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# Permitting Strategy for Hanford Site Research, Development, and Demonstration Activities for Treatment, Storage, or Disposal of Hazardous Waste

## Volume 3: Battelle Technology Summaries


J. F. Donaghue
E. A. Flores
S. W. Gajewski
E. P. J. Hauth
D. E. Toman


September 1993


Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830



Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute


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Pacific Northwest Laboratory
Richland, Washington 99352

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# Executive Summary

As part of the Hanford Site RCRA Permitting Strategy Project, Battelle Pacific Northwest Laboratory (PNL) initiated a technology survey to determine what activities were ongoing or proposed that involved the treatment of hazardous wastes. The survey team contacted each of the organizations within PNL to determine if that organization was conducted or planned to conduct any activities within the scope of this project. Organizational contacts led to follow-up interviews with individual scientists who were involved in testing or developing technologies to treat wastes; in many cases, interviews with technologists generated other potential contacts, who were also interviewed. To ensure that all technologies are represented, the survey team has contacted or initiated contacts with Integrated Demonstration and Integrated Program managers.

This volume describes particular technologies and their applications, purpose, design, waste management details, location details, timetable, and possible permit options as of September 1993. It is important to note that the information included is necessarily tentative because of the inherent uncertainties associated with experimental variables, outcomes of competing projects, funding, and new projects or applications for current activities. This information is, therefore, a snapshot in time, not a depiction of the certain future. The survey thus illustrates the difficulty of describing research, development, and demonstration activities with the detail, specificity, and stability necessary for a Part B permit application. This survey is an ongoing activity.

A database has been constructed to facilitate tracking and reporting of research, development and demonstration (RD&D) projects by category. A data report showing projects by permitting category is included as an Attachment to this document.

This document is Volume 3 of four volumes. Volume 1 contains Initial Conclusions and Recommendations, and Volume 2 contains Permit Options. Volume 4, Westinghouse Hanford Company (WHC) Technology Summaries, is being issued separately by WHC.

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Attachment - Projects by Permit Option and Program

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Compact Processing Unit Demonstration-UST ID

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Separations and Radiochemical Engineering Group

9413273.1065

1. **Summary Description of the Technology and Application:** The cesium compact processing unit (CPU) is a portable chemical process module which will be located near a waste storage tank and used to remove radioactive cesium from tank waste. The CPU has both scheduling and economic advantages relative to a larger, fixed facility. The CPU will be designed to be transportable to the Hanford tank farm, to process one million gallons of DST supernatant in a one-year time, and to have a minimum operating life of one year with no maintenance of the radioactive processing equipment. The cesium will be removed from the waste sufficiently to obtain NRC Class A concentration (1 Ci/m$^3$) for radioactive wastes. Based on these design constraints, efforts have been undertaken to obtain the necessary redundancy for a one-year design life while continuing to keep the system small.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** In this task, a full-scale, prototypic CPU for cesium ion-exchange will be designed, built, and demonstrated using non-radioactive simulants. The unit will be installed in a shielding module and transported to the 200-Area Tank Farm for demonstration. In order to ensure the high decontamination factors required and allow complete loading of the first column, the waste will always pass through three columns in series. The fourth column will be put on standby. The relatively new resorcinol formaldehyde resin will be used in the columns. Prior to entering the columns, the waste will be diluted, heated or cooled, and filtered. The prefilter in the CPU acts only as a polishing filter, since the waste is to be filtered during removal from the tank as part of the tank farm interface subsystem. The post filter is used to prevent resin fines from contaminating the low-level cesium stream. Both filters within the CPU will be backflushable. To reduce waste, the resin will be regenerated. After a column is detected to be fully loaded, the column will be taken off-line and regenerated while the other columns continue to be loaded. In an effort to reduce the quantity of high-level cesium waste, these streams will be sent to one tank and recycled back through the ion exchange columns to assure proper purity. The first step is to wash the column with NaOH in a downflow mode, to remove the aluminate which can precipitate at lower alkalinities. The second step is to rinse the column with water to remove excess NaOH and reduce the quantity of acid required to neutralize the highly alkaline resin. The initial eluting with nitric acid will be done in an upflow configuration in order to obtain the cleanest resin at the bottom of the column. Initially the nitric

acid will not remove the cesium. This low-level cesium nitric acid will also go to the recycle tank. When the cesium begins to elute off the column with nitric acid, it is sent to the high-level cesium tank. After the cesium has been removed from the columns, the columns are again washed with water to remove residual acid. The next step is the regeneration of the columns from their hydrogen to sodium form. The column is now ready to be put back into operation. Most of the NaOH will be sent to the recycle tank, but some will be added to the high-level cesium tank in order to neutralize it to the required 0.01M NaOH concentration for transfer to the tank farms.

3. **What Hazardous Wastes Will Be Introduced to the Process:** No actual wastes are expected to be used during nonradioactive testing. Radioactive demonstrations will at the 200-Area Tank Farm.

4. **What Waste Streams Will Be Produced:** Resorcinol formaldehyde resin, low level cesium nitric acid, high level cesium waste.

5. **Location Details:** The CPU project requires facilities for the nonradioactive demonstration and for the radioactive demonstration. The project will use existing PNL facilities for the non-radioactive demonstration. The facilities currently under consideration for the nonradioactive demonstration are: the EDL (324 Building, 300 Area); the MDL (3000 Area); the 336 Building (300 Area); and the 337 High-Bay (300 Area). The radioactive demonstration will be conducted adjacent to an existing tank farm in the 200-East Area of the Hanford Site.

6. **Timetable:** Nonradioactive demonstration is scheduled for December 1995 through February 1996. Radioactive demonstration is scheduled for December 1996 through December 1997.

7. **Possible Permit Options:** RD&D Permit or Part B TSD Permit.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Hydrothermal Destruction of Organics and Nitrates in Liquid Tank Waste

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Technology Group

1. **Summary Description of the Technology and Application:** Hydrothermal processing involves the application of heat and pressure to liquid tank waste (supernate) in order to accelerate naturally occurring chemical reactions such as hydrolysis and oxidation reduction. Experimental variables include feedwaste composition, temperature, pressure, and duration. Tank waste availability will be a significant limiting factor for this study. These studies support the pretreatment element of the Tank Waste Remediation System program.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** This study is designed to determine the hydrothermal process efficiency for the destruction of organic compounds and nitrates/nitrites during the pretreatment phase. Destruction of organics in tank wastes would resolve safety concerns relating to hydrogen gas generation and facilitate other pretreatment separations and support delivery of an appropriate waste form to the final disposal processes.

3. **What Hazardous Wastes Will Be Introduced to the Process:** 200 L (approximately 225 kg) of diluted liquid tank waste (it requires three volumes of water to pump one volume of tank waste from the tanks) would be used in a single experimental run during fiscal year (FY) 1995. The feed rate would be 1 one/hr (1.12 kg/hr) over a nine-day operating period. The entire volume would probably have to be stored on-hand in order to facilitate preliminary characterization and batch uniformity.

4. **What Waste Streams Will Be Produced:** The waste stream will consist of the tank waste minus whatever organic and nitrate materials have been destroyed by the experimental treatment.

5. **Location Details:** These studies will be conducted in the 324 Building, Room 309 (laboratory).

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Hanford Company (WHC) Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Hydrothermal Processing of 101 SY Tank Waste

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Processes Group

9413274.1069

1. **Summary Description of the Technology and Application:** This technology consists of a low temperature (300°C to 400°C) hydrothermal process (HTP). HTP is a thermal-chemical autogenous processing method that can be used to accelerate the naturally occurring reactions in the tank waste in a controlled manner so that the safety hazards are eliminated and downstream feed specification process requirements can be met. With HTP, organics react with oxidants, such as nitrate, already present in the waste. Ferrocyanides and free cyanide will hydrolyze at similar temperatures and may also react with nitrates or other oxidants present in the waste. Testing is currently taking place with a hot cell glovebox, using simulants. Four tests are planned for this year, using up to 20 g of tank waste per test (assuming that tank wastes from tank sampling activities are available). The technology is capable of batch processing between 1 to 3 L/hr.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** Current technologies have not been designed to deal with the complex nature of tank wastes. The ultimate goal of HTP testing at PNL is to perform a sufficient number of tests with simulant and actual tank waste to demonstrate the viability of HTP for the planned 20 gpm initial pretreatment module, currently scheduled to be on-line by the end of FY 1998. To be a viable process, HTP must reduce the total organic carbon (TOC) level in the tank waste to less than 1556 ppm on a five molar sodium basis.

3. **What Hazardous Wastes Will Be Introduced to The Process:** Currently all testing is done using simulants, but it is planned to run four tests in FY 1994 using up to 100 g of 101 SY waste.

4. **What Waste Streams Will Be Produced:** Testing using simulants produces a hazardous waste, which is disposed of under the current waste management system. Effluent from testing of actual waste will be managed as a liquid hazardous mixed waste stream.

5. **Location Details:** Testing with simulant is currently taking place in Battelle's Mechanical Development Laboratory and the Chemical Process Development Laboratory. Batch autoclave

testing with actual waste is being conducted in an open-face hood in the 325 Building. In 1994 a continuous bench-scale test system is planned to be installed in a hot cell. A location for this system has not yet been identified.

6. **Timetable:** The tests currently use approximately 1 to 3 L/hr of simulants during an 8-hour run. Four tests are slated for next fiscal year using up to 100 g of tank wastes. A bench-scale operation, capable of testing 5 to 10 L/day, is not expected until 1995. It is expected that the bench scale testing will require approximately 4.25 kg of tank waste four to five times per year. Flow for the bench scale tests is approximately 1 L/hr. The possibility exists that Los Alamos National Laboratory will move their system to the Hanford Site by 1995; this system is capable of testing approximately 300 gpd.

7. **Possible Permit Options:** Treatability Study Exemption.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

9. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Clean Salt Process Treatment of Tank Wastes

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Technology Group

1. **Summary Description of the Technology and Application:** The clean salt process is designed to recover inorganic salts from tank waste. Tank waste sludge is diluted with water, then cooled to precipitate sodium fluoride salt, which is removed by filtration or centrifugation. The sample is acidified with nitric acid, then evaporated to precipitate sodium nitrate, which is removed through filtration. These studies support the pretreatment element of the Tank Waste Remediation System program.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of this study is to identify and develop pretreatment technologies that separate salts from tank wastes, thereby reducing volume and improving the feed waste chemistry of the fraction that will ultimately be disposed of by grout or vitrification.

3. **What Hazardous Wastes Will Be Introduced to the Process:** These studies involve the introduction of 1.5 to 8 kg of tank wastes into the process tank and evaporator equipment. The entire sample is introduced into the process at one time. Up to 39 tests on different tank waste types, involving the same sample size, will be conducted over a period of five to eight years, beginning in FY 1995. Total amount of tank waste material used could be as much as 312 kg over the course of the whole investigation; however, sample waste would be delivered and kept on-hand only as needed. Total amount of tank waste stored on-hand would be 8 kg.

4. **What Waste Streams Will Be Produced:** Waste streams will consist of the precipitated salts and the volumetrically reduced tank waste. These will be managed and disposed of as hazardous and mixed wastes.

5. **Location Details :** These studies will be conducted in the 222-S Laboratory, but Building 324 is possible.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** WHC presently has lead on this investigation. WHC contact: Dan Herting, (509) 373-2532

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Electrochemical Oxidation of Organic and Nitrates/Nitrates in Liquid Tank Wastes

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Technology Group

1. **Summary Description of the Technology and Application:** Electrochemical oxidation involves the destruction of organic material in an electrochemical cell. The cell can be operated as a divided or undivided cell. Organic compounds are typically oxidized at the anode and nitrates can be reduced at the cathode. Conversion of these materials can occur at the electrode surfaces and also in the bulk solution if mediators are added. These studies support the pretreatment element of the Tank Waste Remediation System program.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** This investigation represents an attempt to adapt the electrolysis process found primarily in the metal purification industry to treatment of tank waste liquids. Destruction of organics and nitrates/nitrites in tank wastes would facilitate other pretreatment separations and support delivery of an appropriate waste form to the final disposal processes.

3. **What Hazardous Wastes Will be Introduced to the Process:** This investigation would involve the introduction of a single batch consisting of a maximum of 10 L (6 to 12 kg/batch) of tank waste into the experimental cell. Each run would last one to two days and would be performed on five different waste types beginning in FY 1995. Runs would be performed over a two-year period. The study will require a total of 30 to 60 kg liquid tank waste.

4. **What Waste Streams Will be Produced:** The waste stream will consist of tank waste liquid minus the destroyed organics. This waste material will be probably be used for other pretreatment investigations directed toward further separation/reduction or final disposal (grout and glass).

5. **Location Details:** These studies will be conducted in the 324 Building's radiochemical cells.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Electrochemical Treatment of Tank Wastes

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Technology Group

1. **Summary Description of the Technology and Application:** An electrochemical cell is being used to investigate the treatment of tank wastes. Several possible configurations are possible. One configuration involves the use of membranes of various types to separate various components in waste simulants. Examples of the use of this system include the treatment of effluents from other pretreatment processes (e.g., nitric acid recycle) and salt splitting (e.g., splitting of neutral salts into the constituent acids and bases). Another potential application is the electrochemical destruction of organic compounds and nitrates/nitrites. The unit is currently tested with simulants only and there are no plans to use this unit for testing with actual waste. Testing will utilize up to 15 L of simulant, with only one test conducted each day.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** These experiments investigate the feasibility of using electrochemical technology to treat Hanford tank wastes and potentially other wastes.

3. **What Hazardous Wastes Will Be Introduced to the Process:** No hazardous wastes are anticipated to be tested with the process until FY 1995 or 1996.

4. **What Waste Streams Will Be Produced:** The waste streams are anticipated to be composed of various nitrate salts (sodium, potassium, and cesium). In some experiments, these salts will be split into the constituent acids (pH of less than 2) and bases (pH of greater than 12). In other experiments, the feed will be acidic and will be separated into a concentrated and dilute acid stream. If the wastes are hazardous, they will be disposed of in accordance with PNL waste management practices.

5. **Location Details:** The experimental apparatus is currently set up in the 324 Building, Room 309 (laboratory).

6. **Possible Permit Options:** No option is currently required, as testing does not involve wastes. If testing wastes in the future, potential options consist of treatment by generator or the treatability study exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** ACT*DE*CON Actinide Leaching of Tank Waste Sludges

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Technology Group

1. **Summary Description of the Technology and Application:** ACT*DE*CON is a proprietary process which can selectively dissolve and recover actinides and some other radionuclides. Tank waste sludge is introduced into the process vessel where target contaminants are dissolved and the solvents regenerated in a continuous recirculation process. These studies support the pretreatment element of the Tank Waste Remediation System program.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** This experimental investigation of a commercially available process is designed to determine its efficacy when applied to Hanford tank waste sludges. The process would be applied to different waste mixtures, and its performance would be compared with other selective leaching approaches and also evaluated in terms of its complementarity to different types of pretreatment technologies.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Investigation of this process would involve five trials over the course of a year. Each trial will use 8 kg tank waste, which are introduced into the process equipment at the commencement of the week-long trial. Total waste volume requirements for this study would be 40 kg. Testing would begin in FY 1995. Maximum on-hand storage requirements might be minimized by taking delivery of tank waste sample material as needed.

4. **What Waste Streams Will Be Produced:** Waste streams will consist of the separated components and solvents and the residual waste sample. Total volume will be increased slightly by the additives. Each of these materials will be managed as hazardous or mixed waste.

5. **Location Details:** These studies will be conducted in the 324 Building's radiochemical cells.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Selective Leaching of Tank Waste Sludge

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Technology Group

1. **Summary Description of the Technology and Application:** Selective leaching involves the introduction of various solvents and co-agents in order to dissolve and separate specific species of interest from the tank waste sludge. Target leachates include plutonium, americium, chromium, phosphorus, sulphate, aluminum, and zirconium. Complexing and/or oxidizing agents can be added to increase the solubility of the target components. These studies support the pretreatment element of the Tank Waste Remediation System program.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** This study is designed to determine the feasibility of removing the above-noted components in order to optimize the chemistry of the waste feedstock ultimately delivered for vitrification and to minimize that amount of waste that has to be managed as high-level waste.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Currently, 1 g sample are being tested in various leaching solutions. Total waste quantities used in this investigation are less than 100 mL/yr (170 g/yr). This level of activity will continue on into FY 1994. If the lab scale trials are successful, escalation to bench scale would be possible in FY 1995 or FY 1996. Bench-scale investigation would involve approximately 20 sequential trials over the course of a year, each involving 2 kg/trial. The entire sample is introduced into the process at once. Total volume requirements would be approximately 40 kg for the bench scale investigation. Maximum storage requirements might be minimized by taking delivery of tank waste sample material as needed.

4. **What Waste Streams Will Be Produced:** Waste streams will consist of the separated components, solvents, and the residual waste sample. Total volume will be increased slightly by the additives. Each of these materials will be managed as hazardous or mixed waste.

5. **Location Details:** The small-scale testing is on going in the 325 Building. The larger tests will be conducted in the 324 Building's radiochemical cells.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** Transition to WHC at pilot scale. Contact John Appel, (509) 372-0355.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Sludge Dissolution Laboratory Studies

**Organization** Materials and Chemical Sciences Center, Chemical Technology Department, Chemical Process Systems Section, Waste Evaluation and Treatment Group

1. **Summary Description of the Technology and Application:** As part of the TWRS pretreatment program, this project is testing the dissolution behavior of AN-102 tank sludge using multiple stage acid washes.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of this technology testing is to determine the amenability of the process to pretreatment of Hanford tank wastes.

3. **What Hazardous Wastes Will Be Introduced to the Process:** The testing currently uses 0.74 g of AN-102 tank sludge. Additional tests will be run but will probably involve less than 10 g.

4. **What Waste Streams Will be Produced:** The current testing results in a low-level waste (LLW) residue and transuranic waste (TRU) elements in solution. All residues are handled in accord with PNL management procedures.

5. **Location Details:** Testing is located in the 325 Building, Rooms 511 and 516.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Laboratory Development Selective Leaching Processes

**Organization** Materials and Chemical Sciences Center, Chemical Technology Department, Chemical Process Systems Section, Waste Evaluation and Treatment Group

9413273.1083

1. **Summary Description of the Technology and Application:** As part of the TWRS pretreatment program, this project is testing the ability to selectively leach the TRU products from Hanford tank sludge in order to leave a LLW residue. Each test begins with either a water-washed or a dry Hanford tank sludge. The sludge is subjected to a leaching agent in either an acidic or basic aqueous solution, heated to 100°C for up to a hour with stirring, allowed to cool, and then centrifuged. The supernatant is decanted, further leaching agents are added, and the procedure is repeated. Several different acidic and basic (caustic) leaching agents are under investigation.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of this technology testing is to determine the applicability of the process for pretreatment of Hanford tank wastes (removing TRU products).

3. **What Hazardous Wastes Will Be Introduced to the Process:** The testing currently uses tank wastes, usually in extremely small samples (2 g). Current plans are to test the following types of tank sludge in FY 1994: B201, T107, T105, T111, 101AZ, and 102AZ (with possible repeats of tests with sludges from the B110, C112 and C109 tanks). No scale-up of these operations are foreseen for FY 1994; pilot plant scale testing may be scheduled in a few years.

4. **What Waste Streams Will Be Produced:** Wastes from the testing are disposed of in accordance with PNL waste management practices.

5. **Location Details:** The testing is currently located in the 325 Building, Rooms 511 and 516.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Radionuclide Ion Exchange Sorption of Tank Wastes

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Technology Group

9413277.1085

1. **Summary Description of the Technology and Application:** This technology involves the introduction of liquid (supernate) Hanford tank waste into ion exchange columns in order to separate out cesium, strontium, technetium, and TRU fractions. Waste material can be diluted by a factor of two or three before introduction into the ion exchange columns. These studies support the pretreatment element of the Tank Waste Remediation System program.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** These studies are designed to explore the most efficient ion exchange media and process variables for removing radionuclides from the liquid fraction of the tank waste. The initial focus is on cesium removal, but removal of Strontium-90, Technetium-99, and the TRU components are also being considered as part of an effort to reduce the radionuclide content of the grout LLW form to less than Class A limits.

3. **What Hazardous Wastes Will Be Introduced to the Process:** These studies are anticipated to begin in FY 1994 and to continue during subsequent years at about the same level. Each study will involve the introduction of several 2 mL samples of dilute tank supernate into individual test columns using a total of approximately 200 mL of actual waste over the course of a single fiscal year. The total amount of actual waste stored on-hand will be approximately 250 g. Daily feed rate will depend upon the desired superficial velocity in the columns and the column size, but rates are expected to be approximately 10 mL/hr.

4. **What Waste Streams Will Be Produced:** Waste streams will consist of the residual supernate and the separated radionuclides adsorbed onto the ion exchange media. The ion exchange media will be eluted and regenerated, but it is expected that these materials will be solid LLW. These wastes will be disposed of and/or stored as radioactive wastes, depending upon their final characteristics.

5. **Location Details:** These studies will be conducted in the 324 Building's, radioanalytical cells.

6. **Possible Permit Options:** Treatability Study Exemption

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

9413273.006

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Cesium Ion Exchange

**Organization** Materials and Chemical Sciences Center, Chemical Technology Department, Chemical Process Systems Section, Waste Evaluation and Treatment Group

1. **Summary Description of the Technology and Application:** As part of the TWRS pretreatment program, this project is testing the ability to extract cesium from a diluted simulant spiked with a cesium-137 tracer, using ion exchange resins (cesium-100 and a formaldehyde resin). Each test runs approximately 30 hours, with the cesium-100 test using approximately 25 L/test, and the other resin uses approximately 180 L/test. The tests currently use a 200 mL column volume, with the intention of downsizing to a 10 mL column volume for testing with actual tank wastes.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of this technology testing is to determine the amenability of the process to pretreatment of Hanford tank wastes (removing cesium, and possibly Strontium and TRU products).

3. **What Hazardous Wastes Will Be Introduced to the Process:** The testing currently uses simulants, with a cesium-137 spike, which is regenerated after each test to reuse the solutions. Tank waste testing will use a maximum of 100 mL of tank waste, which will undergo further pretreatment testing by other projects following its use in these tests. If the 10 mL column volume test cannot be run, batch testing, using a maximum of 15 mL/test will be performed, with approximately 30 tests required.

4. **What Waste Stream Will Be Produced:** The current testing regenerates the resins and the cesium-137 spiking agent for reuse. Tank waste residues will be used by other projects for their testing needs.

5. **Location Details:** Tests are currently located in the 325 Building, Room 507. Testing with tank wastes may require use of a hot cell, which has not been identified yet.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

9413273.1088

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Solvent Extraction Laboratory Studies

**Organization** Materials and Chemical Sciences Center, Chemical Technology Department, Chemical Process Systems Section, Waste Evaluation and Treatment Group

1. **Summary Description of the Technology and Application:** As part of the TWRS pretreatment program, this project is testing the ability to extract TRUs and strontium-90 from dissolved B-110 tank waste sludge using a multi-stage solvent extraction approach.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of this technology testing is to determine the amenability of the process to pretreatment of Hanford tank wastes.

3. **What Hazardous Wastes Will Be Introduced to the Process**: The testing currently uses simulants. Approximately 50 mL of simulated dissolved sludge is used per test. In FY 1994 there will probably be two or three different types of tank waste examined.

4. **What Waste Stream Will Be Produced**? Simulant residues are disposed of in accordance with PNL waste management practices.

5. **Location Details:** 325 Building, Rooms 511 and 516.

6. **Possible Permit Options:** Testing with simulants does not require a permit; if, in the future, testing is done with actual tank wastes, the treatability study exemption should apply.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Bench-Scale Solvent Extraction

**Organization** Waste Technology Center, Waste Process Engineering Department, Chemical Process Engineering Section, Advanced Remediation Technology Group

1. **Summary Description of the Technology and Application:** This technology will test a continuous solvent extraction system operating in a counter-current mode. Two test apparatuses will be set up, both in laboratories for testing initially with simulants. Once the test apparatus has been proven, one unit will be moved into a hot cell for testing with tank wastes. The other unit will be maintained in a low-radiation location, and additional tests will be performed with nonradioactive simulants and simulants containing radioactive tracers. The process involves diluting the tank waste with acids (such as nitric, hydrofluoric, etc.) at a ratio of 5 to 1, and sending the waste through a series of extraction, scrubbing, stripping, and washing steps, with the goal of separating the high-level TRU wastes from the LLW.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The primary purposes of this testing is to verify the feasibility of the solvent extraction process for the pretreatment of tank wastes and obtain process chemistry data for a larger scale continuous countercurrent solvent extraction system.

3. **What Hazardous Wastes Will Be Introduced to the Process:** The initial testing will be conducted with simulants only. After the initial testing is conducted, and the apparatus is moved into the hot cell, actual tank waste will be tested. This waste is assumed to contain the residues from the current characterization program. Once tank waste testing commences, 39 different waste types are scheduled to be tested, with the minimum waste requirement for operation at 200 mL (volume of in-tank sludge), and the maximum of 3.5 L, not including the diluting agent. This equates to less than 0.5 kg to less than 6 kg for each test, with multiple tests run on each waste type. Design and fabrication of the two units should be complete in FY 1994, with six months of simulant testing, and then actual tank waste testing should start in FY 1995.

4. **What Waste Streams Will Be Produced**: While testing with simulants, the wastes produced will be disposed of as hazardous wastes under the current PNL waste management system. Once testing with tank waste starts, the waste streams are projected to be high-level TRU wastes slated for disposal at the Hanford Waste Vitrification Plant and low-level wastes slated for LLW disposal. Other possible solutions include, 1) returning the waste to the tank farm system,

2) solidifying the wastes in the hot cell as glass or grout, or 3) packaging and storage at the mixed waste facility. The latter option will almost certainly be required for the spent organic solvent.

5. **Location Details:** The unit that will be used for testing the actual waste is tentatively slated for installation in the C-cell in the 324 Building. The other unit is tentatively slated for installation in Room 146 in the 324 Building.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

9413273.092

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Plasma Calcination of Tank Wastes

**Organization** Waste Form Performance Group/Materials Applications Section/Materials Sciences Department/Materials and Chemical Sciences Center

1. **Summary Description of the Technology and Application:** As a part of the TWRS pretreatment program, this activity develops an innovative technology for the decomposition and destruction of organics and cyanides contained in Hanford tank wastes.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** This technology demonstration encompasses the design, development, and demonstration of an innovative technology to treat organic and cyanide contaminated tank wastes in advance of further treatment, either through vitrification or grouting, and disposal. In general, research and development (R&D) activities will proceed through the following steps:

   - concentrating of hazardous waste simulants and small samples of actual hazardous waste through evaporation until it reaches semiviscous state
   - blowing semiviscous waste sludge through a high-pressure torch where it will be subjected to temperatures in excess of 1800 degrees $^0$F
   - pouring residual molten material into a water basin where rapid cooling transforms substance to powder state
   - analyzing residual powder contained in a crucible for destruction of organics and cyanide
   - evaluating the compatibility of a residual substance for further vitrification or grouting treatment
   - assessing viability of technology as a pretreatment method for vitrification or grouting of tank wastes (based on acceptance criteria for LLW disposal).

3. **What Hazardous Waste Will Be Introduced to the Process:** Primarily, bench-scale research will rely on simulated waste products in lieu of actual tank waste. At a maximum, RD&D activities prior to pilot-scale demonstration will require no more than 1 kg of actual tank waste.

4. **What Waste Stream Will Be Produced:** If residues from testing simulants are determined to be hazardous, they will be disposed of as hazardous wastes under the current PNL waste management program. Residues from tank waste testing will be disposed of as hazardous waste.

5. **Location Details:** Bench-scale research will take place in the 325 Building, located within the 300 Area of the Hanford Site.

6. **Timetable:** Laboratory R&D in advance of pilot-scale testing is expected to continue until the end of FY 1995.

7. **Permit Options:** Treatability Study Exemption.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

9. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

9413274.0904

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Vitrification-Terra Vit

**Organization** In Situ Vitrification Group, Waste Treatment Technology Department, Waste Technology Center

1. **Summary Description of the Technology and Application:** The Terra Vit is a new ex situ thermal treatment process based on expertise developed with joule-heated ceramic melter and in situ vitrification (ISV) technologies. Terra Vit is a mobile vitrification process that utilizes either an in-ground or above-ground melter and portable processing equipment such as the equipment associated with the ISV process. The process works by feeding a waste stream, such as contaminated soils, in through the top of the melter and onto a pool of molten soil. Terra Vit can be adapted to treat a wide range of hazardous, mixed, or radioactive waste streams ranging from contaminated soils to combustibles and liquids. Based on existing equipment capabilities, full-scale systems can be configured to treat contaminated soils at rates of 25 to 100 tons/day. Radionuclides and heavy metals will be immobilized in the residual glass product. Organics will be destroyed in the melter due to the high operating temperatures in the plenum space above the melt. Volume reduction for soils is expected to be at least 50%. Secondary wastes from the process including liquid wastes or contaminated high-efficiency particulate air filters are minimized because they can be fed back into the process.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The proposed task involves a demonstration of Terra Vit to treat contaminated soils. The volume of materials to be treated depends on the type and availability of a suitable waste stream and regulatory requirements. However, a demonstration involving the treatment of 100 tons of contaminated soils is proposed. Successful completion of this demonstration will allow the U.S. Department of Energy and WHC to use Terra Vit to process additional contaminated soils, contaminated sediments, and residual wastes from other treatment technologies such as the concentrate from soil washing activities or retrieved buried wastes.

3. **What Hazardous Wastes Will Be Introduced to the Process**: Phase I of the project will be conducted during the remainder of FY 1993 and will demonstrate the Terra Vit technology using uncontaminated soils. This initial demonstration will involve equipment assembly and operation on uncontaminated soils to verify process operating parameters and confirm equipment performance. If Phase 2 takes place (it is still in the proposal stage), a demonstration using contaminated soils will be conducted. This project may be funded in 1994.

4. **What Waste Streams Will be Produced:** None.

5. **Location Details:** Engineering scale work is located in the 324 Building in the 300 Area of the Hanford Site. Large-scale demonstration activities will likely be performed on the ISV site, located adjacent to the 300 Area of the Hanford Site.

6. **Timetable:** Testing of nonhazardous simulants is scheduled for the fourth quarter of FY 1993 and will continue into the first quarter of FY 1994. Pending approval and permitting requirements, onsite testing using actual waste has been proposed for the fourth quarter of FY 1994. Terra Vit may also be used in conjunction with the soil washing that WHC is planning. WHC may use Terra Vit to treat soil washing fines resulting from the proposed soil washing for the 100 Areas.

7. **Relevant Existing Permits:** The ISV site, located adjacent to the 300 Area of the Hanford Site, currently operates under interim status via the Thermal Treatment Part A application. Due to the experimental nature of this activity, however, other permitting options are being considered such as the RD&D mechanism and a land disposal permit for experimental treatment.

8. **Possible Permit Options:** Due to the experimental nature of this activity, options other than the Resource Conservation and Recovery Act (RCRA) Part B permitting mechanism are being considered. These include the RD&D permit or permitting under an experimental land-treatment demonstration.

9. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Vitrification High-Temperature Melter

**Organization** Applied Melter Technologies Group, Waste Treatment Technology Department, Waste Technology Center

1. **Summary Description of the Technology and Application:** The high-temperature melter is a pilot-scale, high-temperature, joule-heated ceramic melter. The high-temperature melter operates within the ceramic heating unit by subjecting feedstocks of waste or waste simulants to alternating currents between two electrodes, creating high-temperature resistance heating in the process. The melter has a maximum capacity of 125 to 190 kg/hr of waste or waste simulant material or 3 to 5 tons/day.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** Near-term experimental activities consist of the following. 1) A six-week experimental run will be conducted using a liquid-fed ceramic melting process. It is expected that 15,000 gal (approximately 30,000 kg) of waste simulants will be vitrified in the test run. The test run is tentatively scheduled for October 1993. 2) A five to six day test run of the high temperature melter will be conducted using waste simulants. It is expected that 7500 gal (approximately 15,000 kg) of waste simulants will be vitrified in the test run. The test run is tentatively scheduled for January 1994.

3. **What Hazardous Wastes Will Be Introduced to the Process**: At the present time, no hazardous wastes are expected to be introduced into these experiments.

4. **What Waste Streams Will Be Produced**? If the testing results in hazardous waste, the waste will be disposed of under the PNL waste management system.

5. **Location Details:** The high-temperature melter is located in the 324 Building in the 300 Area on the Hanford Site.

6. **Timetable:** In the first quarter of FY 1994, this activity will conduct a test run for approximately one week. An additional the run is anticipated for the second quarter of FY 1994.

7. **Possible Permit Options**: In the event that test runs of the magnitude described above involve actual hazardous waste, such activities should be evaluated for permitting under the RD&D mechanism or expanded treatability study exemption, if available.

8. **Battelle Contact**: Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Vitrification Laboratory-Scale Crucible Melting

**Organization** Waste Technology Center, Waste Treatment Technology Department, Applied Melter Technologies Group

1. **Summary Description of the Technology and Application:** Laboratory bench-scale crucible melting consists of small-scale melts to determine the optimal glass-waste matrix for the treatment and disposal of hazardous, low-level radioactive, or radioactive mixed wastes. In general, bench-scale melting is conducted in crucibles using high-temperature joule heating, supplied by small-scale, high-temperature melters.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** These tests are intended to determine the optimal glass-waste matrix for treatment of specific waste streams.

3. **What Hazardous Wastes Will Be Introduced to the Process**: Bench-scale crucible melting involves uses a variety of nonhazardous and hazardous substances as well as trace quantities of radionuclides.

4. **What Waste Stream Will Be Produced**: Testing produces small quantities of nonhazardous, hazardous, low-level radioactive, or radioactive mixed wastes, which are disposed of in accordance with PNL waste management practices.

5. **Location Details:** Laboratory bench-scale vitrification melting is conducted within laboratories of the 324 Building in the 300 Area of the Hanford Site.

6. **Timetable:** Bench-scale melting occurs on an ongoing basis in support of client-sponsored vitrification activities. On average, one melt per day throughout a given year is performed by PNL.

7. **Possible Permit Options**: Treatability Study Exemption

8. **Battelle Contact**: Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** In Situ Corona: In Situ Corona for In Situ Treatment of Nonvolatile Organic Contaminants

**Organization** Advanced Technologies Group, Remediation Technologies Section, Treatment Technologies Department, Waste Technology Center

1. **Summary Description of the Technology and Application:** This project will perform R&D requirements to develop a practical in situ technique for decomposing nonvolatile and bound organic contaminants using gas-phase oxidants that are produced in situ. The gas-phase oxidants are produced by corona, made to occur on soil particles by alternating current (AC) electricity delivered to an array of electrodes installed in the soil. The expected result would be clean soil without resorting to excavation, high temperatures, or injected chemicals. Corona-based soil treatment is expected to be the least sensitive to the type of organic contaminants involved and the most effective in low-permeability soil.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The proposed task will perform R&D necessary to understand the physics and chemistry of in situ corona in sufficient detail to make projections on the effectiveness and practicality of this technique for field applications over a three-year period. The task will provide baseline laboratory data on treatment efficiency, reaction by-products, energy requirements, and site applicability.

   The overall approach will be to bring together existing knowledge of ex situ corona chemistry and in situ application of electrical fields to develop an understanding of how in situ corona could be used to accomplish the in-place destruction of diesel fuel, polychlorinated biphenyls (PCBs), heavy oils, and other nonvolatile compounds and mixtures. The focus will be to provide sufficient laboratory data and knowledge to support transfer of the in situ corona technology to design testing and evaluation (DT&E). (The DT&E phase is expected to be conducted by the volatile organic compound [VOC] arid soils integrated demonstration [ID]).

   Labscale work in advance of demonstration will focus on scale-up parameters and process efficiency.

3. **What Hazardous Wastes Will Be Introduced to the Process**: It is anticipated that during FY 1994 tests will run on 50 kg of contaminated soil, with possible constituents ranging from PCBs, trichloroethylene (TCE), perchloroethylene (PCE), and other chlorinated hydrocarbons.

Additional tests on a scaled-up version of in situ corona may be run in FY 1995 using approximately 1500 kg of contaminated soil. Each series of tests is expected to last one week.

4. **What Waste Streams Will be Produced**: The residual waste stream from the treatment process is expected to be clean but will be disposed of as hazardous waste.

5. **Location Details:** Laboratory-scale work will take place in the 324 Building located in the 300 Area on the Hanford Site.

6. **Timetable:** Bench-scale work is currently underway. Initial treatability tests are tentatively planned for the second quarter of FY 1994. Scale-up treatability tests are anticipated for FY 1995.

7. **Possible Permit Options:** Activities during FY 1994 should qualify for the treatability study exemption. However, larger scale activities taking place later should be evaluated for possible permitting under the RD&D mechanism or an expanded treatability study exemption, if available and if such activities involve the treatment of actual waste.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Liquid Corona

**Organization** Advanced Technologies Group, Remediation Technologies Section, Waste Treatment Technology Department, Waste Technology Center

1. **Summary Description of the Technology and Application:** Liquids and sludges contaminated with organic compounds pose an enormous problem at Hanford, because the contents of several single- and double-shell tanks are contaminated with chelators complexants, other organics that complicate reprocessing, and other waste treatment methods. While many methods have been proposed for treating or removing the organic components of mixed wastes, a potentially simple and inexpensive method that should be evaluated is point-to-liquid (or point-to-plane) corona discharge.

   Point-to-plane corona discharge employs a high-voltage direct current between a negatively charged electrode in air and an electrically grounded liquid, where the liquid is the waste to be treated. The oxidants that are created from the air by the discharge then mix with the liquid, where they destroy the contaminants. The process works at room temperature and pressure and can be accomplished in a simple, stirred tank. So far, laboratory tests have demonstrated destruction of a wide range of organics, including TCE, acrylamide, benzo(a)pyrene, organic dyes, methane, and carbon tetrachloride. The major by-products of the organic destruction are thought to include small, molecular-weight organic acids, carbon dioxide, water, and, when treating chlorinated organics, hydrochloride acid. This process can provide cost- and energy-efficient destruction of a variety of aqueous-phase organic contaminants that are found in many industrial waste streams. This project supports the TWRS pretreatment program.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** Current small-scale laboratory experiments typically use between 100 and 500 mL of aqueous organic solutions. Bench-scale experiments that are in progress in the Advanced Technologies Group will use approximately 5 L of test solution in a batch reactor. It is estimated that one to two years will be spent on the refinement and testing of this bench-scale apparatus. After these tests are completed, it will be possible to begin construction of a pilot-scale liquid corona reactor that will be capable of continuously treating approximately 1 to 2 L/hr of contaminated liquids. Solutions that will be studied using these apparatus include simulants of 101 SY Hanford tank waste and various concentrations of industrial organic wastewater contaminants, such as ethyenediaminetetraacidic Acid (EDTA), TCE, PCE, petroleum hydrocarbons, pesticides, and carbon tetrachloride.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Approximately 2 L of hazardous waste is expected to be used in mid-FY 1994. Additional treatability testing is tentatively scheduled for FY 1995, with the possibility of treating approximately 100 gal (400 L) at a rate of 1 L/h. Treatability testing will take place on a sample liquid waste stream, with possible constituents including organic acids, petroleum hydrocarbons, and chlorinated compounds (e.g., carbon tetrachloride, PCE, TCE, and EDTA).

4. **What Waste Streams Will Be Produced:** Experimental work is designed to show destruction of waste constituents. However, process by-products will be disposed of as hazardous waste.

5. **Location Details:** Work will take place in the 324 Building (EDL), located in the 300 Area of the Hanford Site.

6. **Timetable:** Bench-scale work using simulants is currently underway. Treatability testing of this process is expected to take place in mid-FY 1994, with larger scale treatability testing tentatively scheduled for FY 1995.

7. **Possible Permit Options:** FY 1995 pilot-scale testing may qualify under the treatability study exemption. However, this activity should be evaluated for possible permitting under the RD&D mechanism.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

9. **Westinghouse Contact and Transition:** John Appel, (509) 372-0355. Transition to WHC at pilot scale.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** High-Energy Corona for Destruction of VOCs in Process Off-Gases

**Organization** Advanced Technologies Group, Remediation Technologies Section, Waste Treatment Technology Department, Waste Technology Center

1. **Summary Description of the Technology and Application:** The objective of this task is to develop and conduct field tests on a prototype off-gas treatment unit capable of treating 5 standard cubic feet (scfm) or greater of quantities of water-saturated off-gas containing up to a total of 500 ppm of TCE and PCE. The prototype will represent an innovative, high-energy corona (HEC) technology to completely oxidize these VOCs with no further treatment required, other than acid-gas scrubbing (if effluent Hcl levels require this).

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The expected inherent advantages of the delivered system would include no need of external off-gas heating, cooling, or drying; no need for additives, catalysts, sorbents or any regenerables; and low energy consumption. The objectives of the proposed task will be accomplished in three stages. The first stage will begin with tests to determine the best design embodiment for off-gas treatment. Further tests will obtain sufficient data to complete engineering specifications for the prototype unit. In the second stage, the prototype off-gas treatment unit will be designed, built, and tested to obtain baseline performance data. Completion of the first two stages will produce a pretested prototype unit available for immediate field implementation. The third stage will involve the actual field implementation and testing of the prototype unit. A final summary report will be submitted at the end of the task.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Presently there are no activities involving hazardous waste that are scheduled for this project. However, additional research in FY 1994 may involve using this technology in conjunction with six-phase soil-heating tests involving the treatment of soil contaminated with hazardous waste (less than 50 kg).

4. **What Waste Streams Will Be Produced:** If testing produces hazardous wastes, they will be managed within the PNL waste management system.

5. **Location Details:** The first and second stages of this activity will take place in 324 Building laboratories, located in the 300 Area of the Hanford Site. The location(s) of the third stage of this activity have not yet been determined.

6. **Timetable:** Engineering scale work is currently being conducted using simulants. Possible work in conjunction with other treatment techniques (six-phase soil heating) may be conducted in FY 1994. No tests are definitively scheduled that involve the use of hazardous waste.

7. **Possible Permit Options:** Activities for this project should fall within the treatability study exemption.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** High-Energy Corona, Off-Gas Treatment Component of ERACE System that also Includes Six-Phase Soil-Heating and In Situ Corona Technologies

**Organization** Advanced Technologies Group, Remediation Technologies Section, Waste Treatment Technology Department, Waste Technology Center

1. **Summary Description of the Technology and Application:** The HEC process uses high-voltage electricity to destroy VOCs at room temperature. The equipment consists of an HEC reactor in which the VOCs are destroyed, inlet and outlet piping containing process instrumentation (humidity, temperature, pressure, contaminant concentration, and mass flow rate), means for controlling inlet flowrates and inlet humidity, and a secondary scrubber for removing chloride and hypochlorite species (bleach) when chlorinated organics (e.g., TCE and PCE) are destroyed.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The HEC reactor is a glass tube filled with glass beads through which the contaminated off-gas is passed. Each reactor is 2 in. in diameter, 4-ft long, and weighs less than 20 lb. A high-voltage electrode is placed along the centerline of the reactor, and a grounded metal screen is attached to the outer glass surface of the reactor. A high-voltage power supply is connected across the electrodes to provide 0 to 50 Ma of 60 Hz electricity at 30 kV. The electrode current (and power) depends on the type and concentration of contaminant. One reactor processes up to 5 scfm of soil off-gas. The HEC field-scale process that will be demonstrated at Savannah River uses 21 HEC reactors in parallel to treat up to 105 scfm of contaminated soil off-gas.

3. **What Hazardous Wastes Will Be Introduced to the Process:** The contaminants of concern for the integrated demonstration are TCE, PCE (Savannah River), carbon tetrachloride, chloroform, diesel fuel, and gasoline (Hanford). The input waste stream is contaminated soil off-gas, prefiltered to remove entrained particulates.

4. **What Waste Streams Will Be Produced:** The output will be air that meets or exceeds regulatory requirements for release into the atmosphere. Typical outlet properties would be undetectable concentrations of TCE, ozone, hydrochloric acid, phosgene, and chlorine, with up to 1 ppmv NOx (below regulatory limits.)

5. **Location Details:** This technology is being developed in the 324 Building in the 300 Area on the Hanford Site.

6. **Possible Permit Options:** Treatability Study Exemption or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) onsite Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Six-Phase Soil Heating for Enhanced Removal of Contaminants-VOCs in Non-Arid Soils ID

**Organization** Advanced Technologies Group, Remediation Technologies Section, Waste Treatment Technology Department, Waste Treatment Center

1. **Summary Description of the Technology and Application:** A way to extend the effectiveness of soil-venting methods to less volatile compounds, to less permeable soils (like clay) and, potentially, to contaminated depths near or at the water table, is to heat the soil while venting. By heating the soil and the contaminant, the contaminant's vapor pressure is increased so it diffuses faster into vented air, increasing the rate at which it can be removed. Moreover, by heating a soil to the point where its soil moisture begins to boil, the soil is dried and steam is created, which both increases the soil's permeability and enhances the stripping of the contaminant. This potentially has the added benefit of enabling higher molecular weight, lower volatility compounds to be removed by simple venting.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The objective of the six-phase soil heating task is to develop and demonstrate a technique that uses common AC electricity to heat soils cost-effectively as a means of improving and extending the performance of conventional soil-venting techniques. The specific goal will be to successfully demonstrate the six-phase soil-heating technology for the removal of TCE and PCE from a clay-based soil as part of the volatile organic non-arid ID.

3. **What Hazardous Wastes Will Be Introduced to the Process:** This activity may use as much as 50 kg of actual waste in the form of contaminated soil (TCE, PCE) in FY 1994. No definitive plans to use actual hazardous waste have yet been made.

4. **What Waste Streams Will Be Produced:** If the output waste stream is hazardous, it will be disposed of under the PNL waste management system.

5. **Location Details:** Engineering scale activities for this project are to take place in the 324 Building, located in the 300 Area of the Hanford Site.

6. **Timetable:** A demonstration is scheduled for September 1993. Preliminary design work has already been completed. In September 1992, a field test was performed on the Hanford Site (ISV site) on uncontaminated soil. Small-scale treatability activities (less than 50 kg) may take place in FY 1994.

7. **Possible Permit Options:** FY 1994 testing will possibly fall within the treatability study exemption.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** NitRem Chemistry in Dual-Shell Pressure-Balanced Vessel

**Organization** Technology Transfer

1. **Summary Description of the Technology and Application:** NitRem is a non-catalytic, hydrothermal process designed to convert aqueous nitrogen compounds such as nitrates, ammonia, and amines, into nitrogen gas, water, oxygen, and carbon dioxide. It is intended to be used with industrial, municipal, and federal waste streams. Nitrogen conversion occurs at temperatures between 350°C to 380°C, pressures between 2500 to 4500 psi, and within a wide pH range that depends on the input nitrogen form (e.g., nitrate or ammonia).

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of these tests is to demonstrate the efficiency of the process with a particular waste stream prior to constructing a full-scale operation at the generation point.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Numerous waste streams will be tested in this process, ranging from nonregulated wastes, such as sludge centrate (which is the dirty water remaining after POTW sludge is centrifuged), regulated wastes such as redwater (a process waste stream from production of trinitrotoluene [TNT], listed as waste K047), and mixed wastes.

4. **What Waste Streams Will Be Produced:** Where the input waste stream is nonhazardous (e.g., centrate), the output will not be a hazardous waste and will be disposed of at the local POTW, per direction of the City of Richland. Where the input waste stream is hazardous, the output waste stream may or may not be hazardous, but it will be disposed of in accordance with PNL waste management practices. It is probably not cost-effective to attempt to delist wastes at this small of a quantity.

5. **Location Details:** The technology has been tested in a small (8 mL) cell, using approximately 1 kg total waste. Four more tests will take place within the CEL Building (again small-scale), and

a pilot-scale plant will be constructed at either the MRC or MDL buildings (located on Battelle-owned land) later this year. Operational testing is scheduled to start at the end of 1993 using nonhazardous wastes.

6. **Timetable:** Once operational later in 1993, the pilot plant will test waste streams at a rate of 10 gph, with no more than 55 gal of any one waste stream tested per day. The daily 250 kg treatability study limit and the 1000 or 500 kg storage limit do impact this project, requiring PNL staff to schedule shipments of wastes and begin experiments.

7. **Possible Permit Options:** For testing of nonhazardous waste, no permit option is required. For testing hazardous wastes, the treatability study exemption applies, with the provision that the studies are planned to meet limits within regulation.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle Pacific Northwest Laboratories

**Project Title** Metal-Bearing Acid Recycling

**Organization** Materials and Chemical Sciences Center, Chemical Technology Department, Chemical Process Development Section

1. **Summary Description of the Technology and Application:** This technology uses a combination of advanced materials, distillation, and selective precipitation to concentrate heavy metals and recycle acids for reuse.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of the testing is to demonstrate that the technology effectively recycles spent acid solutions from various industrial facilities prior to installation of the recycling equipment at the industrial site.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Sample sizes are typically one to four 55-gal drums.

4. **What Waste Streams Will Be Produced:** The reclaimed acids and metal concentrate will be returned to the industrial facility for reuse.

5. **Location Details:** The technology is being demonstrated at Tinker Air Force Base, Johnson Technologies, Boeing Aerospace, and Burlington Environmental.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Low-Temperature Catalytic Gasification of Wet Organic Waste

**Organization** Materials and Chemical Sciences Center, Chemical Technology Department, Chemical Process Development Section

1. **Summary Description of the Technology and Application:** Low-temperature gasification involves testing organic wastes (both hazardous and nonhazardous), in the presence of a catalyst (nickel metal on an inert support), under approximately 3000 psig pressure and 360°C. The testing is conducted to determine the efficiency of the technology, primarily in removing organics. There are three reactors in place in the Richland Area. The technology has primarily been tested with nonhazardous wastes, although some specific potassium-listed wastes have been tested at small scales and are intended to be tested in the scaled-up reactor.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The intent of the technology testing is to demonstrate that the technology is efficient in removing organics from specific industrial waste streams (primarily non-Hanford wastes). Once the technology is demonstrated in the laboratory, a mobile onsite demonstration unit will be set up in partnership with the industrial sites selected.

3. **What Hazardous Wastes Will Be Introduced to the Process:** For both the batch and bench-scale continuous flow reactors, sample sizes are very small, ranging from 1 L for the batch reactor to 5 gal for the bench-scale continuous-flow reactor. However, for the scaled-up reactor system, sample sizes are typically two 55-gal drums (the treatment facility limits on storage are of concern here), and the desired testing is 5 gal/h for 10 to 20 hours, with 20 hours being preferable. The 250 kg/day facility limit on treatability studies limits the ability of the researchers to demonstrate the technology effectively.

4. **What Waste Streams Will Be Produced:** Depending on the efficiency of the process, the liquid waste stream may not be hazardous. If testing determines it is hazardous, it is disposed of in accordance with PNL management guidance. The nickel catalyst bed is disposed of as a hazardous waste.

5. **Location Details:** A small batch reactor capable of testing approximately 300 mL per test (with a 35 g catalyst bed) and a bench-scale, continuous-flow reactor capable of testing 1 to 2 L/hr (with

a 1 kg catalyst bed) are in the CPDL (RTL Building). A scaled-up reactor system, capable of testing up to 5 gal/hr (with a 10 kg catalyst bed) is in the MDL.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Chemically Enhanced Semipermeable Earthen Barrier Materials

**Organization** Earth and Environmental Sciences Center, Geoscience Department, Geochemistry Section

1. **Summary Description of the Technology and Application:** These bench-scale investigations involve the fixation or coating of soil particles with additives such as zeolite minerals, rubber, metal oxides, or chelating agents in order to develop earthen barrier materials which will permit permeation by water but will chemically "capture" water-borne contaminants and prevent the migration of same. Actual or simulated wastes are introduced to experimental soil mixtures in a series of test tube batches. Parallel investigations are underway at this time with zeolite and shredded tire admixtures.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** Conventional barrier technology depends upon maximizing hydrological impermeability. This approach often creates water-accumulation problems in waste material containment areas and may cause secondary hydrological problems around sites. Water-permeable barrier materials would act as filtration sponges which might ultimately be geochemically "fine-tuned" to capture specific contaminants.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Liquid waste from Hanford or other DOE waste sites are brought to the laboratory in 5 to 12 gal plastic carboys. Waste materials and experimental soil materials are evaluated in test tube batches involving approximately 30 to 50 mL of solution per tube. At any given time, approximately 100 tests with durations from 10 to 100 days may be ongoing. The amount of liquid feedwaste material or simulant used for the two current investigations does not exceed 5 to 25 L per calendar quarter. Use volumes for a typical suite of tests (e.g., a batch of 100 tubes being studied for 30 days) would be 3 to 5 L. The maximum amount of liquid sample feedwaste stored at the laboratory at any time is approximately 25 L. It is anticipated that these experiments will continue at this level over the next several years. Additional lines of inquiry involving man-made solid chelating agents and naturally occurring cation exchange minerals could be added.

4. **What Waste Streams Will Be Produced:** The amount of solid experimental soil mixtures generated is typically no more than 10 kg per quarter. The waste stream will consist of contaminated

water and soils. The waste liquids are decanted from the test tubes and stored in plastic carboys for disposal. The moist soils and spent test tubes are disposed of as low-level or mixed solid waste, as appropriate.

5. **Location Details:** These studies occur in the 3720 Building (300 Area). Field application studies are anticipated next year at the 100N Area expedited response site under WHC direction and management In the future, studies may occur at other DOE sites.

6. **Possible Permit Options:** Treatability Study Exemption.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** Frank Gustafson, (509) 376-1736 and Cecil Kindle, (509) 372-1353.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Soil Washing

**Organization** Earth and Environmental Sciences Center, Geoscience Department, Geochemistry Section

1. **Summary Description of the Technology and Application:** These bench-scale investigations involve introducing contaminated soils into water or aqueous chemical solutions in order to wash or dissolve contaminant fractions from the soil. Water washing largely involves separating contaminated fines from "clean" coarser particles, the latter of which can be put back in place. Chemical washing also involves sorting by particle size. If successful, dissolution/desorption may remove some or all of the contaminants from particles of any size.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** Contaminated soils must presently be disposed of as either TRU, low-level, or mixed hazardous waste, depending on the nature of contamination. Soil washing could ultimately be accomplished onsite, maximizing the amount of soil that could be put back in place while minimizing the volume of material that would have to be disposed of in an appropriate burial ground. Current limitations on soil washing include process efficiency and practical batch size.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Water and chemical washing experiments together involve use of approximately 50 kg of contaminated soils during each calendar quarter. The soils tested have several contaminants above the action level (cesium-137, uranium-238, cobalt-60, eur. Daily use volumes are approximately 1 kg (2 processing machines, each running a single batch of 500 g in a single day). The maximum convenient amount of contaminated soils stored at the laboratory at any time is approximately 50 to 100 kg. It is anticipated that these studies will continue at this level over the next several years.

4. **What Waste Streams Will Be Produced:** Waste streams typically consist of a contaminated soil fraction and contaminated water/solution. The water is cleaned; spent filters are disposed of appropriately, based on the waste classification, along with the contaminated soil, in accordance with PNL waste management procedures.

5. **Location Details:** These activities take place in the 3720 Building. Scale-up would be to the field demonstration level. Field applications are scheduled, managed, and funded by WHC. WHC may use PNL to support field work by analyzing samples in the laboratory as described.

6. **Possible Permit Options:** Treatability Study Exemption

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** Jim G. Field, (509) 376-3753 or Joan Woolard, (509) 376-2539.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Westinghouse Hanford Company
Pacific Northwest Laboratory

**Project Title** Prototype Surface Barrier 216-B-57 Crib

**Organization** Earth and Environmental Sciences Center, Geoscience Department, Hydrology Section

1. **Summary Description of the Technology and Application:** A prototype surface barrier is to be placed over a portion of an abandoned radioactive waste disposal crib as part of a demonstration for in situ disposal of the contaminated soils. This demonstration is part of the Surface Barrier Development Program. The barrier will cover an area of approximately 2 hectares; center thickness will be 4-5 meters. The barrier is intended to prevent mobilization of contaminants in the subsoil by collecting percolating storm water and any precipitation added as part of the testing program. Construction will begin in August of 1993 and testing and evaluation will continue for three years.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** This experimental barrier will demonstrate water-balance characteristics associated with this design and construction and provide data for long-term performance of such barriers for use in the immobilization of in situ radioactive and chemical contaminants. Such earthen caps, if effective, will be used extensively for permanent in situ disposal of the wastes at the Hanford 200 Areas and at other sites throughout the DOE complex.

3. **What Hazardous Wastes Will Be Introduced to the Process:** This is an in situ containment and disposal technology. Condensate from an air treatment system for radioactive waste tank vents was disposed of in this crib from 1967 through the mid-1970s. There will be no introduction of "new" waste materials.

4. **What Waste Streams Will Be Produced:** None

5. **Location Details:** The barrier will cap the 216-B-57 crib, a CERCLA past-practice unit in the 200-BP-1 Operable Unit in the 200 Area.

6. **Possible Permit Options:** No permit required for this demonstration on a CERCLA Past Practice (CPP) unit; however, similar studies on RCRA past practice units, if undertaken, would require a RCRA permit for disposal and closure.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

8. **Westinghouse Contact and Transition:** WHC is currently the lead on this project. N. Richard Wing, WHC, 345 Hills, Room 13, (509) 376-6806.

9413273.1122

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Base Catalytic Destruction of PCB-Contaminated Soils

**Organization** Materials and Chemical Sciences Center (MCSC), Chemical Technology Department, Chemical Process Development Section, Environmental Remediation Processes Group

1. **Summary Description of the Technology and Application:** This technology consists of an inexpensive, low-temperature, chemical dehalogenation process that can detoxify not only PCBs, but also dioxins, pesticides, and other hazardous organic compounds.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** Current technologies generally involve high-temperature destruction. This uses an inexpensive base (sodium bicarbonate), a long residence time (approximately one hour), and a low-temperature (350°C) rotary reactor.

3. **What Hazardous Wastes Will Be Introduced to the Process:** This technology has been tested at several locations world-wide. When funding is available, a small-scale reactor will be built in Battelle laboratories to test the technology for efficiency with a variety of waste streams prior to installation of a pilot-scale plant onsite. Actual waste streams have not been identified.

4. **What Waste Streams Will Be Produced:** Testing using hazardous products may result in hazardous end-products which will be managed in accord with PNL management practices.

5. **Location Details:** Testing has been conducted offsite thus far; when funding is available, a bench-scale reactor will be installed in the MRC, MDL, or CEL buildings.

6. **Timetable:** Unknown at this time.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Catalyzed Electrochemical Plutonium Oxide Dissolution (CEPOD): Mediated Electrolyte Oxidation Support

**Organization** Advanced Remediation Technology Group, Chemical Process Engineering Section, Waste Process Engineering Department, Waste Technology Center

Chemical Process Systems Section, Chemical Technology Department, Materials and Chemical Sciences Center

1. **Summary Description of the Technology and Application:** This project involves the development of ambient-temperature electrochemical processes for the destruction of hazardous organic wastes and for leaching/dissolving plutonium dioxide in residues. These processes can also be used to oxidize organic components of mixed wastes, ultimately converting mixed wastes to low-level radioactive wastes. Ambient temperature oxidation of the mixed wastes in a condensed phase avoids the possibility of high-temperature volatilization of radionuclides during incineration, thus minimizing gas cleanup requirements and attendant risk of possible airborne contamination release.

   Powerful oxidizers (mediators) such as silver (II), cesium (IV), or cobalt (III) promote the oxidation of organics that are dissolved in an aqueous electrolyte. Hydrocarbon organics are completely converted to carbon dioxide and water. In the case of halogenated organics, halide ions are also liberated. Oxidizers are reduced to lower oxidation states during reaction with water and organics.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of this program is to provide technical support to the Rocky Flats Plant (RFP) for the testing and demonstration of the catalyzed electrochemical oxidation (CEO) system that was supplied to RFP in FY 1993. The CEO technology will be demonstrated as an alternative to incineration for typical RFP combustible wastes.

3. **What Hazardous Wastes Will Be Introduced to the Process:** Approximately 50 mL of RMW plutonium-contaminated waste oil will be introduced over a test run period of 1 to 3 days.

4. **What Waste Streams Will Be Produced:** If the output is hazardous, it will be managed under the PNL waste management system.

5. **Location Details:** Laboratory testing for this project takes place in the 325 Building, located in the 300 Area on the Hanford Site. Pilot-plant activities will take place in the MRC facility located on Battelle private land (3000 Area).

6. **Timetable:** The treatability activities noted above are anticipated for the first quarter of FY 1994.

7. **Possible Permit Options:** Treatability study exemption. Future pilot-scale activities for this project should be evaluated for permit requirements under the RD&D mechanism.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Magnetic and Nonmagnetic Melt/Slag Treatment of Mixed Wastes

**Organization** Nuclear Materials Applications Section/Nuclear Systems and Materials Department/Reactor Technology Center

1. **Summary Description of the Technology and Application:** Studies show that large quantities of metals, both ferrous and nonferrous, exist in the DOE inventory and that much more metal will be generated by future remediation, decontamination, and decommissioning activities. Small quantities of corrosion products, regulated materials, and even trace radionuclides are present in this inventory. With a well-developed melt/slag process and enhancement of slag fluxing, most corrosion products, regulated materials, and radionuclides may be decontaminated for recycle or direct land disposal. The quality of metal produced by both ferrous and nonferrous melt/slag processes needs to be established adequately to define the tradeoffs between minimum treatment for disposal and treatment for recycle.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The objective of this proposal is to identify a reasonable cross section of the types of metal wastes which will ultimately require treatment and to determine through experimentation the partitioning efficiency, waste volume reduction, and other important features achievable through various melt/slag and slag-fluxing treatments. The proposed work is divided into two phases: laboratory-scale experiments (to be preceded by a technology assessment report) in FY 1993 and a pilot-scale demonstration on a larger scale later to demonstrate the compaction and partitioning efficiency of the selected technology, so as to provide ample verification of the data used in tradeoffs between minimum treatment for disposal and treatment for recycle. Potential benefits from this work are substantial reductions in waste volume and recycle of sizeable amounts of metal which would otherwise be disposed of a mixed waste.

3. **What Hazardous Wastes Will Be Introduced to the Process:** No laboratory work has currently been undertaken on this activity and it has not been determined when such work will take place. However, it is anticipated that laboratory testing will involve the use of uranium (natural or depleted) with the possibility of using sample LLW metals and/or radioactive mixed waste metals. Projected glovebox testing will involve approximately 5 to 10 batches of approximately 10 kg/batch.

4. **What Waste Streams Will Be Produced:** The waste output will be managed in accordance with PNL waste management practices.

5. **Location Details:** Research activities are expected to take place in the 306W Building, located in the 300 Area on the Hanford Site.

6. **Timetable:** It is likely that laboratory testing will not take place until the latter half of FY 1994 or the start of FY 1995.

7. **Possible Permit Options:** Treatability Study Exemption.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Development of High Capacity Selective Fixed Sequestering Agents

**Organization** Radiochemical Processing Group, Chemical Process Systems Section, Chemical Technology Department, MCSC

1. **Summary Description of the Technology and Application:** Phase I of the project(s) is to test the capacity, selectivity, and stability of selected sequestering agents and substrates in representative physical, chemical, and radiation environments. Emphasis will be placed on developing and demonstrating extractants with potential applications in radioactive mixed waste management that would result in major cost reductions and environmental benefits.

   Phase II testing of the industrial technology with radionuclides will be conducted at PNL with industry participation. Actual Hanford wastes will be used to determine the usefulness of the industrial materials. Phase III will involve scale-up and pilot-plant testing.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of this work is to develop high-capacity, selective solid extractants for cesium, strontium, chromium, silver, and noble metals from nuclear wastes. A collaborative effort with industry and university participants is underway.

3. **What Hazardous Wastes Will Be Introduced to the Process:** At present, bench-scale testing is underway using simulants. No waste is being used at this stage. Phase II testing, however, will likely involve approximately 1 L of tank wastes, used in multiple tests. The number of such tests is not yet known. Pilot-scale testing in Phase II will likely take place offsite at sponsor locations and not at Hanford.

4. **What Waste Streams Will Be Produced:** If the output of the tests is hazardous, it will be disposed of in accordance with PNL waste management practices.

5. **Location Details:** Phase I and Phase II activities will take place in the 325 Building, located in the 300 Area of the Hanford Site.

6. **Timetable:** Bench-scale activities were begun early in FY 1993. Phase II testing is expected to begin in the first quarter of FY 1994.

7. **Possible Permit Options:** Treatability Study Exemption.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

9413274.1130

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** In Situ Bioremediation of Carbon Tetrachloride, Nitrate, and Chloroform in Groundwater

**Organization** Waste Technology Center,, Waste Treatment Technology Department, Remediation Technologies Section, Bioremediation Group

1. **Summary Description of the Technology and Application:** Native microorganisms can be stimulated with acetate to consume and degrade carbon tetrachloride and nitrates in soils and groundwater. In laboratory, bench-scale, and pilot-scale tests, it has been demonstrated that 99% of nitrates and 93% of carbon tetrachloride contamination in groundwater can be degraded.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The in situ bioremediation process injects acetate and nitrate (as needed after initial nitrate levels are depleted) through a series of injection wells or injection well screens as part of a multi-screened mixing well. These nutrients are mixed with the groundwater through an appropriate injection strategy to maximize contaminant degradation and minimize excessive microbial growth around the well. The injected nutrients produce an active zone of organisms that will degrade contaminants as they are pumped through the treatment zone. The system can employ a series of injection and extraction wells to mix contaminated groundwater with nutrients and microorganisms or the system can use one or more multi-screened mixing wells to mix the water, nutrients, and microorganisms without extraction to the surface. The residual effect on the aquifer of applying this technology will be elevated levels of naturally occurring microorganisms. If the operating scenario using a series of extraction and injection wells is used (rather than the mixing wells), outputs of the system at the surface would include carbon dioxide, nitrogen gas, and excess biomass (microorganisms).

3. **What Hazardous Wastes Will Be Introduced to the Process:** No wastes are introduced to the process. Acetate and nitrate as nutrient materials are introduced.

4. **What Waste Streams Will Be Produced:** No output waste stream is generated. The technology occurs in situ. However, if co-contaminants such as heavy metals or radionuclides are extracted with the VOC and nitrate-laden groundwater, then conventional treatment techniques may need to be employed in addition to the bioremediation. These processes would generate additional secondary waste.

5. **Location Details:** Field demonstration of this technology will take place on the 200-West Area of the Hanford Site, west of T-Plant within the 1 ppm contour of the carbon tetrachloride groundwater plume.

6. **Timetable:** Demonstration of this technology is scheduled during the spring of 1994. Currently, two monitoring wells have been installed, and the first multi-screened mixing well is being completed. A fourth monitoring well and one more mixing well (control) will be installed prior to the initiation of the demonstration in April 1994. Design simulations using a three-dimensional flow, transport, and reaction computer code are underway to help define operating procedures and nutrient injection strategies. The above-ground process control and nutrient injection equipment are being procured. Laboratory tests are ongoing to confirm computer predictions. Design simulations were based on reaction kinetics developed in 1993 with a rigorous set of laboratory experiments, as well as field measurements taken to identify hydraulic and chemical properties of the test site. A detailed test plan identifying all assumptions, performance criteria, procedures, and backup data to support the operational procedures chosen, will be available for review in September or October of 1993.

7. **Possible Permit Options:** No permits are anticipated for this activity. Demonstration will take place under CERCLA expedited response substantive requirements.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Electroseparation

**Organization** Materials and Chemical Sciences Center, Chemical Technology Department, Chemical Process Development Section, Process Technology Development Group

1. **Summary Description of the Technology and Application:** Electrodialysis combines charge selective membranes and an applied electric field to separate charged species. The existing system is configured in a three-compartment cell with the membranes separating the compartments. A waste stream is pumped into the center compartment and a potential is applied between the cathode and anode. The imposed electric field causes the movement of ions; negative ions migrate to the anode and positive ions migrate to the cathode. The waste type is strictly chemical solutions, which are reconstituted and results in no wastes being generated. The current process has a maximum flowrate of 100 mL/min and a maximum operating time of 2 to 3 hours. Typically, the total volume used per compartment is no more than 1 L. A bench-scale apparatus is planned for early FY 1994 (assuming funding is available). This system will operate at a flow rate of approximately 1 L/min and a maximum operating time of 3 hours. With these conditions, up to 180 L of solution may be used. Again, no simulant or actual Hanford wastes are expected to be used.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** This technology will be used to determine the feasibility of using membranes to selectively allow specific charged materials to pass while screening out others. For example, a particular application is to separate sodium ions ($Na^+$) from cesium ions ($Cs^+$), which requires a membrane to pass the $Cs^+$, but retain the $Na^+$.

3. **What Hazardous Wastes Will Be Introduced to the Process:** No hazardous wastes are anticipated to be used within the process. At some point in the future, an industrial waste stream may be tested to determine the feasibility of separating relevant ionic species in waste streams.

4. **What Waste Streams Will Be Produced:** None are anticipated, since the materials are recovered for reuse.

5. **Location Details:** The experimental apparatus is currently set up in the 3720 Building, Room 510 (laboratory); it is expected that the apparatus will be moved into Room 604 at the beginning of FY 1994.

6. **Possible Permit Options:** No option currently required because wastes are not being tested. If at some future time an industrial waste stream is tested, 180 L is approximately 180 kg, therefore, the treatability study exemption should apply.

7. **Battelle Contact:** Harold Tilden, (509) 376-0499.

9413273.1541

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Waste Characterization Studies

**Organization** Material and Chemical Sciences Center, Chemical Technology Department, Chemical Process Systems Section, Waste Evaluation and Treatment Group

1. **Summary Description of the Technology and Application:** Core samples taken from the tank farms are characterized to determine the chemical makeup of the wastes.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of waste characterization is to determine core sample compositions.

3. **What Hazardous Wastes Will Be Introduced to the Process:** A total of 24 core samples per year are expected to be characterized (approximately 36 kg/yr).

4. **What Waste Streams Will Be Produced:** Residues from core sample characterization are used within treatability testing studies or are disposed of in accordance with PNL waste management procedures.

5. **Location Details:** Waste characterization occurs in both the 325 Building and the 329 Building.

6. **Timetable:** Approximately 24 core samples are processed per year (equivalent to 36 kg/yr) over the next few years.

7. **Possible Permit Options:** Analytical Sample Exemption.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Steam Reforming

**Organization** Waste Technology Center, Waste Treatment Technology Department, Remediation Technologies Section, Bioremediation Group

1. **Summary Description of the Technology and Application:** Steam reformation destroys halogenated organics by reaction with super-heated steam. Specifically, when carbon tetrachloride is mixed with steam and heated to 500°C, or higher, the carbon tetrachloride decomposes to carbon dioxide and hydrochloric acid. In turn, a moving bed evaporator is used to neutralize the hydrochloric acid produced by the destruction of carbon tetrachloride. For example, steam reformation could remove carbon tetrachloride from granular activated carbon (GAC) drums without destroying the carbon. This project supports the VOC Arid ID.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The objective of this demonstration is to obtain information on the removal of halogenated organics from GACs and the destruction of halogenated organics by steam reforming. The specific test objectives are as follows: 1) demonstrate 99.99% destruction of carbon tetrachloride and chloroform; 2) demonstrate the absence of hazardous material releases to the air; 3) demonstrate the absence of $CC1_4$ in the spent base; and 4) demonstrate complete regeneration of the activated carbon.

3. **What Hazardous Waste Will Be Introduced to the Process:** The carbon tetrachloride and chloroform to be treated may be considered a listed or characteristic hazardous waste.

4. **What Waste Streams Will Be Produced:** Used GAC canisters; spent slurry (salt); adsorbents (e.g., Selexsorb).

5. **Location Details:** 200 West Expedited Response Action.

6. **Timetable:** Initial offsite demonstration (in California) is scheduled for summer through fall 1993; onsite demonstration has not been scheduled.

7. **Permit Options:** CERCLA on-site permit exemption.

8. **Battelle Contact:** Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Supported Liquid Membrane

**Organization** Waste Technology Center, Waste Treatment Technology Department, Remediation Technologies Section, Bioremediation Group

1. **Summary Description of the Technology and Application:** Supported liquid membrane involves a combination of coupled transport (CT) and reverse osmosis (RO) technologies that can be used to remove radionuclides and nitrates from extracted groundwater. Specifically, CT is a membrane-based process by which ionic species are selectively extracted from dilute aqueous solutions and concentrated. The CT membranes consist of a microporous polymeric support that contains a water-immiscible organic ion-exchange (IEX) agent within its pores. When an aqueous feed solution containing metal ions contacts the surface of the CT membrane, ions are selectively extracted from the solution and into the membrane by reacting with the IEX agent, forming an organic-soluble but water-insoluble ion/agent complex. The ion/agent complex diffuses to the opposite side of the CT membrane where the ion/agent complex dissociates. The ions are released to a second aqueous solution on the product side of the membrane. RO is another and well-established membrane process used mainly for separating dilute aqueous solutions. RO is a pressure-driven process. The feed solution is pressurized to between 200 and 800 psig against a semipermeable membrane. Water selectively passes through the membrane, while ions and some organic compounds in the feed solution are rejected. CT is more efficient at higher-feed concentrations (as this maximizes the flux of ions across the membrane), and RO is more efficient at lower-feed concentrations (as these minimizes the flux ions across the membrane). When CT is combined with RO, the resulting hybrid process is expected to be economical. This project supports the VOC-Arid ID.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The RO/CT groundwater remediation test unit will be used to remove uranium, technetium-99, and nitrate from a selected groundwater source at the Hanford Site. The overall purpose of this test is to determine the efficiency of the RO/CT membranes, the ease of operation and maintaining the RO/CT groundwater remediation test unit, and the amount of secondary waste generated as a result of processing. The goal of the VOC Arid ID RO/CT groundwater remediation test unit is to develop a RO/CT process that will be applicable for removing uranium, technetium-99, and nitrate from almost any contaminated water.

3. **What Hazardous Waste Will Be Introduced to the Process:** None.

4. **What Waste Streams Will Be Produced:** Strip solutions containing uranium, technetium-99, chromium, and/or nitrate, in solution with stripping agents that may include sodium hydroxide, VDPA (1,1-vinylidene diphosphonic acid), and/or HEDPA (1-hydroxethane-1,1-diphosphonic acid); treated water.

5. **Location Details:** A groundwater source at the Hanford Site has not yet been selected.

6. **Timetable:** Initial demonstration is scheduled for the summer of 1994.

7. **Permit Options:** CERCLA onsite permit exemption.

8. **Battelle Contact**: Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Tunable Hybrid Plasma

**Organization** Waste Technology Center, Waste Treatment Technology Department, Remediation Technologies Section, Bioremediation Group

1. **Summary Description of the Technology and Application:** Tunable hybrid plasma is a method for decomposing VOCs in a waste air stream. For example, it could be employed to destroy carbon tetrachloride extracted from the soil column as part of the 200-West Area expedited response action. The primary hardware item is the Massachusetts Institute of Technology (MIT) E-beam plasma reactor, which employs a steady electron beam to produce a low-temperature plasma in the waste air stream, thereby decomposing the organic contaminants. This reactor consists of three major components. First, an inlet air dryer uses wetable membranes to remove water vapor while allowing air and solvent (carbon tetrachloride) vapor to pass through. Second, the E-beam and flow channel ionize the waste air stream and the electrons in the E-beam plasma attach to the carbon tetrachloride molecules and cause them to dissociate. Third, the gas scrubber removes the chlorine compounds from the gas stream using an aqueous caustic solution. The chlorinated compounds created by the electron-beam decomposition of carbon tetrachloride will dissolve in the scrubber water and create salts and carbon dioxide. The gas stream is passed through the bubbler column, and the resulting air steam at the outlet is moist air without chlorine compounds. Two scrubber columns are used alternately so the chlorine-bearing salts can be removed and the caustic replenished. This project supports the VOC Arid ID.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of the demonstration is to show that carbon tetrachloride can be destroyed by the MIT E-beam plasma reactor, particularly when the carbon tetrachloride is in dilute quantities in a waste air stream. The demonstration will also establish the E-beam power requirements for carbon tetrachloride removal, the suitability of a scrubber using a caustic aqueous solution, and preliminary reliability data on components in a field environment. Specific test objectives are to 1) destroy carbon tetrachloride to reduce the concentration from 700 ppm to less than 7 ppm in the waste air stream, 2) capture the chlorine compounds produced by the E-beam plasma in the wet scrubber resulting in less than 7 ppm of chlorine-bearing compounds exhausted to the atmosphere, 3) extract the chlorine salts from the wet scrubber as nonhazardous material, and 4) obtain operation data to define the measurement accuracy requirements on the monitoring instruments used to measure the inlet gas composition and the composition of the scrubber liquid and scrubber outlet gas stream.

3. **What Hazardous Waste Will Be Introduced to the Process:** The carbon tetrachloride vapor to be treated may be considered a listed or characteristic hazardous waste.

4. **What Waste Streams Will Be Produced:** Carbon dioxide, salt, salt-bearing scrubber water.

5. **Location Details:** 200-West Area expedited response action.

6. **Timetable:** Initial demonstration is scheduled for the spring of 1994.

7. **Permit Options:** CERCLA onsite permit exemption

8. **Battelle Contact**: Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** Six Phase Soil Heating

**Organization** Waste Technology Center, Waste Treatment Technology Department, Remediation Technologies Section, Bioremediation Group

1. **Summary Description of the Technology and Application:** Six-phase soil heating (SPSH) removes organic contaminants from the unsaturated zone through a combination of volatilization, steam stripping, and venting for treatment at the surface. This technology could have wide application to the extraction of organics from soils at Hanford and elsewhere. This project supports the VOC Arid ID.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** SPSH may be demonstrated at a fuel-contaminated site in the 300 Area at Hanford. The site was contaminated with gasoline and diesel fuel by a leaking hose and fitting located directly under a pump island at the Hanford 300 Area fire station. The SPSH technology will be used to heat the contaminated soil to roughly 100°C while venting. Heating will increase the vapor pressure of the contaminant and create an in situ source of steam that may assist in stripping less volatile contaminants. The combination of heating and venting is expected to remove most of the volatile fuel components like benzene and other gasoline components, but may not remove significant amounts of semivolatile diesel components (with boiling points on the order of 350°C). A HEC system will treat contaminated soil gases as they are removed by venting. The HEC system will convert fuel vapors to carbon monoxide, carbon dioxide and water. A backup carbon filter will also be used. Condensed aqueous liquids produced during collection and processing of off-gases can either be avoided by heating the off-gas line, or treated by a number of means including a special type of plasma reactor being developed by PNL to treat organic contaminants in underground storage tank wastes. By-products from this liquid treatment technique will be the same as produced by the off-gas plasma reactor.

3. **What Hazardous Waste Will Be Introduced to the Process:** Assuming the soil to be treated is contaminated only with petroleum hydrocarbons and is not contaminated with lead, it will probably not be considered hazardous waste, due to the exclusion of petroleum-contaminated media that fail the TCLP test and which are subject to RCRA Subtitle I (Underground Storage Tank) corrective action (see 40 CFR 261.4(b)(10)).

4. **What Waste Streams Will Be Produced:** Removed contaminant in the vapor state (to be treated at the surface); electrodes and surface cover.

5. **Location Details:** SPSH will be demonstrated near the 300 Area fire station.

6. **Timetable:** Characterization is scheduled for the winter of 1993 and initial demonstration for the spring of 1994.

7. **Permit Options:** If the petroleum exclusion applies, no regulated wastes will be treated, so no permits will be required.

8. **Battelle Contact**: Harold Tilden, (509) 376-0499.

# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** VOC Offgas Membrane Separation

**Organization** Waste Technology Center, Waste Treatment Technology Department, Remediation Technologies Section, Bioremediation Group

1. **Summary Description of the Technology and Application:** Gas Membrane Separation Systems (GMSS), which have been under development for a period of about 11 years by Membrane Technology and Research, Inc., remove organic contaminants from waste air streams. For example, GMSS could be employed to remove carbon tetrachloride from soil vapor extracted as part of the 200-West Area expedited response action. This organic vapor/air separation technology involves the preferential transport of organic vapors through a nonporous semipermeable, gas-separation membrane. Transport is achieved by the influence of a pressure difference between the feed and permeate sides of the membrane. The differential pressure is created by a vacuum pump on the permeate side of the membrane and a compressor on the feed side. Performance of the membrane separation is effected by membrane selectivity and pressure ratio. This project supports the VOC Arid ID.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The purpose of this demonstration is to determine the effectiveness of the GMSS in removing carbon tetrachloride from an airstream that has been vacuum-extracted from the vadose region and to determine its cost-effectiveness relative to adsorption and regeneration of granulated activated carbon (GAC). It is not, however, designed to completely eliminate GAC, but to reduce the VOC loading of the GAC. Another objective is to obtain sufficient information to allow for scale-up design of the system.

3. **What Hazardous Waste Will Be Introduced to the Process:** The carbon tetrachloride vapor to be removed may be considered a listed or characteristic hazardous waste.

4. **What Waste Streams Will Be Produced:** Liquid carbon tetrachloride (potentially recyclable); treated air stream containing residual carbon tetrachloride (to be treated by GAC).

5. **Location Details:** The proposed in-situ VOC removal system has been proposed for demonstration in the 200-West Area carbon tetrachloride expedited response action site.

6. **Timetable:** Initial demonstration is scheduled to be completed in 1993.

7. **Permit Options:** CERCLA onsite permit exemption.

8. **Battelle Contact**: Harold Tilden, (509) 376-0499.

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# RD&D Project Description Format
# RCRA Permitting Strategy Project

**Company** Battelle, Pacific Northwest Laboratories

**Project Title** In Situ VOC Removal

**Organization** Waste Technology Center, Waste Treatment Technology Department, Remediation Technologies Section, Bioremediation Group

1. **Summary Description of the Technology and Application:** This technology creates an in-well air stripper which volatilizes VOCs contained in groundwater and removes these contaminants as a vapor. The stripped VOC vapor is contained within the well, extracted under a vacuum, and treated at the ground surface. By conversion of a groundwater contamination problem into a simple vapor extraction system, the method has the advantage of not requiring removal, handling, treatment, storage, and disposal of contaminated groundwater. In addition, there is no need for a surface air-stripping tower when using this method. This project supports the VOC Arid ID.

2. **Purpose, Experimental Design, and Ultimate Performance Goals:** The objective of this test are 1) to demonstrate that a very simple in situ method exists to greatly reduce the concentration of carbon tetrachloride and other VOCs from the groundwater at the Hanford Site, and 2) to develop a field-scale understanding of the behavior of the demonstrated system in terms of time trajectory of VOC removal, the influence of various gas injection rates on performance and circulation, and to discover any significant difficulties in operating this system. The demonstration unit will consist of a single VOC-removal well and two monitoring wells.

3. **What Hazardous Waste Will Be Introduced to the Process:** The carbon tetrachloride to be removed may be considered a listed or characteristic hazardous waste.

4. **What Waste Streams Will Be Produced:** Removed carbon tetrachloride in the vapor state (to be treated at the surface by granular activated carbon (GAC)); spent GAC canisters.

5. **Location Details:** The proposed in situ VOC removal system will be demonstrated in the 200-West Area at the Hanford Site.

6. **Timetable:** Initial demonstration is scheduled for the fall of 1993.

7. **Permit Options:** CERCLA onsite permit exemption.

8. **Battelle Contact**: Harold Tilden, (509) 376-0499.

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# Attachment

## Projects By Permit Option and Program
## (9/29/93)

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| PROGRAM TECHNOLOGY | LOCATION OF THE EXPERIMENT (NOW) | KG WASTE/ STUDY (NOW) | LOCATION OF THE EXPERIMENT (FUTURE) | KG WASTE/ STUDY (FUTURE) |
|---|---|---|---|---|
| **PERMIT OPTION:** Analytical Sample | | | | |
| TWRS CHARACTERIZATION | | | | |
| WASTE CHARACTERIZATION STUDIES | 325 & 329 BUILDING | 36.000 | 325 & 329 BUILDING | 103.000 |
| | | 36.000 | | 103.000 |
| **PERMIT OPTION:** CERCLA Exemption | | | | |
| VOC - NON-ARID INTEGRATED DEMO | | | | |
| IN SITU BIOREMEDIATION OF CARBON TETRACHLORIDE, NITRATE AND CHLOROFORM IN GROUNDWATER | 200 WEST | NA | 200 WEST AREA | NA |
| VOC-ARID ID | | | | |
| OFFGAS MEMBRANE | 200 WEST | NA | NA | NA |
| VOC-ARID ID | | | | |
| TUNABLE HYBRID PLASMA | NA | NA | 200 WEST AREA | NA |
| VOC-ARID ID | | | | |
| STEAM REFORMING | NA | NA | NA | NA |
| VOC-ARID ID | | | | |
| SUPPORT LIQUID MEMBRANE | NA | NA | GROUNDWATER SITE | NA |
| VOC-ARID ID | | | | |
| IN-WELL STRIPPING | NA | NA | 200 WEST AREA | NA |

| PROGRAM TECHNOLOGY | LOCATION OF THE EXPERIMENT (NOW) | KG WASTE/ STUDY (NOW) | LOCATION OF THE EXPERIMENT (FUTURE) | KG WASTE/ STUDY (FUTURE) |
|---|---|---|---|---|
| **PERMIT OPTION:** Land Disposal Demonstration | | | | |
| NA | | | | |
| VITRIFICATION- TERRA VIT | 324 BUILDING | NA | ISV SITE | 100000.000 |
| | | | | **100000.000** |
| **PERMIT OPTION:** NA | | | | |
| BURIED WASTE INTEGRATED DEMONSTRATIONS PROGRAM | | | | |
| GRAPHITE DC ARC PLASMA AND GLASS MELTER | INEL | NA | NA | NA |
| ERACE SYSTEM PROGRAM | | | | |
| HIGH ENERGY CORONA/ OFF-GAS TREATMENT | 324 BUILDING | NA | NA | NA |
| VITRIFICATION PROGRAM | | | | |
| VITRIFICATION- HIGH TEMPERATURE FURNACE (HTF) | 324 BUILDING | NA | NA | NA |
| VITRIFICATION PROGRAM | | | | |
| VITRIFICATION- LABORATORY SCALE CRUCIBLE MELTING | 324 BUILDING | NA | NA | NA |
| VITRIFICATION PROGRAM | | | | |
| VITRIFICATION- HIGH TEMPERATURE MELTER | 324 BUILDING | 30000.000 | 324 BUILDING | 15000.000 |

| PROGRAM<br>TECHNOLOGY | LOCATION OF THE EXPERIMENT (NOW) | KG WASTE/ STUDY (NOW) | LOCATION OF THE EXPERIMENT (FUTURE) | KG WASTE/ STUDY (FUTURE) |
|---|---|---|---|---|
| **PERMIT OPTION:** NA | | | | |
| SURFACE BARRIER DEVELOPMENT PROGRAM | | | | |
| PROTOTYPE SURFACE BARRIER 216-B-57 CRIB | ONSITE 200 BP-1-OU | NA | NA | NA |
| IN SITU REMEDIATION INTEGRATED PROGRAM | | | | |
| CHEMICALLY ENHANCED SOIL BARRIERS | 3720 BULDING | 200.000 | NA | NA |
| TWRS PRETREATMENT PROGRAM | | | | |
| LABORATORY DEVELOPMENT SELECTIVE LEACHING PROCESSES | 325 BUILDING | 0.020 | NA | NA |
| TWRS PRETREATMENT PROGRAM | | | | |
| ELECTROCHEMICAL TREATMENT OF TANK WASTE | 324 BUILDING | NA | NA | NA |
| NA | | | | |
| ELECTROSEPARATION | 3720 BULDING | NA | 3720 BUILDING | NA |
| NA | | | | |
| BASE CATALYTIC DESTRUCTION OF PCB-CONTAMINATED SOILS | NA | NA | NA | NA |
| TWRS PRETREATMENT PROGRAM | | | | |
| SLUDGE DISSOLUTION LABORATORY STUDIES | NA | NA | NA | NA |
| TWRS PRETREATMENT PROGRAM | | | | |
| SOLVENT EXTRACTION LAB STUDIES | NA | NA | NA | NA |
| VOC-ARID ID | | | | |
| IN SITU HEATING | NA | NA | 300 AREA PPU | NA |

| PROGRAM TECHNOLOGY | LOCATION OF THE EXPERIMENT (NOW) | KG WASTE/ STUDY (NOW) | LOCATION OF THE EXPERIMENT (FUTURE) | KG WASTE/ STUDY (FUTURE) |
|---|---|---|---|---|
| | | 30200.020 | | 15000.000 |
| **PERMIT OPTION:** RD&D | | | | |
| TWRS PRETREATMENT PROGRAM | | | | |
| COMPACT PROCESSING UNIT DEMONSTRATION- UST ID | NA | NA | 200 AREA | 4000000.000 |
| | | | | 4000000.000 |
| **PERMIT OPTION:** RD&D/Treatability Study | | | | |
| TWRS PRETREATMENT PROGRAM | | | | |
| HYDROTHERMAL DESTRUCTION OF ORGANICS AND NITRATES IN LIQUID TANK WASTE | NA | NA | 324 BUILDING | 250.000 |
| NA | | | | |
| SOIL WASHING | 3720 BULDING | 200.000 | 3720 BUILDING | 400.000 |
| NA | | | | |
| LOW-TEMPERATURE CATALYTIC GASIFICATION OF WET ORGANIC WASTE | CPDL | NA | MDL | 800.000 |
| | | 200.000 | | 1450.000 |
| **PERMIT OPTION:** Treatability Study | | | | |

| PROGRAM TECHNOLOGY | LOCATION OF THE EXPERIMENT (NOW) | KG WASTE/ STUDY (NOW) | LOCATION OF THE EXPERIMENT (FUTURE) | KG WASTE/ STUDY (FUTURE) |
|---|---|---|---|---|
| **PERMIT OPTION:** Treatability Study | | | | |
| NA | | | | |
| CEPOD: MEDIATED ELECTROLYTE OXIDATION SUPPORT | NA | NA | 325 BUILDING | 2.000 |
| NA | | | | |
| HIGH ENERGY CORONA FOR DESTRUCTION OF VOC'S IN PROCESS OFF GASES | 324 BUILDING | NA | 324 BUILDING | NA |
| TWRS PRETREATMENT PROGRAM | | | | |
| DEVELOPMENT OF HIGH CAPACITY SELECTIVE FIXED SEQUESTERING AGENTS | 325 BUILDING | NA | 325 BUILDING | 1.000 |
| TWRS PRETREATMENT PROGRAM | | | | |
| ACT*DE*CON ACTINIDE LEACHING OF TANK WASTE SLUDGES | NA | NA | 325 BUILDING | 40.000 |
| TWRS PRETREATMENT PROGRAM | | | | |
| CLEAN SALT PROCESS TREATMENT OF TANK WASTES | NA | NA | 324 BUILDING | 312.000 |
| TWRS PRETREATMENT PROGRAM | | | | |
| ELECTROCHEMICAL OXIDATION OF ORGANICS AND NITRATES/ NITRITES IN LIQUID TANK WASTE | NA | NA | 324 BUILDING | 1.000 |
| TWRS PRETREATMENT PROGRAM | | | | |
| RADIONUCLIDE ION EXCHANGE SEPARATION OF LIQUID TANK WASTE | NA | NA | 325 BUILDING | 0.200 |
| TWRS PRETREATMENT PROGRAM | | | | |
| SELECTIVE LEACHING OF TANK WASTE SLUDGE | 325 BUILDING | 0.170 | 324 BUILDING | 40.000 |

| PROGRAM<br>TECHNOLOGY | LOCATION OF THE EXPERIMENT (NOW) | KG WASTE/ STUDY (NOW) | LOCATION OF THE EXPERIMENT (FUTURE) | KG WASTE/ STUDY (FUTURE) |
|---|---|---|---|---|
| **PERMIT OPTION:** Treatability Study | | | | |
| TWRS PRETREATMENT PROGRAM<br>BENCH SCALE SOLVENT EXTRACTION | 324 BUILDING | NA | 324 BUILDING | 160.000 |
| TWRS PRETREATMENT PROGRAM<br>Cs ION EXCHANGE | 325 BUILDING | NA | NA | NA |
| NA<br>NITREM CHEMISTRY IN DUAL-SHELL PRESSURE-BALANCED VESSEL | CEL | 1.000 | MRC/MDL | 800.000 |
| TWRS PRETREATMENT PROGRAM<br>HYDROTHERMAL PROCESSING OF 101SY TANK WASTE | MDL/CPDL/B25 | NA | NA | 0.100 |
| TWRS PRETREATMENT PROGRAM<br>PLASMA CALCINATION OF TANK WASTES | 325 BUILDING | NA | 325 BUILDING | 1.000 |
| NA<br>METAL/ACID RECYCLING | NA | 800.000 | NA | 800.000 |
| | | **801.170** | | **2157.300** |

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