APPENDIX D

PREDISPOSAL TREATMENT TECHNOLOGIES

The U.S. Environmental Protection Agency (EPA) broadly defines "treatment" as "any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste nonhazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume" (40 CFR 260).

For the purposes of this EIS, "predisposal treatment" is treatment provided to wastes before storage or disposal to reduce their volume or alter their chemical or physical characteristics to render them less toxic or more stable. This appendix categorizes, lists, and defines various predisposal technologies; discusses their applicability to hazardous, low-level radioactive, and mixed wastes generated at the Savannah River Plant (SRP); and describes how the applicable technologies could be employed and the results that might be expected.

D.1 APPLICABLE WASTES

The SRP generates appreciable quantities of hazardous, low-level radioactive, and mixed wastes (Appendix E). Except for nonradioactive polychlorinated biphenyls (PCBs), all such wastes generated on the Plant are recycled, stored for ultimate disposal, or deposited in an onsite waste disposal facility. The Plant does not receive hazardous waste or nonbyproduct mixed waste from offsite sources. TC

In the context of this appendix, predisposal technologies apply only to hazardous, low-level radioactive, and mixed wastes generated by ongoing SRP operations, by existing waste site closure actions, and by offsite, defense-related generators of low-level radioactive wastes.

All hazardous wastes currently being generated either are stored in storage facilities (buildings) or are recovered and recycled. Mixed wastes, such as scintillation solutions and tritiated waste lubricating oils, are stored either at the mixed waste storage facility or at the tritium facility, depending on their levels of radioactivity.

Virtually all hazardous, low-level radioactive, and mixed wastes generated on the Plant are candidates for the application of one or more predisposal treatment technologies. These wastes include the following:

- Hazardous and mixed waste combustible oils, solvents, and solids
- Mixed and low-level radioactive solvents, scintillation solutions, contaminated equipment, razed-building rubble, and job control wastes
- Mixed waste sludges generated at effluent treatment facilities (ETFs)

- Hazardous, mixed, and low-level radioactive ash and scrubber blowdown from incinerators

- Hazardous, mixed, and low-level radioactive waste, including contaminated soil.

D.2 AVAILABLE TECHNOLOGIES

D.2.1 VOLUME REDUCTION

During the past few years, there has been an industry-wide shift from limited waste volume reduction to maximum reduction before disposal. This shift has occurred for a number of reasons. The strongest is the realization that adequate disposal sites are a diminishing resource and, therefore, that future disposal capacity is uncertain and will be more expensive to develop (Voss and Guilbeault, 1984). The stated objectives of the Savannah River Interim Waste Management Program include the implementation of a sitewide effort to reduce the volume of waste generated and to demonstrate the technology for incinerating beta-gamma waste (DOE-SR, 1985). The technologies designed to reduce the volume of wastes for disposal fall into two general categories: (1) incineration; and (2) concentration, which includes compaction and physical treatment methods (Beamer, 1984; DOE, 1985; Enegess, 1984; Giuffre et al., 1984; NRC,
TE 1981; OTA, 1985; Rutland, Papaiya, and Naughton, 1984).

D.2.1.1 Incineration

As a volume reduction technique, incineration is applicable primarily to organic wastes, which combine with oxygen in the air through combustion at high temperatures to form carbon dioxide, water vapor, minor quantities of other waste gases, particulates, and residual ash. The residuals from this process consist of inorganic material (ash) and possibly scrubber blowdown from exhaust gas pollution control devices. Usually, these residuals are sent to a landfill for disposal, often after they have been solidified (see Section D.2.3.4).

D.2.1.2 Compaction

Compaction includes several processes that achieve volume reduction by compression and crushing to reduce interstitial air space within the bulk material. Compaction is much more efficient in terms of disposal capacity; it improves the stability of landfills after closure; and it decreases leachate generation and contaminant migration by minimizing the conduits within which liquids can percolate through the waste. Solid and semisolid waste materials, particularly noncombustibles, can be compacted before disposal to achieve volume reduction if other methods are not possible or feasible.

The nuclear industry has used several compaction techniques to reduce the volume of noncombustible solid wastes before storage, shipping, and disposal (NRC, 1981):

- <u>Compactors</u> - compress material into final storage, shipping, or disposal containers

- Balers - compress material into bales to maintain volume reduction
- Baggers - compress material into slugs that are injected into bags, metal containers, etc.

Supercompactors substantially reduce the volume of large metal objects and other pieces of equipment.

As a predisposal treatment technology, compaction could be applied to a variety of hazardous, low-level radioactive, and mixed wastes, particularly solid noncombustible wastes. It is most applicable in the treatment of laboratory and job control wastes; under special conditions, it would be useful in the predisposal treatment of unincinerated, unsolidified wastes exhumed from existing SRP waste sites. Developmental research might show that supercompactors are applicable to materials from renovations and from decommissioning and decontamination projects. In some instances, compacting wastes as they are placed in above- or below-ground landfills might be desirable. Standard geotechnical techniques using sheepsfoot, rubber-tired, smooth, or vibratory rollers can achieve desired compaction results.

D.2.1.3 Shredding

The shredding of solid wastes containing hazardous or radioactive contaminants not only reduces the size of the particles to be placed in a container, incinerator, or landfill, but also provides a uniform particle size distribution. When applied before incineration or compaction, shredding produces a more uniform burn or a greater, more uniform density of compacted waste.

A number of types of size reduction (shredding) machines are used to handle industrial solid waste; these include the hammer mill, knife-cutters, jaw crusher, and bulky waste crusher. The actual size of the reduction depends on the waste type, feed rate, and type of shearing. Generally, small shredders (7 to 45 horsepower) are used to prepare combustible waste for incineration, while large shredders (160 horsepower) are used to reduce noncombustible wastes for compaction or disposal (Charlesworth, 1985).

Shredders might be installed on some SRP incinerators in the 1994 timeframe. Further research might identify other applications of shredding technology on the Plant.

D.2.2 CONTAINMENT

Containment technologies use fairly inert materials to reduce the leachability of a waste and to improve its stability before disposal. They have been applied successfully to hazardous and low-level radioactive wastes (COE, 1984; DOE, 1985; EPA, 1982a; NRC, 1981). TE

D.2.2.1 Solidification/Stabilization

Wastes can be mixed with a binding agent and cured to form a solid. This usually reduces leachability because the binding agent (1) complexes or binds the hazardous contaminants in a stable, insoluble form, or (2) entraps the waste material in a crystalline matrix.

Typical processes used to solidify low-level radioactive and mixed wastes include the following:

- Cement-based
- Pozzolanic (lime-based)
- Thermoplastic (including bitumen, paraffin, and polyethylene)
- Organic polymer
- Self-cementation
- Glassification

In general, each process has features that make it particularly useful for the treatment of specific kinds of waste. Similarly, each process has limitations that restrict or even preclude its use on certain wastes. Thus, solidification processes tend to be waste-specific. Table D-1 summarizes the compatibility of these processes with various types of hazardous, mixed, and low-level radioactive wastes.

Cement-based and pozzolanic processes are used commonly to solidify hazardous and low-level radioactive wastes, although some of these processes might not be effective in the immobilization of heavy metals and fairly mobile isotopes such as cesium (COE, 1982; Clark, Perry, and Poon, 1985; Croney, 1985; Kalb and Columbo, 1984; Miller et al., 1984). However, the U.S. Army Corps of Engineers (COE, 1984) has found Sealosafe (registered trademark of the Stablex Corporation) to be effective in preventing excessive leaching of heavy metals from a solidified waste. Similarly, a lime/bentonite/cement mixture effectively fixes metals within the solidified mass (Escher and Newton, 1985). The gypsum cement, Envirostone (a registered trademark of United States Gypsum), produces solidified waste forms meeting all the criteria recommended by the U.S. Nuclear Regulatory Commission (NRC) (Phillips, 1984) for compliance with
TE 10 CFR 61 (Rosenstiel and Lange, 1984; Rosenstiel, Bodet, and Lange, 1984).

Solidification technology is applicable to the predisposal treatment of a variety of hazardous, low-level radioactive, and mixed wastes. These include material exhumed from SRP waste sites, incinerator wastes, low-level radioactive and mixed organic and evaporator bottom wastes from the Naval Fuel Material Facility, lead smelter and associated wastes, low-level radioactive contaminated equipment, renovation decommissioning waste, and mixed waste ETF sludges. Because this technology provides a "universally acceptable" waste product, it allows the widest choice of disposal sites (DiSalvo, 1984). In addition, the solidification of radioactive wastes reduces exposure rates associated with transportation and disposal.

Solidification processes, particularly those that are cement based, produce as much as a two-fold increase in the amount (i.e., weight and volume) of waste material to be disposed of (EPA, 1982b). Consideration of this effect is essential for an accurate determination of future disposal capacity needs.

D.2.2.2 Encapsulation

The encapsulation process involves enclosing wastes in a jacket or membrane of impermeable, chemically inert, water-resistant material to facilitate transport, storage, or disposal. It can be applied to solid hazardous wastes

Table D-1. Compatibility of Selected Waste Categories with Different Containment Technologies[a]

Waste component	Cement-based	Lime-based	Thermoplastic-solidification	Organic polymer (UF)[b]	Self-cementing techniques	Glassification and synthetic mineral formulation	Surface encapsulation
			ORGANICS				
Organic solvents and oils[c]	Many impede setting; can escape as vapor	Many impede setting; can escape as vapor	Organics can vaporize on heating	Can retard set of polymers	Fire danger on heating	Wastes decompose at high temperatures	Must first be absorbed on solid matrix
Solid organics (e.g., plastics, resins, tars)[d]	Good; often increases durability	Good; often increases durability	Possible use as binding agent	Can retard set of polymers	Fire danger on heating	Wastes decompose at high temperatures	Compatible; many encapsulation materials are plastic
			INORGANICS				
Acid wastes[c]	Cement will neutralize acids	Compatible	Can be neutralized before incorporation	Compatible	Can be neutralized to form sulfate salts	Can be neutralized and incorporated	Can be neutralized before incorporation
Oxidizers[c]	Compatible	Compatible	Can cause matrix breakdown, fire	Can cause matrix breakdown	Compatible if sulfates are present	High temperatures can cause undesirable reactions	Can cause deterioration of encapsulating materials
Sulfates[d]	Can retard setting and cause spalling unless special cement is used	Compatible	Can dehydrate and rehydrate, causing splitting	Compatible	Compatible	Compatible in many cases	Compatible

Footnotes on last page of table.

Table D-1. Compatibility of Selected Waste Categories with Different Containment Technologies[a] (continued)

Waste component	Cement-based	Lime-based	Thermoplastic-solidification	Organic polymer (UF)[b]	Self-cementing techniques	Glassification and synthetic mineral formulation	Surface encapsulation
Halides[d]	Easily leached from cement; can retard setting	Can retard set; most are easily leached	Can dehydrate	Compatible	Compatible if sulfates are present	Compatible in many cases	Compatible
Heavy metals[c]	Compatible	Compatible	Compatible	Acid pH solubilized metal hydroxides	Compatible if sulfates are present	Compatible in many cases	Compatible
Radioactive materials[c]	Compatible	Compatible	Compatible	Compatible	Compatible if sulfates are present	Compatible	Compatible

[a]Source: DOE, 1985.
[b]Urea-formaldehyde resin.
[c]Some waste streams on SRP frequently contain these components.
[d]Not usually generated on SRP; seldom observed in the groundwater.

in bulk or particulate form (e.g., contaminated demolition debris), containerized wastes, wastes in damaged or corroded drums, and wastes that have been previously stabilized by solidification.

Ideally, the jacket is bonded to the external surface of the waste. As long as the jacket is intact, the potential for leaks is low. However, this technology is in a developmental stage and few data are available on the long-term stability and integrity of covering materials or the costs of a full-scale facility (Ehrenfeld and Bass, 1983; OTA, 1985). TE

D.2.3 OTHER TREATMENT

D.2.3.1 Physical Treatment

Physical treatment processes concentrate semisolid or liquid wastes to render them more suitable for additional treatment or disposal. These processes include carbon adsorption, sedimentation/filtration, evaporation, air stripping, ion exchange, flotation, and reverse osmosis. They are seldom used in a single operation (DOE, 1985), but rather are combined with other technologies (often chemical or biological processes) to provide complete treatment of the waste stream. For example, many processes are employed in the M-Area ETF.

Physical treatment technologies have been proven to be effective and reliable; however, they are most likely to be used in connection with ETFs and generally are not applicable for the predisposal treatment of the types of hazardous, low-level radioactive, and mixed wastes described in this EIS. An exception is evaporation, which could be applied to ETF sludges for volume reduction and the stabilization of semisolid sludge to a dry salt form. TE

D.2.3.2 Chemical Treatment

Chemical treatment processes involve conditioning wastes to enhance sedimentation or filtration. These methods include precipitation, chelation, and flocculation. Other chemical technologies - for example neutralization, oxidation, reduction, solvent extraction, chlorination, and ozonation - destroy or detoxify wastes.

Chemical treatment technologies, particularly neutralization and precipitation, are applicable to the predisposal treatment of certain hazardous and mixed wastes (contaminated water, sludges, and soils from specific seepage and settling basins), but are used most commonly in ETFs.

D.2.3.3 Biological Treatment

Biological treatment technologies involve the use of oxidizing bacteria, algae, fungi, and microorganisms to destroy, stabilize, or alter organic wastes in aqueous streams. They are generally applied to process or domestic wastewaters, leachates, and other contaminated waters. Biological treatment technologies include activated sludge, stabilization ponds, trickling filters, rotating biological contactors, and land treatment.

Although these technologies are used extensively for waste treatment (including land treatment/disposal of certain oil wastes on the SRP), they generally are not applicable to the treatment of highly toxic hazardous wastes or radioactive wastes before disposal and, therefore, are of limited use for predisposal treatment on the Plant. (For additional discussion of biological treatment technologies, refer to Appendix C.)

D.2.3.4 Thermal Destruction Treatment

Thermal destruction of organic wastes, regardless of volume reduction, requires specially designed incinerator facilities that produce high temperatures and, perhaps, long residence times. This controlled incineration uses temperatures typically higher than 800°C. Many incinerators have at least two chambers. The first can be fired under either oxygen-deficient conditions (pyrolysis) or oxygen-rich conditions at temperatures of approximately 700°C; residence times in this chamber are rather long (measured in minutes). The second chamber is usually an afterburner, where combustion of the hazardous contaminants and particulates from the first chamber occurs at high efficiency in an oxygen-rich environment; residence times are usually a few seconds, and temperatures are 1000°C or higher. The performance of the afterburner usually determines both the incinerator's efficiency in destroying the principal organic hazardous constituents and the identity and yield of particulates released to the emission control equipment and stack.

Hazardous waste incinerators must achieve destruction and removal efficiencies (DREs) of 99.99 percent, with the exception of dioxin incinerators, which must achieve a DRE of at least 99.9999 percent (40 CFR 264). Laboratory testing of incinerator performance under pyrolytic conditions on actual (or closely simulated) waste streams is the most effective and reliable method for predicting the emission of hazardous constituents (Dellinger et al., 1985; Mourningham and Olexsey, 1985).

Based on its assessment of incineration as a treatment method for organic hazardous wastes, the EPA (1985a) found incineration to be an environmentally sound technology that offers advantages over current disposal options under some circumstances. The EPA found little impact to health from incineration.

Thermal destruction by incineration does not destroy radionuclides. Therefore, when incineration is used to reduce the volume of wastes containing radioactivity, high-efficiency particulate air (HEPA) filters are needed to recover radioactive particulates from the exhaust gases. Both the recovered particulates and the residual ash, which contains solid radioactive particles, must be disposed of in a suitable disposal facility, usually after solidification.

Regarding its use for predisposal treatment, the Office of Technology Assessment (OTA, 1985) indicates that incineration is a proven, highly effective technology. It would, therefore, be applicable to a wide variety of hazardous, low-level radioactive, and mixed wastes, including those exhumed from existing SRP waste sites during closure actions. Table D-2 summarizes commonly used incineration technologies.

Table D-2. Commonly Used Incineration Technologies

Type	Process principle	Application	Combustion temperature (°C)	Residence time
Rotary kilns	Waste burns in a rotating, refractory cylinder	Any combustible solid, liquid, or gas	800–1650	Seconds for gases; hours for liquids and solids
Single chamber/ liquid injection	Wastes atomize in high-pressure air or steam and burn in suspension	Liquids and slurries that can be pumped	700–1650	0.1 to 1 second
Multiple hearth	Wastes descend through several grates to burn in increasingly hotter combustion zones	Sludges and granulated solid wastes	750–1000	Up to several hours
Fluidized-bed incineration	Waste is injected into an agitated bed of heated inert particles; heat transfers efficiently to wastes during combustion	Organic liquids, gases, and granular or well-processed solids	750–900	Seconds for gases and liquids; minutes for solids

Source: EPA, 1985b.

D.3 APPROPRIATE TECHNOLOGIES

D.3.1 SUMMARY OF PREDISPOSAL TREATMENT TECHNOLOGIES

Table D-3 summarizes the advantages, disadvantages, and limitations of common predisposal treatment technologies.

D.3.2 SUMMARY OF APPROPRIATE TECHNOLOGIES

The use of predisposal waste treatment technologies can produce a substantial change on the characteristics and volume of waste to be disposed of. These changes might preclude certain disposal technologies or limit disposal alternatives to one or two specific technologies. Also, the potential difference in waste volume will have a great influence on the design capacity of required disposal facilities. Therefore, predisposal treatment must be considered as an integral part of the disposal process; it has a major impact on the sizing, design, and operation of facilities.

Tables D-4, D-5, and D-6 summarize the applicability of five predisposal technologies to various hazardous, mixed, and low-level radioactive wastes generated by, or stored at, SRP facilities.

D.3.3 EXPECTED RESULTS OF APPLICATION

Tables D-4, D-5, and D-6 indicate that, potentially, predisposal treatment technologies, specifically incineration, compaction, evaporation, solidification, and encapsulation, can be applied to a wide variety of hazardous, low-level radioactive, and mixed wastes on the SRP. At present, the use of certain technologies is being planned.

The following subsections summarize the expected results of the application of these technologies and, if possible, estimate the potential results of broader applications.

D.3.3.1 Incineration

Because of the effectiveness of incineration technology for volume reduction or thermal destruction of hazardous waste constituents, and because of its relatively low operation and maintenance costs, its development is being pursued actively on the Plant. One demonstration incineration project, the beta-gamma low-level radioactive waste incinerator, and one pilot incineration project, the transuranic (TRU) waste incinerator, are in operation on the Plant.

The beta-gamma incinerator is a two-stage, ram-feed, air-controlled incinerator with a spray-quench tower, bag house, and high-efficiency particulate air (HEPA) filter. Waste in the first chamber is pyrolyzed at 900°C. Final combustion occurs with excess air in the second stage at 1000°C. This incinerator is achieving volume reductions of 95 to 99 percent (Weber, 1985).

The TRU waste pilot incinerator is an infrared, movable-grate type with a capacity of about 11 kilograms of solids per hour. Research conducted with this incinerator could be applied to low-level radioactive and mixed wastes

Table D-3. Advantages, Disadvantages, and Limitations of Common Predisposal Treatment Technologies[a]

Advantages	Disadvantages	Limitations	SRP applications
VOLUME REDUCTION/DESTRUCTION/DETOXIFICATION PROCESSES			
Incineration:			
• Onsite - Destroys organic wastes (99.99+%). - Long-distance transportation of wastes not required.	Onsite feedstock preparation required. Test burn would be required. Skilled operators required. Expensive.	Mobile units have low feed rate.	SRP currently generates and stores large quantities of organic wastes. BGI[c] demonstration facility. Consolidated Incineration facility is being designed for hazardous and radioactive waste
Biological treatment:			
• Conventional - Applicable to many organic waste streams. - High total organic removal. - Inexpensive. - Well understood and widely used in other applications.	Can produce a hazardous sludge that must be managed. Might require pretreatment before discharge.	Microorganisms sensitive to oxygen levels, temperature, toxic loading, inlet flow. Some organic contaminants are difficult to treat. Flow and composition variations can reduce efficiency.	SRP currently generates and stores large quantities of organic wastes. Organically contaminated waste sites generally not amenable to in situ biodegradation.
Chemical treatment:			
• Wet air oxidation - Good for wastes too dilute for incineration or too concentrated or toxic for biological treatment.	Oxidation not as complete as thermal oxidation or incineration. Might produce new hazardous species. Extensive testing is required. High capital investment. High-level operator skills required. Might require post-treatment.	Poor destruction of chlorinated organics. Moderate efficiencies of destruction (40-90%).	Generally not applicable to SRP organic wastes.
• Chlorination for cyanide - Essentially complete destruction. - Well understood and widely used in other applications.	Specialized for cyanide.	Interfacing waste constituents can limit applicability or effectiveness.	Generally, SRP does not produce cyanide wastes.

TC

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Table D-3. Advantages, Disadvantages, and Limitations of Common Predisposal Treatment Technologies[a] (continued)

Advantages	Disadvantages	Limitations	SRP applications
Chemical treatment *(continued)*:			
• Ozonation – Can destroy refractory organics. – Liquids, solids, mixes can be treated.	Oxidation not as complete as thermal oxidation or incineration. Might produce new hazardous species. Extensive testing is required. High capital investment; high O&M.	Limitations not as well understood.	
• Reduction for chromium – High destruction. – Well understood and widely used in other applications.		Interfering waste constituents can limit applicability or effectiveness.	Chromium wastes currently sent to H-Area seepage basin for disposal.
Physical treatment:			
• Compaction/shredding – Low technology. – Well understood and demonstrated.	Might require air pollution control.	Limited primarily to bulky solid wastes.	Compaction of low-level radioactive waste being used to conserve burial ground capacity. TC
SEPARATION/TRANSFER PROCESSES			
Chemical:			
• Neutralization/precipitation – Wide range of applications. – Well understood and widely used in other applications. – Inexpensive.	Hazardous sludge produced.	Complexing agents reduce effectiveness.	Widely used technology at SRP.
• *Ion exchange* – Can recover metals at high efficiency.	Generates sludge for disposal. Pretreatment to remove suspended solids might be required. Expensive.	Resin fouling. Removes some constituents but not others.	Used to treat disassembly-basin purge water before discharge into reactor seepage basins. To be a component of the F/H Effluent Treatment Facility. TC

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Table D-3. Advantages, Disadvantages, and Limitations of Common Predisposal Treatment Technologies[a] (continued)

Advantages	Disadvantages	Limitations	SRP applications
Physical treatment:			
• Carbon adsorption for aqueous streams			
- Well understood and demonstrated. - Applicable to many organics that do not respond to biological treatment. - High degree of effectiveness.	Regeneration or disposal of spent carbon required. Pretreatment might be required for suspended solids, oil, grease. High O&M cost.	Some organics are poorly adsorbed.	Currently used to remove chlorinated organics from drinking water in A/M-Area on an "as-needed" basis.
• Carbon absorption for gases - Widely used, well understood. - High removal efficiencies.	High capital and O&M costs.	More effective for low-molecular-weight polar species. Disposal or regeneration of spent carbon required.	
• Flocculation, sedimentation and filtration - Low cost. - Well understood.	Generates sludge for disposal.	--	
• Stripping - Well understood and demonstrated.	Air controls might be required.	Applicable only to relatively volatile organic components.	A 1.5-m^3/min air stripper is removing chlorinated organics from groundwater in A/M-Area.
• Flotation - Well understood and demonstrated. - Inexpensive.	Generates sludge for disposal.	--	
• Reverse osmosis - High removal potential.	Generates sludge for disposal. Pretreatment to remove suspended solids or adjust pH might be required. Expensive.	Variability in waste flow and composition affects performance.	To be a component of the F/H Effluent Treatment Facility. TC

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Table D-3. Advantages, Disadvantages, and Limitations of Common Predisposal Treatment Technologies[a] (continued)

Advantages	Disadvantages	Limitations	SRP applications
• Evaporation[b] - Well understood. - Low technology. - High degree of volume reduction.	Energy intensive.	Most effective with aqueous wastes of high solids content.	Currently being considered for drying ETF sludges to dry salt form.
CONTAINMENT PROCESSES			
Solidification and stabilization • Improves containment performance. • High short-term effectiveness possible. • Waste material (e.g., fly ash, kiln dust) can be used as pozzolan.	Extensive testing might be required. Many processes developmental. Substantially increases volume of material to be disposed of.	Long-term integrity uncertain. Not useful for many organics.	Cement-fly ash matrix (CFM) is being performed at SRP. TC
Encapsulation: • Improve effectiveness of land disposal.	Developmental. Inefficient space utilization.	Long-term integrity uncertain. Requires solidification of bulk wastes.	Being used at greater confinement disposal demonstration in LLW burial ground.

[a]Source: OTA, 1985.
[b]Source: J. T. Baker Chemical Company, 1979.
[c]Beta-Gamma Incineration TC

Table D-4. Applicability of Predisposal Treatment Technologies to Hazardous Wastes[a]

Waste	Predisposal treatment technology				
	Incineration	Compaction	Evaporation	Solidification	Encapsulation
Organics, mercury and oil	3	5	5	4	5
Lathe coolant, oil	1	5	5	4	5
Oil with lead	3	5	5	4	5
Inorganic acids	3	5	5	4	5
Paint solvent	1	5	5	4	5
Other solvents	1	5	5	4	5
Toluene, xylene	1	5	5	4	5
Pesticides	1	5	5	4	5
CMP liquids	1	5	5	4	5
Sodium dichromate	1	5	5	4	5
Trichloroethane	1	5	5	4	5
Methylene chloride	1	5	5	4	5
Machine coolant	1	5	5	4	5
Naphtha-methylene chloride	1	5	5	4	5
Teargas concentrate	3	5	5	4	5
Toluene and isopropanol	1	5	5	4	5
Varnish and thinners	1	5	5	4	5
Waste paint	1	5	5	4	5
Laboratory chemicals	2, 3	5	5	3, 4	3
DWPF pilot plant sludge	5	5	1	1	3
Trichloroethylene sludge	1	5	5	4	4
Lead smelter waste	5	5	5	1	1
Beryllium-copper alloy	3	2	5	1	1
Alkalines	3	5	5	1	3
Nitrates	1	5	5	4	3
Mercury-contaminated material	1	2	5	4	1
Reactive metals	5	2	5	1	1
Contaminated soil	2	5	5	1	3

[a]Notations:
1. Broadly applicable
2. Moderately applicable
3. Limited to special conditions
4. Applicable when preceded by incineration to ash
5. Not applicable

generated on the Plant. In the first chamber, the waste is pyrolyzed at 870°C. Vaporized organic molecules and combustion products then enter an afterburner where the temperature reaches more than 1200°C for longer than 2 seconds. This type of incinerator has achieved a DRE of at least 99.9999 percent (Schreiber, 1985).

DOE plans a consolidated waste incineration facility (hazardous, mixed, and low-level) for the SRP. Current plans call for this facility to include two incinerators: one would use cyclonic, liquid injection incineration capable of destroying liquid organic wastes, including benzene from Defense Waste Processing Facility (DWPF) operations; the other would use rotary-kiln technology for the incineration of solid wastes (as much as 270 kilograms per hour) (DOE, 1985). Each unit would have spray-quench, wet-scrubber, and mist-eliminator systems. The liquid incinerator would also have a mercury absorption column. In the future, the conversion of this facility to a mixed waste facility might be desirable; if that were done, appropriate shielding and HEPA filters would be necessary.

The estimation of waste volumes in Appendix E includes assumptions for volume reduction by incineration. In general, it is assumed that liquid organics

Table D-5. Applicability of Predisposal Treatment Technologies to Mixed Wastes[a]

Waste	Predisposal treatment technology				
	Incineration	Compaction	Evaporation	Solidification	Encapsulation
Purex solvent	1	5	5	4	5
Scintillation fluid	1	5	5	4	5
Liquid organics	1	5	5	2, 4	5
Tritiated mercury	5	5	5	1	3
Tritiated oil	1	5	5	3, 4	5
PCB contaminated oil	1	5	5	4	5
FMF WWTF sludge	5	5	1	1	3
M-Area ETF sludge	5	5	1	1	3
F- & H-Area ETF sludge	5	5	1	1	3
FPF ETF sludge	5	5	1	1	3
Mercury-contaminated waste	1	3	5	4	3
Job control waste	1	1	5	4	3
Lead shielding	5	5	5	5	1
Mercury-contaminated equipment	5	3	5	5	1
Contaminated soil	3	5	5	1	3

[a]Notations:
1. Broadly applicable
2. Moderately applicable
3. Limited to special conditions
4. Applicable when preceded by incineration to ash
5. Not applicable

Table D-6. Applicability of Predisposal Treatment Technologies to Low-Level Radioactive Wastes[a]

Waste	Predisposal treatment technology				
	Incineration[b]	Compaction	Evaporation	Solidification	Encapsulation
Low-level radwaste solvents	1	5	3	1	5
Tritiated oil	1	5	5	3, 4	5
Purex solvent	1	5	5	4	5
Job control waste	1	1	5	4	1
Targets, equipment, hardware	3	3	5	4	1
Contaminated soil & radwaste	5	3	5	1	1

[a]Notations:
1. Broadly applicable
2. Moderately applicable
3. Limited to special conditions
4. Applicable when preceded by incineration to ash
5. Not applicable

[b]Incineration does not destroy or reduce radionuclides but can be used to reduce the volume, change the physical state, and chemically stabilize low-level radioactive wastes.

would be reduced by 97.5 percent, but that circumstances could reduce that to 95 or 92.5 percent. It is also assumed that combustible solids would be reduced by 92.5 percent and that the incineration of contaminated soils would result in no reduction in volume. The residuals are assumed to include both ash and exhaust gas scrubber blowdown.

D.3.3.2 Compaction

Compactor demonstration programs at the SRP and other DOE facilities (e.g., Oak Ridge and the Fuel Materials Production Facility) are reducing the volume of low-level radioactive waste. The Reactor Department and the Savannah River Laboratory (SRL) both use small (0.15-cubic-meter) box compactors. These units reduce the volume of job-control wastes by approximately 67 percent. Data from these demonstrations will provide the basis for the installation of additional compactors by the Reactor Department.

The Separations Department and Waste Management have installed a large box TC
compactor in H-Area. This unit compacts wastes into 2.6-cubic-meter, carbon-steel boxes. As waste items are received in cardboard boxes, radiation levels are verified and the waste is fed manually to the compactor. Volume reductions of greater than 80 percent have been achieved. This demon- TC
stration will permit the evaluation of (1) volume reduction achievable for low-level radioactive waste, (2) the classification of compactible material, (3) loading techniques, and (4) ventilation control requirements. Appendix E assumes a volume reduction of 75 percent through the use of this technology.

Shredding technology is a subset of compaction. As discussed in Section D.2.1.3, shredding is particularly effective when applied before incineration or compaction. Currently, the SRP and SRL are testing two small shredders (15 and 45 horsepower) for use in preparing combustible, TRU-contaminated waste for incineration (Charlesworth, 1985).

A large (160-horsepower) shredder system that is expected to begin operation by 1990 will reduce decontaminated, noncombustible process equipment and other large items. Testing has determined that a 200-kilogram glove box can be reduced for disposal in a 208-liter drum.

The Raw Materials Department in M-Area has installed a large box compactor. That compactor presumably achieves volume reductions of 76 to 80 percent.

Collectively, these compaction programs should achieve a net reduction of about 2400 cubic meters of low-level waste annually (Mentrup, 1985). This amounts to a 9-percent reduction in the amount of low-level waste to be disposed of annually at the low-level waste burial grounds.

D.3.3.3 Evaporation

No significant research on or demonstration of evaporation technology for reducing ETF sludges to dry salt for disposal has been performed at the SRP in recent years. However, assuming a bulk density of 2400 kilograms per cubic meter of dry salt, the volume reductions would range from 87.5 percent for ETF sludges with 30 percent solids content by weight to 98.3 percent for sludges with 4 percent solids by weight.

D.3.3.4 Solidification

Research on cement/fly ash solidification of ETF sludges is under way at the SRP. The material produced by this method would be formed into monoliths in lined disposal facilities, where it would cure to a concrete-like substance.

Solidification is applicable to a variety of granular solid wastes such as incinerator ash and contaminated soil; semisolid sludges such as the M-Area ETF sludge; and liquids, including contaminated water. DOE has received permits for the construction and operation of facilities to solidify decontaminated DWPF supernate and to dispose of the waste in Z-Area.

Appendix E assumes that, because of the addition of substantial quantities of material to the waste using this technology, the waste form volume would be double the original waste volume. For soil/waste mixtures derived from the TC closure of existing waste sites, solidification should result in a volume increase of approximately 40 percent.

D.3.3.5 Encapsulation

The SRP has an active waste encapsulation program. At present, greater confinement disposal (GCD) techniques are being tested at instrumented facilities in the low-level waste burial ground. The goal of GCD is to dispose of Class B and C low-level radioactive wastes in a facility that would meet the NRC 500-year longevity guideline (10 CFR 61). Self-leveling cement grout is used to encapsulate the wastes as each "lift" is placed in a GCD demonstration borehole or trench (Cook et al., 1984). Such a use of this technology is considered to be disposal rather than pretreatment.

One predisposal alternative combines solidification and encapsulation technologies. It involves the use of a shell of concrete to contain saltstone or low-level waste grouted in place. The concrete containers can be shaped to fit tightly together in rows and columns, eliminating interstitial space and improving stability.