the alkali oxide that was produced. The solution is collected for neutralization and further processing.

Process Name
Vitrification/Induction Melter

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Additives sometimes used
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
Dalton, February, 1993, p c-101-c102.

Process Name
Vitrification/Induction Melter

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

In one vitrification process, a refractory-lined crucible is used with an electrical induction coil encircling the crucible for a heat source. A high frequency power supply provides the electrical input and a cooling water system is needed to cool the induction coil and the power supply. An induction melter can be used to melt metals or vitrify inorganic materials such as incinerator ash to volume reduce the waste and obtain a more stable final waste form. Waste material is placed in the crucible and the power supply is turned on. The material in the crucible begins to melt, forming a molten mass which flows down into the bottom of the crucible, filling the void spaces between the unmelted waste. Once the waste in the crucible is melted, additional waste material is slowly added to the crucible and allowed to melt before the next batch of material is added. When vitrifying inorganic material, an additive may be used to lower the melting point of the waste material. When melting metals, a slag coagulant is added to the top of the molten mass to aid in slag removal. Once the waste is completely melted and at the desired temperature, the melter is tilted so that the molten mass can be poured into a refractory-lined mold.

Process Name
Steam Reforming/Steam Gasification Detoxifier

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Dalton, February, 1993, pl C-48 & C-49.

Process Name
Steam Reforming/Steam Gasification Detoxifier

Description
Steam reforming is the process of converting organic wastes to simpler compounds, typically mixtures of gases rich in hydrogen and carbon monoxide. The gaseous products are sometimes burned as fuel.

In a two stage thermal process, hydrocarbon wastes are first vaporized in an autoclave at 1100 degrees F then injected into a reaction chamber where the organics are decomposed via hydrocarbon, reforming chemistry at 2100 degrees to 3000 degrees F. The off-gas is further processed and may be used as a fuel gas. Non-volatile materials are left for other processing methods.

Process Name
Ion Exchange/Titanium-treated Zeolite

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
PNL; Lane Bray; West Valley Nuclear Services Co. Internet: Susan Bauer (509) 375-2561

Process Name
Ion Exchange/Titanium-treated Zeolite

Description
Ion exchange is the removal of ionic species from waste (usually an aqueous solution) by using the reversible interchange of ions of like-charge between an insoluble solid ion exchange medium and the solution. The ions in solution attach to the solid and are replaced, equivalent for equivalent, by other ions released from the solid. By proper selection of the ion exchanger and ion exchange conditions (e.g., pH) specific ions or groups of ions may be selectively removed from the solution. Ion exchange media are typically organic ion exchange resins, inorganic solids (such as crystalline silico-titanates), or zeolites.

Zeolites are natural minerals and their synthetic analogs that have ion exchange properties. Researchers at Battelle's Pacific Northwest Laboratory have used titanium to modify a commercial zeolite known to remove cesium from solution. The new Ti-zeolite material recovers not only cesium, but also plutonium, strontium, and other potentially dangerous radionuclides. The Ti-zeolite material is added to the radionuclide solution to capture plutonium, strontium and other isotopes. The remaining solution can then be disposed of as low level waste, greatly reducing the volume of material that must be disposed of as high or transuranic waste.

Process Name
Acid Digestion/Asbestos Digestion

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DE-AC21-93MC29249

Process Name
Acid Digestion/Asbestos Digestion

Description
Acid is used to break down the structure of solids in waste by dissolving some phases or by breaking all or some of the solids down to simpler forms. Heat may be used to speed up the action of the acid. If the hazardous component of the waste is either freed to go completely into the liquid acid phase, or stays completely in the remaining solid phase, separation of the liquid from the solid after digestion will result in the hazardous material being concentrated in what is probably a smaller volume than the volume of the original waste. Hazardous materials concentrated in the liquid phase may be further concentrated by other methods such as precipitation.

This technology uses techniques that have already proved successful in the mining, oil, and metals processing industries to remove and separate hazardous and radioactive materials from asbestos. This process uses three methods: acid attack which converts the asbestos to a sanitary waste; electrochemical processing for the removal of heavy metals, RCRA wastes and radionuclides; and dielectric heating to volatilize the organic materials. This process will result in the destruction of over 99% of the asbestos; limit radioactive metal contamination to 0.2 Bq alpha per gram and 1 Bq beta and gamma per gram; reduce hazardous organics to levels compatible with current EPA policy for RCRA delisting; and achieve TCLP limits for all solidified waste.

Process Name
Leaching/Tarra Met Heavy Metal Removal

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Cognis, INC

Process Name
Leaching/Tarra Met Heavy Metal Removal

Description
Leaching is dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The first processing stage is screening to remove oversized material, and wet particle size classification. After dissolution of the metal compounds, the metal ions are removed and recovered from the aqueous leachate by one of three metal recovery steps (liquid ion exchange, resin ion exchange, or reduction). If an ion exchange agent is used, it is later stripped of the bound metal, under conditions in which the extraction agent is also fully regenerated and recycled.

Process Name
Leaching/Acid Extraction

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Lockheed Corporation

Process Name
Leaching/Acid Extraction

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The use of this technology involves the solubilization of the constituents of concern in acid, followed by the isolation of the various soluble elements into appropriate forms. The process utilizes physical separation techniques (if appropriate) to isolate the fractions of concern in minimal volumes. The contaminant is then removed from the contaminant fractions. The goal of the treatment is to minimize the volume of the hazardous/radioactive constituents for ultimate disposal.

Process Name
Decontamination/Metals Recovery from Soil

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Earth Treatment Technologies, INC.

Process Name
Decontamination/Metals Recovery from Soil

Description
Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

The process is unique in that (1) regulated metal contaminants are selectively extracted while non-regulated metals remain in the treated soil, (2) metal contaminants are discharged from the process as a 50% to 99% pure concentrate suitable for and consistent with regulatory requirements for recycling and (3) all soil fractions are remediated on site; therefore no import of backfill soil and no off-site management of any soil fraction is necessary.

Process Name
Air-Steam Stripping/Batch Steam Distillation

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
ITC Corporation

Process Name
Air-Steam Stripping/Batch Steam Distillation

Description
Air and stream stripping technologies remove, or "strip" volatile compounds from contaminated water or aqueous waste streams by forcing air or steam through the waste. The volatile compounds evaporate into the air or steam and are carried away. Steam stripping may also be applied to non-aqueous solvents contaminated with nonvolatile impurities.

The batch steam distillation process removes organics from soils. It is an ex-situ process where the soil is excavated from the site and slurried with water. Volatile organic compounds are removed from the soil by direct steam injection. The volatile organic compounds are incorporated into the steam. The steam is withdrawn overhead, condensed, cooled and collected. The condensed steam can then be treated as a liquid waste with organic contaminants.

Process Name
Biodegradation/White Rot Fungi

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological White Rot Fungi
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
Eathfax Engineering,Inc.

Process Name
Biodegradation/White Rot Fungi

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

White rot fungi (WRF) are naturally occurring organisms that cause the decay of fallen trees by degrading lignin, a complex, three-dimensional, heterogeneous polymer that provides structural support for plants. The structure of lignin varies between plants depending on the availability of the monomers that are utilized in the polymerization process. Because lignin is an irregular, non-repeating polymer with no chiral specificity, it is resistant to degradation by most microbes. White rot fungi evolved to degrade lignin using a non-specific, extracellular, oxidative, free radical process that is initiated by limiting nitrogen, carbohydrates, or sulfur. The fungi degrade lignin to gain access to cellulose which they utilize as an energy (carbon) source. Research has shown that WRF use the same biochemical processes required for lignin degradation to break down a broad variety of carbon-based chemicals, including polycyclic aromatic hydrocarbons, PCBs, coal tars, wood preservatives, chlorinated solvents, pesticides, explosives (TNT\RDX), herbicides, cyanide, dyes, and others. This research has shown that the fungi possess the ability to not only degrade (i.e., cause the disappearance of) a variety of contaminants but also mineralize those contaminants, to carbon dioxide, water, and basic elements.

Process Name
Plasma Process/Silent Discharge Plasma

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☒ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☒ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Plasma Process/Silent Discharge Plasma

Description
A plasma is a completely ionized gas with nearly equal numbers of free positive and negative charges. Plasmas are generally generated by electric arcs or discharges or electrical induction processes. Waste processing technologies use the very high temperatures generated in the plasma to destroy organic wastes or melt inorganic waste.

The Silent Discharge Plasma Reactor (SDPR) is used to destroy organic contaminants in gaseous wastes. In the SDPR, the plasma is produced by electrical discharges in a gas, where one or both of the electrodes are covered by a dielectric layer (glass). The geometry is usually planar, using metal electrodes and glass dielectric plates. A series inverter power supply that switches charged capacitors through a pulse transformer by high power thyristors is used. Gaseous waste is destroyed as it passes through the electrical discharge field between the two dielectric barriers. For wet mixtures, the destruction is directly related to the amount of power input divided by the flow rate.

Process Name
Deactivation/Sodium Hypochlorite Solutions

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☒ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Deactivation/Sodium Hypochlorite Solutions

Description
Deactivation is chemically converting reactive material into a less hazardous material by chemically reacting the material to convert it to a more stable form. The methods include converting reactive materials to their oxides by burning in air or reaction with water or some other oxidizing agent. Deactivation also includes processes which destroy cyanide in solution by conveting it into less hazardous compounds.

This process is designed to treat reactive uranium metal chips and turnings. This process deactivates the metal by reaction with sodium hypochlorite using equipment packaged in the form of skid. The skid consists of a reactor, a settling tank, a drum mixer, and an offgas scrubber and high efficiency particulate air (HEPA) filter. The chips and turnings are stored in 30 gallon drums under diesel oil. The reactor is designed so that sealed drums can be loaded in the top of the reactor. After the reactor is sealed and purged, hydraulically driven hollow spikes pierce the top of the drum and force the drum onto hollow spikes at the bottom. The oil is drained from the drum and collected for separate treatment or reuse. Hypochlorite solution is pumped through the drum, dissolving the uranium. The treatment solution is pumped to a settling tank and sodium thiosulfate is added, precipitating the uranium as uranium dioxide. The precipitate settles and is drawn off into a drum, grout is added, and the drum tumbled. Off-gas treatment includes caustic scrubber to treat small amounts of chlorine that can come from decomposing hypochlorite and HEPA filters to control radioactive particulates. Use of hypochlorite solution creates excess water that is drawn off and discharged to a radioactive waste water treatment plant for treatment. Chlorine gas can be substituted for hypochlorite to achieve a better water balance at the expense of the higher risk associated with handling chlorine.

Process Name
Mercury Recovery/Distillation

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal Distillation
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☒ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Mercury Recovery/Distillation

Description
Mercury recovery methods include technologies designed to separate and collect mercury from other waste materials. The methods are generally thermal (e.g., roasting or distillations) which take advantage of the volatile nature of mercury, or chemical methods in which an easily separated chemical compound of mercury is formed.

Distillation is a process used primarily to clean contaminated, elemental mercury. The mercury is cleaned by heating (which causes vaporization), followed by condensation which leaves the contaminants behind. In one process, mercury is distilled in a unit with three sets of stills and water cooled condensers. Mercury is fed into the first heated pot by vacuum, evaporated, and condensed. The condensate from the first stage is fed directly into the second still, and the distillate form the second still condenser is fed into the third still. If enough of the contaminant has been removed, mercury from the third distillation stage is collected, tested, and put in a proper container for reuse. The vacuum line exhaust gases are cleaned by scrubbing and/or by using an appropriate mercury capturing system.

Process Name
Deactivation/Oxidation with Water

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☒ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Deactivation/Oxidation with Water

Description
Deactivation is chemically converting reactive material into a less hazardous material by chemically reacting the material to convert it to a more stable form. The methods include converting reactive materials to their oxides by burning in air or reaction with water or some other oxidizing agent. Deactivation also includes processes which destroy cyanide in solution by conveting it into less hazardous compounds.

This process deactivates reactive metal hydrides by passing nitrogen gas humidified with water over the wastes. The metal hydride reacts with the water to form metal hydroxide and hydrogen gas. The hydroxide is then neutralized to make a simple salt solution. The hydrogen gas is diluted below the flammability limits and vented. The reaction rate is controlled by adjusting the humidity of the nitrogen and by controlling the reactor temperature. The process can also handle water reactive metals and alloys such as depleted uranium.

Process Name
Liquid-Liquid Extraction/Membrane-assisted Solvent

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Liquid-Liquid Extraction/Membrane-assisted Solvent

Description
In liquid-liquid extraction, also called solvent extraction, one or more species in one liquid phase transfer to a second, immiscible, liquid phase for which the species have a greater affinity. The two liquids must be brought into contact with each other for the extraction to take place. This can be done by simply mixing the two liquids, for example, in a separatory funnel, or in a more elaborate apparatus such as those using counter-current flow.

Membrane assisted solvent extraction (MASX) process extracts dilute volatile organic compounds (VOCs) from water using a natural oil solvent such as sunflower oil. The process is expected to recover part-per-billion levels of VOCs from water and air waste streams.

Development of this technology is a joint DOE/USAD/ANL/Hoechst Celanese project.

Process Name
Filtration/Physical Membrane Microfiltration

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Filtration/Physical Membrane Microfiltration

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

The microfiltration system is designed to remove solid particles from liquid wastes by forming filter cakes typically ranging from 40 - 60 percent solids. The filter material is a thin, durable plastic fabric with tiny openings (about one ten-millionth of a meter in diameter) that allow water or other liquids, along with solid particles smaller than the openings, to flow through. Solids in the liquid stream that are too large to pass through the openings accumulate on the filter, and can be easily collected for disposal.

The technology is best suited for treating waste with solid concentrations less than 5000 ppm. The technology can treat any type of solids, including inorganics, organics and oily wastes. The E.I. DuPont de Nemours and Co. and Oberlin Filter Company membrane microfiltration system was accepted into the Superfund Innovative Technology Evaluation (SITE) Demonstration Program.

Process Name
Complexation/ESI Products

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
ESI John Pirotte 919-941-0847

Process Name
Complexation/ESI Products

Description
Chemical complexing and chelating agents are used to stabilize, concentrate, or collect specific constituents, usually from a liquid waste. Complexing agents are those which bond to atoms or molecules in the waste by formation of a coordinate bond. Chelating agents are a class of organic compounds which form more than one coordinate bond with metal ions in solutions. These agents are important because complexing or chelating agents can be selected based on their ability to bond to only specific species of interest in a solution. Thus they can be used to pull one, or a small group, of hazardous or radioactive ions from a solution containing other non-hazardous and non-radioactive ions. Many ion exchange materials are based on complexation or chelation relations. These are considered separately in the ion exchange group below.

ESI products can be applied in a soil wash process that can be targeted specifically to complex and remove undesirable and toxic ions or radionuclides and permit the soil to be returned clean to its site. The process is either batch or semicontinuous and takes place, typically above ground. ESI patented formulations can remove such contaminants, usually at neutral pH, without the use of acids or caustics, and are effective over a wide range of temperatures. The chemicals can be oxidized after the cleaning process and no undesirable residues are left -- only water, carbon dioxide, carbon monoxide, and nitrogen.

Process Name
Pyrolysis/Packed Bed Reactor

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Pyrolysis/Packed Bed Reactor

Description
Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other processes or to further destroy the material.

A packed bed reactor is a thermal treatment unit where small particles or objects are arranged in the reactor vessel to promote intimate contact between gases, vapors, liquids, and solids. The packed bed promotes more uniform and thorough heating of the waste. The heat decomposes the organic constituents in the waste.

An example of a packed bed reactor used for pyrolysis of organics is at Los Alamos National Laboratory. It consists of a fuel atomizer and injector, an alumina-filled metal cylinder, and an electric furnace. Operation of the reactor has been extended into a high temperature regime (above 1200 degrees C). Liquid waste is injected into the reactor while keeping the fuel-oxidizer ratio well below the lower explosive limit. By keeping the fuel lean (and by partially controlling the combustion reactions with the external electric furnace) no flame is produced.

Process Name
Steam Reforming/Synthetic Detoxifier

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Synthetic Technologies, INC

Process Name
Steam Reforming/Synthetic Detoxifier

Description
Steam reforming is the process of converting organic wastes to simpler compounds, typically mixtures of gases rich in hydrogen and carbon monoxide. The gaseous products are sometimes burned as fuel.

The Synthetica Detoxifier (SAD) uses high-temperature steam and an electrically heated reactor to destroy many hazardous components of a waste using the principle of steam reforming. The organic compounds are reacted in the vapor phase with superheated steam to produce a gas composed primarily of hydrogen and carbon monoxide (syngas). This chemistry is reductive and endothermic. Consequently, dioxins and furans that may be produced by incineration are not a problem. In the standard configuration the syngas that is formed may be further reacted in a catalytic oxidation reaction to form carbon dioxide and water. It is alternatively possible to use the syngas as a fuel or as a chemical feedstock.

Process Name
Biodegradation/SBP Microorganisms

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
SBP Technologies, INC.

Process Name
Biodegradation/SBP Microorganisms

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

SBP Technologies, Inc., (SBP) has established a unique collection of patented microorganisms for use in bioremediation applications. These microorganisms include strains of bacteria, mycobacteria and fungi that utilize high-molecular-weight polycyclic aromatic hydrocarbons (HMW PAH), chlorinated aromatics such as pentachlorophenol, and/or pesticides as sole sources of carbon and energy for growth. Furthermore, the fungi and mycobacteria remove contaminants to very low concentrations due to the use of co-substrates. Toxicological studies have shown that the products of these biotransformations, both terminal and transitory, are often less toxic than their parent compounds.

Process Name
Separation/Manual

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☒ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References

Pauly, February 13, 1990. p.70.

Process Name
Separation/Manual

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

Manual separation involves a physical sorting by workers to separate hazardous and radioactive items from non-regulated materials. In some cases, items are sorted before packaging. Often times, waste containers are opened and the waste inside is sorted. In general, workers require protection from the hazardous or radioactive constituents. Containers can be opened in a glovebox or similar enclosure. Contents can be sorted by hand through the glove ports, or extension tools can be used to separate items.

Process Name
Decontamination/Soil Washing-Solvents

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
VISITT 3.0

Process Name
Decontamination/Soil Washing-Solvents

Description
Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

The technology for the mobile soil restoration unit removes contaminants from excavated soils, debris and sediments using non-toxic environmentally friendly solvents. In the process, the soil restoration unit is moved to the site to minimize the transportation of large volumes of contaminated soil in the public domain. Research is ongoing concerning the potential of the unit to remove metals and transuranic contaminants along with the organic contaminants.

Process Name
Filtration/Acoustic Barrier

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical — Acoustic Barrier
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☒ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
VISITT 3.0

Process Name
Filtration/Acoustic Barrier

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

The acoustic barrier particulate separator separates particulates in a high-temperature gas flow. The separator produces an acoustic wave form directed against the gas flow, causing particulates to move opposite to the flow. The particulates drift to the wall of the separator, where they aggregate with other particulates and precipitate into a collection hopper. The acoustic barrier separator differs from other separators in that it combines both high efficiency and high-temperature capability.

This process by General Atomics - Nuclear Remediation Division, was accepted into the Superfund Innovative Technology Evaluation program in 1993.

Process Name
Filtration/Centrifugation

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
VISITT 3.0

Process Name
Filtration/Centrifugation

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

Used on oily sludges, this process consists of up to four steps: chemical pretreatment; heating at a high gravitational force; three-phase separator centrifuge; and a horizontal bowl decanter centrifuge. By recycling the decanter concentrate back to the separator and feeding separator sediment to the decanter, it is possible to achieve significant volume reduction of the solid wastes while recovering reusable oil and clean water. The process has been demonstrated with petroleum refinery wastes, and other oily waste stream including tank bottoms, sludges, and other pumpable wastestreams with various concentrations of oil. Depending on the characteristics of the feed waste, solids content of the cake discharged from the decanter may exceed 50 percent by weight.

Process Name
Transmutation/Reactor Based

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Fast Neutron Transmutation

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database; Murray, 1994, p. 81 and 150.

Process Name
Transmutation/Reactor Based

Description
Transmutation is the conversion of a radioisotope to a shorter lived or stable isotope by bombarding it with nuclear particles such as neutrons, usually in a nuclear reactor or a particle accelerator.

Reactor-based transmutation bombards and transmutes transuranic and fission product isotopes with neutrons. The neutrons are absorbed to produce new isotopes that may have a short half life or be stable. The process aids natural decay by shortening half lives.

Process Name
Leaching/Calcine Residue

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Calcine Residue

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Calcination destroys organics and nitrates. Leaching of the calcine residue will further reduce volume. New calcination methods being tested are expected to handle the high sodium wastes. Calcine residue volume could be significantly reduced by dissolving major non-radioactive components. The chemical state of the calcine and leach residuals will be established and responses to additional thermal and chemical treatment will be established. This knowledge will be used to identify methods to selectively leach the non-radioactive species or to dissolve broad ranges of constituents for separation. Extraction work will focus on gross acidic dissolution and electrochemical separation.

Process Name
Pyrolysis/Entrained-bed Gasification

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
LANL Database

Process Name
Pyrolysis/Entrained-bed Gasification

Description
Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other processes or to further destroy the material.

In an entrained bed reactor, solid particulates are incorporated in a rapidly moving fluid to promote mixing and heat transfer. The entrained bed gasification process is a non-catalytic partial oxidation process in which carbonaceous substances react at elevated temperatures to produce a gas containing mainly carbon monoxide and hydrogen.

Process Name
Pyrolysis/Advanced Electronic Reactor

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Pyrolysis/Advanced Electronic Reactor

Description
Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other processes or to further destroy the material.

One source of heat that can be used for pyrolysis is electrically heated gas. In the Advances Electric Reactor, contaminated soil can be treated to destroy organic compounds. The reactor vessel uses electrically heated nitrogen gas to destroy the organic contaminants. The flow rate of the gas through the soil is low and temperatures of 4000-5000 degrees F are obtained.

Process Name
Plasma Process/Plasma-Pyrolysis Reactor

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal Plasma
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Dalton, February, 1993, p.C60-C61; Freeman, 1989, p.8.169-8.177.

Process Name
Plasma Process/Plasma-Pyrolysis Reactor

Description
A plasma is a completely ionized gas with nearly equal numbers of free positive and negative charges. Plasmas are generally generated by electric arcs or discharges or electrical induction processes. Waste processing technologies use the very high temperatures generated in the plasma to destroy organic wastes or melt inorganic waste.

In the plasma pyrolysis reactor, a high energy plasma is used to destroy organic contaminants in a liquid feed. The reaction chamber is a horizontal cylinder in which liquid waste molecules are pyrolyzed by passing through a thermal plasma plume. The plasma plume is generated by applying an electric charge to the atmospheric air stream. The gas molecules in the air stream are ionized and temperatures up to 18,000 degrees F are generated. When the liquid waste passes through the plasma, organic contaminants are decomposed into their elemental state. Upon leaving the plasma, the elements recombine forming H_2, CO, HCL and particulate carbon. The exiting gases are cleaned (off-gas scrubbing) and electrically ignited in a flare stack.

Process Name
ReDox/Electrocatalytic Destruction

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
ReDox/Electrocatalytic Destruction

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

In this process electrocatalytic destruction of organics is carried out near room temperature. Thus the only gaseous emissions are oxidation products such as carbon dioxide, water vapor, nitrogen oxides, etc. All radioactive elements remain dissolved in the aqueous electrolyte, available for subsequent recovery.

Process Name
Decontamination/Abrasive Particulate Blasting

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical — Wet Surface Blasting
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
DOE Mixed Waste Treatment Plan

Process Name
Decontamination/Abrasive Particulate Blasting

Description
Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

This process is designed for decontamination of metallic lead. It consists of a trailer-mounted wet surface blasting facility. Surface-contaminated lead bricks and shapes are blasted with a mixture of water, air and grit (usually alumina) at 40 psig. The blasting removes a thin layer from the surface of the lead, removing the contamination. The cleaned bricks and shapes are surveyed and returned to service. The trailer has three sections; a staging area for unpacking containers, the blasting room, and a control room that includes the ventilation system. The ventilation system is high efficiency particulate air (HEPA) filtered and is interlocked to the blasting operation. In the blasting room, the spent fluids drop through a grating where they are collected and recycled. Occasionally the grit must be replaced. The blasting solution is pumped through a cyclone which separates the solids out as a slurry. The slurry is collected in a drum, and grit is added and mixed with an air-driven mixer in the staging area. The water is filtered and discharged to a radioactive wastewater treatment plant. Filtration is usually adequate for the water to pass TCLP for lead.

Process Name
Incineration/Fixed Hearth Plasma Process

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-3 Vol II C-22

Process Name
Incineration/Fixed Hearth Plasma Process

Description
Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources used range from burning fossil fuels to electric arcs and plasmas.

In a fixed hearth plasma process, the primary furnace chamber has a 1.2 megawatt plasma torch that can be operated on helium, argon, nitrogen, oxygen, air or mixtures of these gases. The feed chamber is large enough to accommodate whole 30-gal drums and could be easily modified to accommodate 55-gal drums. The system operates in a batch mode and can operate for 2-4 hours depending on feed composition. The primary furnace is a water-cooled, refractory-lined chamber capable of vacuum-tight operation at temperatures up to 1,800 degrees C. The secondary combustion chamber is a water-cooled, refractory-lined vessel capable of operating at temperatures up to 1,400 degrees C. The secondary combustion chamber has an auxiliary natural gas burner that will deliver up to 1,000,000 BTU/hr. Combustion air is supplied to the primary and secondary chamber by a 7.5 hp blower rated at 1,000 scfm. Gases exit the secondary combustion chamber and are immediately quenched by an air-atomized water spray. Warm dry gases (200 degrees C) exit the evaporative cooler and are filtered in a high temperature baghouse (51 sq. meters of filter area). Flow of gas is induced by a 20-hp fan with a capacity at 5,000 scfm at 10-in water column.

Process Name
Metal Melting/High Temperature Melter

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
DOE/MWIP-3 Vol. II C-26

Process Name
Metal Melting/High Temperature Melter

Description
Metal melting methods are those used to recover, clean, and /or compact metal waste by applying heat to melt the metal. The molten metal flows to form a compact mass, reducing waste volume and can be poured off leaving other materials behind to separate the metal from other non-metal materials. The heat applied to melt the metal can also destroy many organic impurities in the waste.

This technology, at the DOE Savannah River Site, rapidly heats the material to about 2000 degrees C. It has a replaceable melt container and has been used with depleted, natural, and enriched uranium. It is applicable to recycling. Temperatures are better controlled than with arc and plasma melting, minimizing volatilization of low boiling point metals such as cadmium and zinc. It can be fitted with an air lance or oxygen lance for oxidation of organics. It has induction stirring for homogenization and improved metal recovery.

Process Name
Vitrification/Stirred Glass Melter

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
DOE/MWIP-3 Vol. II C-30

Process Name
Vitrification/Stirred Glass Melter

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

A stirring glass melter can be used for vitrification. Stirring provides exceptionally high melting rates while minimizing the temperature and surface area available for volatilization of waste components. The melter can be operated batch-wise to partially maintain the low pollution characteristics of a cold top melter. All major feed preparation and off-gas scrubbing equipment is run using similar instrumental controls. Most feed preparation and off-gas system components are made of Hastelloy C-26 permitting full flowsheet amounts of corrosive acids, halides, sulfates, etc. Extensive instrumentation of off-gas system and feed preparation off-gas allows monitoring for CO, CO_2, H_2, NO, NO_2, N_2O, SO_2 and organics. The melter normally operates with Hg, Ag, Se, Cd, Pb, Cr, Cu, H_2SO_4, HNO_3, etc.

Process Name
Calcination/Rotary Kiln

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-3 Vol. II C-32

Process Name
Calcination/Rotary Kiln

Description
Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. Calcination processes differ primarily in the design of the apparatus and the source of heat.

A rotary kiln consists of an inclined calcining chamber that rotates. The combination of the slope and rotation cause waste input at the high end to move through the chamber and discharge out the low end. The chamber is heated to a temperature sufficient to drive volatiles from the waste and produce a calcined solid. The volatiles and other vapors produced are routed through an off-gas treatment line. Part of this line is a condenser which collects condensable gases. The calcined solid is transferred to crucibles and vitrified. This unit is a laboratory scale unit designed for low cost operation.

Process Name
Stabilization/Sulfur Polymer Cement

Process Objective

- ☐ Reduce Volume
- ☒ Physically Stabilize
- ☐ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☒ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-3 Vol. II C-43

Process Name
Stabilization/Sulfur Polymer Cement

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Sulfur Polymer Cement (SPC) is a thermoplastic that melts at 120 degrees C and unlike hydraulic cement, does not require activation agents to cause solidification. SPC achieves a compressive strength upon cooling that concrete requires 28 days to achieve. Generally, its use requires a significantly reduced amount of SPC than would be required of Portland cement to achieve a solidified form that could pass regulatory criteria. SPC must be cured in the complete absence of water. The modified sulfur cement encapsulation process includes a double planetary orbital mixer with jacketed heating/mixing vessel, vacuum hood, oil bath circulation heater, and hydraulic platen discharge unit. A HEPA filter enclosure has been constructed to enhance capabilities to process radioactive and hazardous materials. It offers a cleaner mixing system to operate, with fewer disposal containers to handle, and fewer waste containers that must be disposed.

Process Name
Stabilization/Polyethylene Encapsulation

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☒ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-3 Vol. II C-44

Process Name
Stabilization/Polyethylene Encapsulation

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Polyethylene encapsulation is a microencapsulation process in which the waste materials do not react chemically with the encapsulating material. In this technology, a thermoplastic material such as asphalt (bitumen) or polyethylene is used to bind the waste constituents into a stable, solid mass. One specific process uses the following equipment: two bench-scale single screw extruders, several volumetric feeders for precise metering of waste and binder, waste form specimen molds and miscellaneous pretreatment equipment. A HEPA filter enclosure enhances capabilities to process radioactive and hazardous materials.

Process Name
Incineration/Fluidized Bed

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Dalton, February, 1993, C-12 & 13.

Process Name
Incineration/Fluidized Bed

Description
Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources used range from burning fossil fuels to electric arcs and plasmas.

In a fluidized bed incinerator, a bed of inert granular material is loaded into a vertical refractory lined vessel and is "fluidized" by passing air through it. The air also serves as combustion air to burn waste. The hot, moving bed has a high thermal capacity and the turbulent action efficiently transfers heat to the waste. A secondary chamber is usually heated to complete combustion of the gases produced. The circulating bed fluidized incineration is a variation of this technology.

Process Name
Precipitation/Enzymatic Transformation of Inorganics

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☒ Biological — Enzymatic Transformation
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Mixed Waste Treatment Technology Catalog

Process Name
Precipitation/Enzymatic Transformation of Inorganics

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

In this process, bacteria are used to form a precipitate that can be removed from solution. The bacteria enzymatically couple with multivalent radionuclides or heavy metals. In the coupling process, the radionuclides or metals are reduced (bacteria being the electron donors). In their reduced state, the metals or radionuclides are less soluble in the solution; they precipitate, and can be removed from the solution. The technology has the potential for remediating surface waters or contained waste streams that are contaminated with soluble multivalent metals or radionuclides.

Process Name
Stabilization/Hydraulic Cement

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☒ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-3 Vol. II

Process Name
Stabilization/Hydraulic Cement

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

The basic hydraulic cement technology is produced by several variations. Contaminated ash, liquid waste, and slurry are mixed by various means with cement and sand where solidification results. Various off-gas systems may be attached.

Process Name
Vitrification/Joule Heated Melter

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☒ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
DOE/MWIP-3 Vol. II

Process Name
Vitrification/Joule Heated Melter

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

This basic technology is known by several names, electrically heated glass melter, high bay ceramic melter, research melter, mini melter, micro melter, etc. Most units consist of an electrically heated glass melter; melter is enclosed in water cooled jacket. Most units have an attached off-gas system. Different systems handle different types and sizes of materials.

Process Name
Liquid-Liquid Extraction/Cobalt Dicarbollide

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
INEL Propose Site Treatment Plan Summary, pg.C-2-81

Process Name
Liquid-Liquid Extraction/Cobalt Dicarbollide

Description
In liquid-liquid extraction, also called solvent extraction, one or more species in one liquid phase transfer to a second, immiscible, liquid phase for which the species have a greater affinity. The two liquids must be brought into contact with each other for the extraction to take place. This can be done by simply mixing the two liquids, for example, in a separatory funnel, or in a more elaborate apparatus such as those using counter-current flow.

Cobalt dicarbollide can be used to extract cesium from radioactive waste solutions. The solvent extraction mechanism involves exchange of organic phase protons from cobalt dicarbollide conjugate acid with metal cations. Cobalt dicarbollide anions are highly stable and able to withstand many forms of thermal, oxidation-reduction, chemical, and radiolytic attack. Thus they are able to withstand protonation in solutions of high acid concentrations and continue to be effective extracting agents.

Process Name
Precipitation/Freeze Crystallization

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
INEL Proposed Site Treatment Plan Summary

Process Name
Precipitation/Freeze Crystallization

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

In the freeze crystallization process, a solution containing contaminants is cooled to a supersaturated state where insoluble crystals begin to form. One system includes crystallizers, a eutectic separator, crystal separators/washers, heat pump refrigeration cycle, crystal melters, strippers, and decanters. There are three choices for the crystallizers: (1) indirect contact, uses a scraped surface of similar type heat exchanger; (2) triple point, uses the solvent (water for aqueous solutions) as the refrigerant at its triple point; and (3) secondary refrigerant, uses an immiscible refrigerant that is injected directly into the waste stream. The refrigerant used evaporates at several hundred times the vapor pressure of the solvent and has been identified as the preferred option for this process. The eutectic separator separates the crystals of solvent and solute into different streams for recovery as pure products. The crystal separator/washers remove the crystals from the mother liquor and wash brine off the crystals. A heat pump refrigeration cycle functions to remove the refrigerant vapor from the crystallizer and to compress it to recover the heat for use in melting the crystals.

Process Name
Stabilization/Asphalt

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
INEL Propose Site Treatment Plan Summary

Process Name
Stabilization/Asphalt

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

The asphalt stabilization process is a microencapsulation process in which the waste materials do not react chemically with the microencapsulating material. The asphalt is used to bind the waste constituents into a stable, solid mass. The asphalt binder may be heated before it is mixed with the waste, or it may be applied as a cold mix. Compaction may be used to remove additional water from the waste. Bitumen may have commercial application for treating oil and gasoline contaminated soils. In this application, the hydrocarbon containing soil is used to dilute the bitumen, which is then used as paving or patching material for roads.

Process Name
Stabilization/Vinyl Ester Styrene Encapsulation

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Vinyl Ester Styrene Resin
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☒ Polymer	☐ Vitrified	

References
INEL Proposed Site Treatment Plan Summary

Process Name
Stabilization/Vinyl Ester Styrene Encapsulation

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Vinyl ester styrene (VES) immobilizes the waste by encapsulating it in a plastic matrix. A waste container is partially filled with vinyl ester resin binder. Liquid waste is mixed with styrene catalyst and a promoter added to the container, and mixed. The mixture solidifies in about one hour.

Process Name
Thermal Desorption/Infrared Heating

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Dalton, February, 1993, C-41 & 42.

Process Name
Thermal Desorption/Infrared Heating

Description
Thermal desorption processes use heat to drive adsorbed and absorbed volatile substances from solid waste. The volatilized substances are usually recondensed or otherwise collected for further processing or disposal.

This process uses direct radiant (infrared) heat in a primary chamber to desorb organics from soils and other fine materials followed by fossil fuel fired combustion of the organics in a secondary chamber. The primary chamber can be operated in a combustion or pyrolysis mode.

Process Name
Liquid-Liquid Extraction/Aqueous Biphasic Separation

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database, DOE/EM-0126P, pg.33

Process Name
Liquid-Liquid Extraction/Aqueous Biphasic Separation

Description
In liquid-liquid extraction, also called solvent extraction, one or more species in one liquid phase transfer to a second, immiscible, liquid phase for which the species have a greater affinity. The two liquids must be brought into contact with each other for the extraction to take place. This can be done by simply mixing the two liquids, for example, in a separatory funnel, or in a more elaborate apparatus such as those using counter-current flow.

The aqueous biphasic separation technique involves the selective partitioning of either solutes of colloid-size particles between two immiscible aqueous phases. The target is submicron particles of actinide oxides (50 micron to 2nm) that are chemically separated from a matrix of soil or ash, focused on the DOE's Fernald site. It could also be used to remove actinide particulates from sludges. Wet grinding of residues to an average particle size of one micron is used to liberate the actinides from the bulk of the particle matrix.

Another proposed application of aqueous biphasic solvent extraction is to remove long-lived radionuclides such as Tc-99, I-123, and Se-179 from alkaline solutions. The solvent system for this application are produced by the addition of polyethylene glycols to high ionic strength electrolyte solutions. The method has been demonstrated on several samples of tank waste supernatants.

Process Name
Leaching/Basic Extractive Sludge Treatment (BEST)

Process Objective

- ☐ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical _____
- ☐ Chemical _____
- ☐ Thermal _____
- ☐ Biological _____
- ☐ Electrokinetic _____
- ☐ Admixtures _____
- ☐ Other _____

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Basic Extractive Sludge Treatment (BEST)

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The BEST solvent extraction system utilizes a unique property of certain amine solvents (triethylamine [TEA]), to separate sludges and sediments into their oil, water, and solid fractions. The key to the success of amine extraction is the property of inverse miscibility. Analysis was conducted for semi-volatile compounds in the raw sediment samples, but this analysis was not conducted on either the solids product or the water product. There were several compounds detected in each sediment sample. The data also indicate that the process efficiently removed all forms of polychlorinated biphenyls (PCBs) present in the sediment samples. Extraction efficiencies for PCBs can be calculated from the compositional data and the feed and product solids PCB analysis. The extraction efficiencies were calculated to the method of absolute weight removal from the environment. Low level sediment extraction efficiency is 99.1% and the high level sediment extraction efficiency is 99.4%. These results indicate that very high samples were excellent. The residual TEA in the water fraction showed very nearly 2% TEA, which is the theoretical limit of aqueous/organic phase separation performance. Some oil, grease and PCBs were present in the water fraction from the TEA stripping process, however, they can be easily removed by pH adjustment and flocculation. After post-water treatment the oil and grease was less than 10 ppm and the PCBs were nondetectable in each sample at a level of a5 ppb. The product solids contained appreciable levels of heavy metals but passed the EPA extraction procedure (EP) toxicity test for metals leachability.

Process Name
Evaporation/APES

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Evaporation/APES

Description
Evaporation is the conversion of water, or some other liquid, to the gaseous state by the application of heat. This method is typically applied to reduce volume of liquid waste streams.

This process dewaters and detoxifies wastewaters, slurries and sludges. It is applicable to wastes that contain organic/inorganic volatile/semi-volatiles such as water, hydrocarbons, ammonia, cyanides, etc. in a non-aqueous environment by evaporation. The evaporator vapor is treated in a catalytic oxidation section to destroy volatile compounds and then condensed to produce near distilled-quality water. The solids and semi-volatiles are concentrated in a heavy oil-based solvent within the evaporator and processed through a liquid solid extractor to separate the heavy solvent from the solids. The heavy solvent, containing any semi-volatile organics is extracted from the solids with a second solvent (light hydrocarbon). The extract is then processed to separate the light and heavy solvents. Both solvents are recovered and recycled to the process although a small blowdown stream of the heavy solvent is typically taken to remove accumulations of semi-volatile organics. The blowdown stream can be sent off-site for incineration or destroyed in the catalytic oxidation unit. The extracted solids are desolventized by using a dryer such as a rotary drum dryer and the solvent is recycles to the process. Residual solids from contaminated soils or dredgings can usually be returned to the source. Solids from other wastes may be stabilized, to fix heavy metals, and then landfilled. Residuals will be cleaned and stabilized to be sent to landfill or to be returned to the source depending upon regulatory requirements. The entire system is operated in a closed loop to minimize emissions of solvents to the atmosphere.

Process Name
Leaching/Explosive Laden Sediments

Process Objective

- ☐ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical physical separation
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☒ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Explosive Laden Sediments

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Leachability studies indicated that wet, explosive laddened sediments can be effectively decontaminated by leaching with water/acetone mix. Three to four contact stages of 30 minutes each were required to reduce the explosives level to less than 10 mg/kg. Solubility tests demonstrated a non-linear solubility of explosives with acetone/water. Saturated solutions between 50 % and 90 % acetone form a two phase liquid solution which should be avoided since this could hinder penetration of solvent through sediment.

Process Name
Air Steam Stripping/Supercritical Fluid Extraction (SCF)

Process Objective

- ☐ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical decontamination
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Air Steam Stripping/Supercritical Fluid Extraction (SCF)

Description
Air and stream stripping technologies remove, or "strip" volatile compounds from contaminated water or aqueous waste streams by forcing air or steam through the waste. The volatile compounds evaporate into the air or steam and are carried away. Steam stripping may also be applied to non-aqueous solvents contaminated with nonvolatile impurities.

In SCF extraction, a solvent gas such as carbon dioxide or propane at high pressure and moderate temperature is contacted with the liquid phase. Slight changes in the system temperature or pressure can cause large changes in solvent density and consequently in its ability to dissolve relatively nonvolatile components. Thus, manipulation of system temperature and pressure can be useful in extraction and separation of organic contaminants from aqueous streams. Data is reported here for the extraction of phenol and other aromatics from dilute solutions. After the contaminants enter the supercritical phase, conventional technology would use distillation to separate the concentrated contaminants from the SCF phase. An alternative to this step is also being investigated. It is the catalytic oxidation of the high pressure solvent/contaminant mixture. High-pressure air can be added to the SCF-contaminant mixture in the desired quantities, and conventional mixed-metal oxides can be used as catalysts. Some results for polycyclic aromatic hydrocarbon and toluene oxidations at <600 K are reported.

Process Name
Leaching/Extraksol

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — physical separation
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Extraksol

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The Extraksol process is a closed-system, mobile decontamination technology that treats unconsolidated soil materials by solvent extraction. The system has no gaseous or liquid discharges. Treatment with Extraksol involves material washing, drying and solvent regeneration. Contaminant removal is achieved through desorption/dissolution. Treated material is dried and acceptable for replacement at its original location. The method is a batch process that involves mixing of approximately 1 ton of contaminated material in a revolving extraction vessel and washing it with solvent. Visual observation of the extractant is used to assess the state of contamination. Washing time varies from 1 to 2 hours depending on the type and concentration of contaminants within the soil. Following completion of washing, the solvent is extracted and regenerated. Contaminated solvent is regenerated by distillation. The soil is dried in a closed system. Four different solvent mixtures were tested. Polychlorinated biphenyls (PCBs) polyaromatic hydrocarbons (PAHs), oils, and pentachlorophenols (PCPs) were successfully extracted from clay-bearing soil, Fuller's earth, oily sludge, activated carbon, and gravel by the one ton per hour Extraksol unit.

Process Name
Flocculation/Flotation

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Flocculation/Flotation

Description
Flocculation methods use of a reagent (flocculant) in a dispersion of solids in a liquid to cause the solids to agglomerate and form a fluffy mass that typically floats on top of the liquid. This allows the flocculated solids to be easily separated from the liquid.

The process is effected by well-chosen mineral separation techniques which together result in a complete purification process. To achieve a separation between the contaminants and the soil in a soil-water mixture, the surfaces of the particles have to be adequately manipulated, in such a way that the former will be hydrophobic and the latter will be hydrophilic. The manipulation is not related to changing the chemical structure of the particles, but to modification of the surfaces by selective adsorption. The hydrophobic particles attach to air bubbles produced in the soil-water mixture. Flotation processes are determined by surface phenomena. The available surface depends on the grain size. A particle in water obtains an electric surface charge due in part to ionization, adsorption, orientation of dipoles or crystal lattice defects. Around the charged particle, a diffuse layer or a cloud of counter ions with an opposite charge is formed reducing the potential to zero. This phenomenon is called an electric double layer. When the particles are forced to move in relation to the liquid, the slipping plane in the diffuse layer shows the zeta potential an electrokinetic phenomenon.

Process Name
Ion Exchange/Resin in Pulp

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Ion Exchange/Resin in Pulp

Description
Ion exchange is the removal of ionic species from waste (usually an aqueous solution) by using the reversible interchange of ions of like-charge between an insoluble solid ion exchange medium and the solution. The ions in solution attach to the solid and are replaced, equivalent for equivalent, by other ions released from the solid. By proper selection of the ion exchanger and ion exchange conditions (e.g., pH) specific ions or groups of ions may be selectively removed from the solution. Ion exchange media are typically organic ion exchange resins, inorganic solids (such as crystalline silico-titanates), or zeolites.

Resin in pulp (RIP) technology has been used by Davy Research and Development, Ltd. to treat soils, sediments, dredgings, and solid residues contaminated with organics and inorganics. RIP has also been used to recover uranium where anion exchange resins are used to adsorb uranium as the uranyl anion. The soil or other material is sized and leached. The leach liquor is then passed to a RIP contactor where the contaminants are adsorbed on the resin. The resin can be regenerated and recycled. The RIP technology is suitable for treating a wide range of materials contaminated with inorganic wastes. Inorganics treated to date include heavy metal and cyanide-containing wastes.

This technology was accepted into the Superfund Innovative Technology Evaluation (SITE) Emerging Technology Program in July 1991.

Process Name
Separation/Magnetic Barrier

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical — Magnetic
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Separation/Magnetic Barrier

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

Magnetic barrier separation is a process that uses magnetic forces to separate diamagnetic materials from more weakly diamagnetic and non-magnetic materials. The system uses parallel planes of magnetic force. Diamagnetic particles moving through the planes are attracted to a magnetized collection surface. The magnetic force is at a maximum at the collection surface and decreases abruptly with distance. The force experienced by any particle depends on its position in the field. Particles passing close to a surface may be captured, while particles passing farther away may escape. Laboratory barrier separators are in wide use for separating the component species of mineral samples.

Process Name
Calcination/Plasma Arc

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Calcination/Plasma Arc

Description
Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the Appendices differ primarily in the design of the apparatus and the source of heat.

The plasma arc calciner concept is being tested for use on Hanford high sodium tank waste. In this design a plasma arc provides the heat for the calcining process. Previous attempts to calcine this waste with other types of calciners (rotary kiln, spray tower, and fluidized bed) were not satisfactory due to molten material plugging the reactors. This unit will help determine if a plasma arc calciner will work on a variety of Hanford single shell tank wastes.

Process Name
Actinide Recovery/Polymers for Plutonium & Americium

Process Objective

- ☐ Reduce Volume
- ☒ Physically Stabilize
- ☐ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Office of Technical Development

Process Name
Actinide Recovery/Polymers for Plutonium & Americium

Description
Actinides are elements with atomic numbers 89 (Actinium) through 103 (Lawrencium) and include the common fissile, source, and/or transuranic (TRU) elements thorium, uranium, neptunium, plutonium, americium, and curium. Actinide recovery is the selective removal and capture of actinide elements from other materials in a waste stream. The volumes of TRU and TRU mixed wastes will be greatly reduced if actinides can be selectively removed and concentrated. The material left after actinide removal can probably be handled as Low Level Waste (LLW) or mixed LLW. The technologies identified as actinide recovery technologies in this report are typically multi-stage chemical separation processes in which actinides are separated using successive dissolution, precipitation, and ion exchange steps.

Concentration of actinides uses water-soluble chelating polymers to selectively retain the metal ions of interest while the unbound metal ions are removed with the bulk of the aqueous solution as the permeate by membrane ultrafiltration. Water-soluble polymers have been evaluated for selective retention of americium(III) and plutonium(III) from dilute aqueous solutions high in salt content that simulate waste streams from the Technical Area-50 treatment plant at Los Alamos National Laboratory (LANL). A phosphoric acid based polymer was chosen over other experimental polymers because of its high solubility over a wide pH range, ease of synthesis, high selectivity for actinides over other metal ions and the ability to bind actinides at low pH.

Process Name
Stabilization/Chemically Bonded Ceramics

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Office of Technical Development

Process Name
Stabilization/Chemically Bonded Ceramics

Description
Stabilization technologies are those which immobilize waste, typically by incorporating it into a solid, relatively inert material. Materials used for stabilizing waste include cements, grouts, sulfur cement, thermoplastic or thermosetting polymers, and asphalt (bitumens).

Metallic oxide contaminants, such as BeO and HgO and phosphoric acid may be processed into hydrophosphates by reaction at room temperature. This low-temperature processing occurs quickly, minimizing worker exposure and costs. Ceramic phosphates are also non-flammable, insoluble in ground water, and stable at higher temperatures.

Process Name
Ion Exchange/ReFIX Resin

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Office of Technical Development

Process Name
Ion Exchange/ReFIX Resin

Description
Ion exchange is the removal of ionic species from waste (usually an aqueous solution) by using the reversible interchange of ions of like-charge between an insoluble solid ion exchange medium and the solution. The ions in solution attach to the solid and are replaced, equivalent for equivalent, by other ions released from the solid. By proper selection of the ion exchanger and ion exchange conditions (e.g., pH) specific ions or groups of ions may be selectively removed from the solution. Ion exchange media are typically organic ion exchange resins, inorganic solids (such as crystalline silico-titanates), or zeolites.

Resorcinol-Formaldehyde Ion Exchange (ReFIX) resin is applicable to high-level radioactive waste containing dissolved cesium. The solutions are typically alkaline high-activity wastes, a mixture primarily of sodium nitrate and sodium hydroxide. The ReFIX resin is specific for adsorption of cesium ions and has 10 times the capacity of the baseline Duolite(TM) CS-100 phenol-formaldehyde resin. The resin is used by loading it into columns and passing the waste solution through the column. One benefit of the ReFIX resin is that it is essentially unaffected by changes in temperature. High concentrations of competing sodium and potassium ions reduce the cesium sorption and diffusion efficiency of the ReFIX resin. The resin can be regenerated for reuse by eluting with nitric acid.

Process Name
Biodegradation/Biocatalytic Destruction

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☒ Biological Enzymatic Catalyst
- ☒ Electrokinetic Electrically Stimulated Enzymes
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Office of Technical Development

Process Name
Biodegradation/Biocatalytic Destruction

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous, or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

This process uses immobilized enzymes coupled with biphase partitioning to efficiently destroy nitrate and nitrite. The reducing equivalents are provided by a low-voltage electrical current, which transfers electrons from the cathode to the enzymes via an electron transfer dye. The biphase system is necessary to protect the enzymes from excessive concentrations of electrolytes, especially H{+} and OHO which would result in enzyme inactivation, while simultaneously allowing the transfer of nitrate and nitrite from the waste stream to the catalytic chamber. The use of enzymes enables very large specific catalytic activity to be obtained without the need for additional chemical reagents or the production of secondary waste streams.

Process Name
Biodegradation/High Salt Tolerant Bacteria

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological High Salt Tolerant Bacteria
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE Office of Technical Development

Process Name
Biodegradation/High Salt Tolerant Bacteria

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous, or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

This process uses a mixed culture of natural bacteria isolated from the Great Salt Lake and the Death Valley area. They are able to grow and reduce nitrate in the very high salt concentrations found in the tank wastes. The bacteria are grown in a bioreactor and then recycled to a biosorption tank, where they are mixed with the incoming waste. Agitation is provided by sparging with evolved N2 and CO2 gases. The high radioactivity and metals concentration in this tank may kill the bacteria, but dead bacteria biosorb metals equally well. The bacteria and any chemical precipitates that may have formed are removed by filtration to generate a biomass sludge containing nearly all the radionuclides, transuranics and toxic metals. The liquid containing the nitrate, organics and very low levels of metals flows into the bioreactor, where it is mixed with acetic acid as a carbon source for bacterial growth. The nitrate is reduced to innocuous nitrogen gas that is released to the atmosphere after being filtered. Any remaining metal would adsorb on the growing bacteria, but the metallic concentration is now too low to inhibit bacterial metabolism. The effluent from the bioreactor, after filtration, is a concentrated solution of nonradioactive, nonhazardous salts in which nitrate has been replaced, mainly by bicarbonate.

Process Name
Precipitation/Ultrasonically Catalyzed

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Ultrasonic

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Atomic Energy of Canada Lmt.

Process Name
Precipitation/Ultrasonically Catalyzed

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

Ultrasonic energy can be used in a precipitation system to increase the physical and chemical rate processes leading to separation. The ultrasonic energy acts to stir the system which increases the contact between the precipitating reagent and the ionic solution.

Process Name
Decontamination/Chemical

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — Surface Decontamination
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
DOE Office of Technical Development

Process Name
Decontamination/Chemical

Description
Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

This process uses a solvent containing a chelating agent. Chelating agents are organic compounds attached to a metal ion by at least two coordinate bonds. The contaminated objects of interest for this procedure are metal objects with metal ion contamination on the surfaces and in grain boundaries where the contaminants penetrated during prolonged exposure to high temperature. The intent is for the chelating agent to bond to the contaminant ions and bring the contaminants into solution. The solvent can be regenerated through precipitation of the chelated metals, enabling the solvent to be used and reducing the final waste volume.

Process Name
Pyrolysis/Molten Metal Bath

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☒ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References

DOE Office of Technical Development; Dalton, February, 1993, p. E3-E8.

Process Name
Pyrolysis/Molten Metal Bath

Description
Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other processes or to further destroy the material.

Using a molten metal bath, organic compounds can be decomposed into their constituent elements. The technology involves feeding mixed waste into a molten metal bath. Organic compounds are destroyed and/or volatilized. Inorganic, non-metal compounds form a slag that separates from the metal phase. Through the addition of selective reactants (catalysts) and appropriate reaction engineering, the remaining elements combine to form commercially valuable products. Thus, the technology can be used to recycle industrial by-products and waste.

Process Name
Amalgamation Treatment Process

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☒ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Advanced Recovery Systems Inc.

Process Name
Amalgamation Treatment Process

Description
Amalgamation, or amalgam treatment, is the mixture of liquid, elemental mercury contaminated with radioactive materials with inorganic reagents such as copper, zinc, nickel, gold, and sulfur to form a non-liquid, solid or semi-solid alloy or compound; thereby reducing potential emissions or leaching of elemental mercury.

There are a variety of radioactively-contaminated mercury bearing wastes that have been generated at DOE Facilities. These wastes are classified as D009 characteristic and therefore are considered as mixed wastes. Disposal of these special wastes in a licensed radioactive landfill requires that the final waste form be non-hazardous. There has been two successful treatability studies to render mercury-bearing mixed waste as non-hazardous per requirements in 40 CFR. The first treatability study was conducted on elemental mercury contaminated with low levels of tritium. The study successfully demonstrated the effectiveness of the amalgamation treatment process to immobilize elemental mercury to meet the RCRA treatment standard for D009 wastes. The amalgam produced in proving tests using two kilograms of elemental mercury had TCLP leach mercury concentrations averaging 0.06 mg/L, below the regulatory limit of 0.2 mg/L. Several significant findings were derived from this study. The first is that the waste mercury only comes in contact with the ultimate disposal container and does not contact processing equipment. The second is that expensive blending/mixing equipment is not required to convert the waste to a final non-hazardous waste form. The second treatability study was performed on samples of aqueous and organic bearing mercury solutions contaminated with trace levels of tritium. The mercury treatment process selected for this study was demonstrated as an effective treatment for the mercury-bearing solutions. Both the organic and aqueous phases of the treatability samples were treated to produce test filtrates containing 0.02 mg/L mercury and solid residues having TCLP leachate mercury concentrations averaging 0.003 mg/L. This result is nearly three orders of magnitude less than the RCRA treatment standard of 0.02 mg/L mercury in TCLP leachate. An additional finding of this work was that the final waste form was a solid free standing monolith with good handling and storage characteristics. In summary, the above studies have successfully converted several different forms of mercury mixed wastes to non-hazardous waste forms that fully achieve land disposal requirements.

Advanced Recovery Systems, Inc. (ARS) has developed a technology to convert a variety of mercury-bearing mixed wastes to final non-hazardous waste forms. A treatment system has been designed and is to be permitted for treating mercury bearing debris generated at a fuel production facility. This technology is applicable to other DOE mercury wastes and may have merit for mercury mixed wastes containing other hazardous metals such as cadmium, silver, and lead.

Process Name
Precipitation/Photocatalytic Removal

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Photoreaction

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Precipitation/Photocatalytic Removal

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

When complexed with organic materials, radionuclides are extremely stable and thus difficult to remove from water using conventional techniques. Photocatalysis can break up the organic complex leaving the radionuclide accessible to removal. Thus, some precipitation systems use ultraviolet light as part of the precipitation process to enhance availability of radionuclides for reaction with the reagents.

Process Name
ReDox/UV, O_3

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical photochemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
ReDox/UV, O_3

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

This process is an ultraviolet light/ozone process for the on-site destruction of pesticides, herbicides, and halogenated hydrocarbons in wastewater. Total organic carbon was reduced from 42 ppm to 4 ppm. TCE was reduced from 69 ppb to below the detection limit.. BTX and ethylbenzene were treated with 99% removal efficiency.

Process Name
ReDox/UV, H_2O_2

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — photochemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
ReDox/UV, H_2O_2

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

This process has demonstrated the treatment of solvent-contaminated groundwater with hydrogen peroxide and ultraviolet light. Specific contaminants include TCE, PCE, DCE, DCA, and chloroform.

Process Name
ReDox/UV, H_20_2, O_3

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical photochemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
ReDox/UV, H_20_2, O_3

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

The ultraviolet (UV) radiation and oxidation process uses UV radiation, ozone, and hydrogen peroxide to destroy toxic organic compounds, particularly chlorinated hydrocarbons in water. The process oxidizes compounds that are toxic or refractory (resistant to biological oxidation) in concentrations of parts per million or parts per billion. The system consists of a treatment tank module, an air compressor and ozone generator module, and a hydrogen peroxide feed system.

Contaminated groundwater, industrial wastewater, and leachates containing halogenated solvents, phenol, pentachlorophenol (PCP), pesticides, polychlorinated biphenyls (PCBs), and other organic compounds are suitable for this treatment process. This technology was accepted into the Superfund Innovative Technology Evaluation (SITE) Demonstration Program.

Process Name
Decontamination/Ultrasonic

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Decontamination/Ultrasonic

Description
Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

This technology is designed to treat soils with organic and inorganic contaminants. The technology is a two-stage process. The first stage extracts the contaminants from the soil; the second stage oxidizes contaminants present in the extract. The extraction is carried out using ultrapure water and ultrasound. Oxidation involves the use of ozone and ultraviolet light. The treatment products of this technology are decontaminated soil and inert salts.

After excavation, contaminated soil is passed through a one-inch screen. Soil particles retained on the screen are crushed using a hammermill and returned to the screen. Soil particles passing through the screen are sent to a soil washer, where ultrapure water extracts the contaminants from the soil. Ultrasound is used as a catalyst to enhance the washing process.

Treatment units available for the Superfund Innovative Technology Evaluation (SITE) demonstration can treat one to five cubic yards of solids per hour. This technology can be applied to soils, solids, sludges, leachates, and groundwater containing organics, such as polychlorinated biphenyls (PCBs), pentachlorophenol (PCP), pesticides and herbicides, dioxins, and inorganics, including cyanides. The technology can effectively treat total contaminant concentrations ranging from one part per million (ppm) to 20,000 ppm. Soils and solids greater than one inch in diameter need to be crushed prior to treatment.

Process Name
ReDox/UV Laser

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical photochemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
ReDox/UV Laser

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

This technology is designed to photochemically oxidize organic compounds in wastewater by adding a chemical oxidant and applying ultraviolet (UV) radiation using an Eximer laser. The photochemical reactor can destroy low concentrations of organic in water. The energy is sufficient to fragment the bonds of organic compounds, and the radiation is not absorbed to any significant extent by the water molecules in the solution. The process is envisioned as a final treatment step to reduce organic contamination in groundwater and industrial waste waters to acceptable discharge limits. The overall reaction uses hydrogen peroxide as the oxidant in the reaction. The reaction products are carbon dioxide, water, and the appropriate halogen acid.

The chemical oxidant used is hydrogen peroxide. It is introduced to the solution to provide hydroxyl radicals required for oxidation. The reactor effluent is directed to a vented storage tank, where the carbon dioxide oxidation product is vented. An appropriate base (such as calcium carbonate) may be added to the storage tank to neutralize any halogenated acids formed when treating fluids contaminated with halogenated hydrocarbons. The reaction kinetics depend on: 1) contaminate concentration, 2) peroxide concentration, 3) UV radiation dose, and 4) UV radiation wavelength. This technology can be applied to groundwater and industrial water containing organics. Typical target compounds tested in which greater than 95 percent destruction removal efficiency (DRE) was obtained, include benzene, chlorobenzene, chlorophenol, dichloroethehene, and phenol. The technology was tested under the Superfund Technology Evaluation (SITE) Emerging Technology Program.

Process Name
ReDox/UV, H_2O_2,Catalyst

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical photochemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/P
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/P
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/P
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/P
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/P

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
ReDox/UV, H_2O_2,Catalyst

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

The photolytic oxidation process is designed to destroy organic contaminants dissolved in water through an advanced chemical oxidation process using ultraviolet (UV) radiation, hydrogen peroxide, and a proprietary catalyst. Contaminated water is fed into the system, and hydrogen peroxide and the proprietary catalyst are added. The mixture is then pumped to the treatment system consisting of six reactor tanks, where the actual destruction of the organic contaminants take place. Each reactor tank houses a xenon UV lamp mounted din a quartz sleeve. The water flows in the space between the chamber wall and quartz tube in which each lamp is mounted. The UV lamps serve two purposes. First, the combination of UV light and hydrogen peroxide produces hydroxyl radicals, which are powerful chemical oxidants. Oxidize organic contaminants, producing harmless byproducts. Second, the UV light directly breaks molecular bonds in the contaminants. An advantage of this technology is its ability to shift the UV spectral output to closely match the adsorption characteristics of the contaminants of concern.

This technology treats groundwater contaminated with fuel hydrocarbons at concentrations up to a few thousand milligrams per liter. The technology can be combined with other processes such as air stripping, steam stripping, or biological treatment for optimal results. This technology was accepted into the SITE Demonstration Program in July 1991.

Process Name
Precipitation/UV & $KMNO_4$

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Precipitation/UV & $KMNO_4$

Description
Precipitation is the formation of a new solid phase within some other phases. Usually the precipitate if formed in a liquid solution by dissolving new compound in the solution to provide ions that form an insoluble compound with other ions already present in the solution. For example, adding a soluble sulfate compound a solution containing dissolved barium causes insoluble barium sulfate to precipitate. For this report, this group of processes also includes crystallization processes. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until salts in the solution becomes supersaturated and precipitate.

The purpose of the study was to evaluate, through bench-scale testing, the effectiveness and technical feasibility of several water treatment technologies for remedial action, including oxidation/precipitation technologies. The goal was to find an optimization of technologies capable of treating inorganic compounds, such as iron, arsenic, metals, etc., found in groundwater. The results of the chemical oxidation/precipitation study indicate that potassium permanganate (KMn04) oxidation followed by flocculation with an anionic polymer provided the best treatment for iron and arsenic removal.

Process Name
ReDox/O_3 and H_2O_2

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
ReDox/O_3 and H_2O_2

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

This work investigated the detoxification of pentachlorophenol and creosote by chemical oxidation using ozone and/or hydrogen peroxide as oxidizing agents.
Experiments were conducted in a batch, stirred-tank reactor to determine the feasibility of the oxidation process. In aqueous solutions containing dissolved ozone, the rates of depletion of ozone were nearly identical in the reactor with or without suspended sands. However, the rate of depletion of ozone was much faster because of additional ozonation reaction when reactors contained soils contaminated with PCP. The experimental results show that contaminated soils are amenable to treatment by this oxidation process.

Other oxidizers being investigated by other workers include hydrogen peroxide, hypochlorites, chorine, and chlorine oxidizers can be enhanced when they are used in combination with ultraviolet light.

Process Name
Evaporation/Positive Pressure System

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Evaporation/Positive Pressure System

Description
Evaporation is the conversion of water, or some other liquid, to the gaseous state by the application of heat. This method is typically applied to reduce the volume of liquid waste streams.

This process is an apparatus for pollution abatement in the treatment of liquids containing dissolved salts, metals, organics and particulates by means of positive pressure atmospheric evaporation and photo-oxidation. The apparatus combines technologies for treatment of hazardous and non-hazardous liquid wastes. The process operates in batch mode, using a steel drum sump and the treatment apparatus. This apparatus consists of heat belts to warm the sump, a blower, and a ultraviolet lamp. Heat to 150 degrees F is used to evaporate the liquid waste. The blower increases the rate of evaporation, exhausts the vapors to the exterior, and supplies air for ozone generation. An additional air pump can be used to supply air to the bottom of the sump to agitate the liquid waste. There are no condensing coils or liquids condensed. The evaporator can handle pH neutral aqueous solutions, as well as solvents in up to 0.1 percent concentration in aqueous solutions. Ozone and UV light catalyze oxidation of the vapors as they are generated.

This process is patented, Patent #4,834,836.

Process Name
Radiolysis/Gamma-Ray Destruction of PCBs

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Radiolytic/Gamma Radiation

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Radiolysis/Gamma-Ray Destruction of PCBs

Description
Radiolysis processes use ionizing radiation to dissociate molecules. X-rays, gamma rays, and electrons are the types of ionizing radiation most commonly used. Alpha particles, fission fragments, and other forms of ionizing radiation also produce radiolysis.

Previous work has indicated that some chloro-organic compounds in alkaline isopropanol solutions are dechlorinated when exposed to high energy radiation. This process intends to study the application of the process to polychlorinated biphenyls (PCBs). Capacitors and transformers from which PCBs have been drained still contain some residual PCBs. In this process, organic solvent is circulated through the drained capacitors and transformers to flush out the PCBs. The solvent is then exposed to a high intensity gamma ray field which causes radiolysis of the PCBs. Typically, the radiation causes the chlorine to break off of the compound leaving a biphenyl. The chlorine in the solvent reacts with potassium ions in the solvent to form potassium chloride which can be extracted. The solvent is recirculated through the equipment until the PCB level is reduced to an acceptable level.

Process Name
Separation/Electrodeposition

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Separation/Electrodeposition

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

Electrodeposition is a process where a thin layer or coating of metal is deposited on an electrode by passing an electric current through an aqueous solution of salt containing ions of the element being deposited. Oxidation-reduction reactions occur at the electrodes and are driven by direct current voltage. Often, the metal plating can be stripped off the electrode mechanically and bumed or oxidized before storage in concrete.

Electrodeposition has been known historically as a technique that can be used to remove metal ions from electroplating solutions. However, commercial processes have been unable to remove heavy metals from waste electroplating solutions.

Some heavy metals require special process and cell design, particularly if the allowable discharge limits are low.

To reduce the heavy metal concentrations to very low values (about 0.2 ppm) a porous cathode must be used which results in a deposit which cannot be mechanically stripped. This in turn leads to higher storage volumes. However one can use a 2-stage process and only use the porous electrode for final cleanup. This effort involves completion of a pilot plant to remove heavy metals from waste solutions. Electrode materials and electrolytes can be chosen for each heavy metal to be plated.

Process Name
Precipitation/Alternating Current Electrocoagulation

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Precipitation/Alternating Current Electrocoagulation

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

The alternating current electrocoagulation (ACE) technology offers an alternative to chemical precipitation for stable emulsions and suspensions. Electrocoagulation introduces highly charged polyhydroxide aluminum species into aqueous media. The charged particles prompt the flocculation of colloidal particles and destabilization of oil-in-water emulsions.

Liquid/liquid and solid/liquid phase separations are achieved with production of sludges that can be filtered and dewatered more readily than those formed through chemical flocculent addition. The technology can be used to break stable aqueous suspensions containing submicron-sized particles of up to ten percent total solids and stable aqueous emulsions containing up to five percent oil. Coagulation and flocculation occur simultaneously within the separator. Charge neutralization and the onset of coagulation occur within the separator as a result of exposure of the effluent to the electric field and dissolution of aluminum from the electrodes.

This technology can be employed in conjunction with conventional water treatment systems, including those relying on metal precipitation, membrane separation technologies, mobile dewatering and incineration units, and soil extraction systems. A typical decontamination application, for example, would produce a water phase that could be discharged directly to a stream or local wastewater treatment plant for further treatment. The solid phase, after dewatering, would be shipped off-site for disposal, and the dewatering filtrate would be recycled. Any floatable material would be reclaimed, refined, otherwise recycled or disposed of. This technology was accepted into the Superfund Innovative Technology Evaluation Program in July 1988.

Process Name
Precipitation/Electrochemical Coprecipitation

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Precipitation/Electrochemical Coprecipitation

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

Electrochemical coprecipation is a process where direct current is conducted through a cell containing carbon steel electrodes, generating ferrous ions. The ferrous ion moves into solution and forms ferric hydroxide precipitates with metals such as chromium, copper, nickel, zinc, tin, and vanadium. The presence of chelating agents in the wastewater does not prevent proper removal of the metals because the chelates are broken down by the iron.

Electrochemcial coprecipitation offers distinct advantages over chemical precipitation, especially for electroplating and printed circuit board waste solutions. Traditionally, chemical precipitation has been used to remove heavy metals from the wastewater. However, when several metals must be treated, it is difficult to meet EPA regulations because each metal has a different point of minimum solubility on the pH scale. Electrochemical removal of heavy metals overcomes pH problems encountered in chemical precipitation methods.

Process Name
Precipitation/Microbial Coprecipitation

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Magnetic Separation

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Biopraxis, Information Submittal, (619)452-2413

Process Name
Precipitation/Microbial Coprecipitation

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

Microbial Metal Precipitation with Magnetic Separation couples microbial formation of an extracellular metal precipitate with high gradient magnetic separation (HGMS). There are three simple steps in Microbial Metal Precipitation with Magnetic Separation. First, inexpensive additives enhance microbial uptake of heavy metals. Second, the metal-encrusted microbes are removed rapidly and economically by HGMS. Third, the recovered magnetic fraction is processed. If the metal contamination is severe enough that significant quantities of metals are recovered, the recovered rich metal "ore" can be subjected to conventional pyrometallurgical or hydrometallurgical processing and recycled, thereby transforming pollutants into precious resources. If not, the stable, highly insoluble magnetic fraction can be solidified and disposed.

Since Microbial Metal Precipitation with Magnetic Separation utilizes microbial metal coprecipitation processes, it can be used to treat low or high concentrations, of a wide variety of metals and radionuclides, reducing even low initial concentrations by an additional three or more orders of magnitude. Precipitation with magnetic separation utilizes very little power, making it both practical and economical.

Process Name
Adsorption/Impregnated Polymers

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☒ Polymer	☐ Vitrified	

References
DOE/EM-0126P; p.23.

Process Name
Adsorption/Impregnated Polymers

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

Recent research on adsorption has focused on the use of impregnated polymers as the adsorption resin (instead of granular activated carbon). The polymer is the substrate and chemical ligands are bound to the polymer structure. The ligands used are chosen based on their ability to selectively bind with the contaminant of interest. Research involves testing and selection of ligands with the required selectivity and binding constant, incorporation of the chosen ligands into polymeric structures, evaluation of the separation properties (capacity, recycle and long-term stability) of the supported ligands, and a complete engineering assessment of the polymer systems in combination with complementary and completing technologies.

Process Name
Precipitation/Actinide Complexation

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P

Process Name
Precipitation/Actinide Complexation

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

This technology uses chemical complexation as a first step in a precipitation process. The process is intended for solutions containing both actinides and lanthanides. The solution is first complexed using carbonate which forms complexes with actinide elements. The complexed actinides will remain in solution during the precipitation step. A second reagent is then added to the solution to precipitate the lanthanide elements. A commercially available pyrazoylborate reagent has been tested and found to have potential for precipitation of the lanthanide elements.

Process Name
Liquid-Liquid Extraction/SREX

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P

Process Name
Liquid-Liquid Extraction/SREX

Description
In liquid-liquid extraction, also called solvent extraction, one or more species in one liquid phase transfer to a second, immiscible, liquid phase for which the species have a greater affinity. The two liquids must be brought into contact with each other for the extraction to take place. This can be done by simply mixing the two liquids, for example, in a separatory funnel, or in a more elaborate apparatus such as those using counter current flow.

The SREX (strontium extraction) process is a liquid-liquid extraction process designed to selectively remove strontium from radioactive waste solutions. The process can be used in conjunction with TRUEX (transuranic extraction), PUREX (plutonium extraction) and NEPEX (neptunium/plutonium extraction) processes. The main objective of these processes is to minimize the amount of waste that must be vitrified by reducing the level of alpha activity and reducing the concentrations of Sr-90, Cs-137, and Tc-99 in dissolved sludge wastes.

Process Name
Separation/TALSPEAK Process

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P

Process Name
Separation/TALSPEAK Process

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

The TALSPEAK technology is a process that can be used to separate actinides from lanthanides. It is an advanced, low-waste generation chemical process which coextracts the two groups of elements into di-2-ethylhexylphosphoric acid (HDEHP) from a carboxylic acid solution and then partitions the actinides into an aqueous phase by stripping HDEHP into a carboxylic solution containing diethylenetriamine pentaacetic acid (DTPA).

Bench scale experiments have been conducted to determine the influence of zirconium and molybdenum on this process. Possible process improvements to the TALSPEAK process, such as alternative acid systems and operation at higher temperatures, have been pointed out.

Process Name
Complexation/Plutonium Removal

Process Objective

- ☐ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P

Process Name
Complexation/Plutonium Removal

Description
Complexing and chelating agents are used to stabilize, concentrate, or collect specific constituents, usually from a liquid waste. Complexing agents are those which bond to atoms or molecules in the waste by formation of coordinate bonds. Chelating agents are a class of organic compounds which form more than one coordinate bond with metal ions in solution. These agents are important because complexing or chelating agents can be selected based on their ability to bond to only specific species of interest in a solution. Thus they can be used to pull one, or a small group, of hazardous or radioactive ions from a solution containing other non-hazardous and non-radioactive ions.

The objective of this proposed technology is to develop a separation system using a highly selective complexing agent derived from a natural material to remove plutonium (and perhaps other TRUs) from ionic strength waste waters which vary in pH. Desferriozamine shows promise for this purpose.

Process Name
Ion Exchange/Reillex -HPQ

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P

Process Name
Ion Exchange/Reillex -HPQ

Description
Ion exchange is the removal of ionic species from waste (usually an aqueous solution) by using the reversible interchange of ions of like-charge between an insoluble solid ion exchange medium and the solution. The ions in solution attach to the solid and are replaced, equivalent for equivalent, by other ions released from the solid. By proper selection of the ion exchanger and ion exchange conditions (e.g., pH) specific ions or groups of ions may be selectively removed from the solution. Ion exchange media are typically organic ion exchange regions, inorganic solids (such as crystalline silico-titanates), or zeolites.

Reillex(TM)-HPQ resin has been shown to have superior stability toward radiation and nitric acid than other resins and is being tested as a possible replacement for baseline Dowex resin. Reillex(TM)-HPQ is a new anion-exchange resin containing pyridinium functional groups. The resin is used in the form of a bed through which the solution is passed.

The resin has been applied for the removal of Tc-99 from Hanford tank wastes.

Process Name
Leaching/TRU Containing Sludge

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P

Process Name
Leaching/TRU Containing Sludge

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The aim of the washing is to minimize the amount of TRU containing sludge through dissolution of the inert components. The sludge residue will then be subjected to a series of leachings in which it is possible that the TRUs can be removed leaving a non-TRU residue.

This program provides a broad evaluation of processing of sludge and supernate and direct support to the comprehensive sludge/supernate processing developments for both MVST and Hanford tank waste. A letter report on the initial thermodynamic evaluation of MVST sludge washing has been issued. These experimental studies are being conducted by PNL staff.

Process Name
Adsorption/Cobalt Dicarbollide Impregnated Polymers

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P; pg. 3

Process Name
Adsorption/Cobalt Dicarbollide Impregnated Polymers

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

This technology uses a synthetic solid-based sequestrant composed of carbon dicarbollide incorporated into a polymer base to remove contaminants from waste waters. Cobalt dicarbollide is a nearly ideal hydrophobic anion for the extraction cationic species from aqueous solutions into an organic solutions. When fused to a polymer-base, cobalt dicarbollide acts as an adsorption agent. The literature indicates that, under the appropriate conditions, cesium and strontium can be extracted with very high selectivity and yield. In addition, cobalt dicarbollide is believed to possess superior radiation stability.

This technology builds on a considerable body of experimental and developmental work performed at the Nuclear Research Institute in Rez, the Czech Republic.

Process Name
Separation/Magnetically Assisted

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Magnetically Assisted

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P

Process Name
Separation/Magnetically Assisted

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

The magnetically assisted chemical separation process combines the selective and efficient separation afforded by chemical sorption with the magnetic recovery of ferromagnetic beads. It uses magnetic beads coated with either a selective ion-exchange material, an organic complexant containing a solvent for contaminant removal, or solvents for the selective separation of radionuclides. The beads are formed from a magnetic material coated with organic polymer or bonded ion-exchange resin. The coatings extract the contaminants and the beads are then magnetically removed.

Process Name
Adsorption/Synthesized Ligands

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126 P; pg.13

Process Name
Adsorption/Synthesized Ligands

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

This technology involves the use of high capacity, highly selective, solid sequestrants for the removal of specific contaminants from nuclear waste streams. Synthesized chemical ligands are chemically anchored to particles which can be incorporated into the 3M Company's Empower(TM) membrane. The size, shape and chemical nature of the ligands can be designed to reject all but the targeted materials. Four ligands have been successfully synthesized, attached to particles and incorporated into the Empower(TM) membrane. The membranes have then undergone testing of their ability to remove cesium and strontium under a variety of harsh conditions. These tests, in non-radio-active environments, show that the membrane can isolate these contaminants even when the latter are present at concentrations as low as a few parts per billion. Even at flow rates far higher than normal, the degree of decontamination achievable appears to far exceed that of conventional alternatives, such as ion exchange zeolites.

Process Name
Leaching/Cobalt Dicarbollide Extraction

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0126P; pg 17

Process Name
Leaching/Cobalt Dicarbollide Extraction

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

A project seeks to evaluate, test, and develop the use of cobalt dicarbollide for the extraction of cesium from alkaline supernatant solutions and salt cake at the Savannah River facility. Elements of the work include acquisition of cobalt dicarbollide, radioactive and non-radioactive testing of its physical properties and testing of its effects on borosilicate glass, reproducible demonstration of the decontamination factors for cesium removal from radioactive and non-radioactive wastes, examination of the factors controlling the achievable decontamination factor, demonstration of direct feed of the cesium cobalt dicarbollide salt to borosilicate glass, evaluation of the glass properties, evaluation of the long-term stability of the cobalt dicarbollide anion, and finally, demonstration of the cobalt dicarbollide anion recycle to minimize the required quantities of the reagent.

Process Name
Biodegradation/Vacuum Extraction System

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Biodegradation/Vacuum Extraction System

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

The bioremediation/vacuum extraction process decontaminates soils that have been contaminated with fuels by removing the contaminated soil and stockpiling it for treatment. This technology can be applied to soils contaminated with diesel, JP5, or other fuels. In order to decontaminate the stockpiled soil, it is processed through a screen to eliminate rocks greater than four inches in diameter. The screened soil is transported to a site that is protected by a 40-millimeter liner with eight inches of sand base. Three feet of contaminated soil is spread along the base of the prepared pile and then a series of vacuum extraction pipes are trenched in the soil and connected to the Vacuum Extraction System (VES) blower. The VES blower provides movement of oxygen through the pile. The remaining soil is piled into a trapezoid shape about 15 feet high, 200 feet long, and 60 feet wide. Fertilizer is added, and an irrigation system is installed. Computer-controlled sensors are placed within the pile to monitor temperature, pressure, and soil moisture.

The field pilot test conducted in Bridgeport, California, showed two results: After approximately two months of operation, the average concentration of total petroleum hydrocarbons (TPH) is 120 ppm; and the Navy declared the tested site was "clean" in a report prepared for the California Regional Water Quality Control Board. Remediation costs are estimated at approximately $80 per ton of soil at the Bridgeport, California, pilot project.

Process Name
Decontamination/Mechanical Vibration

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Decontamination/Mechanical Vibration

Description
Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

The Harbauer soil washing system uses a vibration unit to decontaminate soil. The soil is separated by particle size, mixed with an extractant, then passed through a mechanical vibration unit. Here the soil is subjected to oscillations from a mechanical vibration unit to dislodge contaminated fines from the soil matrix. The extractant with the freed contaminants are separated from the cleaned soil. Contaminant particles are separated from the extractant by a flocculation process.

Process Name
Leaching/CREP Soil Washer

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Leaching/CREP Soil Washer

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The oil cleaning recycling environmental protection (CREP) soil washer system is a proprietary combination of surfactants, solvents, and aromatic hydrocarbons which cleans and extracts oil from various media. Oil-contaminated sand/gravel that are larger than 50 mm are fed into the system via a hopper. The CREP solution is injected into the sand as it is mixed in a screw mixer. Sand travels to a rotating separation drum where the oil floats off and spills in a collection tank. Clean sand is reused and the contents of the oil collection tank (including the CREP solution) are transferred to a holding tank until it can be removed for refining or disposal.

Process Name
Filtration/Belt Press

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Filtration/Belt Press

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

This soil cleaning method is based on techniques of soil washing and particle sizing. Large pieces of rubble are crushed and separated out by wet sieving. Soil particles are then washed of adsorbed contaminants by scrubbing with detergents and adjusting pH with sodium hydroxide. A hydrosizer removes low density organic and carbon particles (wood or rubber). The fines are separated by hydrocyclones and dewatered in a belt press, where the contaminants are concentrated. Scrub water, overflow from the sieve, hydrocyclones, and the belt press are cleaned in the water treatment system. Treatment is by flocculation/precipitation/neutralization to remove contaminants.

Process Name
Leaching/Dutch Association of Soil Treatment Companies

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Dutch Association of Soil Treatment Companies

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The first separation removes the coarse fragments. The middle fraction is sieved out by use of water (wet-sieving). The separated materials are collected in a container and are analyzed to make sure that the remaining contaminants match the accepted levels. After the pretreatment, the main soil stream is intensively mixed with the process liquid, which can be done with mechanical equipment. This mixing process disconnects the pollutants from the grains of soil and transfers them into the water-phase. The next step consists of separation of cleaned soil-fractions from the polluted process-liquid. The remaining fraction (so called fines), is removed by a lamella-separator or by use of hydrocyclones. If necessary, flocculants or coagulants are added to the separation process. After sedimentation, the fines will be dewatered. The contaminated process liquids and all water used in the treatment processes are cleaned in a water purification system. After the residual fines have been removed by sedimentation, the water is treated by means of precipitation, neutralization, coagulation, and flocculation in order to remove the dissolved contaminants. In the last step of water treatment, the flocs are floating on the surface and are removed. Dissolved organics can be removed by activated carbon, and the cleaned water can then be drained off or reused again as process water.

This is a physical/chemical soil treatment process developed by the Dutch Association of Soil Treatment Companies.

Process Name
Leaching/Water-Based Soil Washing

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Water-Based Soil Washing

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

This is a water-based, volume reduction process for treating excavated soil. Soil washing may be applied to contaminants concentrated in the fine-fraction of soil (silt, clay, and soil organic matter) and the surface contamination associated with the coarse (sand and gravel) soil fraction. The goal is for the soil product to meet appropriate cleanup standards. After debris is removed, soil is mixed with water and subjected to various unit operations common to the mineral processing industry. Process steps can include mixing trommels, pug mills, vibrating screens, froth flotation cells, attrition scrubbing machines, hydrocyclones, screw classifiers, and various dewatering operations. The core of the process is a multistage, counter-current, intensive scrubbing circuit with interstage classification. The scrubbing action disintegrates soil aggregates, freeing contaminated fine particles from the coarser sand and gravel. In addition, surface contamination is removed from the coarse fraction by the abrasive scouring action of the particles themselves. Contaminants may also be solubilized, as dictated by solubility characteristics or partition coefficients. The contaminated residual products can be treated by other methods. Process water is normally recycled after biological or physical treatment. Options for the contaminated fines include off-site disposal, incineration, stabilization, and biological treatment. This technology was initially developed to clean soils contaminated with wood preserving wastes such as polycyclic aromatic hydrocarbons (PAHs) and pentachlorophenol (PCP). The technology may also be applied to oils contaminated with petroleum hydrocarbons, pesticides, polychlorinated biphenyls (PCBs), various industrial chemicals, and metals.

Process Name
ReDox/Catalytic Ozone

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
ReDox/Catalytic Ozone

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

The technology is designed to treat soils with organic and inorganic contaminants. The technology is a two-stage process: the first stage extracts the contaminants from the soils, and the seconds stage oxidizes contaminants present in the extract. The extraction is carried out using ultrapure water and ultrasound. Oxidation involves the use of ozone and ultraviolet light. Ultraviolet light and ultrasound catalyze the oxidation of contaminants by ozone. System capacities range from one cubic foot of solids per hour (water flow rate of one gallon per minute) to 27 cubic yards of solids per hour (water flow rate of 50 gallons per minute). The Excalibur technology was accepted into the SITE Demonstration Program in July 1989.

Process Name
Leaching/Heavy Organics, PCB's, Dioxins

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Heavy Organics, PCB's, Dioxins

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Solvent washing is a method of cleaning soils contaminated with heavy organic compounds such as polychlorinated biphenyls (PCBs) and dioxin. The soil washing method is based on a patented solvent blend that has successfully reduced PCB concentrations in soil to less that 2 parts per million (ppm), the level at which soil can be placed at the site without containment. The solvent used should be immiscible with water and must be able to break up solid clods without grinding or shredding. The solvent for each wash is delivered to a reclamation system, where it is distilled. The contaminant is concentrated as a still bottom. The still bottom, a small volume of the original soil, and a liquid residue can be further treated on- or off-site depending on economic and other considerations. Once the desired level of decontamination is achieved, the residual solvent is removed from the soil by steam stripping. Process equipment is mobile, operates at low temperatures, is totally enclosed , and generates very few residual wastes.

Process Name
Biodegradation/Sewage Sludge Inocula

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Biodegradation/Sewage Sludge Inocula

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

Soils contaminated with polycyclic aromatic hydrocarbons (PAH) can be inoculated with sewage sludge. The microbes in the inocula degrade the PAHs. Solvent extraction with ethanol and naptha will remove the carcinogenic PAHs from the sand fraction of the soil to .8 ppm.

Process Name
Leaching/Soil Washing-Heap Leach Technology

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Soil Washing-Heap Leach Technology

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Recent efforts at soil washing have encountered difficulties largely associated with liquid/solid separation. Heap leach technology involves the placing of contaminated soil, sludge, or solid waste on a drainage blanket over an impervious pad and percolating appropriate leach solutions through the waste, under unsaturated flow conditions. Fine-grained waste may require agglomeration. Drainage from the toe of the pad is piped to a recovery/regeneration unit where the metals of concern are recovered and the leach solution regenerated. Leaching is continued until the solid material is sufficiently cleaned.

Process Name
Leaching/Extraction of Organics from Soil

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Extraction of Organics from Soil

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The soil washing process utilizes mining and enhanced oil recovery techniques economically and efficiently to achieve immediate separation of hydrocarbons and solvents from the soil. The physical-chemical process involves the dissolution of certain contaminants into the extraction liquid and the dispersion of other contaminants into the liquid as undissolved compounds. Complete separation of highly-contaminated colloidal suspensions can be consistently achieved.

Process Name
Leaching/Superwetter II Nonionic Surfactant

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Superwetter II Nonionic Surfactant

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

A continuous mechanical/chemical process that removes and separates organics and inorganic compounds from individual soil particulates. The chemical part of the system is a non-ionic surfactant that is significant in its use in the mechanical system. The surfactant aids in preferentially displacing hydrocarbons, metals, and other organic and inorganic substances from the soil particles. The contaminated soil is introduced to a surfactant bath in a clarifier. The material is slurrified and processed through a shearing device and a vibratory screen. The screen has a spray system to clean large rocks and debris. The screened material gravities into another clarifier. The secondary clarifier is equipped with jet mixers that provide scrubbing action and suspension. The slurry is further processed through a second shearing device and a series of hydrocyclones. The hydrocyclones separate the liquid phase from the solids. The cleaned liquid leaves the hydrocyclones through the overflow and the concentrated solids with a small amount of the liquid leave the hydrocyclones through the underflow. The concentrated solids that report to the hydrocyclone underflow are processed through a decanting centrifuge. Both the clean overflow from the hydrocyclones and the effluent from the centrifuge are polished through a filter. An advantage to this staging system is the ability to add other components to the closed loop for treatment. Custom ion exchange/absorbent resins can be used in the polishing filter to retain specific contaminants in the cake of the polishing filter.

Process Name
Leaching/Solvent Extraction of Dredged Sludges (SEDS)

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Solvent Extraction of Dredged Sludges (SEDS)

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Solvent Extraction for Dredged Sludges (SEDS) is an innovative and cost effective process to treat dredged sludges containing volatile/semi-volatile organics, oils, grease, and coal tar compounds. The key components of this process are a special solvent system, and a multi-stage counter current-extractor. The special solvent system is a mixture of polar and non-polar components which help in breaking the emulsion of oil, water, and inorganic constituents. The process can extract organics from a concentration as high as 40% by weight., and discharge a relatively non-hazardous stream of inorganics with less than 0.1% organics. The water stream (in case of wet sludges) containing organics dissolved in the lower parts per million range can be biotreated in a bioreactor.

Process Name
Separation/Particle Sizing

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Separation/Particle Sizing

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

Particle sizing is a physical separation technology that uses the difference in particle sizes to selectively concentrate contaminants. The concept of reducing soil contamination through the use of particle separation is based on the finding that most organic and inorganic contaminants tend to bind either chemically or physically to clay and silt particles (smaller particles). Washing processes that separate the fine clay and silt particles from the coarser sand and gravel soil particles effectively separate and concentrate the contaminants into a smaller volume of soil that can be further treated or disposed.

Heijmans has developed a semi-transportable soil washer. It currently handles 11 tons/hour of soil. The washer consists of several particle sizing steps. First, soil is wet seived, removing coarse material. The slurry is extensively mixed in the scrubber with extracting agents and oxidizing chemicals. A flotation unit is used to separate out organic contaminants. The scrubber water and the contaminated fines are passed through a tiltable plate separator and the water is treated by flocculation/precipitation.

Process Name
Leaching/CO2-Water Extraction

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/CO2-Water Extraction

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

The removal of heteroatoms, nitrogen, sulfur, and metals containing compounds from oils and oil-contaminated soils is both economically and environmentally desirable. This technology is based on a CO2-water extraction process which requires neither heat or extreme pressures and will remove the heteroatom containing oil products with no physical modification or destruction of the oil such as would occur with present removal techniques. This process involves treating oil and oily-containing material with water under CO2 pressure. The heteroatoms are preferentially solubilized and are extracted into the agitated CO2-water phase. This heteroatom extraction technology can treat multiple wastes including crude oils, oil fraction, heavy oils, shale oils, and coal liquids which are present in soil, waste streams, etc. The process requires only CO2 and water at low temperatures and pressures.

Process Name
Biodegradation/Metal Free Environments

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Biodegradation/Metal Free Environments

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous, or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

This is a two step process. Metals must first be removed from the waste stream so they do not poison the microbes which will degrade the organics. This extraction process removes a variety of metals. They are recovered in a concentrated, dissolved form for isolation/reuse. The extraction agent is non-toxic, commercially available and re-usable. The leaching solution can serve as important nutrients in the slurry bioreactor.

Process Name
Leaching/Soil Washing for Dioxins

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Leaching/Soil Washing for Dioxins

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Several washing solutions were tested to decontaminate soils contaminated with dioxins. One kilogram of soil was spiked with a solution of dioxin/TCDD and isooctane. The extraction efficiency was measured by Soxhlet extraction of the soil residue after it had undergone three simple batch extractions with a specific solvent system. The study summarizes the data for each of the soil washing solutions. Results indicated that freon and freon/methanol extraction systems were most effective for removal of dioxin/TCDD from soil.

Process Name
Adsorption/Algae Cell Walls

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Adsorption/Algae Cell Walls

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

The Algae Cell-Wall technology is designed to remove heavy metals from aqueous solution. The process is based upon the natural affinity of algae cell walls for heavy metal ions. Pilot-scale testing showed effective mercury recovery from contaminated groundwaters. These studies showed that not only did mercury concentration vary over the sampling period, but also the data suggest that the chemical species of mercury varied over the sampling period as well.

Process Name
Filtration/Vapor - Separation Membrane

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical Vapor-Separation Membrane
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Filtration/Vapor - Separation Membrane

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

Cross-flow pervaporation system is a process for removing volatile organic compounds (VOCs) from contaminated water. The performance of the cross-flow pervaporation system increases with temperature, with an equipment limitation of 35 degrees C. Permeable membranes that preferentially adsorb VOCs are used to partition VOCs from the contaminated water. The VOCs diffuse from the membrane and water interface through the membrane and are drawn off by a vacuum pump. Upstream of the vacuum pump, a condenser traps and contains the permeating vapors, condensing all the vapor, therefore, allowing no discharge to the atmosphere. The condensed organic vapors represent only a fraction of the initial wastewater volume, and may be sent for disposal at significant cost savings. Industrial waste streams may also be treated with this process, and solvents may be recovered for reuse.

A modular three liters per minute separation unit in which wastewater flows across the outside of a hollow fiber membrane has been tested at the Wastewater Technology Centre. In this configuration, the vacuum pump is applied to the inside of the fiber. This design provides very high packing densities and low pressure losses on both the feed and permeate sides. Pervaporation can be applied to aqueous waste streams (groundwater, lagoons, leachate, and rinse waters) contaminated with VOCs, such as solvents, degreasers, and gasoline. The technology is applicable to the types of wastes currently treated by carbon adsorption, air stripping, and reverse osmosis separation. This technology was accepted into the Superfund Innovative Technology Evaluation (SITE) Emerging Technology Program in January 1989.

Process Name
Precipitation/Iron Coprecipitation

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Precipitation/Iron Coprecipitation

Description
Precipitation is the formation of a new solid phase within some other phase. Usually the precipitate is formed in a liquid solution by dissolving new compounds in the solution to provide ions that form an insoluble compound with other ions already present in the solution. Crystallization processes produce a new solid phase in a liquid by either removing solvent until salts in the solution become supersaturated and precipitate, or by lowering the temperature of the solution until the salts in the solution become supersaturated and precipitate. The precipitates can be separated from the remaining liquid by filtration, settling, centrifugation, or other means.

The iron coprecipation process consists of a feed tank, filtrate tank, a pump, and a cross flow filter. Iron added to the waste is precipitated under elevated pH. The process does not remove nitrate. Iron coprecipation/filtration is used to remove metals (especially radionuclides) from surface run-off wastes generated by remedial actions at uranium mill tailing sites and uranium from nitrate-containing wastes at the DOE Oak Ridge facility.

Process Name
Acid Digestion/Phosphoric Acid

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-26 p.2-40

Process Name
Acid Digestion/Phosphoric Acid

Description
Acid is used to break down the structure of solids in waste by dissolving some phases or by breaking all or some of the solids down to simpler forms. Heat may be used to speed up the action of the acid. If the hazardous component of the waste is either freed to go completely into the liquid acid phase, or stays completely in the remaining solid phase, separation of the liquid from the solid after digestion will result in the hazardous material being concentrated in what is probably a smaller volume than the volume of the original waste. Hazardous materials concentrated in the liquid phase may be further concentrated by other methods such as precipitation.

This process is being developed at Savannah River, with design principles very similar to the sulfuric/nitric acid-digestion process that was developed at Hanford in the 1970s and 1980s. Nitric acid is used as the oxidant, and is regenerated by air in an acid recovery system. The Savannah River team has replaced the sulfuric acid of the Hanford system with a concentrated phosphoric-acid medium, which acts as a dehydrating agent and allows nitric acid to be retained in solution at atmospheric pressure and temperatures up to 190 degrees C--well above its normal boiling point of 121 degrees C. Many organics will not decompose below 150 degrees C, and preliminary results indicate that a 30 degree C increase in temperature increases reaction rates by an order of magnitude. Thus, the temperature at which nitric acid remains a liquid is raised to ensure complete oxidation of organic intermediates which do not decompose below 150 degrees C. Also, the phosphoric acid aids in the decontamination of the noncombustible materials in the waste since many actinide oxides are soluble in concentrated phosphoric acid at temperatures near 200 degrees C.

Process Name
ReDox/Ultrasonic Destruction

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other High Frequency Sound

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-26 p. 2-65

Process Name
ReDox/Ultrasonic Destruction

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

This process uses ultrasonic energy (high-frequency sound) waves to produce an alternating adiabatic compression and rarefaction of the liquid media being irradiated. During the expansion cycle, a sound wave of sufficient intensity can generate cavities, which grow gradually with each cycle. Upon reaching a critical size, the final compression part of the wave violently collapses the cavities, creating extremely high-local temperatures of up to 5000 degrees C and high-local pressures up to 500 bars. In this environment, water is decomposed into extremely reactive hydroxyl radicals and hydrogen atoms which propagate outward into the surrounding fluid to react with organic material. During the subsequent cooling phase, these can recombine to form hydrogen peroxide and molecular hydrogen. Organic vapors within the collapsing bubbles are destroyed by direct pyrolysis. Inorganic compounds can be either oxidized or reduced.

Process Name
Radiolysis/X-Ray and Gamma-Ray

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Ionizing Radiation

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-26 pg. 2-119, LANL Database

Process Name
Radiolysis/X-Ray and Gamma-Ray

Description
Radiolysis processes use ionizing radiation to dissociate molecules. X-rays, gamma rays, and electrons are the types of ionizing radiation most commonly used. Alpha particles, fission fragments, and other forms of ionizing radiation also produce radiolysis.

When organic-contaminated soil or water is bombarded with energetic x-rays or gamma rays, secondary electrons and ions are produced in the contaminated material. The ionization leads to broken bonds in complex molecules and the formation of radicals that react with the contaminants to form water, carbon dioxide, oxygen, and simpler organic compounds. While some of the by-products initially formed may be hazardous, the complete conversion of contaminants and by-products is claimed to be achieved at sufficiently high radiation dose levels and residence times without undesirable waste residuals or air pollution.

Process Name
Biodegradation/Microbes for Dechlorination

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE MWIP-26; pgs. 4-12, 4-13, 4-14

Process Name
Biodegradation/Microbes for Dechlorination

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous, or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

Most of the environmental contamination by PCBs is in the form of complex commercial mixtures containing >60 different congeners with varying degrees of chlorination. Such chlorinated organic materials frequently resist microbial degradation, and biodegradation of this large number of distinct substrates requires broad enzymatic specificity. However, two distinct classes of bacteria have been identified that biodegrade PCBs by different mechanisms. These include aerobic oxidative biodegradation and microbial reductive dechlorination of PCBs under anaerobic conditions. Naturally occurring aerobic bacterial biodegradation of PCBs is quite common in the environment and has been well studied. The aerobes break open the carbon ring of lightly chlorinated PCBs and destroy the compounds. In general, most PCB degrading aerobic bacteria are able to degrade only the lower chlorinated PCB congeners. But several aerobic bacterial strains have demonstrated the exceptional ability to degrade an even larger range of congeners, up to and including penta-, hexa-, and even several heptachlorobiphenyls. These are relatively low-temperature technologies that produce less- or non-toxic organic byproducts.

Process Name
ReDox/Silent Discharge Plasma

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-26; pgs.6-20, 6-21

Process Name
ReDox/Silent Discharge Plasma

Description
Oxidation/reduction processes are those where the oxidation state of waste species are increased (oxidized, electrons lost) or decreased (reduced, electrons gained). Oxidation or reduction occurs in many other processes which are considered in other technology groups in this report. For example, incineration processes and deactivation processes for reactive metals both involve oxidation.

Silent Discharge Plasma (SDP) is based on the industrial technology used to generate large quantities of ozone. The system uses two electrodes. Typically one or both are covered with a dielectric layer (e.g. glass) which separates the electrode (s) from the gas. When an alternating high voltage is applied to the electrodes, a large number of microdischarges are created in the gas. The microdischarges are statistically spread in space and time over the electrode area and create substantial quantities of plasma.

This technology is applicable to destruction of vapor-phase organics.
Destruction products include CO_2, H_2O, and HC1 and low levels of carbonyl halides when chlorinated hydrocarbons are involved. Most organic destruction products are of very low concentration (<1ppm).

Process Name
Plasma Process/High Energy Corona

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☒ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-26; pgs. 6-24, 6-25

Process Name
Plasma Process/High Energy Corona

Description
A plasma is a completely ionized gas with nearly equal numbers of free positive and negative charges. Plasmas are generally generated by electric arcs or discharges or electrical induction processes. Waste processing technologies use the very high temperatures generated in the plasma to destroy organic wastes or melt inorganic waste.

In this process, a high energy plasma is used to destroy organic contaminants in a gas. A good example is the High Energy Corona (HEC) reactor. The HEC consists of a cylindrical ceramic or glass reactor with an inner electrode along the centerline of the cylinder. A grounded metal screen is attached to the outer surface of the glass cylinder. The annular region between the coaxial electrode and the glass tube is filled with dielectric pellets. When a high voltage alternating electric field is established across the gap between electrodes, corona discharges occur among the dielectric beads creating a plasma. When the gas to be treated is pulled through the packed dielectric material, the plasma (consisting of electrons, radicals, and excited molecules and atoms) destroys the contaminants. In this case, it is exposure to the plasma that causes destruction of the contaminants.

Process Name
Metal Melting/Metal Refining

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
DOE/MWIP-26; pg.7-21

Process Name
Metal Melting/Metal Refining

Description
Metal melting methods are those used to recover, clean, and /or compact metal waste by applying heat to melt the metal. The molten metal flows to form a compact mass, reducing waste volume and can be poured off leaving other materials behind to separate the metal from other non-metal materials. The heat applied to melt the metal can also destroy many organic impurities in the waste.

Metal melting and refining technology is an established decontamination method in which contaminated steel, copper, or other contaminated waste can be melted with a suitable slag. This technology may be used to treat metal-bearing and other types of mixed waste to destroy the organic contaminants, achieve waste volume reduction, recycle the contained metal, and produce a compact, leach resistant waste form. Generally, the waste is introduced into a molten metal bath within a refractory lined vessel, and the process parameters are controlled so that the constituents separate into a metallic layer, a slag layer (oxidized material and an off-gas stream). The separation of metals from oxidized material depends on the differences in chemical reducibility, melting points, vapor pressure, density, miscibility of the melts, and additives used in the process. A variety of operating environments (oxidizing to reducing) are possible in these systems.

Radioactively-contaminated solid metal wastes can potentially be treated using metal melting technology. Over a third of the debris in the DOE waste inventory is metal or predominantly metal, including discarded metal equipment removed from gloveboxes that are surface contaminated with low-level radioactive material coupled with hazardous organics (such as pump and lubricating oils). Some melting systems allow for treatment of these heterogeneous wastes, whereas other systems require size reduction in order to introduce the wastes into the bath. Uranium transuranic elements, and many other radionuclides have a higher affinity for oxygen than iron, copper, nickel, etc., so these elements are preferentially oxidized and concentrated in the oxide, or slag, phase. Liquid slag is separated and vitrified, making it chemically stable and resistant to leaching, and may be treated as a low-level waste. Although the amount of radioactive elements remaining in the metal depends on operating conditions, the amount is expected to be very low. Any radioactive components remaining in the metal will be stabilized and evenly distributed in solution in the bulk of the metal rendering them less hazardous than the original surface-contaminated waste material. The liquid metal can be cast into convenient shapes and recycled within the DOE complex in the form of shielding material or waste containers.

Process Name
Separation/Electrosorb

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Separation/Electrosorb

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

The ELECTROSORB (TM) process uses the principles of electrokinetics to separate ionic contaminants from aqueous solutions. The ionic contaminants are forced to migrate under a direct current potential, and are collected at the electrodes. The process combines electrosmosis and electrodialysis phenomena. The process can be used to treat containerized wastes or it can be used in-situ to treat contaminated soils. To treat wastes in situ, wells are drilled. Electrodes are inserted into the well casings. Groundwater acts as an electrolyte. Water can be added to treat soils and sludges.

Process Name
Vitrification/Terra-Vit

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
Battelle Pacific Northwest Laboratories

Process Name
Vitrification/Terra-Vit

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

Terra-Vit is a continuous, above ground thermal treatment technology that oxidizes, melts, and transforms a broad spectrum of wastes into a glass- or rock-like material. The melting energy is derived from the feed and from direct electrical heating of the molten material, similar to the process of the commercial glass industry. The process is typically operated continuously, 24 hours per day, particularly for large-scale operations (5 to hundreds of tons per day). The process can accommodate a broad range of chemical and physical compositions.

Process Name
Vitrification/Stir-Melter, Inc.

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal Stir-Melter
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
Stir-Melter, Inc. (Subsid/Glasstech, Inc.)

Process Name
Vitrification/Stir-Melter, Inc.

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

A compact electric resistance glass melter for vitrifying inorganic hazardous waste residues has been developed. Toxic heavy metal oxides go into solution in glass and become non-leachable per TCLP standards. Although intended primarily for inorganic wastes, organic constituents up to 20 percent or more may be oxidized in the melter.

Process Name
Radiolysis/Electron Beam and X-rays

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Electron Beam Radiolysis

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database, DOE/MWIP-26, pg. 2-107

Process Name
Radiolysis/Electron Beam and X-rays

Description
Radiolysis processes use ionizing radiation to dissociate molecules. X-rays, gamma rays, and electrons are the types of ionizing radiation most commonly used. Alpha particles, fission fragments, and other forms of ionizing radiation also produce radiolysis.

When material is exposed to high energy electrons from an electron beam accelerator and/or x-rays from an x-ray generator, ion pairs are formed in the material. These produce broken bonds and, especially in aqueous solutions, highly- reactive free radicals and hydrogen peroxide. The free radicals and hydrogen peroxide react with organic contaminants, breaking chemical bonds and producing carbon dioxide, water, non-hazardous salts, and intermediate organic reaction products.

Process Name
Decontamination/High Pressure Water

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical — Water contains detergent
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
EG&G ER&WM-SP-94-01B

Process Name
Decontamination/High Pressure Water

Description
Decontamination processes remove hazardous and/or radioactive material from the surface of objects by primarily mechanical means. In some cases the decontaminated objects may be clean enough to be considered no longer hazardous or radioactive and thus be available for reuse with no special restrictions. This can greatly reduce the volume of material that must be considered waste. Decontamination technologies include abrasive or particulate sanding with agents such as sand, ice, or solid carbon dioxide; washing with high pressure water or supercritical carbon dioxide; and scarification. The washing methods may be enhanced by the use of detergents, chelating or complexing agents, or ultrasonic or mechanical vibration.

This process decontaminates by using a spray to apply an aqueous detergent solution to debris followed by use of a high-pressure water jet to blast contaminants from the debris. The detergent solution and rinse water are continuously cleaned and recycled during the washing process. This keeps the quantity of water used to a minimum. The process water is cleaned by filtration, ion exchange, neutralization, and activated carbon. When the water is too contaminated for further use, it is neutralized and sent to a waste water treatment plant. The used activated carbon is thermally treated. This process can be applied to various types of debris including metallics, masonry, and other solid debris contaminated with hazardous chemicals such as polychlorinated biphenyls (PCBs), lead, and other metals.

Process Name
Leaching/Microbially Produced Acids

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
O'Brien, M. C., September 1993

Process Name
Leaching/Microbially Produced Acids

Description
Leaching is the dissolving of a soluble material from its mixture with an insoluble solid by application of a liquid solvent.

Specific microbial cultures would be grown for collection of microbially produced acids (organic or inorganic) and/or other chelators. These products would be added to the contaminated soil (this technology is most likely not applicable to contaminated concrete or debris) in slurry-phase mixed reactors to leach the metals and/or radionuclides from the soil. The resulting leachate would be two to five times greater volume than the contaminated soil. The leachate would be collected and further treated to concentrate the contaminants as desired. This leaching process is relatively rapid and would require a slurry residence time of between ten minutes and two hours. The applicability of this technology is very likely site/soil/contaminant-specific and would require evaluation on a case by case basis. The presence of large concentrations of organics in the soil may be detrimental to this type of leaching. This technology cannot remove all of the contamination from the soil, but can be expected to remove as much as any other known technology.

Process Name
Incineration/Slagging Kiln

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
INEL Draft Site Treatment Plan

Process Name
Incineration/Slagging Kiln

Description
Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources used range from burning fossil fuels to electric arcs and plasmas.

The slagging kiln is a non-conventional incinerator which operates at very high temperatures so that the entire waste material essentially melts into a slag. Almost all slagging kilns are based on improved rotary kiln incinerators. The primary chamber operates at 2,000 to 2,200 degrees F to combust waste to gases, thus producing a melted slag. The melted slag later solidifies and fractures into small pieces, and is eventually drawn from the process.

This technology operates at very high temperatures, which provides excellent destruction for organics present in the waste and produces a final waste form as slag that is removed continuously; therefore, it does not interfere with waste oxidation. It also features reduced off-gas particulates as a result of adsorption of particulates in the slag.

The disadvantages include: 1) the high capital cost for installation, 2) the recurring need to replace the refractory lining, 3) the probability of volatilizing metals due to high temperatures, 4) limited shut down and start up cycles, and 5) difficulty in sealing for contamination control.

Process Name
Vitrification/Electric Arc Melting

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References

Banaee, J. ER&WM-SP-94-018 August 1994

Process Name
Vitrification/Electric Arc Melting

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

This technology has been used in the steel industry for several years. It uses graphite electrodes to melt inorganic waste components into a glassy slag, and pyrolyze or combust organics. The electrodes may be submerged in the molten bath to create the temperatures necessary to melt the waste material, or the electrodes may remain above the surface of the bath to create an arc-plasma zone of high temperatures. Generally, temperatures of 1,650 degrees C are routinely maintained within the furnace chamber, and higher temperatures are achievable.

The electric furnace melter can handle a variety of waste types such as organics, inorganics, and bulk metals. It produces a robust, non-leachable waste form. High temperatures provide excellent destruction of organics.

There is a heavy consumption of electrodes, especially in oxidizing conditions. The high temperatures result in high volatilization of heavy metal in waste.

Process Name
Incineration/Liquid Injection

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
O'Brien, M.C. September 1993

Process Name
Incineration/Liquid Injection

Description
Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources used range from burning fossil fuels to electric arcs and plasmas.

This technology consists of liquid waste being introduced into a combustion chamber using specially designed nozzles. Combustion gases are then cooled and treated to remove particles and neutralize acid gases. Effective operation requires finely atomized liquids.

Process Name
Thermal Desorption/Thermal Distillation

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal — EPA BDAT equivalent to incineration
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References

Banaee, J. ER&WM-SP-94-018 August 1994

Process Name
Thermal Desorption/Thermal Distillation

Description
Thermal desorption processes use heat to drive adsorbed and absorbed volatile substances from solid waste. The volatilized substances are usually recondensed or otherwise collected for further processing or disposal.

The high-temperature thermal distillation system was developed by Seaview Thermal Systems. Contaminated materials are subject to high temperatures approaching 2,000 degrees F, generated electrically. There is no combustion oxidation in the system. Instead, the targeted organic contaminants are vaporized in a nitrogen environment. The residual solid final product is inert, chemically stable, and can be disposed of in accordance with federal and state regulations.

The high temperature thermal distillation system achieves treatment standards without oxidation. According to the vendor, the technology is recognized by the EPA as a Best Demonstrated and Available Technology, equivalent to incineration for treatment of hazardous organic wastes. A full scale (100 tons per day) system is currently operating in Los Angeles, CA.

Process Name
Pyrolysis/High Temperature Fluid Wall

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References

Banaee, J. ER&WM-SP-94-018 August 1994

Process Name
Pyrolysis/High Temperature Fluid Wall

Description
Pyrolysis methods use heat to break compounds (usually organic) apart into simpler units. Pyrolysis is done in the absence of oxygen. If this were not the case, combustion would usually take place. Pyrolysis products are typically combustible and are sometimes burned as fuel for other processes or to further destroy the material.

In the high temperature fluid wall technology, high temperatures, generally electrically produced, quickly reduce organic wastes to their elemental state. The system consists of a cylindrical porous core of refractory material capable of emitting sufficient energy for the reactor. The core is insulated in a fluid-tight pressure vessel and heated by electrodes. Surrounding the core is a larger reactor vessel that leaves a annular space between the core and the reactor vessel. Waste materials are introduced into the top of the reactor and fall through the annular space between the core and the reactor vessel. Solid waste materials must be finely ground and liquid waste must be atomized. As the waste travels through the reactor, it is heated very rapidly and reactions are almost instantaneous. Power densities of over 1200 watts/square inch, and temperatures around 4000 degrees F exist in the reactor.

The waste is transformed into two components: a non-toxic combustible gas, and fused slag. An interesting feature of the system is that gas flows radially out from the core to produce an annular envelope of gas around the waste. This results in a minimization of slag deposition on the radiator surface of the core. This is an improvement over conventional gasifiers since it reduces core wear.

Process Name
Metal Melting/Induction Melter

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References

Banaee, J. ER&WM-SP-94-018 August 1994

Process Name
Metal Melting/Induction Melter

Description
Metal melting methods are those used to recover, clean, and /or compact metal waste by applying heat to melt the metal. The molten metal flows to form a compact mass, reducing waste volume and can be poured off leaving other materials behind to separate the metal from other non-metal materials. The heat applied to melt the metal can also destroy many organic impurities in the waste.

Metal melting processes generally consist of several steps: 1) preconditioning, such as size reduction and sorting; 2) preheating; 3) melting; 4) cooling; and 5) final treatment for shipping. Here, the melting step is accomplished using an induction furnace. The induction furnace produces heat in a metal charge by electromagnetic induction. Upon heating, slag forms and floats on top of the metal phase. Melter operational variations in temperature, mixing, and oxidizing/reducing conditions may significantly affect the two phases. Radioactive contaminants tend to oxidize and concentrate in the slag, leaving the metal phase relatively free of contamination. Any combustible and volatile materials enter the off-gases, which require further treatment prior to discharge to the atmosphere.

An example of this technology is the metal processing of the Scientific Ecology Group (SEG) Inc..

Process Name
Thermal Desorption/Indirectly Heated Screw Conveyer

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
O'Brien, M. C. September 1993

Process Name
Thermal Desorption/Indirectly Heated Screw Conveyer

Description
Thermal desorption processes use heat to drive adsorbed and absorbed volatile substances from solid waste. The volatilized substances are usually recondensed or otherwise collected for further processing or disposal.

The indirectly heated screw conveyor is a patented low temperature (approximately 56 degrees F) thermal treatment process used to remove volatile organics from soils and sludges. The system consists of hollow flite screw conveyors heated by a working fluid in a closed loop heat transfer cycle. Vapors from the soil or sludge are drawn off by an induced draft fan.

Process Name
Thermal Desorption/Anaerobic Retorting

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☒ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References

Banaee, J. ER&WM-SP-94-018 August 1994

Process Name
Thermal Desorption/Anaerobic Retorting

Description
Thermal desorption processes use heat to drive adsorbed and absorbed volatile substances from solid waste. The volatilized substances are usually recondensed or otherwise collected for further processing or disposal.

The Soil Tech ATP System removes organic contaminants from soils, sediments, and sludges through anaerobic thermal desorption in an indirectly fired rotary kiln. The technology relies on a transportable rotary processor. The operation is continuous and provides preheating of incoming feed material in the preheat zone. Desorption of contaminants occurs in an anaerobic retort zone at temperatures over 1,000 degrees F. The oxygen-free environment of the retort zone is maintained by proprietary seals which allow the conveyance of solid material but does not allow the passage of gases between zones. Ancillary systems condense the vapors desorbed from the retort zone. The technology is in full scale operation and has been demonstrated at EPA sites for non-radioactive soils contaminated with VOCs, SVOCs, and PCBs.

Process Name
Evaporation/Externally Fired Roaster

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References

Banaee, J. ER&WM-SP-94-018 August 1994

Process Name
Evaporation/Externally Fired Roaster

Description
Evaporation is the conversion of water, or some other liquid, to the gaseous state by the application of heat. This method is typically applied to reduce the volume of liquid waste streams.

The process uses an indirectly heated rotary dryer to continuously volatilize water and organic contaminants from soil, sludges, and other solid media. Elemental mercury wastes can also be treated. The treated solids are cooled and deducted using the condensed water removed from the feed. An inert carrier gas (nitrogen) transports the volatilized components to a gas treatment system. The gas treatment train removes the entrained particulate solids with a high energy scrubber and then cools the entire gas stream (two condensers in series) to less than 5 degrees C to condense the volatilized organics. Ninety to ninety-five percent of the carrier gas is reheated to 315 degrees C and recycled to the dryer. The remainder of the carrier gas passes through a 2-micron filter and a carbon adsorption system before being discharged to the atmosphere. The condensed liquid organics removed from the soil need to be destroyed by combustion in an afterburner before disposal.

Process Name
Incineration/Plasma Arc

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☒ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References

Banaee, J. ER&WM-SP-94-018 August 1994

Process Name
Incineration/Plasma Arc

Description
Incineration is a controlled process in which combustible solid, liquid, or gaseous waste is burned in air or oxygen and changed into non-combustible gases and ashes. There are many types of incinerators in use or under development. They vary in the type of waste they are designed to incinerate, in the method of introducing the waste into the combustion chamber and removing ash, in the manner in which combustion air (or oxygen) is supplied, and in the source of the heat used to start combustion and insure complete combustion. Heat sources used range from burning fossil fuels to electric arcs and plasmas.

This technology uses the energy from a thermal plasma arc, generated by joule heating of a gaseous electrical conductor between two high-voltage electrodes, to combust organics and melt inert waste components. High-temperature gas (as high as 9,000 degrees F) or a mixture of gases, which can include ambient air, is used to treat wastes. The type of gas chosen can make the plasma system's atmosphere reducing, oxidizing, or inert; hence, changing its function. For example, an oxidizing atmosphere is usually used to destroy organic wastes, whereas a reducing atmosphere is used to extract metals from ore or to melt scrap. During cooling of the plasma gas, enough energy is released to disassociate the molecules of hazardous waste or to provide the thermal energy required for endothermic reactions. Very small gas volumes are required for the plasma arc, resulting in low off-gas volumes. Molten solid material can be removed continuously by overflow or poured by batch and forms a leach-resistant, vitrified (glass) waste form. The plasma-arc furnace can reprocess all of its by-products such as fly ash, filters, and scrubber residues.

The plasma arc is an emerging (pilot scale) technology that has not been demonstrated on an industrial scale. This technology requires significant electrical energy. The operation and control of a plasma arc furnace is more complex than for conventional incineration. High temperatures may lead to high NO_x levels and volatilized heavy metals.

Process Name
Reverse Osmosis

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical — uses reverse osmosis membranes
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
CBD Submission

Process Name
Reverse Osmosis

Description
Reverse osmosis is a technique in which pressure is applied to a solution causing a pure solvent (usually water) to pass through a semi-permeable membrane. The result is pure water on one side of the membrane and a lowered-volume, more concentrated solution on the other side of the membrane.

This process removes dissolved inorganic and organic contaminants from water and wastewater. Separation is through the use of a semi-permeable membrane. Inorganic ions can be rejected by up to 99%, organics rejection > 90%. Reverse Osmosis competes with ion exchange. For most streams, reverse osmosis is more economical than ion exchange because less waste is produced.

Process Name
Filtration /SemiPermeable Membrane

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
CBD Submission

Process Name
Filtration /SemiPermeable Membrane

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

Removes suspended and emulsified particles from wastewater streams. Typically, better than 99% of all particles can be removed. Separation is accomplished via a semi-permeable membrane, at low pressure.

Competes with conventional technologies such as clarification, media filtration, dissolved air flotation, coagulation/flocculation. No chemical addition needed, high removal efficiency, low operator interface benefits.

Process Name
Radiolysis/UV Extraction

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☒ Electrokinetic photochemical
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☒ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
CBD submission

Process Name
Radiolysis/UV Extraction

Description
Radiolysis processes use ionizing radiation to dissociate molecules. X-rays, gamma rays, and electrons are the types of ionizing radiation most commonly used. Alpha particles, fission fragments, and other forms of ionizing radiation also produce radiolysis.

This lamp will use rare-gas alkali-metal exciplex molecules created in a high-pressure electron-beam discharge plasma to carry out small-scale organic decomposition experiments.

An efficient commercial-scale process for treating organic contaminants in liquid and gas effluents from industrial operations is urgently needed for many vital industrial sites and also for treatment of stored "mixed" wastes at various national nuclear laboratories, such as Hanford. An attractive potential treatment is based on reactions using UV-assisted photochemical processes to generate OH in gas liquid phase mixtures which decomposes organic compounds.

Process Name
Biodegradation/Stromatolite Remediation

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☒ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☒ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☒ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
CBD submittal

Process Name
Biodegradation/Stromatolite Remediation

Description
This group includes all methods in which living organisms are intentionally used to metabolize and beneficially alter waste. The organisms may be bacteria or other microorganisms, fungi, or plants. The organisms are used to decompose organic compounds or certain sulfur, phosphorous or nitrogen-containing inorganic compounds (e.g., sulfate, phosphate, nitrate) to simpler, less hazardous compounds. Biodegradation reactions have been used for years to clean sanitary and other waste waters.

Separation of microorganisms and hazardous cations from their host soil forms the unique basis of Stromatolite Remediation. Stromatolites survive today in only "extreme" aqueous environments which are uninhabitable to more delicate organisms which feed on bacteria and algae ("extreme" refers to high salinities, high temperature geothermal springs, high and low pH, and high radiation environments).
The in-situ microorganisms not only tolerate the contaminants but also adsorb and sometimes utilize the contaminants as either a carbon source (organic contaminants) or as an energy source (metals and radionuclides) (Stroetmann et al., 1995).

Process Name
Separation/Beryllium and Lithium removal

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☒ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
CBD submittal

Process Name
Separation/Beryllium and Lithium removal

Description
Separation includes techniques such as manually sorting waste to segregate hazardous items from non-hazardous items, radioactive items from non-radioactive items, and using magnetic properties to segregate waste items. These separation techniques produce no chemical or physical change in the waste.

A proprietary process in which the mixed waste (especially a transuranic mixed with beryllium or lithium) is converted chemically and thermally. After conversion, treatment allows separation of the two metals with further processing generating the former waste as reusable halide salts.
This process has been tested at the bench-top level on only a few transuranics. The reliability has been high and the process parameters offers wider ranges than are normally associated with chemical conversions. It eliminates most of the waste train and converts it to industrial feedstock. Energy usage and efficiency have not been determined, but the latter is high.

Process Name
Steam Reforming/High Temperature Reactor

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☒ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/EM-0125P

Process Name
Steam Reforming/High Temperature Reactor

Description
Steam reforming is the process of converting organic wastes to simpler compounds, typically mixtures of gases rich in hydrogen and carbon monoxide. The gaseous products are sometimes burned as fuel.

This process steam reforming system uses a high temperature reactor equipped with several feed systems designed to gasify different waste forms. Wastes are gasified and then the gasified organic materials are fed to the Detoxifier, where they are destroyed by heat. When the organic materials in the waste contain substantial amounts of heteroatoms, acid removal is performed to prevent corrosion.
This project will address mercury processing, nitrate decomposition (aqueous processing), and organic destruction, and will demonstrate the use of a flexible treatment technology that could function as an alternative to incineration.

Process Name
Adsorption/Carbon in Pulp

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
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- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL Database

Process Name
Adsorption/Carbon in Pulp

Description
Adsorption is the retention of solid, liquid, or gas molecules, atoms, or ions on the surface of a material. Absorption is the penetration of molecules, atoms, or ions into the bulk of a solid or liquid material. Technologies assigned to this group include adsorption by activated carbon (or activated charcoal) and by gel beads and absorption by organic sponges. Several technologies in which adsorption is driven by strong magnetic fields are included in this group. Ion exchange technologies meet the definition for inclusion in this group. However, because ion exchange is so widely known and practiced, these technologies are broken out as a separate group.

The Carbon in Pulp (CIP) process has commonly been used for recovery of metals from ores. The process is commonly used in recovering precious metals where activated carbon is used to adsorb gold and silver leached as cyanide complexes. In the CIP process, liquids are passed to a contactor where the contaminants are adsorbed onto activated carbons. It is a batch process where the carbon is in pulp form rather than in column or packed-bed, continuous form.

Process Name
Ion Exchange/Ultrasonically Catalyzed

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References

Process Name
Ion Exchange/Ultrasonically Catalyzed

Description
Ion exchange is the removal of ionic species from waste (usually an aqueous solution) by using the reversible interchange of ions of like-charge between an insoluble solid ion exchange medium and the solution. The ions in solution attach to the solid and are replaced, equivalent for equivalent, by other ions released from the solid. By proper selection of the ion exchanger and ion exchange conditions (e.g., pH) specific ions or groups of ions may be selectively removed from the solution. Ion exchange media are typically organic ion exchange resins, inorganic solids (such as crystalline silico-titanates), or zeolites.

Atomic Energy of Canada Limited (AECL), through a cooperative agreement with the US EPA and US DOE is developing an ultrasonically-enchanced, chemical conditioning process to remove radioactive elements and heavy metals from contaminated leachates. Use of an ultrasonic field significantly increases the rate of physical and chemical processes, such as ion exchange.

Process Name
Acid Digestion/Sulfuric Acid

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
DOE/MWIP-26 p.2-32

Process Name
Acid Digestion/Sulfuric Acid

Description
Acid is used to break down the structure of solids in waste by dissolving some phases or by breaking all or some of the solids down to simpler forms. Heat may be used to speed up the action of the acid. If the hazardous component of the waste is either freed to go completely into the liquid acid phase, or stays completely in the remaining solid phase, separation of the liquid from the solid after digestion will result in the hazardous material being concentrated in what is probably a smaller volume than the volume of the original waste. Hazardous materials concentrated in the liquid phase may be further concentrated by other methods such as precipitation.

This acid-digestion technology is an oxidation process carried out in a concentrated sulfuric-acid medium which functions to break carbon-hydrogen bonds in organic waste, and also acts as a corrosive on metallic and nonmetallic inorganic waste. The sulfuric acid carbonizes and partially oxidizes the waste; but the primary oxidant is nitric acid, which is added continuously to the digester at a rate proportional to the waste addition rate. In this process, the organics are converted to carbon dioxide, water, and other gaseous products, and the nonvolatile inorganics form insoluble oxides and/or sulfate salts.

The waste material is fed into the digester vessel which contains the acid solution. Oxidation and corrosive destruction takes place in the digester. Sulfuric and nitric acid are fed in the proper proportion to maintain the required acid concentration ratios (sulfuric-acid / nitric-acid ratio > 100) to ensure the waste is chared and oxidized rather that nitrated. An external electric heater is used to maintain an operating temperature of 250 degrees C to 300 degrees C. Metal catalysts can be used to increase the rates of oxidation.

Process Name
Filtration/Vacuum

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Ayers (et al.), 1994

Process Name
Filtration/Vacuum

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

A vacuum filter normally consists of a porous cylinder that is passed over a trough containing the waste. A vacuum is applied to the inside of the cylinder, and the waste is picked up as the cylinder rotates. The vacuum draws the water from the waste which is then scraped from the cylinder. Vacuum filters produce solid concentrations of 20 - 40 percent.

Process Name
Filtration/Pressure Gradient

Process Objective

- ☒ Reduce Volume
- ☐ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☒ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Ayers (et al.), 1994

Process Name
Filtration/Pressure Gradient

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

Pressure filters are capable of dewatering sludges to wet solids between 30 - 45 percent. Compressing the filter plates forces the water from the sludge. Types of pressure filters include screw jack, hydraulic cylinder, and pressure leaf.

Process Name
Filtration/Gravity

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Considine, 1984. p.858.

Process Name
Filtration/Gravity

Description
Filtration is the separation of solid (particulate) material from a fluid by passing the fluid through a medium that will not pass the particulates. Centrifugation separates solid (particulate) materials from a liquid by rapidly spinning the mixture in a closed container and allowing the two phases to separate due density differences.

In gravity settling tanks the solid concentrations of sludges and slurries may be increased from less than 1 percent to 2 - 15 percent. Lagoons are also used for large volumes of waste, which require treatment. Their operation may be enhanced by the addition of vacuum assisted underdrain systems.

Process Name
Liquid-Liquid Extraction/PUREX

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☐ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Tang, et. al., 1990, p. 102

Process Name
Liquid-Liquid Extraction/PUREX

Description
In liquid-liquid extraction, also called solvent extraction, one or more species in one liquid phase transfer to a second, immiscible, liquid phase for which the species have a greater affinity. The two liquids must be brought into contact with each other for the extraction to take place. This can be done by simply mixing the two liquids, for example, in a separatory funnel, or in a more elaborate apparatus such as those using counter current flow.

The PUREX (plutonium extraction) process is commonly used for the separation of uranium and plutonium from the fission products in spent nuclear fuel. The organic phase for the process is tributyl phosphate (TBP) in a paraffinic hydrocarbon diluent (e.g., decane and dodecane). Tetravalent plutonium is more extractable in this process than the hexavalent form and the trivalent form does not extract at all. This can be used to remove plutonium from a waste stream to reduce the volume of transuranic waste.

Process Name
Transmutation/Accelerator Based

Process Objective

- ☒ Reduce Volume
- ☐ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Proton Transmutation

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Murray, 1994, p.81; Bowman, Los Alamos National Laboratory, (505) 667-4045

Process Name
Transmutation/Accelerator Based

Description
Transmutation is the conversion of a radioisotope to a shorter lived or stable isotope by bombarding it with nuclear particles such as neutrons, usually in a nuclear reactor or a particle accelerator.

Accelerator based transmutation involves a linear accelerator to bring protons up to an energy of 1600 MeV. The proton produces the neutrons in a subcritical molten salt reactor. A high energy nuclear process called spallation releases as many as 50 fast neutrons per proton. The resultant neutrons bombard the fuel isotopes, transmuting them into less hazardous from.

The nuclear system being studied at Los Alamos National Laboratory allows for the destruction of spent nuclear fuel, and excess weapon and process stream plutonium. Long-lived fission and transuranic waste can be transmuted in this system.

Process Name
Evaporation/Negative Pressure System

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Considine, 1984

Process Name
Evaporation/Negative Pressure System

Description
Evaporation is the conversion of water, or some other liquid, to the gaseous state by the application of heat. This method is typically applied to reduce the volume of liquid waste streams.

Vacuum evaporation is frequently used in a single compartment or in multiple stages with each successive stage operated at an increasing vacuum utilizing the heat of condensation of the vapor from the preceding stage. In multiple stage evaporators, there is a savings in the cost of heat. There is also an increased expenditure for apparatus. Vacuum evaporation is frequently utilized to lower the temperature to which a substance is subjected and thus avoid decomposition by passing warm dry air over the substance.

Process Name
Complexation/Decontamination

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical — Surface Decontamination
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☒ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☒ Debris	☐ Polymer	☐ Vitrified	

References
DOE Office of Technical Development

Process Name
Complexation/Decontamination

Description
Complexing and chelating agents are used to stabilize, concentrate, or collect specific constituents, usually from a liquid waste. Complexing agents are those which bond to atoms or molecules in the waste by formation of coordinate bonds. Chelating agents are a class of organic compounds which form more than one coordinate bond with metal ions in solution. These agents are important because complexing or chelating agents can be selected based on their ability to bond to only specific species of interest in a solution. Thus they can be used to pull one, or a small group, of hazardous or radioactive ions from a solution containing other non-hazardous and non-radioactive ions.

This process includes application of complexing and chelating agents to decontamination of objects contaminated by metal ions. This application covers contamination on the surface of metal objects and in grain boundaries where the contaminants penetrated during prolonged exposure to high temperature. The intent is for the complexing or chelating agent to bond to the contaminant ions and bring them into solution. The solvent can be regenerated through precipitation of the captured metals, enabling the solvent to be reused and reducing the final waste volume.

Process Name
Dehalogenation/Gamma-Ray Destruction of PCBs

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☒ Other Radiolytic/Gamma Radiation

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☒ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
LANL database

Process Name
Dehalogenation/Gamma-Ray Destruction of PCBs

Description
Dehalogenation is technologies whose goal is to convert hazardous halogenated compounds to simpler, less hazardous materials by removing the halogen atoms from the compounds. Removal of chlorine from PCBs or dioxins is one example of dehalogenation.

Previous work has indicated that some chloro-organic compounds in alkaline isopropanol solutions are dechlorinated when exposed to high energy radiation. This process intends to study the application of the process to polychlorinated biphenyls (PCBs). Capacitors and transformers from which PCBs have been drained still contain some residual PCB. The organic solvent is circulated through the drained capacitors and transformers to flush out the PCBs. The solvent is then exposed to a high intensity gamma ray field which causes radiolysis of the PCBs. Typically the radiation causes the chlorine to break off of the compound leaving a biphenyl. The chlorine in the solvent reacts with potassium ions in the solvent to form potassium chloride which can be extracted. The solvent is recirculated through the equipment until the PCB level is reduced to an acceptable level.

Process Name
Calcination/Molten Sulfur

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
TANG, 1990. pg.107

Process Name
Calcination/Molten Sulfur

Description
Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the Appendices differ primarily in the design of the apparatus and the source of heat.

In support of plutonium production operations, the Savannah River Laboratory developed a calcination process using molten sulfur at 150 degrees C (302 degrees F), so that the water and volatile acids are driven off and the chemical compounds are decomposed and/or chemically reduced. The resulting sulfur-waste slurry is then heated at 400-440 degrees C (752-824 degrees F) before being cooled back to 115-120 degrees C (239-248 degrees F) and transferred as a liquid to the final container, where it is allowed to solidify.

Process Name
Calcination/Fluidized Bed

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
TANG, 1990. pg. 106

Process Name
Calcination/Fluidized Bed

Description
Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the Appendices differ primarily in the design of the apparatus and the source of heat.

A hot demonstration plant facility (Demonstrational Waste Calcining Facility) with a capacity of 60 gallons per hour was installed at the National Reactor Testing Station, Idaho. Aqueous aluminum nitrate waste is calcined in a fluidized bed at 400-500 degrees C (752-932 degrees F); the water evaporates, the nitric acid decomposes to water and nitrogen oxide, and the metallic nitrates decompose to the corresponding oxides. Among the problems noted have been excessive solid carryover in the calciner off-gas, feed-nozzle caking and erosion, dust leakage in the transport air blower system, and formation of alpha aluminum in the calciner product. The original waste calcination facility operated from 1963 to 1981. The New Waste Calcination Facility started up in September 1982.

Process Name
Calcination/Pot Calcination of Solids

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
TANG, 1990. pg. 107

Process Name
Calcination/Pot Calcination of Solids

Description
Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the Appendices differ primarily in the design of the apparatus and the source of heat.

This process involves evaporation to dryness and calcination at temperatures of 700-900 degrees C (1292-1652 degrees F) of solids in a pot that would serve as the final storage container. Developed at Oak Ridge National Laboratory, this system has potential advantages because of its simplicity, versatility in processing several waste types, minimal aerosol problems, and elimination of further packaging of the final product. A pot calciner pilot plant was established at Hanford. One of the major development areas concerned the off-gas problems associated with this process, i.e. physical entrainment of mixed waste solids and volatility of such waste components as ruthenium, sulfates, cesium, and sodium.

Process Name
Calcination/Heat Spray

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
TANG< 1990. pg.107

Process Name
Calcination/Heat Spray

Description
Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the Appendices differ primarily in the design of the apparatus and the source of heat.

This process consists of feeding liquid wastes through a pneumatic nozzle into the top of a tower while the walls are heated to 850 degrees C (1562 degrees F) and by passing low-voltage current through the entire column. The process is technically successful, but it has been largely superseded by the simpler practice of feeding the glass melter with an aqueous waste slurry rather than with precalcined solids.

Process Name
Calcination/Ceramic Sponge Fixation

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☐ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☒ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
TANG, 1990. pg. 107

Process Name
Calcination/Ceramic Sponge Fixation

Description
Calcination processes are those in which waste is heated to a high temperature to oxidize waste and drive off water and other volatiles, but not high enough to melt the non-volatile residue. The product left is typically a dry, granular solid. The calcination processes included in the Appendices differ primarily in the design of the apparatus and the source of heat.

In this process, liquid radioactive waste is absorbed in ceramic sponges. The process involves the preparation of a highly porous clay body, which is fired to approximately 1100 degrees C (2012 degrees F). After being soaked in the liquid radioactive waste and dried several times, the clay body is finally fired at 1300 degrees C to fix the radionuclides permanently in the ceramic material. Off-gases from the kiln pass through a silica gel bed, a condenser, and finally absolute filters.

Process Name
Plasma Process/Plasma Arc Furnace

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☒ 2200 Pure Organic Liquids
- ☒ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☒ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
Hamilton, et. al., 1995

Process Name
Plasma Process/Plasma Arc Furnace

Description
A plasma is a completely ionized gas with nearly equal numbers of free positive and negative charges. Plasmas are generally generated by electric arcs or discharges or electrical induction processes. Waste processing technologies use the very high temperatures generated in the plasma to destroy organic wastes or melt inorganic waste.

In this process, the plasma is used to heat a reactor to decontaminate metals. An example is the KVS/EPI DC Plasma Arc Furnace. The basic concept of the furnace is that waste material is put into a high temperature bath of molten inorganic/metallic material. Any organic contaminants in the waste are dissociated into their component elements because of the high temperatures. Any inorganic contaminants are incorporated into the molten slag phase. Since the organic material is disassociated at very high temperature, the organic destruction efficiency is better than other, more conventional, thermal treatment systems.

Process Name
Mercury Recovery/Sulfur Impregnated Carbon

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☒ Chemical
- ☐ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☒ 1100 Wastewaters
- ☒ 1200 Aqueous Slurries
- ☒ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☐ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☒ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
Gates, et. al. (1995)

Process Name
Mercury Recovery/Sulfur Impregnated Carbon

Description
Mercury recovery methods include technologies designed to separate and collect mercury from other waste materials. The methods are generally thermal (e.g., roasting or distillations) which take advantage of the volatile nature of mercury, or chemical methods in which an easily separated chemical compound of mercury is formed.

Recovery of mercury using sulfur-impregnated carbon is an adsorption technique for removing mercury form liquid waste streams. Laboratory work has shown that mercury is adsorbed on sulfur-impregnated activated carbon beads, which is a relatively inexpensive adsorption system when compared to more expensive ion exchange resins.

Process Name
Plasma Process/Plasma Centrifugal Furnace

Process Objective

- ☒ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☒ Physically Stabilize
- ☒ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☒ Admixtures Additives are sometimes used.
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
NTTC database, General Laboratories Information

Process Name
Plasma Process/Plasma Centrifugal Furnace

Description
A plasma is a completely ionized gas with nearly equal numbers of free positive and negative charges. Plasmas are generally generated by electric arcs or discharges or electrical induction processes. Waste processing technologies use the very high temperatures generated in the plasma to destroy organic wastes or melt inorganic waste.

In a plasma centrifugal furnace, waste is fed to a rotating hearth such that the waste and molten material are held to the side of the reactor by centrifugal force. During rotation, the waste moves through a plasma generated by a torch. The plasma is stationary and the waste material moves through the plasma at a high rate of speed. The plasma acts as a heating source for the waste, converting it to molten material. It also acts to destroy organic contaminants exposed to the positive and negative charges in the plasma. To remove molten material from the furnace, the rotation of the hearth is slowed, and the slag flows through a central bottom opening. Upon cooling, the waste becomes a highly durable, glassy slag. Inorganic waste contaminants (both hazardous and radioactive) are stabilized in the slag. This can also be considered a vitrification process.

Process Name
Thermal Desorption/Counter Current Batch Washing

Process Objective

- ☐ Reduce Volume
- ☒ Mitigate Hazardous Properties
- ☐ Physically Stabilize
- ☐ Mitigate Radioactive Properties

Process Type

- ☒ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☐ Radioactive	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☐ TRU	☐ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☐ 3100 Inorganic Process Residues
- ☐ 3150 Solidified Process Residues
- ☐ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☐ 4200 Contaminated Soil Debris
- ☐ 4900 Uncategorized Soils
- ☐ 5100 Metal Debris
- ☐ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☐ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☒ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☐ Vitrified	

References
ITC Corporation

Process Name
Thermal Desorption/Counter Current Batch Washing

Description
Thermal desorption processes use heat to drive adsorbed and absorbed volatile substances from solid waste. The volatilized substances are usually recondensed or otherwise collected for further processing or disposal.

This particular process has two stages. In the first, soil vapor extraction removes volatile organics by steam injection. This is followed by acid extraction where the soil slurry is washed with hydrochloric acid to remove metals. Subsequent counter current batch washing with water removes the residual acid from the soil. The solids are then separated from the final wash solution by gravimetric sedimentation. The acid extract steam is routed to a batch distillation system for the recovery of hydrochloric acid and heavy metals.

Process Name
Vitrification/High Temperature Melter

Process Objective

- ☒ Reduce Volume
- ☒ Physically Stabilize
- ☒ Mitigate Hazardous Properties
- ☐ Mitigate Radioactive Properties

Process Type

- ☐ Mechanical
- ☐ Chemical
- ☒ Thermal
- ☐ Biological
- ☐ Electrokinetic
- ☐ Admixtures
- ☐ Other

Waste Type Application & Process Maturity

☒ Radioactive	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ Radioactive-Mixed	☐ Conceptual	☒ Pilot/Innovative	☐ Commercial/Proven
☒ TRU	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ TRU-Mixed	☒ Conceptual	☐ Pilot/Innovative	☐ Commercial/Proven
☒ Hazardous	☐ Conceptual	☐ Pilot/Innovative	☒ Commercial/Proven

Matrix Type (major categories from MWIR Appendix G):

- ☐ 1100 Wastewaters
- ☐ 1200 Aqueous Slurries
- ☐ 2100 Aqueous/Organic Liquids
- ☐ 2200 Pure Organic Liquids
- ☐ 2900 Uncategorized Organic Liquids
- ☒ 3100 Inorganic Process Residues
- ☒ 3150 Solidified Process Residues
- ☒ 3200 Organic Process Residues
- ☒ 4100 Contaminated Soils
- ☒ 4200 Contaminated Soil Debris
- ☒ 4900 Uncategorized Soils
- ☒ 5100 Metal Debris
- ☒ 5200 Inorganic Non-metal Debris
- ☐ 5300 Combustible Debris
- ☒ 5400 Heterogeneous Debris
- ☐ 6100 Lab Packs
- ☐ 6200 Reactive Metals
- ☐ 6300 Explosives/Propellants
- ☐ 6400 Compressed Gases/Aerosols
- ☐ 7100 Elemental Mercury
- ☐ 7200 Elemental Lead
- ☐ 7300 Beryllium Waste
- ☐ 7400 Batteries
- ☐ 8100 Unknown Liquids
- ☐ 8200 Unknown Solids
- ☐ 8900 Uncategorized Unknown

End Waste Form

☐ Ash	☐ Liquid	☐ Sludge	☐ Other
☐ Cement	☐ Metal	☐ Soil/Particulates	
☐ Debris	☐ Polymer	☒ Vitrified	

References
DOE/MWIP-3, Vol. II, p. C-26.

Process Name
Vitrification/High Temperature Melter

Description
Vitrification processes use heat to melt non-metallic, inorganic waste and then cool the melt to form glassy products. The heat used in melting is sometimes also used to destroy organic materials that may be present. In some vitrification processes, the glass waste form produced is ready for final disposal. Many different melter designs and heat sources for vitrification have been produced or proposed.

This technology, at the DOE Savannah River Site, rapidly heats the material to about 2000 degrees C. It has a replaceable melt container and has been used with depleted, natural, and enriched uranium. It is applicable to recycling. Temperatures are better controlled than with arc and plasma melting, minimizing volatilization of low boiling point metals such as cadmium and zinc. It can be fitted with an air lance or oxygen lance for oxidation of organics. It has induction stirring for homogenization and improved metal recovery.