FOSTER WHEELER ENVIRONMENTAL CORPORATION

September 25, 1997
ARCS I A97-120
No Response Required

SUPERFUND RECORDS CTR
New Bedford Harbor
4.6

Mr. James Brown
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US EPA Region I (CAP)
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Subject: ARCS I - EPA CONTRACT NO. 68-W9-0034
WORK ASSIGNMENT NO. 030-IL43
NEW BEDFORD HARBOR RI/FS
HOT SPOT TREATABILITY STUDIES
DATA COMPENDIUM

Dear Mr. ~~Brown~~: Jim

please find the New Bedford Harbor Hot Spot Treatability Study Data Compendium. Per your direction, copies have also been forwarded to the individuals included on the attached distribution list. The Data Compendium is comprised of ten volumes and includes the vendor reports from each of the pilot study tests, the TRC reports for the vent gas sampling program conducted during two of the tests (Geosafe and SAIC/Eco Logic), and the laboratory data reporting forms for the samples collected during the study. A list of each Data Compendium volume and the respective contents is attached to this cover letter.

For ease of reference, the laboratory data are subdivided by batch, matrix and/or sampling location. A cover sheet is included in the front of each section providing cross-references for the sample identification numbers and the sampling locations. The laboratory data are paginated sequentially using a prefix specific to the pilot test and Data Compendium volume. The following prefixes were used for each laboratory data volume:

Volume	Title Page	Number Prefix
II	Ionics RCC/CRTI - Laboratory Data (Part I) begins with the prefix	11
III	Ionics RCC/CRTI - Laboratory Data (Part II)	12
V	Geosafe - Laboratory Data (Part I)	21
VI	Geosafe - Laboratory Data (Part II)	22
IX	SAIC Eco Logic - Laboratory Data	31

[redacted]

SDMS Doc ID 579026

[redacted]

Unique page numbers were not established for the three treatability study vendor reports (Volumes I, IV and VIII) and the TRC sampling reports (Volumes VII and X). These reports were copied and included as received.

Please call me at (617) 457-8277 if you have any questions or require additional information.

Sincerely,

Alan S. Fowler
Project Manager

Enclosure
Attachments
ASF/clc

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H. Horahan
B. Pencola
File: PM 1.1
NBH 30 1.5 (c/l only); 10.6 (entire document)

DISTRIBUTION LIST
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HOT SPOT TREATABILITY STUDIES
DATA COMPENDIUUM

September 1977

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New Bedford Harbor Hot Spot Treatability Study Data Compendium

Volume I:	Ionics RCC/CRTI -	Test Report for On-Site Pilot Scale Demonstration Testing of the B.E.S.T.® Solvent Extraction Process and Solvated Electron Technology at New Bedford Harbor, prepared by Ionics RCC
Volume II:	Ionics RCC/CRTI -	Laboratory Data (Part I)
Volume III:	Ionics RCC/CRTI -	Laboratory Data (Part II)
Volume IV:	Geosafe -	Pilot-Scale Treatability Testing of the In Situ Vitrification (ISV) Technology PCB-Contaminated "Hot Spot" Sediments from the New Bedford Harbor Superfund Site, prepared by Geosafe
Volume V:	Geosafe -	Laboratory Data (Part I)
Volume VI:	Geosafe -	Laboratory Data (Part II)
Volume VII:	Geosafe -	Source Testing Results of Treated Sediment at the New Bedford Harbor Superfund Site, prepared by TRC
Volume VIII:	SAIC Eco Logic -	On-Site Pilot-Scale Testing of the ECO LOGIC Process at the New Bedford Harbor Superfund Site, prepared by SAIC Eco Logic
Volume IX:	SAIC Eco Logic -	Laboratory Data
Volume X:	SAIC Eco Logic -	Source Testing Results of a Treatability Study at the New Bedford Superfund Site, prepared by TRC

ARCS I WORK ASSIGNMENT NUMBER 030-1L43
EPA CONTRACT NUMBER 68-W9-0034
FOSTER WHEELER ENVIRONMENTAL CORPORATION

NEW BEDFORD HARBOR
HOT SPOT TREATABILITY STUDY
DATA COMPENDIUM
VOLUME I: IONICS RCC/CRTI
SEPTEMBER, 1997

Test Report for On-Site Pilot Scale Demonstration Testing of the B.E.S.T.® Solvent Extraction Process and Solvated Electron Technology at New Bedford Harbor, prepared by Ionics RCC.

NOTICE

THE INFORMATION IN THIS DOCUMENT HAS BEEN FUNDED BY, THE UNITED STATED ENVIRONMENTAL PROTECTION AGENCY (EPA) UNDER ARCS I CONTRACT NO. 68-W9-0034 TO FOSTER WHEELER ENVIRONMENTAL CORPORATION (FOSTER WHEELER). THIS DOCUMENT IS A DRAFT AND HAS NOT BEEN FORMALLY RELEASED BY EITHER FOSTER WHEELER OR THE EPA. AS A DRAFT, THIS DOCUMENT SHOULD NOT BE CITED OR QUOTED, AND IS BEING CIRCULATED FOR COMMENT ONLY.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

March 26, 1997
ARCS I A97-044
No Response Required

Mr. David Dickerson
Remedial Project Manager
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Subject: ARCS I - EPA CONTRACT NO. 68-W9-0034
WORK ASSIGNMENT NO. 030-1L43
NEW BEDFORD HARBOR RI/FS
HOT SPOT TREATABILITY STUDIES
IONICS RCC/CRTI - VENDOR REPORT OF PILOT STUDY TESTING

Dear Mr. Dickerson:

Enclosed please find two copies of the Ionics RCC/CRTI pilot scale report. Per your direction, copies have also been forwarded to the individuals included on the attached distribution list. This vendor report was prepared by Ionics RCC and CRTI and reflects their interpretations and conclusions. As a result, Foster Wheeler requests this cover letter be attached to copies distributed by the EPA. The report includes a summary of the data generated during pilot scale operations, documents some specific challenges experienced in the field while treating the Hot Spot sediments, and provides a basis for full scale operation parameters and costs.

Vendor cost information is not being included in the public distribution copies at this time as it is more appropriate to release this information for all three vendors at the same point in time. The third and final vendor report (SAIC/Eco Logic) is currently scheduled to be completed in May 1997. It is also important to note that the cost estimates Foster Wheeler will present in the upcoming Feasibility Study Addendum will use much of vendor cost information, but will also rely heavily on Foster Wheeler's experience in implementing alternative treatment technologies.

In summary, the combination of the Ionics RCC and CRTI processes was effective in treating the PCB contaminated Hot Spot sediment. This includes effective separation of the PCBs with Ionics RCC's solvent extraction process and effective PCB destruction using the CRTI's Solvated Electron process. The residual solids from the solvent extraction process also passed TCLP testing for the heavy metal contaminants.

The scale-up plan for the Ionics RCC process looks positive and includes many pieces of unit process equipment that are routinely available. However, one of these items is a long-lead item that can take several months to obtain. As a result, we estimate that it may take 12 to 18 months to design, fabricate and field test a solvent extraction unit. The scale-up plan for the CRTI process is less complete, with several materials handling issues requiring resolution. These issues include:

- Determining the effectiveness of the CRTI process without over-dosing with sodium.
- Whether additional treatment of CRTI process residuals will be required.
- Establishing an effective mechanism for the transfer of concentrated PCB wastes from the Ionics RCC process to the CRTI treatment unit.

Foster Wheeler believes that information to address these issues can be gathered during the design process. We also believe the design of these processes should include a detailed hazop plan and analysis given the hazardous nature of the various process reagents used. These reagents include diisopropylamine, sodium, and ammonia. While these materials are routinely used in industry, their application to hazardous waste cleanup is still somewhat new.

Please feel free to contact me at (617) 457-8277 if you have any questions or require additional information.

Sincerely,

Alan S. Fowler
Project Manager

Enclosure

cc: Distribution

File: PM 1.1
NBH-30 1.5 (l/o)
NBH-30 8.9.7 (l/o)
NBH-30 8.9.6

TEST REPORT

for
ON-SITE PILOT-SCALE DEMONSTRATION TESTING

of the
B.E.S.T.® SOLVENT EXTRACTION PROCESS
and
SOLVATED ELECTRON TECHNOLOGY

at
NEW BEDFORD HARBOR

prepared for
Foster Wheeler Environmental
Boston, Massachusetts

Subcontract No. 8860-6028

March 1997

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NEW BEDFORD HARBOR
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ATTACHMENTS

EXECUTIVE SUMMARY

This report describes the on-site pilot scale demonstration program conducted with Resources Conservation Company's (RCC's) B.E.S.T.® Solvent Extraction process and Commodore Remediation Technologies' (CRTI's) Solvated Electron Technology at New Bedford Harbor, Massachusetts. This report also describes the full scale remediation units recommended by RCC and CRTI. These units include a 160 tons per day RCC unit and a 3.4 tons per day CRTI unit. The on-site pilot scale demonstration program was performed under a contract with Foster Wheeler Environmental (Foster Wheeler). The objective of this program was to demonstrate the feasibility of the B.E.S.T. process for extracting polychlorinated biphenyls (PCBs) from Hot Spot sediments, and chemically destroying those PCBs with the CRTI Solvated Electron Technology.

Hot Spot sediment samples from the New Bedford Harbor Confined Disposal Facility were tested during the pilot scale test program. The pilot scale test program was conducted in two on-site phases. Phase I consisted of pilot scale testing to determine the optimum process operating parameters for the RCC and CRTI processes. Phase II pilot scale testing was conducted to verify that the RCC and CRTI processes could consistently extract and destroy PCBs when using the 'optimum' parameters as determined in Phase I testing.

The test results clearly demonstrate that RCC's B.E.S.T. Solvent Extraction process can effectively extract the PCBs to low residual levels. The PCB levels in the sediment were reduced from 2,400 mg/kg to 6 mg/kg (well below RCC's self imposed target level of 10 mg/kg), with all the removed PCBs being collected in the concentrated organic fraction at a concentration of 40,000 mg/kg. The pilot tests also clearly demonstrate that CRTI's Solvated Electron Technology can destroy those extracted PCBs via non-thermal, chemical destruction. The PCB levels in the organic fraction were reduced from 40,000 mg/kg to less than 6 mg/kg. Therefore, overall PCB removal from the sediment was 99.75%, and the overall destruction of the PCBs from the concentrated organic fraction was 99.985%.

RCC and CRTI are able to achieve this PCB cleanup performance without use of any thermal destruction process, such as incineration. Because no thermal destruction is used, there are virtually no process by-product gasses generated that will be discharged to the environment. Unlike incineration or other thermal processes, the B.E.S.T. process is designed to have no process emissions to the air. The system uses a single vent to discharge non-condensable gases (mostly nitrogen). RCC uses condensers, water scrubbers and activated carbon to ensure virtually zero emissions of the process solvent. This, combined with the inherent safe nature of the process solvent, makes the B.E.S.T. process more safe than any thermal treatment process. The solvent is environmentally friendly as it biodegrades readily, and does not bioaccumulate in the environment.

With the completion of this test, RCC and CRTI have completed all prerequisite testing for site specific design to begin. The steps required by RCC and CRTI to supply a system and remediate the site would be as follows: preliminary design (including site specific detailed layout and Piping & Instrumentation drawings); start final design; equipment procurement; equipment fabrication and delivery; complete final design (including installation drawings); checkout and testing; and operation. It would take about 12 months from notice to proceed until equipment delivery. CRTI is ready to begin procurement as soon as notice to proceed is received, and will have equipment ready for shipment within 4 months.

RCC and CRTI believe that the B.E.S.T. Solvent Extraction process and the Solvated Electron Technology present a safe, effective, and permanent approach to treating the Hot Spot sediments. After RCC and CRTI processing, the PCB residuals from the Hot Spot sediments are essentially eliminated. Based on these successful test results, we recommend that the US EPA employ the RCC and CRTI non-thermal processes to safely remediate the sediment in the Confined Disposal Facility.

1.0 INTRODUCTION AND OBJECTIVES

1.1 Project Background

The Environmental Protection Agency (EPA) has identified the potential need to remediate PCB-contaminated Hot Spot sediments from the New Bedford Harbor. A number of sediment contaminant separation and/or destruction technologies are being evaluated. Solvent extraction, followed by PCB dechlorination, is one of the technical approaches under evaluation.

This report describes the results of the on-site pilot scale solvent extraction and PCB dechlorination process demonstration program. The program was designed to evaluate the capability of RCC's B.E.S.T. Solvent Extraction process to extract PCBs from contaminated sediments and evaluate the capability of CRTI's Solvated Electron Technology to chemically destroy those extracted PCBs. Independent analyses of samples were performed to ensure accurate reporting of results.

The pilot scale test program was conducted in two on-site phases over a 2 1/2 week period. Phase I pilot testing was conducted to determine optimum process operating parameters for extracting and destroying PCBs. Phase II pilot testing was conducted to verify that the B.E.S.T. process, when operating at optimum process parameters, can repeatedly extract the PCBs from the sediments, and that the Solvated Electron Technology can repeatedly achieve chemical destruction of the extracted PCBs.

1.2 Project Objectives

The objectives of the pilot test were as follows:

1. Evaluate and quantify: 1) the effectiveness of the B.E.S.T. process to extract PCBs from the Hot Spot sediment samples and 2) the effectiveness of the Solvated Electron Technology to destroy the PCBs in the organic fraction produced by the B.E.S.T. process.

2. Quantify the disposition of key constituents to support mass balance calculations (e.g., PCBs).

3. Identify potential environmental and/or engineering constraints related to the use of the B.E.S.T. process to extract contaminants from the Hot Spot sediment samples and the Solvated Electron Technology to destroy the extracted PCBs.

4. Produce data of sufficient quality such that a risk assessment of treatment residuals may be performed.

5. Evaluate the viability of the B.E.S.T. process and the Solvated Electron Technology to be scaled up to full scale operations including the overall development time-frame and estimated full scale treatment costs.

6. Characterize the operational hazards associated with full scale implementation of B.E.S.T. process and the Solvated Electron Technology.

7. Evaluate the performance of the B.E.S.T. process and the Solvated Electron Technology against the nine detailed evaluation criteria contained in the National Contingency Plan (NCP), including the ability of the B.E.S.T. process and the Solvated Electron Technology to reduce toxicity, mobility, and volume of the hazardous constituents.

8. Collect data and observations necessary to evaluate the effectiveness and feasibility of the B.E.S.T. process and the Solvated Electron Technology at full scale operation. Evaluate parameters such as material handling, pretreatment requirements, material feed rates, and batch processing rates. Projected full scale economics for treatment of large volumes of sediment including costs for treatment and disposal of waste streams, site preparation, and mobilization of equipment will also be evaluated.

1.3 Report Organization

This report is organized to provide ready access to each major task completed during this on-site pilot scale demonstration test program. Section 1.0 - Introduction and Objectives provides a project overview and lists the primary objectives of the program. Section 2.0 - Process Description provides a description of the B.E.S.T. Solvent Extraction process and the CRTI Solvated Electron Technology pilot unit operations. Section 3.0 - Pilot Scale Optimization Testing describes the initial testing conducted to determine the optimum process parameters for use in later verification testing. Section 4.0 - Pilot Scale Verification Testing details the results of the tests conducted at the optimum process parameters. Section 5.0 - Full Scale Treatment is a scale-up discussion and a detailed estimate of the cost for treating the Hot Spot sediments. Recommendations and Conclusions are presented in Section 6.0.

1.4 Technology Features

The B.E.S.T. process has many features that will ensure success at the New Bedford Harbor site:

- Batch extraction configuration provides flexibility for treating feed material with widely varying PCB concentrations, silt, clay and moisture content;

- No additional water is added during treatment, therefore the moisture content of the treated soil is controllable;

- B.E.S.T. treated soil passes TCLP for metals, and has been shown (at other sites) to support re-vegetation when returned to the site as backfill;

- The B.E.S.T. process operates at near ambient temperature and pressure, therefore safety concerns with operating at high pressures (as is the case with liquefied petroleum gas) are mitigated; and

- The B.E.S.T. process has no continuous flare on the vent system, unlike high pressure liquefied petroleum gas processes. The only vent from the B.E.S.T. process is continuously monitored to ensure that no organic emissions are released to the environment.

The CRTI Solvated Electron Technology (SET) is particularly suited to treating matrices with high PCB concentrations, such as that in the organic fraction generated from the B.E.S.T. process. The SET process and equipment:

- Is relatively small since it is based on a continuous process, rather than treating large batches;
- Operates at low temperatures and pressures (essentially ambient);
- Maintains a low inventory of reagents for safety considerations; and,
- Emits only very small quantities of ammonia gas to the atmosphere (less than 10 pounds per day).

Both the RCC B.E.S.T. process and the CRTI SET process can be successfully converted to full scale.

2.0 PROCESS DESCRIPTION

SUMMARY

This demonstration was conducted by using a combination of two treatment technologies operated in series. The combination provides an effective treatment process that is responsive to the site requirements for non-thermal removal and destruction of contaminants. Solvent extraction of the contaminants from the sediment was conducted with the B.E.S.T. Solvent Extraction process. The extracted contaminants were then chemically destroyed using the CRTI Solvated Electron Technology. Both of these treatment processes are described in the following sections.

2.1 B.E.S.T. Process Overview

The B.E.S.T. Solvent Extraction process uses a unique property of certain amine solvents to extract hazardous contaminants from soil, sludge, and sediment. Hazardous organic contaminants in the material concentrate in the organic (oily) portion of the material. The key to the success of amine extraction is the property of inverse miscibility. At temperatures below about 80 degrees °F, the amine solvent is miscible with water, i.e., diisopropylamine and water are mutually soluble. Above this temperature, diisopropylamine and water are only partially miscible. This physical property can be exploited by using cool diisopropylamine (i.e., below 80 degrees F) to simultaneously solvate organics and water, allowing intimate contact between the solvent and the contaminant organics.

In the B.E.S.T. process, inverse miscibility allows the feed sample and the solvent to create a single phase extract solution. That extract solution is a homogenous mixture of solvent, organics, and any water found present in the feed sample. Unlike other solvent extraction systems where extraction efficiencies are hindered by water and emulsions that have the effect of blocking contact with the contaminants, amine solvents can achieve intimate contact with the contaminated materials at nearly ambient temperatures and pressures. This allows the B.E.S.T. process to treat feed samples with high water content without a penalty in extraction efficiency.

Once extraction of the feed sample is complete, the solids are separated from the homogeneous extract solution by gravity settling and/or centrifugation. The clean solids are then dried to remove residual solvent.

The extract solution is separated into its components. The solvent and water are removed from the extract solution by evaporation and subsequent condensation. After condensing, the solvent/water mixture temperature is maintained in the range where the solvent and water are only partially miscible. With the specific gravity of the solvent being 0.72, as compared to the water specific gravity of 1.0 (much heavier), the solvent and water are easily separated by gravity. The solvent is recycled for use in subsequent extractions. Traces of residual solvent that remain in the water are removed by steam stripping. The water can then be re-used within the treatment process or discharged to a public water treatment facility as sewerage. Both solvent and water thus are removed from the homogeneous extract solution and can be reused because of their low PCB content.

Meanwhile the organics remain in a concentrated form as the solvent and water continue to be removed by evaporation. After removal of all the solvent and water, the concentrated organics are transferred to the CRTI Solvated Electron Technology process equipment for non-thermal chemical destruction of the PCBs.

2.1.1 B.E.S.T. Unit Operations

The B.E.S.T. process pilot unit is a solvent extraction system capable of processing contaminated sediment, sludge, and soil. The pilot unit's main function is to demonstrate the process fundamentals through the use of scaled-down versions of actual full scale equipment components; namely, the extraction vessels (Extractor/Dryer, and Premix Tank), the solid bowl fines centrifuge, the decanter, and the solvent evaporator. The pilot unit allows on-site testing of contaminated feed samples in larger quantities than is practical to process in laboratory glassware. It also generates operational data for each unit operation during processing of a specific feed sample. This operational information allows the development of accurate full scale design and operation projections.

The pilot unit is designed for batch operation of the extraction cycles. While each of the major process operations can be operated in a batch mode, some unit process operations (such as fines centrifugation) are normally operated continuously. The pilot unit has a nominal feed volume of about one cubic foot (8 gallons, or approximately 130 pounds) of feed sample per batch.

For purposes of system description, the pilot plant operations have been divided into the following sections:

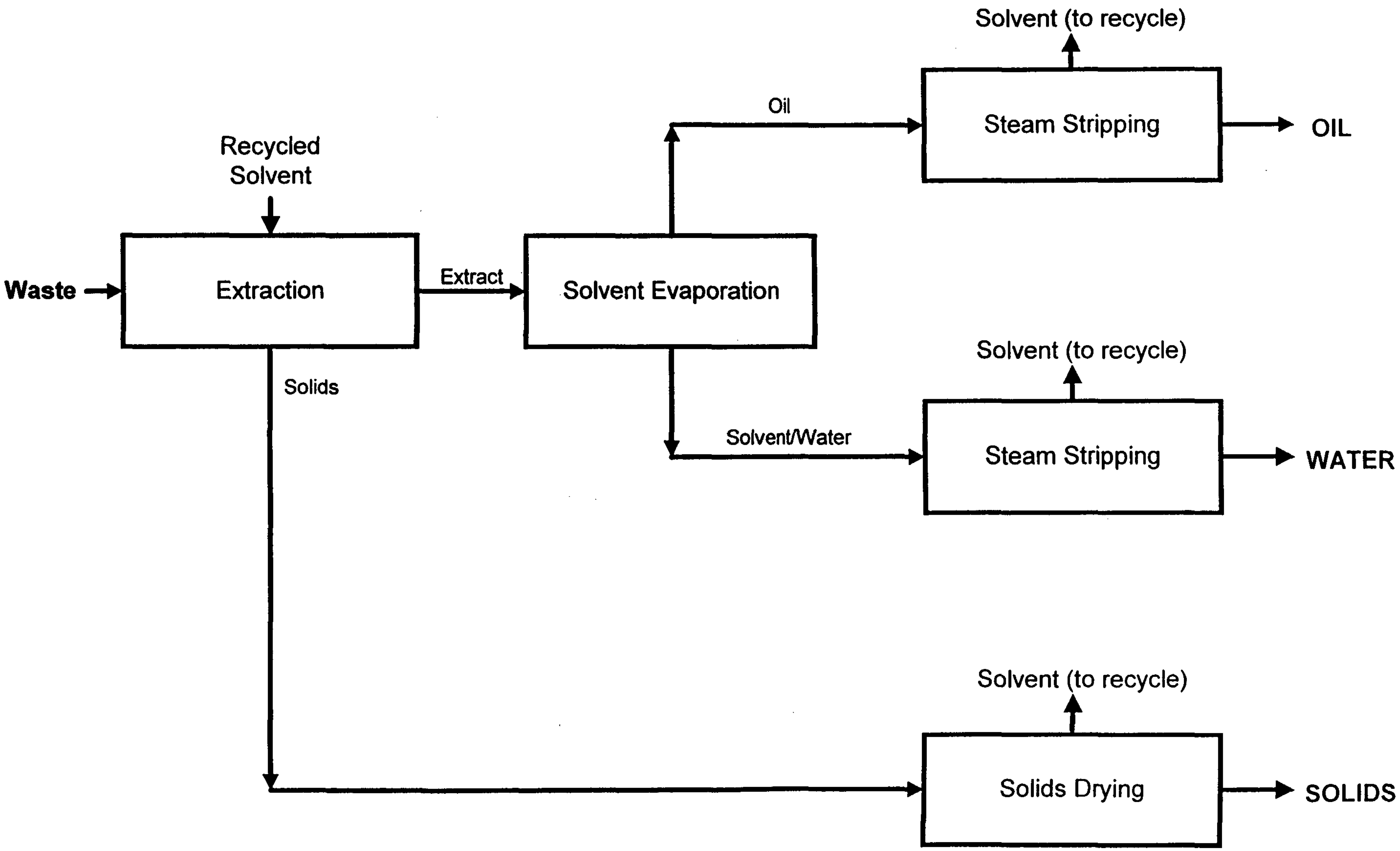
- Feed Sample Preparation
- Extraction
- Solids Drying
- Solvent Recovery
- Solvent/Water Separation

The CRTI Solvated Electron Technology follows these steps, and is described in Section 2.2. A block diagram of the B.E.S.T. process is provided in Figure 2-1.

2.1.2 Feed Sample Preparation

Preparation of feed samples for pilot unit testing involves only screening to remove materials greater than 1/4 inch in size. This feed size requirement applies only to the smaller pilot scale test equipment. Material less than approximately one inch in diameter can be treated with the full scale B.E.S.T. process equipment. Oversize material is decontaminated separately.

Figure 2-1
B.E.S.T. Process Block Diagram



Feed samples for this pilot test were collected by Foster Wheeler. RCC personnel screened the feed sample to remove material greater than 1/4 inch in diameter. After screening, the feed sample was homogenized, using a mixer, and sampled. The feed was then placed in buckets for use during pilot testing.

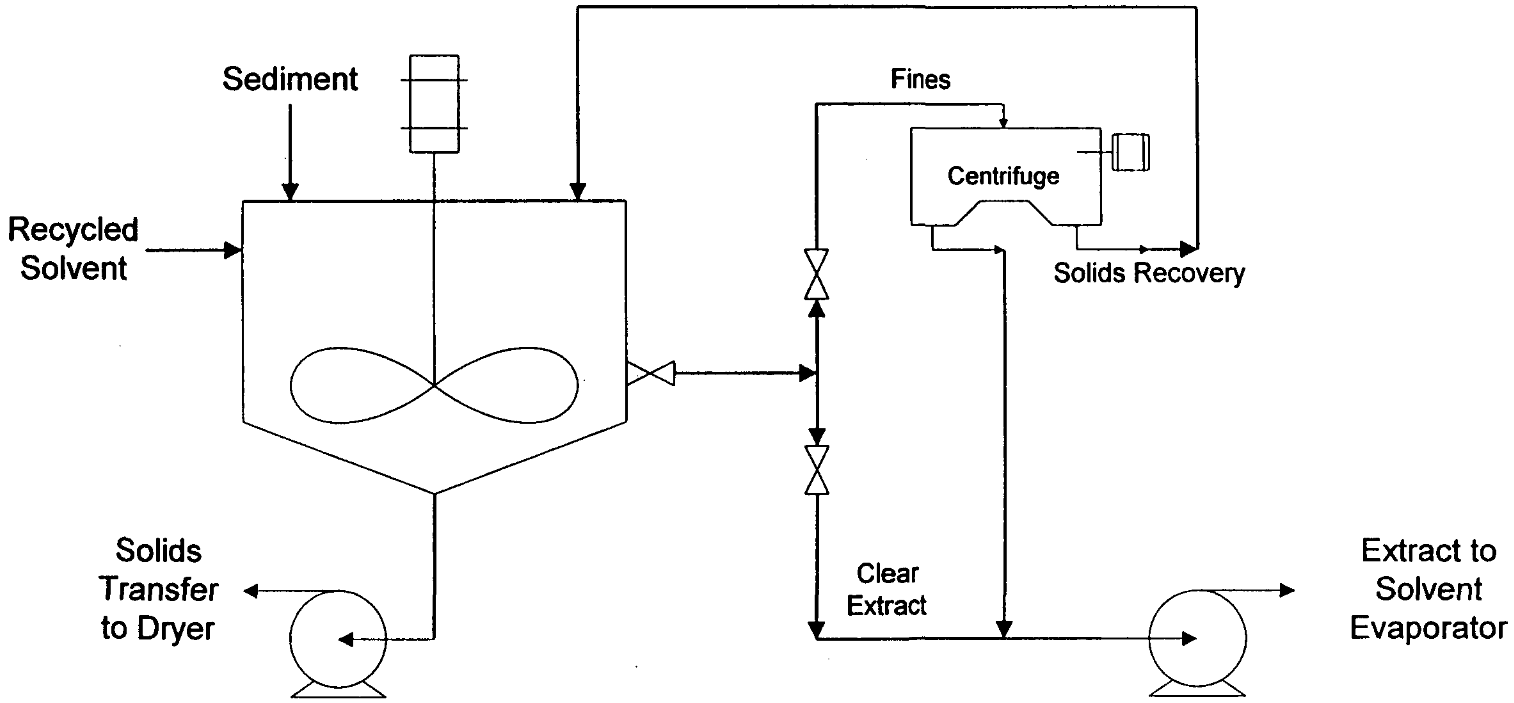
2.1.3 Extraction

The vessel used for the first extraction cycle depends on the nature of the feed sample. Feed samples that have a high organic and/or water content are extracted first in the Premix Tank. The Premix Tank is a larger vessel and thus allows using more solvent with a batch of feed. This gives more efficient initial solvation of water and organics. Other feed samples with low water and organic content are extracted first in the Extractor/Dryer. Due to their relatively high moisture content, the Hot Spot sediment feed samples treated during this test were processed first in the Premix Tank.

The Premix Tank is a vertically mounted cylindrical vessel. The Premix Tank has a mixer shaft penetrating the top of the vessel and extending to near the bottom of the vessel. The shaft has paddles mounted on it to mix the Premix Tank contents.

The extraction process is shown in Figure 2-2. The feed sample is loaded into the Premix Tank through a capped opening on top of the Premix Tank. Solvent is then added to fill the Premix Tank and mixing is started to begin the first extraction cycle. Mixing continues for several minutes, then is stopped to allow for settling of the solids by gravity.

Figure 2-2
Extraction



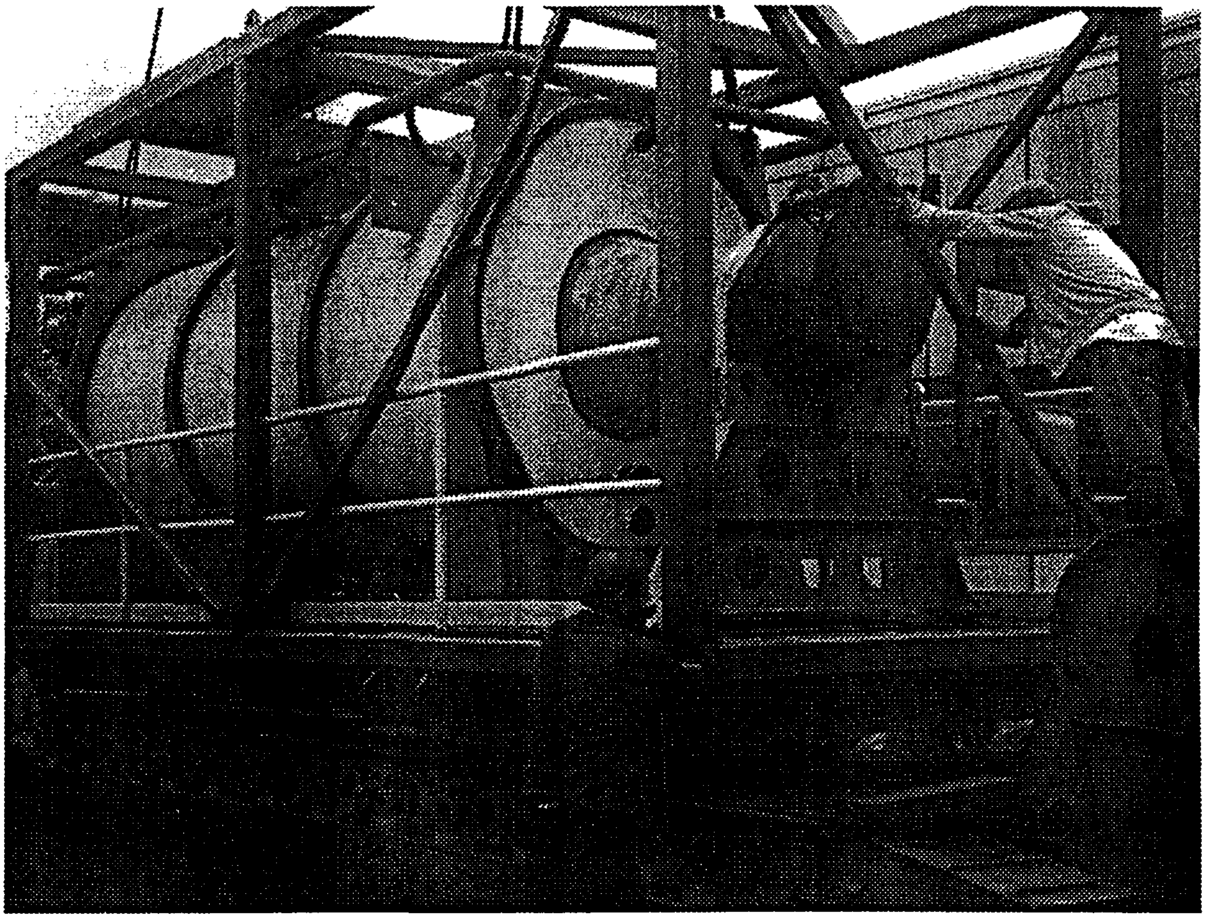
After a period of settling, the homogenous extract solution is decanted (drained off the top) from the solids. After all extract solution has been decanted, the Premix Tank is again filled with solvent for the next extraction cycle. Additional extraction cycles, including fill/mix/settle/decant, are repeated as required.

The extract solution (solvent/organics/water) from the Premix Tank is either transferred to the fines centrifuge or sent directly to solvent recovery. If the decant solution contains fine solids that did not settle effectively by gravity, the decant solution is routed to the centrifuge for mechanical removal of those fine solids. The solids-free decant solution from the centrifuge (centrate) is routed to the solvent evaporator for solvent recovery. If the decant solution does not contain fines, it is simply pumped directly to the solvent evaporator without going through the centrifuge.

2.1.4 Solids Drying

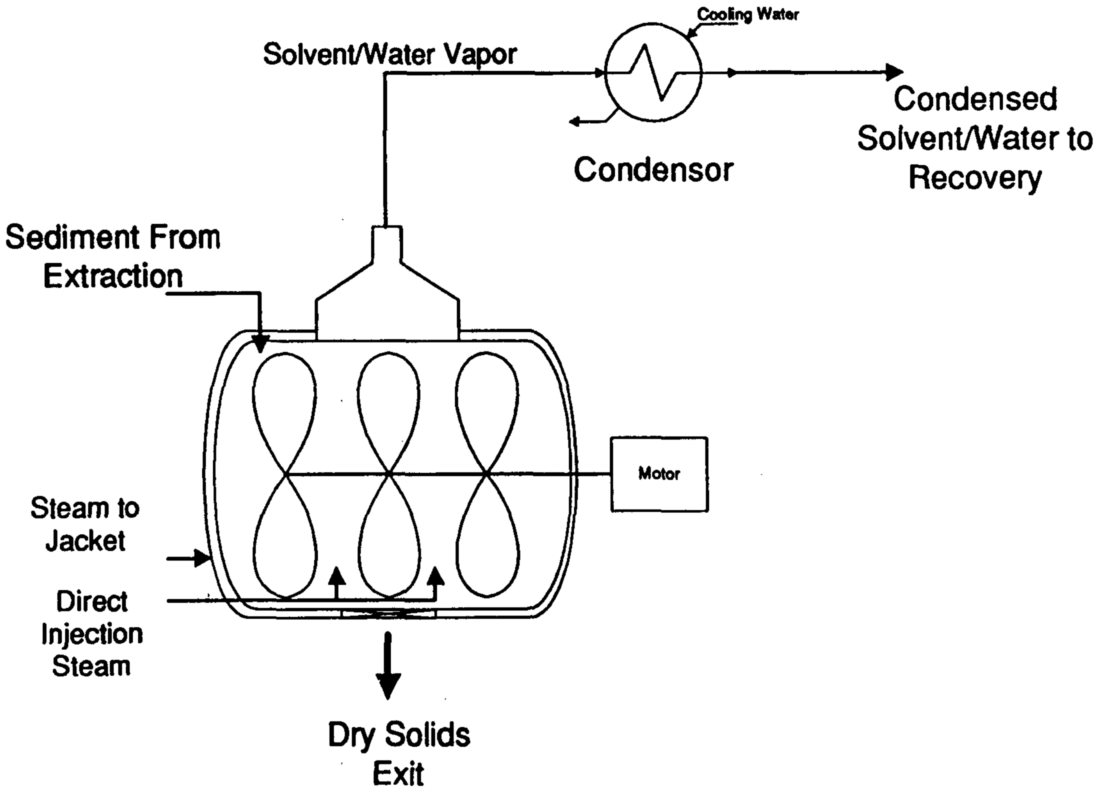
The Extractor/Dryer is a horizontally mounted, cylindrical vessel. The Extractor/Dryer is outfitted with a shaft running the length of the cylindrical axis. The shaft has paddles mounted on it to aid in the mixing of the Extractor/Dryer contents. A steam jacket surrounds the Extractor/Dryer to provide the heat necessary to dry the solids and remove any residual solvent. A photo of the Extractor/Dryer follows.

The solids remaining in the Premix Tank after the final extraction cycle are pumped to the Extractor/Dryer and dried. The solids drying unit operation is depicted in Figure 2-3. The Extractor/Dryer is equipped with direct steam injection ports as well as the previously described steam jacket. Steam is added to the jacket to indirectly heat the Extractor/Dryer and its contents to about 170 degrees F. After the bulk of solvent is driven off by evaporation, steam is injected directly into the Extractor/Dryer. The entire drying process is done with the Extractor/Dryer mixing paddles rotating. This mixing increases the heat transfer and reduces the solids drying time. The remaining solvent and direct injection steam form a low boiling temperature azeotrope vapor. Additional direct injection steam drives the azeotrope vapor out of the Extractor/Dryer. The evaporated solvent driven off earlier, and the azeotrope now driven out of the Extractor/Dryer, is routed to the dryer condenser.



RCC's Extractor/Dryer

Figure 2-3
Solids Drying

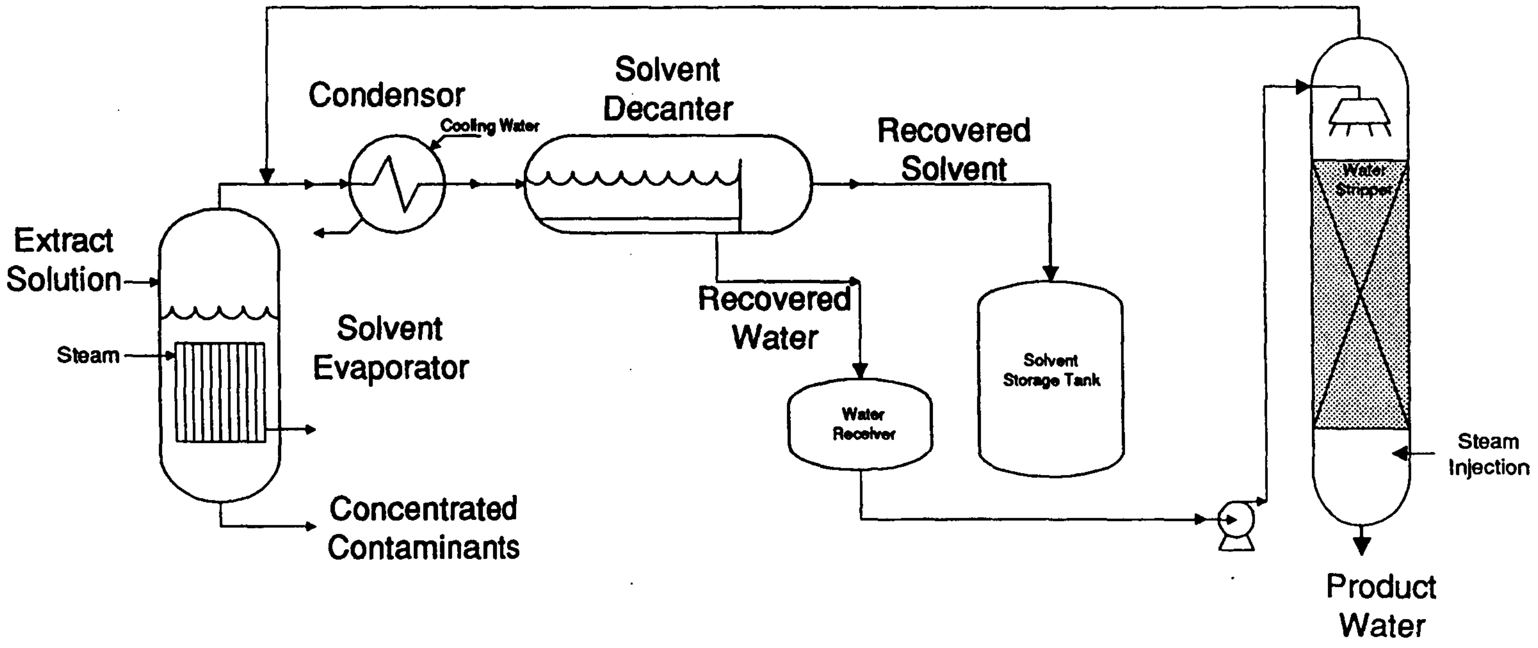


The condensed solvent/water mixture from the dryer condenser is routed to the normal solvent recovery path for re-use. After all the solvent is removed from the Extractor/Dryer, the temperature of the vapor rises to the boiling point of water. The drying is continued past this point for a short time to ensure that all residual solvent is removed. The direct injection steam which condenses in the Extractor/Dryer and stays behind helps to minimize dusting. After the drying process is complete, the solids are removed through the discharge port on the bottom of the Extractor/Dryer.

2.1.5 Solvent Recovery

The decanted extract solution (centrate) from the end of Section 2.1.3 is pumped to the solvent evaporator. In the solvent evaporator, the centrate is heated to its boiling point and evaporated forming an azeotrope of solvent and water. The solvent/water azeotrope is continuously produced and is directed through a rectifier to the main condenser. The rectifier is installed to limit the carry-over of semi-volatile compounds from the solvent evaporator into the recycled solvent. The condensed vapor from the main condenser (solvent and water) forms a non-homogenous condensate consisting of a solvent phase and a heavier water phase. This mixture is directed to the solvent decanter, where the water and solvent phases are separated by gravity. The solvent decanter is maintained at about 150 degrees F. At this temperature, the water and solvent are only partially miscible. The lighter solvent phase retains about 5% water and the heavier water phase retains about 5% solvent. The recovered solvent, with its 5% water, is recycled back to the solvent storage tank for reuse. The recovered water, with its 5% solvent, drains by gravity into the water storage tank where it is stored for residual solvent removal. Solvent recovery and water recovery are shown in Figure 2-4.

Figure 2
Solvent/Water Recovery

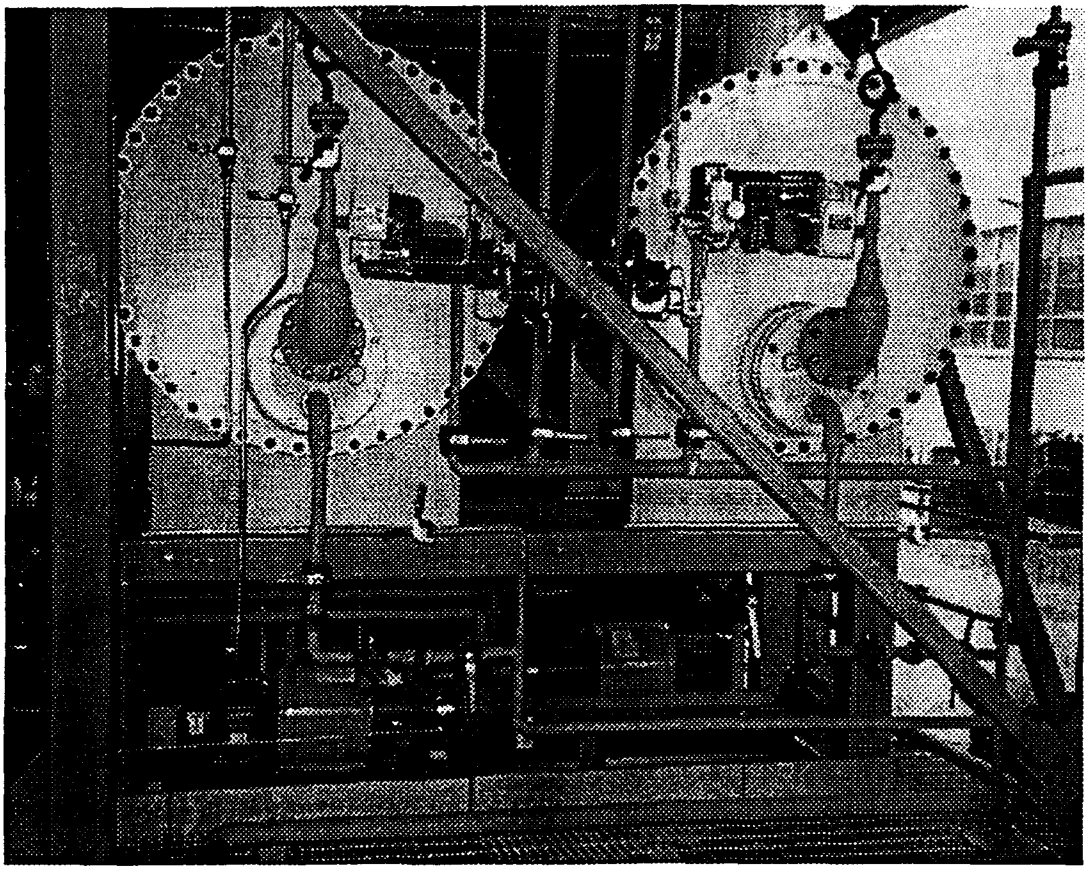


The organic fraction from the sediment concentrates in the evaporator. A continuous bleed of concentrated organics and solvent is diverted from the evaporator to one of the two oil polishers.

The two oil polishers operate in batch mode. One of the two oil polishers is at all times receiving the continuous bleed of organics/solvent from the solvent evaporator, while the other oil polisher is 'polishing' a batch of B.E.S.T. concentrated organics.

Oil polisher "A" receives a continuous bleed of organics/solvent from the solvent evaporator. Indirect steam heating continuously evaporates solvent from the organics/solvent mixture in oil polisher "A", concentrating the organics in the oil polisher. This mode of operation is called the concentration phase. When organics have reached sufficient concentration in oil polisher "A", organic/solvent feed to the oil polisher is stopped and the organics in oil polisher "A" are steam stripped to remove residual solvent. This mode of operation is called the steam stripping phase. When the residual solvent has been removed, the remaining B.E.S.T. organics fraction is pumped out of oil polisher "A" to the CRTI process for PCB destruction.

Oil polisher "B" operates in a similar fashion to oil polisher "A". When oil polisher "A" is in the concentration phase, oil polisher "B" is in the steam stripping phase, and vice versa. Therefore, one polisher is always receiving the organic/solvent mixture from the evaporator while the other polisher is either in the steam stripping mode or in standby. A photo of oil polisher "A" and "B" follows.



RCC Oil Polisher "A" and "B"

2.1.6 Solvent/Water Separation

The water originally contained in the feed sample is separated from the extracted organic fraction by evaporation, and then separated from the solvent by decanting, as described in Section 2.1.5, Solvent Recovery. However, the water still retains about 5% residual solvent.

The residual solvent is removed from the water by simple steam stripping. The water recovered from the solvent decanter is heated to about 140 degrees F and injected into the top of a stripping column. Steam is injected directly into the bottom of the column and flows upward through the water that is traveling down the column. The steam heats the water and strips the residual solvent from it. The stripped solvent and steam exit the column at the top and are directed to a condenser. Condensed solvent is routed to the solvent decanter for normal solvent recovery operations. The stripped water is collected at the bottom of the column and set aside for sampling.

2.2 Solvated Electron Technology Overview

Solvated Electron Technology (SET) is a chemical destruction process based on solvated electron chemistry, a phenomenon discovered over one hundred years ago. Dissolving an alkali metal, such as cesium, rubidium, lithium, potassium, calcium, or sodium, in an appropriate solvent chemically generates a solvated electron solution. The solvent usually contains nitrogen, as is the case with anhydrous liquid ammonia. The bright blue color that is visible immediately upon introduction of the alkali metal is indicative of an abundance of free electrons in the solution. Solvated electron solutions are powerful reducing agents that can be conveniently regarded as solutions of metallic cations and electrons. These electrons are effectively detached from alkali and alkaline earth metals by several solvents, including ammonia, amines, and ethers. For the New Bedford Harbor treatability study, sodium was the active metal of choice, and anhydrous ammonia was the solvent of choice. The dissolution may be shown as follows:

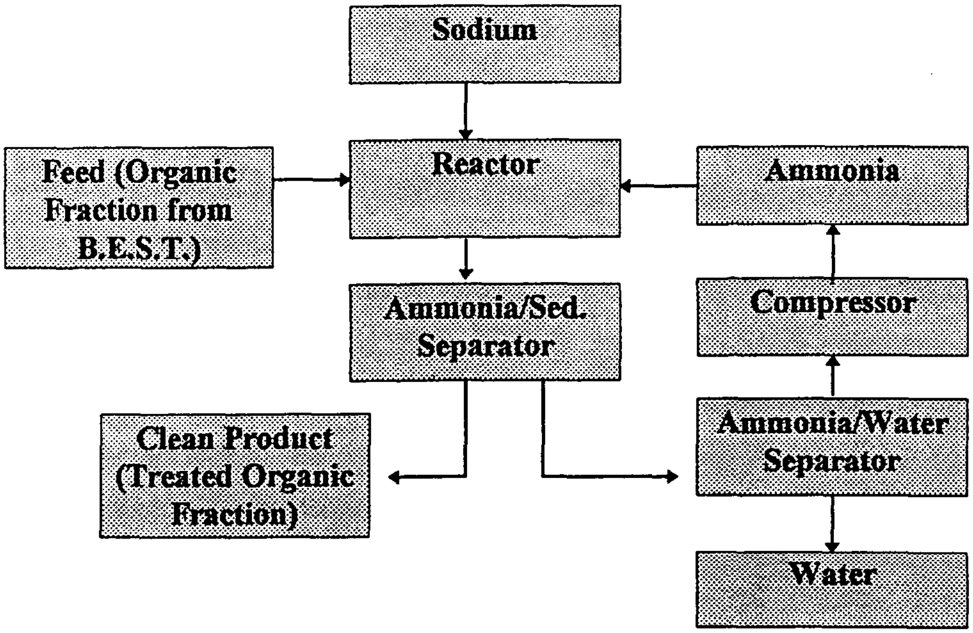
$$Na^{o} \xrightarrow[NH_3]{\text{Liquid}} Na^{+} + e^{-}$$

Although the solvating phenomenon is known chemistry, theory indicates maintaining the solvated electron solution is difficult. The solution's reactions with many common constituents, such as iron oxide and other metal oxides, water, oxygen, nitrogen, nickel, and copper, result in removing free electrons from solution. For this reason, laboratory experiments involving solvated electrons have scrupulously avoided such materials. However, Commodore's experimentation with actual contaminated soil samples under authority of its EPA R&D permits has determined that the solution will preferentially attack chlorinated and fluorinated compounds, even in materials containing large quantities of competing materials.

In application, the process employs a reactor vessel in which contaminated material and liquid ammonia are mixed. The ammonia mixes with the contaminated organic material (the organic fraction from the B.E.S.T. process) forming a solution. After brief additional mixing, sodium is added. Electrons are freed from the sodium by the ammonia, and the freed electrons chemically destroy the contaminants, in this case, PCBs.

When the process is complete, ammonia is retained in the system for re-use, and the treated organic material is removed. The following chart illustrates the basic SET process:

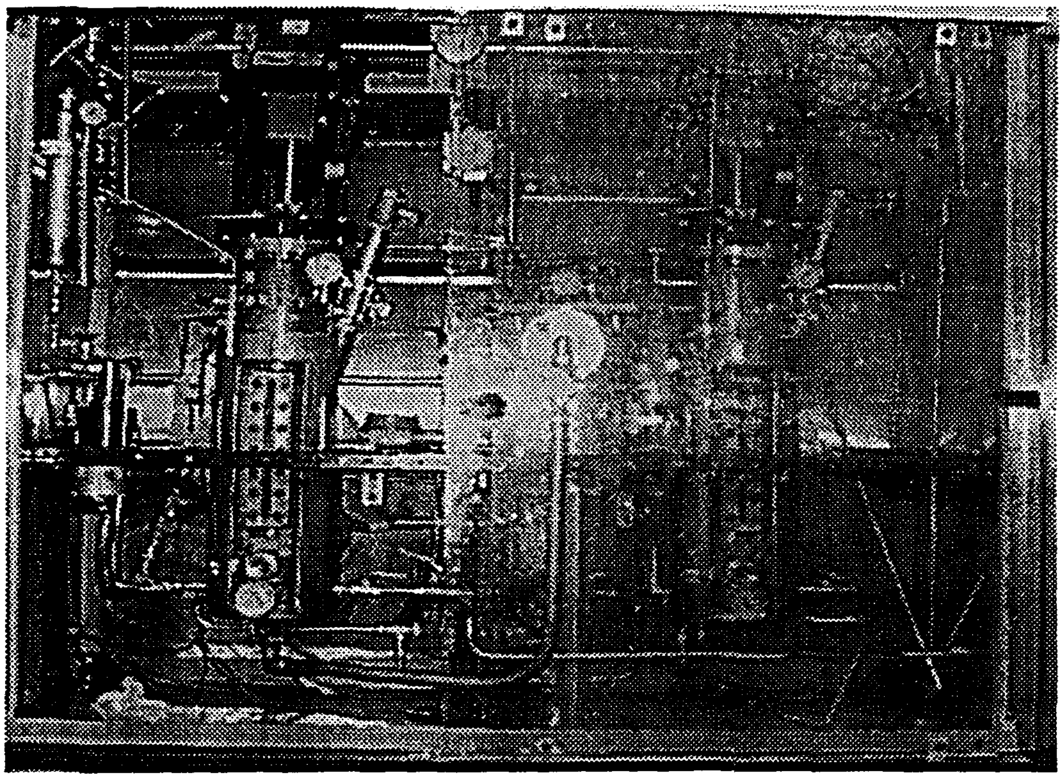
Solvated Electron Technology (SET)$^{\text{TM}}$ Process Summary



By-products of the process primarily consist of metal salts (sodium chloride – i.e., ordinary "salt"), biphenyls, and trace amounts of ammonia.

2.2.1 SET Unit Operations

A mobile pilot scale SET unit, capable of processing approximately 1 gallon of concentrated organic per day, was employed for the New Bedford Harbor Treatability study (picture follows).



CRTI's Pilot Scale SET Unit

The unit consists of a reactor pressure vessel, a zero discharge holding vessel for treated product, and a storage pressure vessel for recycling liquid ammonia (this vessel is identical to and interchangeable with the reactor vessel). Concentrated organic material (extracted from the sediment) is introduced into the reactor vessel, where it is mixed with liquid anhydrous ammonia, then a calculated amount of metallic sodium is added through a special port in the top of the vessel. As the sodium dissolves, electrons are released to the solution, and these electrons, or free radicals, destroy PCBs through a chlorine substitution process. When the reaction is complete (approximately 15 minutes), the entire contents of the reactor vessel are directed to the zero discharge holding vessel, and ammonia is transferred to the storage vessel using a common heating and cooling operation. After ammonia removal, the treated material is manually removed from the zero discharge holding vessel and the process is repeated.

3.0 PHASE I: PILOT SCALE OPTIMIZATION TESTING

The on-site pilot scale demonstration test program at New Bedford Harbor was designed and conducted in two parts. The two parts were Phase I: Pilot scale Optimization Testing, and Phase 2: Pilot scale Verification Tests. The following sections describe the testing conducted to determine the optimum process parameters which were used during later verification testing.

3.1 B.E.S.T. Process Pilot scale Optimization Tests

The purpose of optimization testing was to identify the optimum process parameters required to extract the PCBs from the contaminated feed samples, and the optimum parameters to achieve complete chemical destruction of the extracted PCBs by the SET process.

Three optimization tests (batches) were conducted with the feed sediment sample. The expected optimum process parameters for the feed sample were determined based on prior bench scale testing, engineering analysis, and computer modeling of sample characterization results. These parameters were used, and adjusted, during optimization testing. The optimum process parameters, as identified during this optimization testing, were then used during the verification testing.

3.1.1 Feed Sample Preparation and Loading

Feed material from the Confined Disposal Facility (CDF) was screened to remove oversize material, homogenized, and stored in buckets. Analytical samples of the feed were collected during the transfer to the buckets. The amount of feed material loaded to the Premix Tank was determined by the solids content of the feed material, bulk density of the solids, and solids settling characteristics. Sufficient feed material was added to the Premix Tank such that later, during the drying step, the Extractor/Dryer was at least 1/4 (8 gallons) full of dried solids when complete. This minimum solids loading of the Extractor/Dryer allowed for proper heat transfer and mixing in the Extractor/Dryer during drying.

To achieve the optimal removal of organic contaminants with each extraction cycle, the Premix Tank was loaded with just enough feed material such that the solids settled to just below the middle decant port of the Premix Tank. This feed loading allowed the greatest contaminant removal with each extraction cycle while maximizing the amount of solids that could be processed per batch.

3.1.2 Solvent Extraction Testing

Five major extraction parameters were optimized: extraction temperature, extraction time, solids settling time, decant level, and the number of extraction cycles. By varying one or more of these parameters, the optimum combination of extraction variables was determined.

The extraction temperature has been shown to affect several parameters. These parameters include extraction efficiency, water removal, and solids settling characteristics. Evaluating the effect of changing temperature on these parameters during the optimization testing identified the optimum temperature for each extraction cycle.

The optimum extraction time was determined by evaluating the effect of extraction time on extraction efficiency and balancing that against the overall cycle time required to process a batch of feed sample. A longer extraction time generally yielded higher extraction efficiency but also increased the time to treat a batch of feed sample. Therefore, shorter extraction times may have caused a greater number of total extraction cycles to be performed, but the total time to treat a batch of feed sample may actually have been less.

Optimum solids settling times were determined only after the optimum feed sample load had been determined. The optimum solids settling time is a function of the size of the feed material load per batch. The optimum settling time was determined based on the maximum amount of solids which could be effectively processed by the fines centrifuge, and also was based on attempting to minimize the overall batch process cycle time.

The optimum decant level is a function of solids loading, settling time, centrifuge loading requirements, and anticipated extraction efficiency. The goal was to select a decant level just slightly above the settled solids level. This decant level minimized the solvent heel volume remaining in the Premix Tank after decanting, and maximized the fraction of the contaminants removed with each extraction cycle. Since the pilot unit only has three decant ports, the feed sample loading was adjusted to aid in obtaining the optimum decant level.

Finally, the number of required extraction cycles was determined. The number of extraction cycles required to achieve the desired extraction is a function of all of the previously mentioned parameters. Once all other parameters were optimized, the number of required extraction cycles was determined. With only three optimization batches, and five variables to determine, some educated interpolation was required. Therefore the exact number of extraction cycles required for verification testing was not completely certain. To be conservative an additional two extraction cycles were performed during verification testing.

3.1.3 Pilot Scale Optimization Test Results

3.1.3.1 Batch 1

The feed sample load used for batch 1 was 130 pounds. Three cold (less than about 80 °F) extraction cycles were used for batch 1 processing. The optimum extraction temperature for treating this feed sample was determined to be near the complete miscibility point of the solvent/water mixture in the Premix Tank.

For batch 1, the optimum extraction time ranged from 5 minutes for the first extraction cycles to 15 minutes for the final extraction cycles. Longer extraction times were required for the final extraction cycles due to the lower extraction efficiency encountered when the contaminants reach very low levels, as was the case.

The decant level was at 62 percent (upper port) of the Premix Tank full volume for the first 3 extractions, and then at the 32 percent (mid port) for subsequent extractions. After the water had been removed in the initial extractions, the solids settled to a lower level and this allowed a greater fraction of the remaining contaminants to be decanted with each extraction.

The feed sample settled quickly. This resulted in a clear solids-free extract solution (solvent/contaminants/water). Therefore, fines centrifugation was not required during batch one. The extract solution was decanted directly into the solvent evaporator.

The solids and solvent heel remaining in the Premix Tank were pumped over to the Extractor/Dryer and dried to remove the residual solvent. When the batch 1 treated solids were discharged from the bottom of the Extractor/Dryer, some treated solids adhered to the paddles and to heat transfer surfaces of the Extractor/Dryer. These solids were ultimately removed during unit decontamination. During typical pilot scale testing, only a few batches of each feed sample type are processed. Therefore, in some cases, these treated solids that hang-up in the system, and are removed during the decontamination, can account for a significant portion of the total treated solids inventory. In full scale operations, or pilot scale tests with a large number of batches for each feed material, the fraction of the total treated solids which hangs up in the system, and is removed during decontamination, is considerably less.

The caustic addition required to achieve the desired treated solids solvent residual for batch 1 was 18 ml of 50% NaOH per kilogram of dry solids. This caustic load was added to the Extractor/Dryer just prior to the drying step.

The concentrated organics (PCBs and oil) remained in the evaporator throughout the processing of all the optimization batches. After the third batch of feed sediment was processed, (the final optimization batch), the solvent/organic solution in the solvent evaporator was concentrated to about 30 liters, and pumped into the oil polisher. Since the amount of organic compounds present in each of the three batches was extremely low, these extractable organic compounds were accumulated together throughout all three optimization batches. The combined organic compounds were processed together during polishing of the final oil.

3.1.3.2 Batch 2

Batch 2 was processed by deliberately allowing fines to carry over to the centrifuge. The solids/liquid separation is very effective in the centrifuge when compared to that achieved by gravity settling. This increased separation allowed a greater extraction efficiency. The feed sample load used for batch 2 was 132 pounds. This feed material was loaded directly into the Extractor/Dryer.

Extraction was started by adding solvent to the material in the Extractor/Dryer. The material was mixed while solvent was continually added. A mixture of solvent, water, organics, and fines was allowed to flow out of the vessel. This mixture was transferred to the centrifuge for liquid-solids separation. The solids were continually returned to the Extractor/Dryer, while the extracted centrate was routed to the normal solvent recovery system for recovery and re-use.

The caustic addition required to achieve the desired pH and treated solids solvent residual for batch 2 was 18 ml of 50% NaOH per kilogram of dry solids. This caustic load was added to the Extractor/Dryer just prior to the drying step.

The concentrated organics (PCBs and oil) remained in the solvent evaporator throughout the processing of all three optimization batches. After the third batch of feed was processed, the solvent/organic solution was concentrated to about 30 liters, and pumped into the oil polisher.

3.1.3.3 Batch 3

Batch 3 processing was conducted similarly to batch 1. The feed material load used for batch 3 was 124 pounds. Three cold extraction cycles were conducted in the Premix Tank during batch 3. The optimum extraction temperature for treating this feed sample was determined to be near the complete miscibility point of the solvent/water mixture in the Premix Tank.

For batch 3, the optimum extraction time ranged from 5 minutes for the first extraction to 30 minutes for the final extraction. Longer extraction times were used for the final extraction due to the lower extraction efficiency encountered when the contaminants reached very low levels.

The extract solution was decanted from the mid port of the Premix Tank for all extractions during batch 3. As for batch 1, the extract solution was free of fines, and thus was not centrifuged. Extract solution was routed directly to the solvent evaporator.

The solids and solvent heel in the Premix Tank was then pumped over to the Extractor/Dryer for drying.

The caustic addition required to achieve the desired pH and treated solids solvent residual for batch 3 was 18 ml of 50% NaOH per kilogram of dry solids. This caustic load was added to the Extractor/Dryer just prior to the drying step.

The concentrated organics (PCBs and oil) remained in the evaporator throughout the processing of all three optimization batches. After the third batch of feed was processed, the solvent/organic solution was concentrated to about 30 liters, and pumped into the oil polisher.

The oil polisher is a smaller, isolated solvent evaporator. Since the volume of organics present in the feed samples was very small, the volume of concentrated contaminant was too small for effective concentration in the main solvent evaporator. The oil polisher is smaller, so it allowed a smaller volume of material to be circulated and heated without a large percentage of the material adhering to the inner surfaces. The extracted contaminants were concentrated in the oil polisher and then pumped into sample containers for analyses and subsequent treatment with the Solvated Electron Technology PCB destruction process. The solvent and water recovered during oil polishing was returned to the pilot unit for re-use.

3.1.4 Optimization Testing Conclusions

The performance of the first three batches was used to determine the parameters to used during verification testing. Based on observation of the testing, it was determined to use Premix Tank extractions as was done for batch 1 and 3. A feed batch load of about 140 pounds was determined to be optimum. The extraction temperature, extraction time, solids settling time, and decant level from the third batch were observed to be optimum, so they were repeated during verification testing.

The only parameter in question was the number of extraction cycles to use. Based on modeling, it was determined that 8 extraction cycles should be sufficient. Therefore, 10 extraction cycles were performed, to be conservative, during verification testing.

3.2 CRTI SET Process Pilot scale Optimization Tests

The concentrated organic fraction generated from RCC's optimization test phase (batches 1, 2, and 3) was the feedstock used for CRTI's SET process optimization tests. Optimization testing was conducted to determine the parameters necessary to achieve complete chemical destruction of the PCBs and generate data which would be used to provide an accurate estimate of the full scale treatment costs.

The CRTI equipment used at New Bedford Harbor was capable of treating up to one gallon of contaminated matrix per twelve hour day. The feed rate for this unit is adequate to demonstrate Solvated Electron Technology's ability to destruct PCBs chemically, especially in concentrated form such as was delivered by the B.E.S.T. process.

Four parameters were optimized. These included one major parameter (sodium mass) and three minor parameters (ammonia volume, premix time, treatment mix time).

The first optimization run determined that ammonia volume required was between 8 and 9 liters. This amount of ammonia allowed adequate mixing of the product oil and sufficient contact with the solvated solution. There was little expansion or contraction of the treatment matrix during operations, and sight glass monitoring of fluid level was possible.

The first optimization run also determined that approximately 10 minutes of pre-mix time was sufficient to slurry the product oil in the ammonia completely prior to sodium addition. After this pre-mix was completed, sodium aliquots were dropped through the reactor vessel entry port, and after each a 2 to 5 minute solvation mix time elapsed.

Determination of the amount of sodium mass required to destruct the PCBs was more complicated. It was decided to start with much more sodium than stoichiometrically required (i.e. "overkill"), then reduce the sodium dosage in the subsequent two runs to only that amount necessary for complete PCB destruction. Unfortunately, cross-contamination during the second and third runs mandated a decision to "overkill" the remaining verification runs. As a result of this excess sodium in the treated organics, an additional post-treatment step to reduce the pH to below 12 was required. The soda amides present due to the excess sodium also required venting to remove excess ammonia.

The "overkill" issue will not be applicable to full scale operations because excess addition of sodium will not be required. Testing completed on equipment at CRTI's Marengo facility has perfected measurement of the solution conductivity as an indicator of complete PCB destruction, regardless of the matrix or contamination level being treated, thereby eliminating the need for excess sodium addition. High conductivity is indicative of sufficient sodium and the ability of the solvated solution to react properly with contaminants. Conversely, low conductivity measurements assure that all sodium has been spent in the process. CRTI has developed conductivity control curves applicable to the continuous process which allow the treatment process to operate essentially in stoichiometric fashion, eliminating excess sodium in the treated product. Data from these tests, or demonstrations of this technique, are available for review at the Marengo site.

3.2.1 Feed Sample Preparation and Loading

At the start of testing, the CRTI pilot unit was configured to pump heavy liquids as feedstock. The concentrated organic fraction from the B.E.S.T. unit discharged as a liquid. However, after cooling to ambient temperature, the organics solidified. The organics solidified when cooled because of the constituency of the organic contaminants in the original sediment. The B.E.S.T. process removes all the contaminant organics from the sediment, including heavy organics such as wax, not just the PCBs. This is evidenced by the order of magnitude reduction of 'Oil & Grease' from the feed to the treated solids (see Table 4-2 and Table 4-3).

When RCC and CRTI discovered that the organic fraction cooled to a waxy solid, the CRTI pilot unit was adapted to receive this solid matrix. The organic fraction was then fed into the reactor vessel through a side access port. While this feed method was not representative of full scale equipment, it did allow for the tests to continue. Thus, the expected method of loading materials into the full scale SET unit could not be demonstrated in pilot scale. In full scale, the organic fraction from the B.E.S.T. system would be pumped directly into the SET reaction vessel while it is still hot. Also, the pump and piping used for the B.E.S.T. organic fraction transfer would be heat traced to maintain the organic temperature in the event organics are held in the lines during a process interruption. Existing RCC full scale B.E.S.T. equipment uses explosion proof, self regulating electrical heat tracing manufactured by Thermon.

The feed method for transfer of organics from the B.E.S.T. full scale unit to the SET full scale unit is more fully described in Section 5 of this report.

3.2.2 Solvated Electron Technology Testing

The sodium metal added to the solvated waste solution was the primary focus of optimization. The ratio of sodium metal to PCBs had to be sufficient to ensure that enough solvated electrons were present in solution to achieve complete destruction of the PCBs. If the amount of electrons was insufficient, additional metal had to be added. The addition of excess metal causes the 'clean product' to require post treatment. For these reasons, it is desirable to achieve complete PCB destruction with as little metal as possible.

CRTI's first optimization batch run was made with a high sodium dosage, namely, approximately 80% of the mass of the waste treated. During the following two runs the sodium to waste ratio was lowered to 50% and 40%, respectively. When analytical results of these runs became available, CRTI chose a metal to waste ratio of 65%. This ratio of metal to waste was much higher than would be called for by stoichiometric analysis. The scaled up SET unit operates at a ratio of less than 10% sodium mass to treated mass.

3.2.3 Optimization Testing Analysis Results

Samples were collected during optimization testing to verify the process performance and allow monitoring of the effect of changing process parameters. Samples were analyzed for PCBs and basic composition (oil, water, solids). Attachment 1 provides a summary of the analysis results package for the testing. The results of the optimization test analyses conducted by the on-site laboratory are summarized below in Table 3-1:

Table 3-1: On-Site Laboratory Results for PCBs

CRTI Optimization Runs

PCBs before treatment	PCBs after treatment			
	Batch 1	Batch 2	Batch 3	Batch 4
74,394 ppm	< 0.5 ppm (non-detectable)	1,119 ppm	490 ppm	4,697 ppm

The treated material from batches 2 through 4 contained dramatically more PCBs than originally anticipated. The source of PCBs in these samples was identified to be contamination from feed material lodged in the loading port. This small amount of feed material (RCC's concentrated organics) was not completely contacted with the solvated electron solution because it became held up in the feed port. The uncontacted, and therefore untreated, material was subsequently dislodged from the port by pressure differentials during transfer of the treated material from the reactor vessel to the zero discharge holding vessel, thereby re-contaminating the treated material. This re-contamination was discovered based on the results of on-site lab analyses. When discovered, on-site operations were modified to transfer the treated product from the reactor vessel to the zero discharge vessel in a solvated condition before quenching, rather than quenching the solution in the reactor. Thus, any material dislodged from the feed port during transfer was effectively treated in the discharge piping or the discharge vessel. Subsequent performance test runs verified the identification of and the solution to this phenomenon.

3.2.4 Optimization Testing Material Balance

The amount of materials added to and recovered from the pilot unit during optimization testing was recorded. A summary of this material balance for optimization testing follows:

	Run 1	Run 2	Run 3	Run 4
Material Added, grams	1,254	953	876	878
Material Recovered, grams	1,232	932	840	834
Percent Recovery (%)	98 %	98 %	96 %	95 %

The material balance data indicated adequate accounting of all materials.

4.0 PHASE II: PILOT SCALE VERIFICATION TESTING

The purpose of verification testing was to conduct tests (batches) at consistent optimum process conditions. Data generated during these tests confirmed that the B.E.S.T. solvent extraction process can successfully remove PCBs from the contaminated sediments on a repeated basis, and that the Solvated Electron Technology can successfully achieve complete chemical destruction of the extracted PCBs on a repeated basis. The verification testing was conducted by processing sediment under the optimized conditions identified during optimization testing. Analytical samples were collected during verification testing for analysis by an EPA regional laboratory and by a Foster Wheeler contracted laboratory.

4.1 B.E.S.T. Verification Testing

4.1.1 B.E.S.T. Process Parameters

The following process parameters were selected for operation of the B.E.S.T. process during verification testing:

- A feed load of about 140 pounds was used for each batch.
- Extraction temperature was less than 80 °F for the first extraction then increased with each extraction. The temperature was greater than 130 °F for extractions 7 through 10.
- Extraction mixing times were set at 10 minutes for extraction cycles 1 through 3, and 15 minutes for extraction cycles 4 through 10.
- The settling time was set at about 30 minutes for extractions 1 through 3. The settling time was set less than 15 minutes for extractions 4 through 10, and was often less than 5 minutes. The solids settled to a lower level for extractions 4 through 10 than for extractions 1 through 3, and thus more extract was removed during the later extractions.
- Ten extraction cycles were conducted with the feed material.
- The fines centrifuge was not used.
- Caustic addition during drying of the sediments was 18 ml of 50% NaOH per kilogram of dry treated solids.

- The PCB contaminated organic fraction remained in the evaporator throughout the processing of both verification batches. After the second verification batch was processed, the solvent/organic solution was concentrated to about 30 liters, sampled, and transferred to the oil polisher for further concentration. After polishing, the organic fraction was placed in containers for sampling and treatment with the Solvated Electron Technology.
- The recovered water was stripped to remove residual solvent and then sampled.

4.1.2 Feed Sample Analyses Results

Analytical samples were taken of the feed material for all five batches. These samples were analyzed for many contaminant components, including PCBs and Oil & Grease. The total solids were also measured. Results of these analyses, for all five batches, follows in Table 4-1 and 4-2.

4.1.3 Interstage and Treated Solids Analyses Results

The solids in the Premix Tank were sampled after the 2nd, 4th, 6th, and 8th extraction cycles. These interstage solids samples were analyzed for PCBs. Results of interstage solids sample PCB analyses are presented in Table 4-1.

Treated solids were analyzed for PCBs, Oil & Grease, total solids, diisopropylamine, and total metals and TCLP metals per the test plan. Results of the treated solids analyses are presented in Table 4-1, and 4-3. Results of TCLP analyses are provided in Attachment 2. All TCLP results were below regulatory limits. A summary of TCLP regulatory limits are presented in Table 4-4, as well as included in Attachment 2.

PCB analyses were also performed on feed, interstage samples, and treated solids, by the on-site laboratory, on a "24-hr turnaround" intended basis . These results are not as accurate as the previously presented Foster Wheeler and EPA results, however they show approximate results and trends. A table showing all the on-site laboratory results is presented in Table 4-5.

Table 4-1: PCB Analysis Results (mg/kg, dry basis)

	Optimization Testing			Verification Testing	
	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
Feed	2,100	2,500	2,500	2,400	2,500
2nd Extraction Solids	---	---	---	250	---
4th Extraction Solids	---	---	---	43	---
6th Extraction Solids	---	---	---	5	---
8th Extraction Solids	---	---	---	5	---
Treated Solids	13	19	7	5	6

Note: All PCB values shown are an average of results.

Table 4-2: Feed Material Analysis Results

	Optimization Testing			Verification Testing	
	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
Oil & Grease (%)	1.7	1.2	2.1	2.0	1.9
Total Solids (%)	49	53	49	56	58

note: All Total Solids numbers, and some Oil & Grease numbers, are an average of results.

Table 4-3: Treated Solids Analysis Results

	Optimization Testing			Verification Testing	
	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
Oil & Grease (%)	0.13	0.32	---	0.25	---
Total Solids (%)	78	88	87	90	92
Diisopropylamine (mg/kg)	2.4	2.7	---	4.8	1.1

note: All Total Solids numbers, and some Oil & Grease and DIPA numbers, are an average of results.

Table 4-4: TCLP Regulatory Limits Summary

TCLP Volatile Organics	MCL (mg/L)
Vinyl Chloride	0.2
1,1-Dichloroethene	0.7
2-Butanone	200
Chloroform	6
Carbon Tetrachloride	0.5
Benzene	0.5
1,2-Dichloroethane	0.5
Trichloroethene	0.5
Tetrachloroethene	0.7
Chlorobenzene	100

TCLP Semivolatile Organics	MCL (mg/L)
1,4-Dichlorobenzene	7.5
2-Methylphenol	200
3- & 4-Methylphenol	200
Hexachloroethane	3
Nitrobenzene	2
Hexachlorobutadiene	0.5
2,4,6-Trichlorophenol	2
2,4,5-Trichlorophenol	400
2,4-Dinitrotoluene	0.13
Hexachlorobenzene	0.13
Pentachlorophenol	100
Pyridine	5

TCLP Herbicides	MCL (mg/L)
2,4-D	10
Silvex (2,4,5-TP)	1

TCLP Organochlorine Pesticides	MCL (mg/L)
Lindane	0.4
Heptachlor	0.008
Heptachlor Epoxide	0.008
Endrin	0.02
Methoxychlor	10
Chlordane (technical)	0.03
Toxaphene	0.5

TCLP Metals	MCL (mg/L)
Arsenic	5
Barium	100
Cadmium	1
Chromium	5
Lead	5
Selenium	1
Silver	5

TCLP Mercury	MCL (mg/L)
Mercury	0.2

Table 4-5: On-Site "24-Hour Turnaround" PCB Analysis Results (ppm)

	Optimization Testing			Verification Testing	
	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
Feed	3,900	2,800	3,700	3,600	3,000
1st Extraction Solids	---	790	290	3,700	680
2nd Extraction Solids	---	910	55	2,000	780
3rd Extraction Solids	---	310	36	780	430
4th Extraction Solids	41	140	23	87	120
5th Extraction Solids	220	68	24	40	39
6th Extraction Solids	5	160	50	22	14
7th Extraction Solids	4	55	4	6	8
8th Extraction Solids	13	19		5	7
9th Extraction Solids				3	4
10th Extraction Solids				3	3

Note: These PCB results are from "24-Hour Turnaround" laboratory analysis. The accuracy of these results is not as great as the accuracy of the Foster Wheeler or EPA results. However, these results show trends.

4.1.4 Organic Fraction Analyses Results

The organic fraction was sampled and analyzed for PCBs and diisopropylamine. Results of the diisopropylamine are presented in Table 4-6. PCB results can be found in Section 4.2.

Table 4-6: Organic Fraction Analysis for Diisopropylamine

Analyte	Batch 1, 2, & 3	Batch 4 & 5
Diisopropylamine, mg/kg	220,000	73,000

4.1.5 Product Water Analyses Results

The product water was sampled and analyzed for PCBs, Oil & Grease, Total Solids, TDS and TSS, and diisopropylamine. Results of the product water analyses are presented in Table 4-7, following:

Table 4-7: Product Water Analysis

Analyte	Batch 1, 2, & 3	Batch 4 & 5
PCBs, mg/l	< 0.002	< 0.002
Oil & Grease, mg/l	<10	90
Total Solids, mg/l	180	310
TDS, mg/l	180	290
TSS, mg/l	< 5	19
Diisopropylamine, mg/l	2.7	< 0.5

4.1.6 Verification Testing Material Balances

The amount of materials, by individual component, added to and recovered from the B.E.S.T. pilot unit during verification testing follows:

	PCBs	Solids	Oil
Material Added	170-184 g	72 kg	2.4 -2.6 kg
Material Recovered	91 - 182 g	71 kg	0.6 - 3.0 kg
Percent Recovery, %	49-107%	99 %	23-125 %

Notes:

The balances were drawn over batches 4 and 5 combined.

Ranges of material added, material recovered, and percent recovery reflect ranges in respective analytical results.

Water balance cannot be determined due to undefined retention of decontamination water in the pilot unit.

The material balance data indicates adequate accounting for these components.

4.2 Solvated Electron Technology Verification Testing

4.2.1 Feed Sample Preparation and Loading

Feed sample loads of 606, 619, and 646 grams of the B.E.S.T. concentrated organic fraction were used respectively for the verification batches 5, 6, and 7. The material was received in a solid state, and was chopped to small pieces for inserting into the reactor vessel. No other pretreatment was performed. The material was loaded into an empty, ambient pressure and temperature reactor vessel, then the vessel was closed and filled with anhydrous ammonia. After a nominal ten minute mixing period, sodium was added per a 65% sodium to waste ratio. Solvation was indicated both by color and conductivity, and after approximately twenty minutes of reaction time, the material was discharged to the zero discharge vessel for ammonia removal. One liter of quench water was added to this vessel after ammonia recovery, and the combined treated materials and water were removed from the zero discharge vessel and stored in five gallon plastic pails. This material was sampled in accord with the project Sample Analysis Plan.

4.2.2 Solvated Electron Technology Sample Analyses Results

4.2.2.1 Feed Sample Analyses

The concentrated organic fraction from the B.E.S.T. process verification testing was the feedstock for CRTI verification testing (CRTI runs 5, 6, and 7). This feed material (the organic fraction from B.E.S.T. batches 4 and 5) was sampled and analyzed for its constituents. The results of the PCBs and diisopropylamine analyses are summarized here in Table 4-8:

Table 4-8: Verification Testing Concentrated Organic Fraction Analysis [feed for CRTI testing]

Total PCBs	DIPA
40,000 mg/kg	73,000 ppm

4.2.2.2 Treated Product Samples

The CRTI treated product from verification testing (CRTI runs 5, 6, and 7) was sampled and analyzed for its constituents. The results of the PCBs, TSS, water content, and diisopropylamine analyses are summarized here in Table 4-9:

Table 4-9: Verification Testing Treated Product Analysis
[product from CRTI testing]

CRTI Test Run Number	Total PCBs, mg/kg	Total Suspended Solids, mg/l	Water Content (by KF), %	diisopropylamine, mg/kg
5	5.1 *	4270	74	9.1
6	1.3 *	2790	71	200
7	3.0 *	20400	56	520

*** Note: PCB results were near the detection limit, therefore numbers are estimates.**

The PCB analytical results were estimates because the PCB levels were close to the detection limit. The results indicated that in some cases, the CRTI treatment process residual PCBs were below the detection limit. These results demonstrate that the SET process can successfully destroy PCBs to very low residual levels.

4.2.2.3 Recycled Ammonia Samples

For each verification batch run, a 200 ml sample of the recycled ammonia recovered from the test was collected in a one liter jar and evaporated to atmosphere. The jar was then washed with hexane, and the hexane analyzed for PCBs. The analytical results of these samples is presented here in Table 4-10:

Table 4-10: PCB Analysis of Recycled Ammonia

CRTI Run Number	PCBs,
5 (first sample)	< 40 •g/l
5 (second sample)	< 1.98 mg/l
6 (first sample)	< 4.0 •g/l
6 (second sample)	< 1.98 mg/l
7	< 1.98 mg/l

These results demonstrate that the recycled ammonia transported essentially no PCBs during the process.

4.2.2.4 Scrubber Water

A vent scrubber is installed in the pilot system to remove any ammonia which might escape the process by the vent. The water in the scrubber was sampled after each CRTI run to verify that PCBs were not exiting the process by the vent. After each CRTI run, a 1 liter sample of scrubber water was collected and analyzed for PCBs. The samples taken showed PCB results of 13 •g/l, 12 •g/l, 3.7 •g/l, and 83•g/l. These extremely low PCB levels show that PCBs were not escaping the process by the vent.

4.2.3 Verification Testing Material Balance

The amount of materials added to and recovered from the CRTI pilot unit during verification testing was recorded. A summary of this material balance for verification testing follows:

	Run 5	Run 6	Run 7
Material Added, g	3,006	2,986	3,059
Material Recovered, g	2,987	2,949	3,034
Percent Recovery (%)	99 %	99 %	99 %

The material balance data indicated adequate accounting for all materials.

5.0 FULL SCALE TREATMENT

SUMMARY

The full scale treatment solution proposed by RCC and CRTI is a combination of RCC's B.E.S.T.® solvent extraction process 160 tons per day unit, and CRTI's SET 3.4 tons per day unit. Both companies have the experience, technical knowledge, and financial resources to successfully complete the sediment remediation project at the New Bedford Harbor site. RCC has 25 years of experience designing, fabricating, and operating full scale equipment. CRTI has three full scale chemical reaction remediation systems currently in operation, including two which remediate PCBs.

RCC and CRTI combine these years of industrial treatment experience with recent PCB full scale treatment experience on other sites. For the past twelve years, RCC has been actively commercializing the B.E.S.T.® Process for treating hazardous wastes at Superfund and other sites. RCC began commercialization of the B.E.S.T.® Process with the design, construction, and operation of a 70 ton per day unit used to treat 3700 tons of PCB contaminated wastes at the General Refining Inc. (GRI) Superfund site. Since successful completion of this project in 1987, the B.E.S.T. solvent extraction process and equipment design have been continuously improved. The process improvements have been based on the full scale operating experience achieved at the GRI Superfund site, as well as over 25 pilot scale tests and over 300 bench scale tests. These improvements include: equipment and design modifications to treat a wide range of feed compositions including low moisture soil as well as high water content sediment and sludge; enhanced organic extraction efficiency due to continuous process optimization; improved solid/liquid separation and evaporation techniques; and improved solids handling systems.

RCC has recently delivered a 50 ton per day radioactive and organic mixed waste soil treatment system which shares most of the process features with the 160 ton per day unit recommended for New Bedford Harbor. Also, the unit recommended for New Bedford Harbor shares most of the features of the system selected for remediation of the Norwood Superfund Site, a project which was stopped by lack of funding.

CRTI has been operating two batch/continuous liquid chemical destruction units over the past six months, recovering and destroying mixed chloroflorocarbons, at its facility in Marengo, Ohio. Operating experience on one of these units, the L150, provides many of the scale-up parameters for the continuous processing unit proposed for treating New Bedford Harbor concentrated organic contaminants. This unit is hereinafter referred to as "L900".

Results from the New Bedford Harbor pilot testing allow RCC and CRTI to customize their treatment process designs. This combination of experience, testing, and corporate commitment ensures a successful full scale remediation.

5.1 Full Scale Process Viability

The B.E.S.T.® Process and the Solvated Electron Technology (SET) process were successfully demonstrated in pilot testing. Demonstration that each process will be successful (viable) in full scale can be shown by comparison with previous projects, as well as by comparison to other successful full scale operations.

5.1.1 B.E.S.T. Scale-Up Viability

RCC has developed a bench scale and pilot scale treatability test protocol that closely simulates the vessels and processes to be used in full scale treatment. This protocol gives RCC data which has been shown to predict full scale performance. The data also serves to permit RCC to estimate treatment costs. Because successful pilot testing was conducted on the exact material to be remediated, the RCC model is expected to very accurately predict full scale results and treatment costs. The RCC protocol used for this scale-up has been scrutinized by an independent contractor and found to be reliable.

The reliability of the RCC tests to predict full scale performance has been verified by the US EPA report *Evaluation of the B.E.S.T. Solvent Extraction Sludge Treatment Technology - Twenty-Four Hour Test*, by Enviresponse, Inc., under EPA Contract 68-03-3255. Evaluating the B.E.S.T. process, this report states:

> "Resources Conservation Company has conducted many laboratory tests and developed correlations to which data from full scale operations, such as the General Refining site, can be compared."

Table 5-1 presents data from two separate treatability tests and from full scale operation at the General Refining, Inc., Superfund site. These data demonstrate a close correlation between bench scale treatability test data and full scale operating data.

Table 5-1
PCB Concentrations in Raw Sludge and Product Fractions (ppm)
at the General Refining Inc. Site

	Bench scale Test A	Bench scale Test B	Full scale Processing
Raw Sludge, mg/kg, dry basis	14	12	13.5
Product Solids, mg/kg, dry basis	0.02	0.14	<0.13
Product Water, mg/l	<0.01	<0.01	<0.005
Percent Removal, %	99.9	98.8	>99

When combined with successful pilot testing, this correlation of testing results to full scale results demonstrates the full scale viability of the B.E.S.T. process. Furthermore, the process has such a great amount of flexibility that process changes can easily be made to increase the extraction performance (percent removal). Variables that could be changed to increase percent removal of PCBs include: number of extraction stages; mixing time; solvent to feed ratio; extraction temperature; and solvent use.

However, the most important demonstration of full scale viability is previous success with full scale operations. RCC has successfully operated the B.E.S.T. solvent extraction process at full scale with a 70 ton per day unit at the General Refining Inc. Superfund site. RCC has recently delivered a 50 ton per day radioactive and organic mixed waste soil treatment system which shares most of the process features with the 160 ton per day unit recommended for New Bedford Harbor. RCC has also conducted successful pilot scale demonstration tests with 25 hazardous waste samples, and has conducted over 300 successful bench scale treatability tests on a wide variety of soil, sludge, and sediment. The solvent extraction process proposed for the New Bedford Harbor site is similar to both the 70 tons per day full scale unit used at the General Refining site, and the 50 tons per day unit delivered recently. The proposed unit draws from the sediment handling components of the General Refining unit, and the solids handling and drying components of the 50 TPD unit. The proposed 160 tons per day B.E.S.T. solvent extraction unit will be capable of treating all materials present on the New Bedford Harbor site.

5.1.2 B.E.S.T. Process Component Scale-up

RCC's B.E.S.T. pilot unit is a scaled down version of the full scale unit proposed for use at the New Bedford Harbor site. The pilot testing provided data which was readily scaled-up to the full scale application.

RCC's B.E.S.T. solvent extraction process has evolved over the past 10 years, resulting in significant process improvements and yielding three, distinct design configurations for treating feed streams with a wide range of compositions. The three design configurations are:

Configuration 1 -	Very low solids content (i.e., oily sludge)
Configuration 2 -	Intermediate to high solids content (sediment, sludge, and soil)
Configuration 3 -	High solids content (soil)

In 1987, RCC's first full scale B.E.S.T. solvent extraction process system treated contaminated oily sludge at the GRI Superfund site using Configuration 1, above. This system used continuous extraction, continuous drying, and continuous solvent recovery to treat the very low solids content sludge. Premix Tanks, similar to those proposed for use at New Bedford Harbor, were used to conduct the extractions. The solvent/water/oil/solids slurry was continuously pumped from these vessels through centrifuges. The centrifuged solids were sent to a continuous dryer and the liquid phase mixture was separated into oil, water, and solvent fractions. The solvent was recovered and reused for subsequent extractions.

In 1993, RCC designed a full scale unit to treat soil, sludge, and sediment in a single treatment train, using Configuration 2, above. The design used a combination of Premix Tanks and Extractor/Dryers to conduct the extractions in a batch mode. Solids drying was conducted batchwise in the Extractor/Dryer while solvent recovery and other unit operations were conducted continuously.

In 1996, RCC delivered a high solids (soil) treatment system to treat soil contaminated with a mixture of organics and radioactive waste using Configuration 3, above. The Extractor/Dryer was used to conduct all the extractions and solids drying in a batch mode. Solvent recovery and other unit operations were conducted continuously. A similar design was used for the Norwood Superfund site in 1995.

The proposed design for the New Bedford Harbor site will use Configuration 2 to treat the PCB contaminated Hot Spot sediment. This design uses a combination of batch extraction, batch drying of solids, and continuous solvent recovery, as discussed above. The extraction vessel used will be the Premix Tank, which is the same vessel used for extraction at the GRI Superfund site. Solids drying will take place in the Extractor/Dryer, the same drying device used in RCC's 1993 and 1996 system designs.

The primary process units used in the operation of the B.E.S.T. process are the extraction vessels (Premix Tanks) and the dryer (Extractor/Dryer). These vessels are used for solids loading, contaminant extraction, solids drying, and solids unloading. Scale-up of the B.E.S.T. process was, therefore, primarily dependent on data collected with the pilot scale Premix Tank and Extractor/Dryer.

Littleford Day, the preferred manufacturer of the Extractor/Dryer vessel, uses a unit identical to RCC's pilot scale Extractor/Dryer for scale-up calculations of their own full scale equipment. Data obtained from pilot testing with the Extractor/Dryer was easily and accurately scaled-up to the proposed full scale system. The detailed description of the method used to scale-up the pilot scale operating data is presented in Section 5.2 of this proposal.

Scale-up of the Premix Tank is straightforward. The Premix Tank is a vertical, cylindrical, baffled tank equipped with a standard propeller-type mixer. There are hundreds of fabricators throughout the country available to fabricate the Premix Tank.

Other unit operations in the B.E.S.T. process, such as solvent evaporation, water stripping, and centrifugation use common, off-the-shelf pieces of equipment. Each of these unit operations were also tested during the pilot test. This equipment is readily and accurately scaled-up to full scale operation. RCC has demonstrated these unit operations at full scale (70 tons/day) during the GRI Superfund Site project.

5.1.3 CRTI Scale-up Viability

Development of the SET process has been ongoing since 1982. The development work has generated significant supporting data for the chemistry and for its application to various matrices. Scale-up of the process began in 1994, with a 400 gallon batch reactor for solid materials becoming operational in 1995. Three 500 gallon soil reactors and a 100 gallon liquid reactor have since been added, with the instrumentation to monitor process parameters such as:

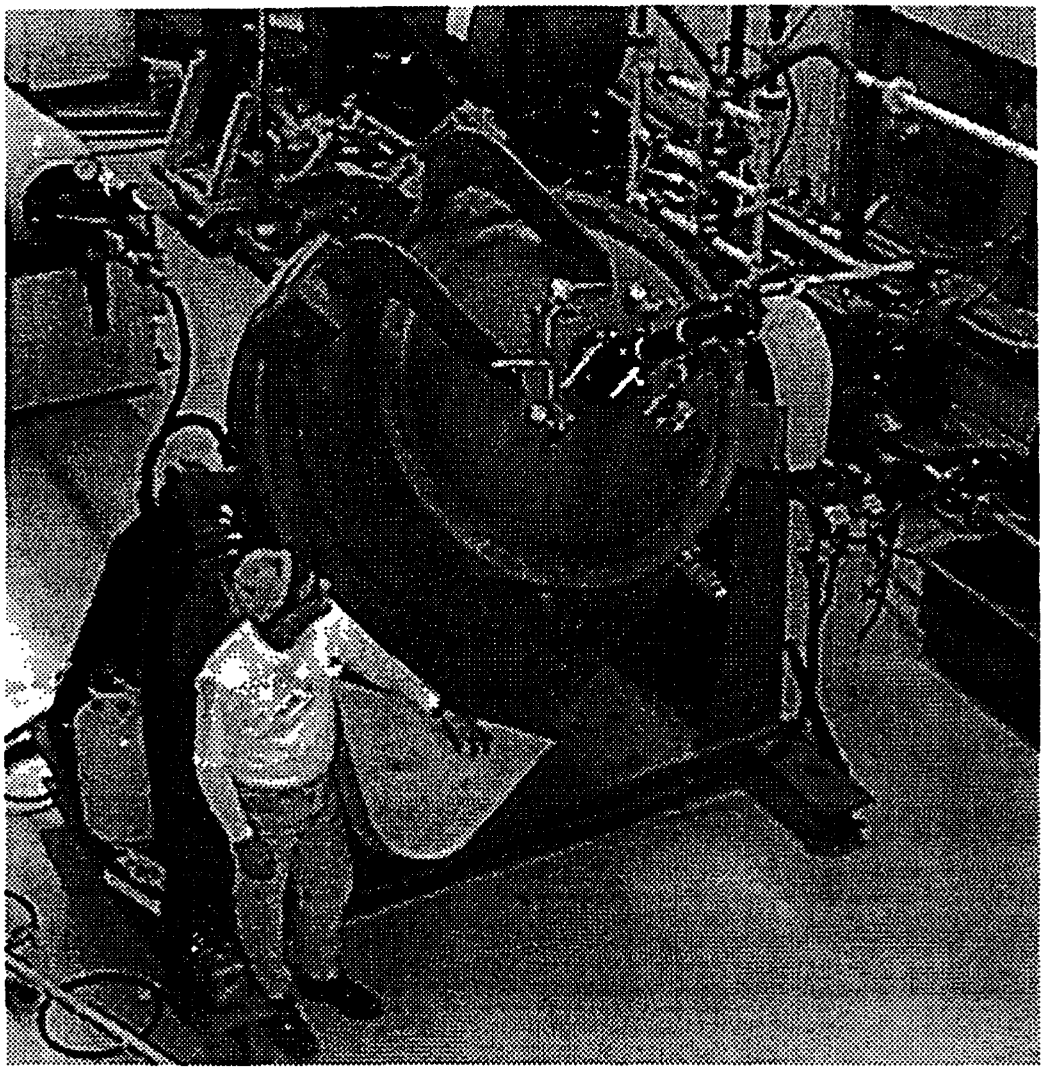
Heat of reaction for various reactants
Reaction times
Sodium usage
Optimum sodium concentrations
Optimum ammonia ratios
Ammonia recovery efficiency
Waste stream analysis
Conductivity repeatability
PCB destruction efficiency

These process parameters have remained consistent throughout scaled-up versions, and provide design criteria for the L900 unit.

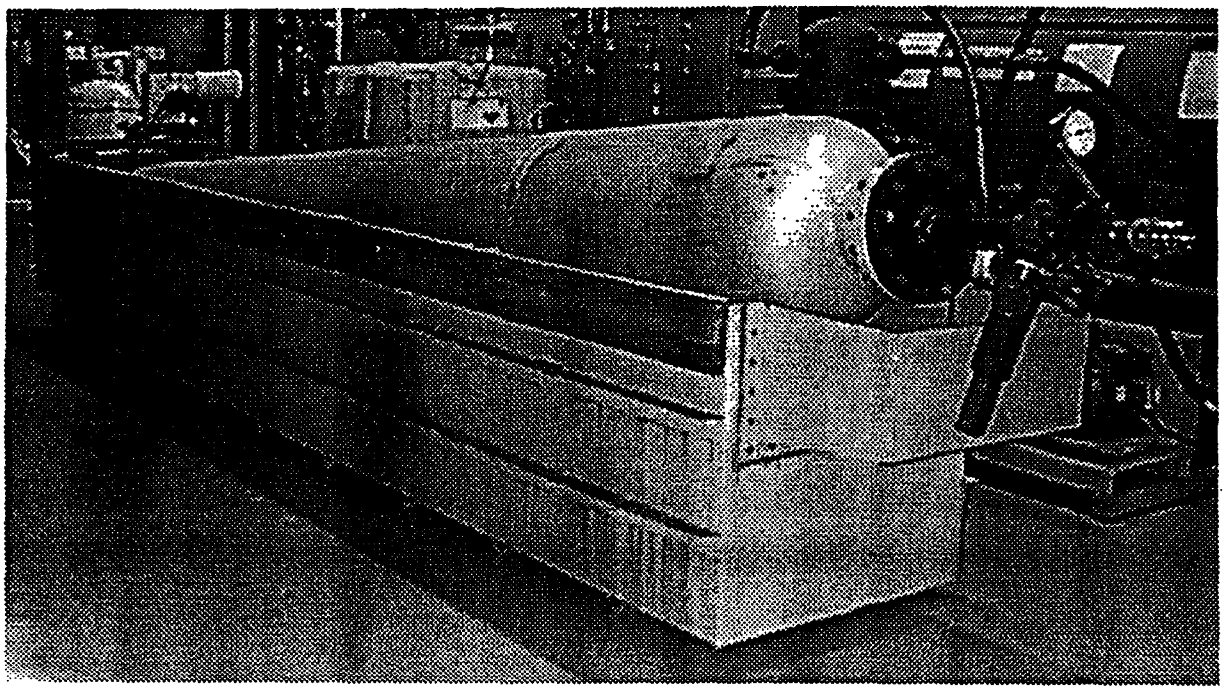
The most critical parameters have been adequate mixing and reaction time. Because the SET process requires contact of free electrons with each target molecule, adequate mixing must be provided for each equipment configuration. Also, instrumentation results show that the reaction time is less than 3 seconds. Together, these features have directed scale-up activity towards smaller equipment volumes utilizing faster throughput to achieve both reliability of the process and increased treatment rates. The following chart shows the evolution of scale-up activities:

SOLVATED ELECTRON TECHNOLOGY EQUIPMENT EXPERIENCE						
Status	Year Built	Units Built	Reactor Capacity (designation)	Through-Put	Matrix	Where Used
Retired	'82-'89	8	1 to 2 liters	• liter/hr	Liquids/Soil	Laboratory
In Use	1989	1	2 liters	• liter/hr	Liquids/Soil	Laboratory
	1991	1	15 liters	2 liters/hr	Liquids/Soil	EPA R&D
	1993	6	2 liters	4 liters/hr	Soil	Laboratory
	1995	1	400 gal. (S/4)	200 #s/hr	Soil/Solids	R&D; EPA Demo
	1995	2	15 liters (CMDU2)	2 liters/hr	Liquids	Mobile unit; New Bedford, Port Hueneme
	1996	3	500 gal. (S/2)	400 #s/hr	Soil	R&D; EPA Demo
	1997	1	100 gal (L150)	66 #s/hr	Liquids	CFCs, commercial
In Work	1997	1	100 gal. (L200)	100 #s/hr	Liquids	Chemical warfare agents
	1997	1	30 gal. (MS10)	1 ton/hr	Mixed Wastes	DOE/radioactive soils
	1997	1	30 gal. (S10)	1 ton/hr	Soil	Soil, commercial
	1998	1	Continuous (S50)	5 tons/hr	Soil	Soil, commercial
	1998	1	Continuous (L900)	400 #s/hr	Liquids	Concentrates; commercial

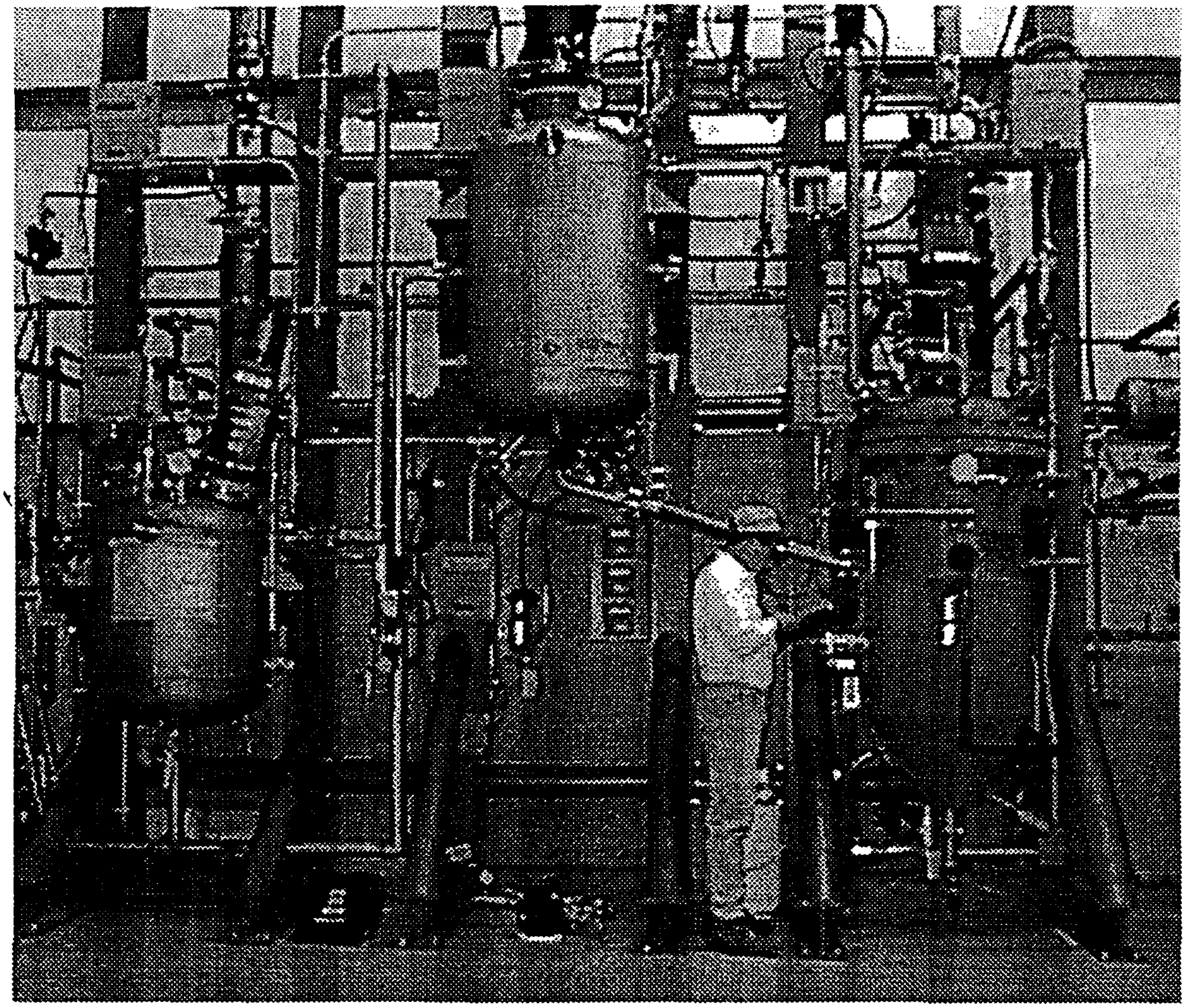
Pictures of three of the above units (S/4, S/2, and L150) follow:



CRTI's Type S/4 Reactor



CRTI's Type /2 Unit



CRTI's Type L150 Unit

The system proposed for New Bedford (L900) is a refinement of the L150 and L200 units, using the same basic process and process parameters. Prior to the expected contract date for New Bedford remediation, CRTI will have completed the MS10, S10, and L200 units.

The unit used for this treatability study (CMDU2) was configured to treat liquid materials. Since the organic fraction from RCC's B.E.S.T. process was a solid at ambient temperature, CMDU2 was re-configured at the site (after the first two optimization runs) to accommodate a solid matrix. CMDU2 best models a continuous contaminated liquid feed into a solvated solution. This unit was not intended to demonstrate optimal treated material removal operations, however, and this sub-process was performed manually.

CMDU2 demonstrated that PCB contamination in a liquid feed to a solvated solution is easily and quickly destroyed. The first optimization run was performed as a liquid feed operation, and resulted in non-detectable PCBs in the treated product. Although CMDU2 did not demonstrate continuous treated product removal, the L150 unit currently in operation in Marengo does, as well as liquid feed and higher throughput. The contaminated liquid feed rate for the proposed L900 unit is approximately 7 pounds per minute, 200 times the rate demonstrated at New Bedford, but only 7 times greater than the rate attained by the L150 unit. All these rates are relatively small, since CRTI would be dealing with concentrated wastes at New Bedford, and throughput is not considered an issue.

The proposed RCC full scale treatment unit would be capable of a sustained throughput of 160 tons of sediment per 24 hour day, which equates to 136 tons per day by applying an availability factor of 85%. Based on the pilot scale data, 21.3 liters of a concentrated organic contaminant stream are generated per ton of treated sediments, making it necessary that CRTI's full scale unit be sized at 2,900 liters per day. Allowing for an availability factor of 85%, the CRTI unit must have a minimum rating of 3,412 liters per day, or 3.37 tons per day, based on a 0.9 specific gravity for the matrix.

5.1.4 Solvated Electron Technology (SET) Component Scale-up

CRTI recommends a continuous treatment unit to destruct PCBs in the organic fraction that would be delivered from the B.E.S.T. process. The primary components of the system are static mixers, ammonia handling modules, a scrubber subsystem, and pumping equipment. All these components are readily available industrial products, and all have been successfully incorporated in CRTI systems previously described.

5.2 Scale Up Techniques and Existing Equipment at Scale

This section provides more detail as to how B.E.S.T. and SET scale up calculations are performed, as well as discussing existing equipment at the design scale.

5.2.1 B.E.S.T. Scale-up Plan

This section provides data and a summary of the calculations used to scale-up the B.E.S.T. pilot scale data to full scale operation. The detailed description of the method used to obtain the scale-up data is provided under Section 5.2.1.2. The scale-up data and calculations generated as a result of the relevant project experience reflects the design and operational logic of the proposed full scale unit.

5.2.1.1 B.E.S.T. Process Design Basis and Flow Schematic

RCC proposes using a B.E.S.T. unit with a design feed rate of 160 tons per day to treat the PCB-contaminated material at the New Bedford Harbor site and is estimated to have a footprint of approximately 80' x 80'. The unit nominal feed rate of 136 tons per day is based on 85% availability, and on the feed characterization assumptions (i.e., design basis) presented in Table 5-2. This design basis was developed by using the pilot scale treatability data collected by RCC in 1996, and the information supplied by Foster Wheeler in 1996.

Table 5-2

New Bedford Harbor Feed Characterization

Feed Sample Description	Foster Wheeler Sample ID Number	Total PCBs, mg/kg	Oil and Grease, mg/kg	Total Solids, %
Batch #1 Feed	FW 49 and 50	1900 (1)	17000	45 (1)
Batch #2 Feed	FW 63 and 77	2200 (1)	12300 (1)	53 (1)
Batch #3 Feed	FW 80 and 81	2300 (1)	21400 (1)	49 (1)
Batch #4 Feed	FW 109 and 110	2400 (1)	19800 (1)	56 (1)
Batch #5 Feed	FW 129 and 130	2500 (1)	19200	58 (1)

Note (1) Average of Foster Wheeler results (estimate only)

A process flow schematic for the full scale B.E.S.T. process, configured for use at New Bedford Harbor, is presented in Figure 5-1. Table 5-3 shows the anticipated flow rates for the significant process streams.

B.E.S.T. Solvent Extraction Process

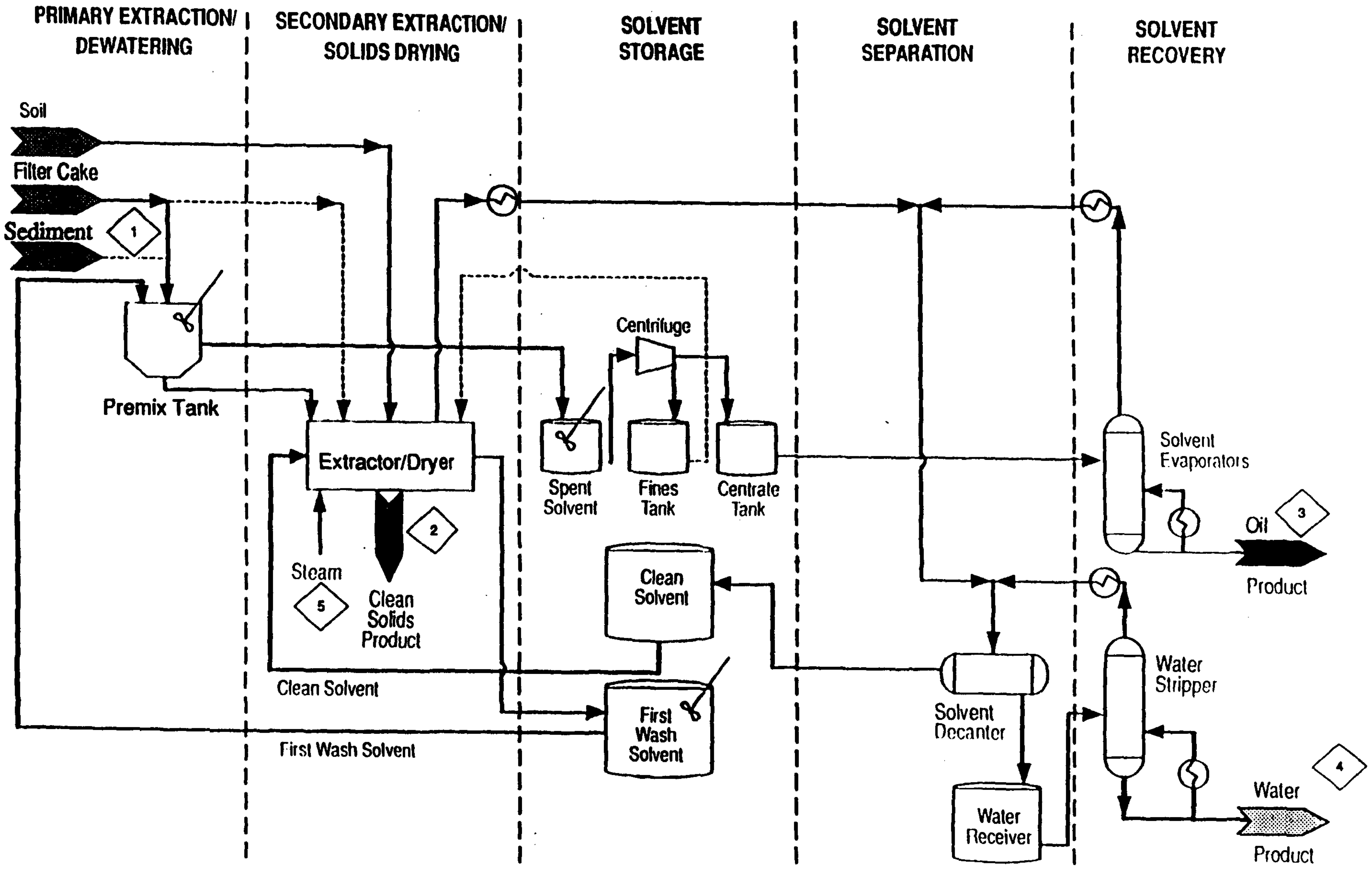


Table 5-3

New Bedford Harbor Full Scale B.E.S.T. Flow Summary

Stream Number	Identification	Flow Rate, ton/day
1	Feed	160
2	Treated Solids	84
3	Oil Product	3
4	Water Product	79
5	Solids Stripping Steam	6

5.2.1.2 Data Used for Scale-up Calculations

This section provides the pilot scale data used to determine the following specific Extractor/Dryer scale-up parameters: 1) solids settling characteristics, 2) total number of extraction stages required to reach the target treated soil contaminant level, and 3) solids gravimetric characteristics (i.e., specific gravity, water content, oil and grease content). Other scale-up parameters, defined through pilot scale testing, include: 4) Extractor/Dryer hydraulic drive power requirements, 5) solids drying time, and 6) Extractor/Dryer heat transfer. These parameters are used to calculate the key variables which affect the system design capacity; namely design extraction vessel feed load and design cycle time (i.e., the time to process one batch of feed material).

5.2.1.2.1 Process Parameters Scale-up

Pilot scale testing of the New Bedford Harbor site sediment was conducted by RCC and CRTI in 1996. The results of the pilot testing can be found in sections 1 through 4 of this report.

As discussed in Section 5.1, RCC's bench scale treatability testing protocol has been shown to scale-up to pilot scale and full scale applications with a high degree of accuracy. In the case of the New Bedford Harbor pilot scale treatability tests, mathematical modeling of the B.E.S.T. process predicted contaminant removal to below 10 mg/kg after six extraction stages The correlation between RCC's mathematical model and actual pilot scale performance verifies that the scale-up process will be accurate.

The results of the pilot scale treatability testing conducted in 1996 is summarized in Table 5-4. This data demonstrates that the B.E.S.T. solvent extraction process can reduce the PCB contamination of sediment from the New Bedford Harbor site to less than RCC's treatment goal of 10 ppm in six extraction stages.

Table 5-4

Pilot Scale Testing RCC Results Summary

RCC Batch Number	Feed PCBs, mg/kg	Treated Solids PCBs, mg/kg	Treated Solids FW Sample ID #	% Removal of PCBs
Batch #4	2400 (1)	5 (1)	FW 126 and 127	99.8 %
Batch #5	2500 (1)	6 (1)	FW 151 and 152	99.8 %

Note (1) **Average of Foster Wheeler results (estimate only)**

The solids settling characteristics observed during testing showed that all sediment from the New Bedford Harbor site settled rapidly by gravity in the extract solution. This rapid settling allows for a short full scale settling time (average 10 minutes). The ten minute full scale settling time is calculated by observing the pilot scale settling time and scaling-up proportionally to the full scale extraction vessel (Premix Tank) dimensions. That is, the settling velocity of the solids through the solvent is expected to be the same in the full scale system as during pilot testing and, therefore, full scale solids settling time is calculated by multiplying the pilot scale settling time by the ratio of full scale to pilot scale vertical settling distances. This settling time is a key variable factored into the overall extraction design cycle time and design feed load. As discussed in Section 5.1.2, scale-up of the Premix Tank is straightforward. The Premix Tank is a vertical, cylindrical, baffled tank equipped with a standard propeller-type mixer. There are hundreds of fabricators throughout the country available to fabricate the Premix Tank.

Solids specific gravity, water content, and oil and grease concentration were also determined during pilot scale testing. Since the oil and grease concentration of the New Bedford Harbor site sediment is relatively low, it was not a limiting factor in the determination of the optimum/maximum extractor vessel feed load. The feed characterization analyses, except for specific gravity, were presented previously in Table 5-2. The specific gravity of the treated solids was measured by RCC on site. The specific gravity for Batch 4 and 5 treated solids was 1.96 and 2.32, respectively.

The treated solids specific gravity is used to determine the residual diisopropylamine expected to remain in the extraction vessel following each extraction stage (i.e., the solvent heel). The solvent heel is one of the determining factors used to predict the number of extraction stages required. As discussed above, it was determined that a target concentration of 10 ppm PCBs could be met after six extraction stages. This pilot scale data could be directly scaled-up to the full scale application because the solvent-to-solids ratio and the solids-to-vessel volume ratio used during the pilot scale tests are identical to those used in the full scale application.

5.2.1.2.2 Full Scale Hydraulic Drive and Drying Time Scale-up

Extractor/Dryer hydraulic drive power requirements, solids drying time, and Extractor/Dryer heat transfer characteristics were determined for the New Bedford Harbor site sediment by pilot scale testing. The Extractor/Dryer on the pilot unit is the same as used by the Extractor/Dryer manufacturer's facility (Littleford), to scale-up all of their operating systems. Littleford has designed and constructed approximately 5,000 Extractor/Dryer type vessels using data from this size pilot unit. Attachment 3 presents a brochure that describes the Littleford Extractor/Dryer vessel.

The hydraulic drive requirements for the full scale Extractor/Dryer system were calculated by use of the Extractor/Dryer manufacturers scale-up parameters. The power requirements were based on the power consumption observed by RCC during pilot scale testing. A direct scale-up of the hydraulic requirements gives a peak power consumption of approximately 240 horsepower, which occurs near the end of the solids drying process. The slow speed paddle type mixer, characteristic of all Littleford units, had no difficulty mixing the sediment/solvent matrix. (Mechanical and process difficulties might be expected with the sediment/solvent matrix using alternate mixing technologies such as conventional, high speed, high shear mixers.)

Solids drying time and heat transfer characteristics were measured during pilot scale testing and were scaled-up to the full scale system size based on the Extractor/Dryer manufacturer's mathematical modeling and experience and as verified by RCC. The heat transfer coefficients obtained during pilot scale testing have been shown to be equivalent to heat transfer coefficients measured on full scale Extractor/Dryers, as long as the Froude numbers of the units are duplicated. (The Froude number is a function of mixer tip speed.) A pilot scale drying time of about 35 minutes was obtained. This correlates to a full scale drying time of about 75 minutes, which is the drying time assumed for full scale capacity calculations. (The full scale drying time is greater than the pilot scale drying time due to a lower ratio of heat-transfer-surface to heat-transfer-volume in the full scale Extractor/Dryer).

5.2.2 CRTI Scale-up Plan

This section provides data and a summary of the calculations used to scale-up the SET pilot scale data to full scale operation. The detailed description of the method used to obtain the scale-up data is provided under Section 5.2.2.2. The scale-up data and calculations generated as a result of the relevant test platform experience reflects the design and operational logic of the proposed full scale unit.

5.2.2.1 SET Design Basis

CRTI proposes to design, assemble, and test an L900 SET unit for the B.E.S.T. concentrated organic fraction application. The unit would be capable of sustained operation at four tons of organic material per day, which includes an availability factor of 85%. Actual operations would average 3.4 tons per day. The L900 would accept and process feedstock in liquid form, with PCB concentrations at any level. Consistent with data determined from the New Bedford treatability study, the organic fraction would contain particle sizes no greater than 10 microns, and would remain liquid at temperatures at or above the B.E.S.T. solvent evaporator unit discharge temperature. The organic fraction temperature would be maintained at or above its discharge temperature in order to ensure that the organic fraction remains fluid.

5.2.2.2 Data Used for Scale-up Calculations

This section provides the pilot scale data used to determine the following SET component sizing: ammonia handling subsystem, static mixer volume, tank volumes, pump sizes, and system operating pressures and temperatures.

5.2.2.2.1 Process Parameters Scale-up and Flow Schematic

The concentrated organic fraction exits the RCC B.E.S.T. process from the solvent evaporator at approximately 160 degrees F and in a fluid state. Rather than allowing the material to cool to ambient temperature and solidify, CRTI's SET equipment design will receive, store, and process this feedstock as a fluid by maintaining its temperature at or above 160 degrees F. The treated material will exit the system from the ammonia dryer at this temperature, and in a fluid state. The full scale system, unlike pilot scale, is designed to sustain near stoichiometric conditions, thus minimizing the formation of soda amides and preventing the treated product from being highly caustic. Process water injection will neutralize soda amides that are formed as a result of the catalytic action of any iron compounds present. A final pH polishing is provided prior to packaging for disposal.

Based on over two years of experimentation with pilot scale and commercial scale SET units, as well as six months of design reviews performed as a result of the New Bedford treatability study, CRTI proposes a concept it has developed for treating RCC's concentrated organic fraction in essentially a continuous fashion. The feedstock is stored in a fluid form at approximately 170 degrees F and is pumped into a reaction device with anhydrous ammonia containing solvated sodium sustained by molten sodium injection as required. A process block flow diagram of this L900 subsystem follows as Figure 5-2.

RCC's organic fraction is collected from the RCC solvent evaporator by flowing through trace heated piping to a sparger system feeding 500 gallon insulated and trace heated "tote" tanks, and is pumped from the bottom of the tote tanks using a specially designed positive displacement pump. This positive displacement diaphragm type pump has been used both in the L150 SET unit and in the pilot scale unit used by CRTI to process chemical warfare agents. RCC's concentrated organic fraction is transferred through a flow meter to Static Mixer "B" at a rate of approximately 32 gallons per hour and at a temperature of 160 to 190 degrees F. Sodium will be received in bulk form cast in a 55 gallon drum with nitrogen filling the void space. Four drums of sodium at a time will be stored in a drum heater box, complete with fan, electric heating elements, and controls. All four drums are maintained at approximately 240 °F, at which temperature sodium is liquid. One drum (at a time) is connected to a diaphragm type sodium pump, which feeds sodium liquid to the one side of Static Mixer "A". Approximately 100 gallons per hour of liquid anhydrous ammonia from the system ammonia reservoir tank is continuously pumped and metered to Static Mixer "A", where they rapidly solvate molten sodium. An aging section following Static Mixer "A" allows full solvation time, as confirmed by in-line conductivity probes. The organic fraction and solvated sodium solution exiting Static Mixer "B" pass through another aging section and are slightly cooled to remove reaction heat. After aging, a calculated amount of decanted process water is injected at Static Mixer "C". The process water reacts with any residual byproduct sodium amides formed to release ammonia and byproduct gases. Ammonia and any byproduct gases are removed from the organic material downstream of Static Mixer "C". Waste product is removed as a slurry, and is mixed with acid waste from the scrubber system to effect neutralization.

The treated material is then containerized for on-site disposal. It is estimated that 600 cubic yards of treated waste product material would be generated from a full scale operation. Ammonia from the evaporator is recovered by a compressor packaged system (employing regenerative heat recovery to the system) using a closed circuit water based cooling tower. An ammonia dryer is provided in the ammonia recovery system to maintain the recycled ammonia at less than 0.5% dissolved water. Makeup ammonia is provided from a vendor supplied "nurse" tank.

An ammonia scrubber system is included with this process to neutralize ammonia passing from the system with non-condensable byproduct gases from the process. Sulfuric acid from drums is used for the scrubber neutralization medium. The entire system is designed to operate at a maximum 400 psig, and at a maximum design temperature of 250 degrees F. Although the sodium reagent and RCC's concentrated organic fraction are introduced into the continuous reaction system at temperatures up to 200 degrees F, the reaction system itself operates at approximately 100 degrees F. Maintaining this temperature optimizes reaction efficiency and allows reduced operating pressures for safety considerations. The L900 unit would be packaged for shipment on four standard flat bed trailers, and requires approximately 2,500 square feet of setup space.

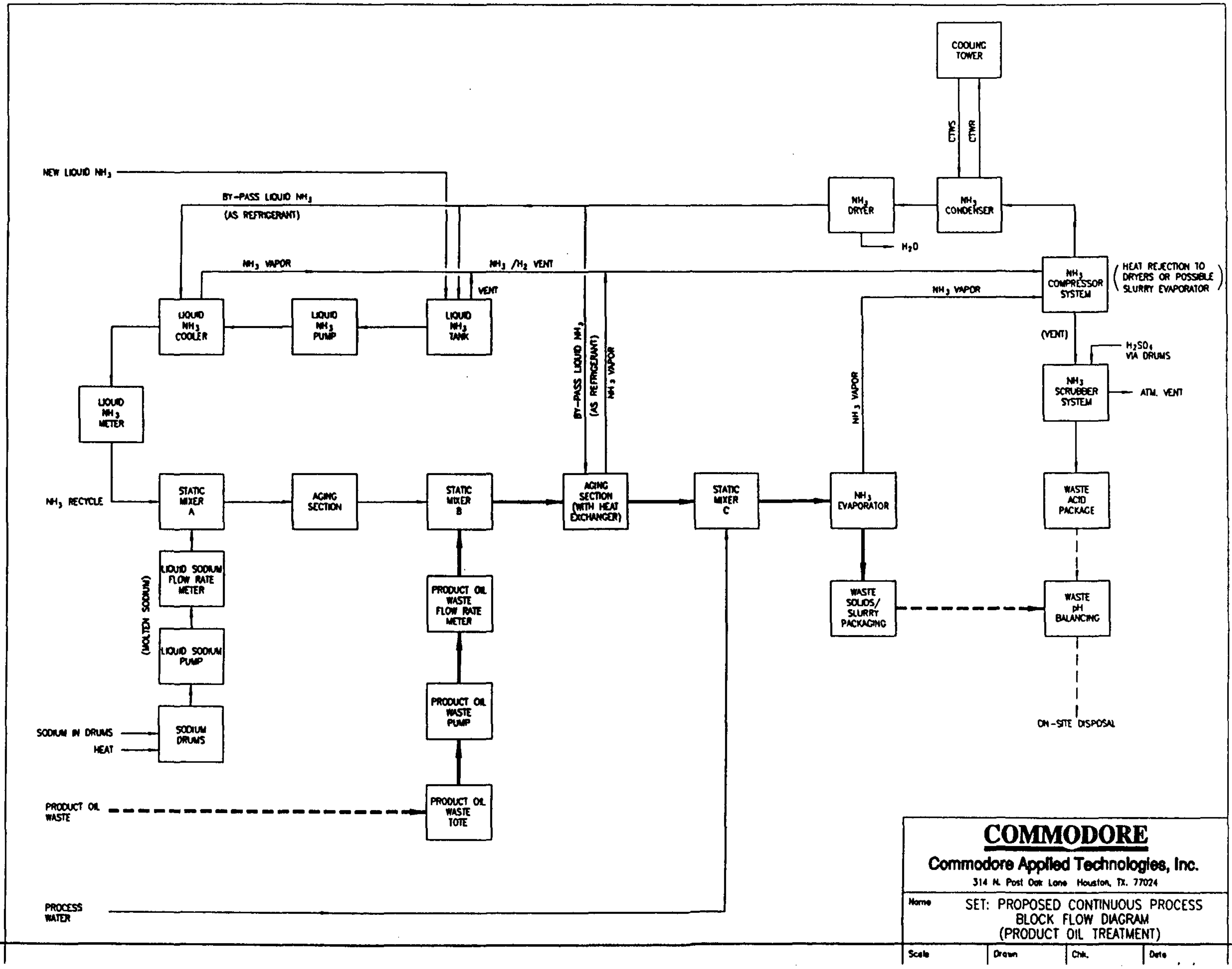


Figure 5-2: L900 System Block Flow Diagram

The L900 unit will be designed to accept a feed rate of 300 pounds per hour, and operate at an 85% capacity factor. Commensurate with RCC's unit operations, CRTI will schedule 24 hour per day, 7 day per week waste processing activities.

5.2.2.2.2 Design Bases, Assumptions, and Calculations

The following assumptions and dependent calculations form the basis for equipment sizing:

Assumptions:

1 24 hours per day worked
2 7 days per week
3 160 tons/day RCC unit throughput, (at 100% capacity)
4 85 % estimated capacity factor, (downtime for maint., inclement weather, etc.)
5 19,000 tons of sediments to be treated
6 4 liters of organic fraction per 375 pounds of sediments treated
7 7.48 pounds per gallon, organic fraction density assuming 0.9 S.G.
8 2 % estimated oil and grease content of sediments

Calculated Values

9 136 average tons sediments treated per day by RCC unit
10 140 days required to treat materials
11 4.6 months required to treat materials (not including mobilization and demobilization)
12 2,901 liters organic fraction per day to be treated by CRTI
13 766 gallons organic fraction per day to be treated by CRTI
14 5,736 pounds of organic material to be treated daily
15 239 pounds of organic material to be treated hourly
16 2.87 tons of organic material to be treated daily
17 5,440 pounds of organic material to be treated daily based on % oil and grease analysis provided by Foster Wheeler
18 296 pounds estimated maximum water content (17 less 20)
19 5.17 % estimated maximum water content
20 3.37 tons/day unit capacity, based on capacity factor

Design Basis

400	psig, operating pressure
250	degrees F., system design temperature
100	degrees F., system operating temperature
210	degrees F., sodium transfer temperature
170	degrees F., organic fraction storage temperature
2,000	gallons organic fraction storage capacity
32	gallons per hour organic fraction processing rate
100	gallons per hour anhydrous ammonia flow rate

CRTI's L900 SET unit is designed to treat 4 tons of RCC's organic fraction per 24 hour day. This capacity is conservatively commensurate with RCC's B.E.S.T. process generation of organic fraction, which is estimated to be 2.9 tons per day. In addition, heated tote tank stowage will be provided to accommodate 3 days of full B.E.S.T. process production as an L900 maintenance contingency.

5.2.2.2.3 Process Materials

Sodium - Feed rate for this material is 450 pounds per day, volumetrically equivalent to 45 gallons (one drum). The material is delivered in cast 55 gallon drums, and is heated to approximately 210 degrees F. to liquefy it for pumping into the L900 unit. Sodium burns readily in air if ignited. Sodium also is reactive with water, releasing hydrogen and forming caustic sodium hydroxide. Industry (including CRTI) has extensive experience with this material in its elemental form, and it may be easily and safely handled by trained personnel. No more than one week's supply of the metal will be stored on site (7 drums), and this storage will be in a fireproof vault.

Anhydrous Ammonia - Ammonia is recycled in the L900 system, at a rate of approximately 130 gallons per hour. Minor ammonia venting will occur from the scrubber system, estimated at less than 5 pounds per day. A monitoring system and forced air will ensure ambient concentrations of ammonia will not exceed 25 parts per million measured at operator level. Ammonia will be stored in the L900 system ammonia liquid tank, which is sized at 500 gallons. No more than 80% of this capacity will be used. CRTI's treatability study proved the system's ability to contain and recycle ammonia, and emissions of this material were of no environmental or personnel health and safety concern. Anhydrous ammonia will be delivered to the site by outside suppliers and fed to the liquid tank under pressure. Ammonia is a common chemical, used in large quantities as a fertilizer. The material is safely handled by trained personnel, and each of CRTI's technicians are fully trained by ammonia industry professionals. Ammonia is an inhalation and caustic burn risk in its gaseous form, and presents freeze burn risk in liquid form. Accepted emergency precautions for major spills of this material include containment and evacuation, allowing the liquid to vaporize to atmosphere. Approximately 200 pounds (30 gallons) of the material was safely handled without incident in the New Bedford Harbor treatability study.

Sulfuric Acid is used in small amounts to neutralize ammonia entrained in non-condensable gases from the scrubber system. Waste acid is used as a treatment media to assist in neutralizing the treated organic slurry. Rate of use of this material is estimated at no more than ten pounds per day. The total inventory on site at any one time will not exceed 100 gallons. Sulfuric acid poses a risk of burn to living organisms, and methods to neutralize or dilute spills, as well as deluge showers for personnel must be employed at points of use. The relatively small amount of this material on site poses little risk to off-site personnel.

5.2.2.2.4 Waste Generation and Disposal

Treated Material (waste product) will consist of dried (<20% water content by weight) solids containing mostly oils and greases, and shall also include biphenyls, metals as received, and sodium chloride. An estimated 6,700 pounds of this material will be generated per day (4 cubic yards, or 15 drums volume). For the total project, 600 cubic yards of material will be disposed on site by returning to an available confined disposal cell. This product will have a pH no greater than 12, and will contain only trace amounts of ammonia. Water in the L900 system is used 1) in a closed cooling system for the ammonia recovery subsystem; 2) in a closed loop boiler package used to evaporate ammonia from treated products; 3) as a diluent for sulfuric acid in the scrubber; and 4) as a quenching material as necessary for any unreacted soda amides in the treated product. This latter use is calculated to be approximately 3 pounds per hour, and the ammonium hydroxide generated is neutralized by the scrubber system. The amount of water used to dilute the sulfuric acid is again minimal, and costs for water treatment are not consequential. Water removed from processed materials will be neutralized to a pH of 7 to 9 and further processed by ultrafiltration to reduce PCB levels to less than 3 parts per billion. This water will be reused in the system, and excess discharged after neutralization and ultrafiltration to a confinement cell.

5.2.2.2.5 Site Preparation

An area of approximately 2,500 square feet is required for laydown of the L900 system. It is contemplated that one corner of the existing asphalt pad will be made available for this purpose. The organic fraction storage tanks will be conveniently located between the B.E.S.T. process equipment and the L900, such that the B.E.S.T. solvent evaporator will discharge directly to the tanks. An impervious barrier (herculite or equivalent) will be placed on top of the asphalt prior to setting the equipment. Berming will be installed by CRTI to effect drainage to a sump area. A fabric cover will be installed to protect parts of the L900 system from inclement weather.

5.2.2.2.6 Support Requirements

The L900 system support requirements are:

- three phase 480 volt power, 200 amp service; 140 kw
- potable water for safety deluge showers
- use of site decontamination bay
- use of site personnel showers and laundry services

5.2.3 Scale-up Calculation Summary

Conversion of pilot scale equipment and costs to full scale is facilitated by use of pilot scale equipment designed to mimic full scale equipment. Thus, a successful pilot test not only demonstrates the viability of full scale performance, it allows for operating cost estimates. The scale-up calculations in this section have been used to determine the limiting factors during processing and to estimate process costs.

The two limiting factors which determine the design capacity of the solvent extraction system are the design cycle time and the design batch feed load. The design cycle time is a function of solids loading time, solvent transfer rate to the extraction vessel, extraction time, solids settling time, time to decant the extract solution from the extraction vessel, total number of required extractions, solids drying time, and solids discharge time. All of these parameters, with the exception of solids loading/discharge time, have been determined and scaled-up from pilot scale testing. Solids loading/discharge time will be calculated based on the sediment type, conveyor speed, nitrogen purge rate, and constraints such as the manual loading rate of sediment into the solvent extraction system.

5.3 Safety/Operating Hazards

Potential operating hazards, mechanical and emissions that could exist during full scale operations are discussed in this section.

As with any industrial facility, the greatest danger of accident is from slips, trips, and falls. This danger is minimized by strict adherence to OSHA standards for industrial facilities. OSHA standards dictate safe standards for access/egress, ladders, stairwells, railings, and other safety devices.

5.3.1 RCC Potential Hazards

Hazards associated with industrial operations fall into two general categories: physical hazards and chemical hazards. B.E.S.T. operations have the potential for both types of hazards.

5.3.1.1 RCC Physical Hazards

The physical hazards that may be encountered are noise, exposure to the cold, heat stress, sharp surfaces, falling objects, lifting, electrical shock, and those associated with work near heavy and industrial equipment. The Site Safety Officer, or alternate (SSO/alternate), will address activity-specific safety procedures to minimize the potential for injury associated with these hazards during full scale operations.

5.3.1.2 RCC Chemical Hazards

The RCC process uses several chemicals, as part of the process, as additives, and for sampling and testing. Some of these substances are chemical hazards. A description of each chemical hazard follows:

Diisopropylamine - Process Solvent

A primary hazard associated with the B.E.S.T. process results from the solvent diisopropylamine. Of primary concern is diisopropylamine's flammability. Diisopropylamine is a volatile, flammable, liquid that can release vapors forming flammable mixtures in air that are explosive when exposed to an ignition source. Its vapors are significantly heavier than air (over three times) and can travel considerable distances along the ground to an ignition source, potentially resulting in flashback. All feasible precautions will be taken to prevent the release of vapors and to reduce the chance of creating or introducing an ignition source. Additionally, combustion products may be toxic and should be avoided in case of fire. See the MSDS for diisopropylamine in Attachment 4 for further details.

Due to its caustic nature, diisopropylamine is also an inhalation, skin contact, and ingestion hazard. Diisopropylamine liquid and vapors are severe irritants to the skin, eyes, and mucus membranes of the respiratory tract. Direct contact with the liquid may cause burns. Accidental ingestion may cause internal burns.

The potential hazards from diisopropylamine are mitigated by strict compliance with OSHA and Fire Department regulations regarding the handling of flammable and hazardous substances. Also, a limited amount of solvent is in use at any one time in the full scale system.

Engineering precautions also mitigate the potential hazard of the process solvent. The solvent flammability is controlled through the use of a nitrogen blanket throughout the system and through the use of instrumentation to detect any solvent leakage. A monitoring system is installed with numerous sensing points which detects solvent leakage from the system.

Process instruments and controls also contribute to safety and health protection by allowing operators to monitor the system and by supplying automatic shutdowns for unsafe process conditions. Specific instruments and controls that also supply safety features are as follows:

1. Solvent tanks are equipped with level sensors which warn the operator if a tank is filled above the normal operating range. Also, shutoffs are in place which activate if a tank is filled above maximum allowable levels.

2. Numerous temperature and pressure sensors are installed at critical locations on the system. Abnormal temperatures or pressures readings provide alarms that upset system conditions exist.

Refrigerant Freon 22

Freon 22 is used as a refrigerant in the B.E.S.T. process. It is of relatively low toxicity; however, if a significant amount were released, it could present an inhalation hazard due to its displacement of oxygen. It is also an eye and skin contact hazard. Should the refrigerant gases become partially ignited in a fire, extremely toxic gases would result.

Chemical Additives

Sodium hydroxide is sometimes used for post-treatment of feed material. Sodium hydroxide is caustic and may cause burns upon contact or ingestion.

Nitrogen

Cryogenic or compressed nitrogen is used to purge tanks and equipment to maintain an inert atmosphere for prevention of fire or explosion. Liquid nitrogen is a dangerous freezing hazard, but ordinarily should never be encountered. Leaks of nitrogen pose the danger of producing oxygen deficient atmospheres.

Methanol and Hexane

Methanol and Hexane are mixed 1:1 by volume and used in very small quantities for decontamination. Both solvents are extremely flammable. Avoid contact of the solvents with skin, eyes, and clothing.

Alconox®

Alconox is a glassware cleaning detergent that may be used on site to clean lab equipment. Alconox has a very low health hazard but should not be ingested. Contact with skin or eyes may cause irritation.

Citric Acid and Powersorb

Citric Acid and Powersorb Universal Sorbent are available on site for spill cleanup response.

Citric Acid is available as a mild neutralizer for caustic spills such as NaOH or diisopropylamine. Citric Acid dust may irritate or burn eyes. Prolonged skin contact may cause severe irritation and possibly a mild burn.

Powersorb Sorbent is not a health hazard and may be handled without any precaution. However, after Powersorb has been used to clean up a spill it must be handled as if it were the spilled material.

Hydrochloric Acid

Hydrochloric Acid is used to preserve water samples. Very small quantities of highly concentrated acid is added to some samples. Hydrochloric acid is poisonous and may be fatal if swallowed or inhaled. Do not breath the vapors. It may also cause severe burns if allowed to contact skin, eyes or clothing. Extreme caution should be used when handling Hydrochloric Acid.

Dust and Volatile Emissions from Sediment

Operation of the full scale system may require implementation of control methods for particulate matter (i.e., fugitive dust) and volatile organic compounds (VOC) generated during waste feed materials preparation, feeding, and processing.

Several methods can be used to control fugitive dust emissions during waste feed materials preparation. Enclosures can be installed at sediment transfer points and at areas in which waste materials are sorted in preparation for feeding to the system. These enclosures can be equipped with ventilation that directs captured dust to a small fabric filter unit for control.

Depending upon the magnitude of emissions, add-on VOC control may be necessary. There are several VOC control technologies available for use on temporary sources. Portable thermal and catalytic fume incineration units and non-regenerable carbon adsorption systems could be supplied (by the Contractor) to control VOC emissions from the waste storage area.

5.3.2 CRTI Potential Hazards

System operation poses certain hazards to on-site personnel, therefore a complete failure modes and effects analysis will be performed during final design stages. However, the amount of reagent materials on site and the system operating temperatures and pressures mitigate, if not eliminate, off-site health and safety risks exposures.

5.3.2.1 CRTI Physical Hazards

The CRTI system operates at temperatures approaching the boiling point of water, and at pressures as high as 210 psig, depending on the operating temperature. The design pressure of the system is 400 psig, with relief valves set at 350 psig. One of the advantages of a continuous system is its smaller size as compared to an equivalent throughput using batch designs. The inventory of material present in the system at any time limits the amount subject to release due to any postulated event. For the L900, no more than 100 gallons of ammonia/organic contaminant mixture is present at once. The reaction system is operated in liquid state, and any leak or rupture immediately reduces motive pressures. The auto-refrigeration property of ammonia immediately cools any released inventory to low temperatures, therefore the chance of a release from the confines of the site are remote.

The sodium handling piping is contained within a guard pipe, with conductivity sensors to detect any leak of the liquid sodium.

Extensive personnel training and use of protective clothing and safety related equipment and procedures will be sufficient to protect personnel and the environment from exposure to system mechanical failures.

5.3.2.2 CRTI Chemical Hazards

Anhydrous Ammonia

Anhydrous ammonia is used as a solvating medium for the creation of active metal electrons in the PCB destruction vessel. This compound is immediately dangerous to life and health in airborne concentrations greater than 300 ppm. It is irritating to the eyes, nose and throat. Inhalation can cause dyspnea, broncospasm, chest pain, and pulmonary edema. Contact with skin can cause burns and vesiculation.

During normal operations, ammonia is vented in small amounts (estimated at 5 pounds per day) from the scrubber system, which is included to vent non-condensable gases from the system. Operation of the SET pilot unit during the New Bedford treatability study proved ammonia emissions were not an issue, and release of this relatively small amount of ammonia is well within EPA regulatory control limits of 100 pounds per day reportable quantity. This ammonia release, through the L900 negative pressure vent system, will not result in ambient ammonia concentrations above 25 parts per million, the American Congress of Governmental Industrial Hygienists (ACGIH) established "no adverse effect" level for worker exposure during a normal 40 hour work week. Workers near the equipment may notice occasional ammonia odors (a human being can detect ammonia concentrations in air as low as 2 parts per million), but these odors are not at a nuisance level and will not be detectable outside the fenced boundary. As demonstrated during site operations, no off-site odors were noted, and workers within the fenced boundary did not complain of ammonia odors.

did not complain of ammonia odors.

The maximum inventory of anhydrous ammonia subject to release by spill is 400 gallons, well below normal design conditions for industrial refrigeration applications. Any liquid release of ammonia would be contained by the safety containment berms. Fumes from such a release would require partial site evacuation, however site personnel would be capable of quickly covering and recovering spilled material. Spills of significant amounts of liquid ammonia will remain liquid and slowly evaporate because of auto-refrigeration. Proper spill response, in accord with the Ammonia Safety Training Institute guidelines, requires evacuation of personnel not involved in recovery operations, and trained ammonia spill response personnel to monitor and contain released volumes. For the maximum feasible spill (400 gallons), CRTI's bermed laydown area would be filled to less than 0.2", and this amount will evaporate in less than 8 hours. Evaporation is the preferred method of dealing with ammonia volumes in open areas.

Sodium Metal

Sodium is an active metal source of electrons for the Solvate Electron PCB destruction process. It is used in the PCB destruction vessel. Sodium metal is a water reactive and reacts rapidly with moisture in air or tissues to form sodium hydroxide and sodium oxide. It can cause severe eye and skin burns from reactions to sodium hydroxide. Effects may be permanent. Inhalation will cause irritation of the upper respiratory passages with coughing and discomfort. Ingestion will cause abdominal discomfort characterized by nausea, severe pain, diarrhea, and collapse.

A sodium release would result in a high risk of ignition. Consequently a rigorous sodium handling system would be applied to prevent leaks of sodium and to prevent exposure of sodium to moisture. These handling requirements are routinely in use in industries employing large quantities of sodium as feed material. Handling requirements and safety features include nitrogen blankets, confined storage, guarded double piping with conductivity leak detection between the inner and outer pipe, and special fire fighting techniques. These techniques include soda ash blanketing of the burning material to shut off oxygen supply, and preclude any possibility of water addition to the blaze.For the proposed system, the sodium inventory which could possibly be released is minimal because only one drum would be connected to the L900 reaction system at any time, and no more than 7 drums would be present on site at any time.

5.4 Cost Workup

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~~Section 5.4 has been attached separately because of it's confidential nature.~~ Please refer to ~~Attachment 5 for~~ pages 77 through 84.

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[redacted]

[redacted]

[redacted]

[redacted]

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[redacted]

[redacted]

5.5 Time Frame to Accomplish Scale-up

The B.E.S.T. solvent extraction system can be ready for shipment approximately 12 months after notice to proceed. The 12 month time period will consist of several months of purchasing and final design activities, fabrication, and preparation for equipment delivery. Some equipment may require greater than nine months from date of order to equipment delivery and, therefore, must be ordered soon after receiving a notice to proceed.

The L900 would be scaled up from an existing unit (L150) and a unit in the build cycle (L200). As such, a significant amount of detailed design information is currently in-place which would be used to procure and construct the L900 system. Items more likely to extend this schedule are custom fabricated pressure vessels. CRTI has contracted with two suppliers to supply such vessels for its other systems, and believes the fabrication timing is realistic. The L900 completion is not expected to be a critical path item for the overall project and mobilization to the site could commence within four months from notice to proceed.

5.6 Full Scale Treatment Summary

The B.E.S.T. process has many features that will ensure success at the New Bedford Harbor site:

- Batch extraction configuration provides flexibility for treating feed material with widely varying PCB concentrations, silt, clay and moisture content;
- No additional water is added during treatment, therefore the moisture content of the treated soil is controllable;
- B.E.S.T. treated soil passes TCLP for metals, and has been shown (at other tests) to support re-vegetation when returned to the site as backfill;
- The B.E.S.T. process operates at near ambient temperature and pressure, therefore safety concerns with operating at high pressures (as is the case with liquefied petroleum gas) are mitigated; and

- B.E.S.T. process has no continuous flare on the vent system, unlike high pressure liquefied petroleum gas processes. The only vent from the B.E.S.T. process is continuously monitored to ensure that no organic emissions are released to the environment.

The CRTI SET process is particularly suited to treating matrices with high PCB concentrations, such as that in the organic fraction generated from the B.E.S.T. process. The SET process and equipment:

- Is relatively small since it is based on a continuous process, rather than treating large batches;

- Operates at low temperatures and pressures (essentially ambient);

- Maintains a low inventory of reagents for safety considerations; and,

- Emits only very small quantities of ammonia gas to the atmosphere (less than 10 pounds per day).

Both the RCC B.E.S.T. process and the CRTI SET process can be successfully converted to full scale.

6.0 RECOMMENDATIONS AND CONCLUSIONS

6.1 Pilot Scale Conclusions

The pilot scale testing at New Bedford Harbor was a complete success. All the test objectives, as set forth in the test plan, were achieved. A list of the objectives and results associated with each follows:

> Objective 1: "Evaluate and quantify the effectiveness of the B.E.S.T. process to extract PCBs from the Hot Spot sediment samples and the Solvate Electron process to destroy the PCBs in the organic fraction produced by the B.E.S.T. process."
>
> Analysis of samples showed that PCBs were extracted from the sediment and that PCBs were destroyed in RCC's organic fraction. Analysis showed that PCB levels in the sediment were reduced from about 2,400 mg/kg to about 6 mg/kg. Analysis also showed that PCB levels in the extracted organic fraction were reduced from about 40,000 mg/kg to less than 6 mg/kg. Therefore, the test successfully evaluated and quantified the effectiveness of both the B.E.S.T. and SET process.
>
> Objective 2: "Quantify the disposition of key constituents to support mass balance calculations (e.g., PCBs, PAHs, heavy metals)."
>
> Mass balance calculations were conducted during verification testing for the B.E.S.T. process on solids, oil and grease, and PCBs. The material balance data indicate adequate accounting for these components.
>
> Objective 3: "Identify potential environmental and/or engineering constraints related to the use of the B.E.S.T. process to extract contaminants from the Hot Spot sediment samples and the Solvate Electron process to destroy the extracted PCBs."
>
> Pilot testing revealed that the concentrated organic fraction from the B.E.S.T. process would solidify when allowed to cool. This unexpected result has forewarned both RCC and CRTI. For the full scale design, the organic fraction will now be pumped directly into the CRTI reaction chamber, and the system piping will be heat traced to maintaining the organic fraction temperature.

Objective 4: "Produce data of sufficient quality such that a risk assessment of treatment residuals may be performed."

Treated sediment, water product, and treated oil samples were collected from pilot testing. The analysis of these "final product" samples will allow risk assessment to be performed. All three product streams had PCB residuals less than 10 ppm. Also, the treated sediment solids passed the TCLP leachate test for metals, so further fixation treatment should not be required.

Objective 5: "Evaluate the viability of the B.E.S.T. process and the Solvate Electron PCB Destruction process to be scaled up to full scale operations including the overall development time-frame and estimated full scale treatment costs."

Testing results allowed for full-scale evaluations to be conducted. The viability of both the B.E.S.T. and the SET process were demonstrated. Section 5 of this report details the full-scale analysis results.

Objective 6: "Characterize the operational hazards associated with full scale implementation of B.E.S.T. process and the Solvate Electron PCB Destruction process."

This report effectively characterizes the hazards associated with full scale operation. Section 5.3 of this report details these hazards fully. While potential hazards do exist, these hazards can be adequately managed through standard industrial practice and guidelines.

Objective 7: "Evaluate the performance of the B.E.S.T. process and the Solvate Electron PCB Destruction process against the nine detailed evaluation criteria contained in the National Contingency Plan (NCP), including the ability of the B.E.S.T. process and the Solvate Electron PCB Destruction process to reduce toxicity, mobility, and volume of the hazardous constituents."

The National Contingency Plan (40 CFR 300) lists nine criteria for evaluation of remediation alternatives (see section 300.430.e.9.iii). The criteria are as follows:

A. Overall protection of human health and the environment.
B. Compliance with ARARs.
C. Long-term effectiveness.
D. Deduction of toxicity, mobility, or volume through treatment.
E. Short-term effectiveness.
F. Implementability.
G. Cost.
H. State acceptance.
I. Community acceptance.

Results of the pilot testing will allow for a full evaluation per these NCP standards. RCC and CRTI are confident that each will be evaluated favorably with respect to these standards. A combination of RCC and CRTI technology results in elimination of the toxic material (PCBs), by non-thermal methods.

Objective 8: "Collect data and observations necessary to evaluate the effectiveness and feasibility of the B.E.S.T. process and the Solvated Electron PCB Destruction process at full scale operation. Evaluate parameters such as material handling, pretreatment requirements, material feed rates, and batch processing rates. Projected full-scale economics for treatment of large volumes of sediment including costs for treatment and disposal of waste streams, site preparation, and mobilization of equipment will also be evaluated."

Testing results demonstrates that both the B.E.S.T. and SET process are viable at full scale. Materials handling, pretreatment requirements, material feed rates, and batch processing requirements have all been evaluated based on the pilot test, and results are summarized in Section 5 of this report. This also includes projected full-scale economics (in Section 5.4).

With all the objectives satisfied, plus excellent process results, it is clear that pilot scale testing was a resounding success.

6.2 Full Scale Conclusions

Both RCC and CRTI have sufficient full scale experience to successfully complete remediation of the New Bedford Harbor Confined Disposal Facility. RCC has 25 years of experience designing, fabricating, and operating full-scale equipment. CRTI has three full-scale chemical reaction remediation systems currently in operation, including two which treat PCBs.

RCC and CRTI combine these years of industrial treatment experience with recent PCB full-scale treatment experience at other sites. For the past twelve years, RCC has been actively commercializing the B.E.S.T.® process for treating hazardous wastes at Superfund and other sites. RCC began commercialization of the B.E.S.T.® process with the design, construction, and operation of the 70 ton per day unit used to treat 3700 tons of PCB contaminated wastes at the General Refining Inc. (GRI) Superfund site. The equipment design has been continuously improved upon, based on the experience of the GRI Superfund site cleanup, and based on over 25 pilot scale tests, and over 300 bench scale tests. Also, a 50 ton per day radioactive and organic mixed waste soil treatment system has recently been delivered to a client.

CRTI has been operating two full-scale batch/continuous liquid chemical destruction units over the past six months, recovering and destroying mixed chloroflorocarbons, at its facility in Marengo, Ohio. Operating experience on one of these units, the L150, provides many of the scale-up parameters for the L900 unit (which is proposed for processing New Bedford Harbor sediment concentrated organic contaminants).

6.3 Full Scale Viability

Because of the great success of the pilot scale testing, and because of the full-scale experience of RCC and CRTI, full scale success is assured.

Both RCC and CRTI pilot scale equipment is designed to mimic full scale operations. Any process problems, material handling problems, sampling problems, or problems with the final product, will be exactly the same in the pilot test as can be expected for full scale operations. There were a few material handling problems encountered during pilot testing. However, these were due strictly to lack of foreknowledge of the feed material characteristics. The organic fraction handling problems were easily overcome by use of standard techniques. Had we anticipated the nature of the organic fraction before the testing, the measures taken could have been in place at the start.

Process results were highly successful, as demonstrated by the degree of PCB reduction achieved. In addition, the similarities in process design and operation between the proposed full scale treatment systems and those used during the New Bedford Harbor pilot scale study minimize the potential for process problems at full scale.

6.4 Recommendations

The full scale treatment solution we recommend is a combination of RCC's B.E.S.T.® process, and CRTI's SET process. We recommend a 160 tons per day RCC unit and a 3.4 tons per day CRTI unit be employed. Both companies have the experience, technical knowledge, and financial resources to successfully complete the full-scale sediment remediation at the New Bedford Harbor site.

*****

Attachment 1

Sample Analysis Summary

Initial Sediment and DIPA

FW ID Number	Sample ID Number	Batch	Sample Description	PCB Arochlor 1242, mg/kg	PCB Arochlor 1260, mg/kg	Total PCBs, mg/kg	PCDD/PCDF TEFs, ppt	O&G, mg/kg	TDS, mg/L	TSS, mg/L	Total Solids	Water % (by KF)
FW 37	FF-DR1-5C-01	na	Composite Drums 1 - 5	88 PC 340 PCD	13 PC 33 PCD	101 (1) 373 (1)	1170	14400	---	---	36 %, 52.1 %, 54.4 % (9)	---
FW 39	FF-DR6-10C-01	na	Composite Drums 6 - 10	64 PC 360 PCD	0.066 U 6.6 U	64 (1) 360 (1)	1100	24700	---	---	50 %, 55.3 %, 54.4 % (9)	---
FW 43	FF-DR11-15C-01	na	Composite Drums 11 - 15	58 PC 370 PCD	0.069 U 6.9 U	58 (1) 370 (1)	1090	18200	---	---	48 %, 52 %, 53.6 % (9)	---
FW 51	RE00-S6-G01	na	Initial DIPA	0.99 U	0.99 U	< 1.98	1.85	2680 mg/l	44	< 5.0	44 mg/l	3.4

Sample FW37 has a different arochlor mix (1242 plus 1260, instead of 1242 plus 1254 like all the BEST samples have).
Sample FW39 appears to only have arochlor 1242.

(1) Estimated data. Result is calculated as the sum of detected contentrations for arochlors 1242 and 1254.
(9) Total Solids are from PCB, SVOC, TEF, and/or metals data sheet.

Definition of Terms:
PCB = Polychlorinated Biphenyl
O&G = Oil and Grease
TDS = Total Dissolved Solids
TSS = Total Suspended Solids
TS = Total Solids
KF = Karl Fischer
DIPA = Diisoproplyamine

RCC Batch #1

FW ID Number	Sample ID Number	Batch	Sample Description	PCB Arochlor 1242, mg/kg	PCB Arochlor 1254, mg/kg	Total PCBs, mg/kg (12)	PCDD/PCDF TEFs, ppt	O&G, mg/kg	TDS, mg/L	TSS, mg/L	Total Solids	Water % (by KF)	DIPA, mg/kg
FW 49	RE01-S1-G01	1	Feed	2000 D	700 PD	2700 (1)	2320	---	---	---	49% (9)	---	---
FW 50	RE01-S1-G02	1	Feed	1200 D	330 P	1530 (1)	2270	17000	---	---	49% (9)	---	---
FW 60	RE01-S3(8)-G01	1	Treated Solids	10 D	2.1 P	12.1 (1)	39.1	1950	---	---	78% (9)	---	2.4
FW 61	RE01-S3(8)-G02	1	Treated Solids	11 D	2.3 P	13.3 (1)	25	721	---	---	78% (9)	---	---
FW 69	RE01-S6-G01	1	DIPA	0.99 U	0.99 U	< 1.98	0.736	462 mg/l	52	< 5	52 mg/l	5.4	---
FW 70	RE01-S2-G01	1	Oversized Sediment	1400 PE 2000 D	380 P 480 PD	1780 (1) 2480 (1)	---	---	---	---	52 % (9)	---	---
FW 71	RE01-S2-G02	1	Oversized Sediment	9800 E 16000 D	5200 E 7200 D	15000 (1) 23200	---	---	---	---	59 % (9)	---	---
FW 174	RE01-S14-G01	1	Decontamination Water	---	---	---	---	---	6300	636	6940 mg/l	---	---

(1) Estimated data. Result is calculated as the sum of detected contentrations for arochlors 1242 and 1254.

(9) Total Solids are from PCB, SVOC, TEF, and/or metals data sheet.

(12) Where possible, data was not used which was flagged E (exceeded calibration range), or flagged J (detected blow the quantitation limit).

RCC Batch #2

FW ID Number	Sample ID Number	Batch	Sample Description	PCB Arochlor 1242, mg/kg	PCB Arochlor 1254, mg/kg	Total PCBs, mg/kg	PCDD/PCDF TEFs, ppt	O&G, mg/kg	TDS, mg/L	TSS, mg/L	Total Solids	Water % (by KF)	DIPA, mg/kg
FW 63	RE02-S1-G01	2	Feed	1800 D	720 PD	2520 (1)	1150	11700	---	---	54% (9)	---	---
FW 77	RE02-S1-G02	2	Feed	1800 D	730 PD	2530 (1)	1170	12800	---	---	53% (9)	---	---
FW 68	RE02-S3(F)-01	2	Treated Solids	15 D	3.1 P	18.1 (1)	17.9	1810	---	---	85% (9)	---	2.7
FW 75	RE02-S3(F)-02	2	Treated Solids	16 D	3.7 P	19.7 (1)	18.2	4670	---	---	91% (9)	---	---
FW 78	RE02-S6-G01	2	DIPA	0.7 JP	0.99 U	0.7 (1)	0.959	351 mg/l	128 mg/l	< 5 mg/l	128 mg/l	5.9	---
FW 177	RE02-S14-G01	2	Decontamination Water	---	---	---	---	---	4810 mg/l	5040 mg/l	9850 mg/l	---	---

(1) Estimated data. Result is calculated as the sum of detected contentrations for arochlors 1242 and 1254.

(9) Total Solids are from PCB, SVOC, TEF, and/or metals data sheet.

RCC Batch #3

FW ID Number	Sample ID Number	Batch	Sample Description	PCB Arochlor 1242, mg/kg	PCB Arochlor 1254, mg/kg	Total PCBs, mg/kg	TEFs, ppt	O&G, mg/kg	TDS, mg/L	TSS, mg/L	Total Solids	Water % (by KF)	DIPA, mg/kg
FW 80	RE03-S1-G02	3	Feed	1800 D	490 P	2290 (1)	1320	21300	---	---	49% (9)	---	---
FW 81	RE03-S1-G01	3	Feed	2000 D	770 PD	2770 (1)	---	21400	---	---	49% (9)	---	---
FW 89	RE03-S6-G01	3	DIPA	1.2	0.36 JP	1.56 (1)	1.67	592 mg/l	88.0 mg/l	<5 mg/l	88.0 mg/l	6.1	---
FW 90	RE03-S6-G02	3	DIPA	0.93 JP	0.36 JP	1.29 (1)	1.4	29 mg/l	72.0 mg/l	< 5 mg/l	72.0 mg/l	6.8	---
FW 91	RE03-S3(F)-G01	3	Treated Solids	3.9	1.2 JP	5.1 (1)	---	2288 (10)	---	---	87% (9)	---	---
FW 92	RE03-S3(F)-G02	3	Treated Solids	8.5	1.3 P	9.8 (1)	---	2288 (10)	---	---	87% (9)	---	---
FW 179	RE03-S14-G01	3	Decontamination Water	---	---	---	---	---	3320 mg/l	7140 mg/l	10500 mg/l	---	---
FW 102	OP1-S4-G01	1 - 3	Oil/DIPA	7200 D	1800 P	9000 (1)	2980	30600 mg/l	---	26600 mg/l	---	---	---
FW 103	OP1-S4-G01	1 - 3	Oil/DIPA	22000 D	7900 PD	29900 (1)	2500	47200 mg/l	---	17000 mg/l	---	---	---
FW 104	OP1-S10-G01	1 - 3	Raw Oil	33000 D	12000 PD	45000 (1)	22100 (13)	---	---	---	---	---	330200
FW 105	OP1-S10-G02	1 - 3	Raw Oil	41000 D	14000 PD	55000 (1)	19800 (13)	---	---	---	---	---	103000
FW 106	OP1-S5-G01	1 - 3	Product Water	1.0 ug/l U	1.0 ug/l U	< 2.0 ug/l	10.3 ppq	<10 mg/l	179 mg/l	5.0 mg/l	184 mg/l	---	1.9 mg/l
FW 107	OP1-S5-G02	1 - 3	Product Water	1.0 ug/l U	1.0 ug/l U	< 2.0 ug/l	11.1 ppq	<10 mg/l	174 mg/l	< 5 mg/l	174 mg/l	---	3.4 mg/l

(1) Estimated data. Result is calculated as the sum of detected contentrations for arochlors 1242 and 1254.
(9) Total Solids are from PCB, SVOC, TEF, and/or metals data sheet.
(10) Sample not analyzed for O&G. Mean value from Batches 1 and 2 used.
(13) Values are corrected for % solids, and may therefore be high.

RCC Batch #4

FW ID Number	Sample ID Number	Batch	Sample Description	PCB Arochlor 1242, mg/kg	PCB Arochlor 1254, mg/kg	Total PCBs, mg/kg	PCDD/PCDF TEFs, ppt	O&G, mg/kg	TDS, mg/L	TSS, mg/L	Total Solids	Water % (by KF)	DIPA, mg/kg
FW 109	RE04-S1-G02	4	Feed	1800 D	560	2360 (2)	985	21800	---	---	59% (9)	---	---
FW 110	RE04-S1-G01	4	Feed	1800 D	560	2360 (2)	1030	17700	---	---	54% (9)	---	---
FW 112	RE4-S3(2)-G01	4	DIPA/Soil after 2 cycles	190 D	61 PD	251 (1)	---	---	---	---	---	---	---
FW 114	RE4-S3(4)-G01	4	DIPA/Soil after 4 cycles	35 D	8.2 PD	43.2 (1)	---	---	---	---	---	---	---
FW 116	RE4-S3(6)-G01	4	DIPA/Soil after 6 cycles	4.4	0.60 P	5.0 (1)	---	---	---	---	---	---	---
FW 118	RE04-S3(8)-G01	4	DIPA/Soil after 8 cycles	4.7	0.38 JP	5.08 (1)	---	---	---	---	---	---	---
FW 126	RE04-S3(F)-G01	4	Treated Solids	4.4	0.72 JP	5.12 (1)	12	2450	---	---	89% (9)	---	6.2
FW 127	RE04-S3(F)-G02	4	Treated Solids	3.9	0.63 JP	4.53 (1)	16.2	---	---	---	90% (9)	---	3.4
FW 128	RE04-S6-G01	4	DIPA	0.42 JP	0.99 U	0.42 (1)	1.32	760 mg/l	80 mg/l	< 5 mg/l	80 mg/l	5.5	---
FW 170	RE04-S14-G01	4	Decontamination Water	---	---	---	---	---	4970 mg/l	480 mg/l	5450 mg/l	---	---
FW 171	RE04-S14-G02	4	Decontamination Water	---	---	---	---	---	5120 mg/l	1190 mg/l	6310 mg/l	---	---

(1) Estimated data. Result is calculated as the sum of detected contentrations for arochlors 1242 and 1254.
(2) The total mg/kg is derived from taking arochlor 1242 from the diluted injection and 1254 from the original injection because neither injection has both arochlors in the proper range at the same time.
(9) Total Solids are from PCB, SVOC, TEF, and/or metals data sheet.

RCC Batch #5

FW ID Number	Sample ID Number	Batch	Sample Description	PCB Arochlor 1242, mg/kg	PCB Arochlor 1254, mg/kg	Total PCBs, mg/kg	PCDD/PCDF TEFs, ppt	O&G, mg/kg	TDS, mg/L	TSS, mg/L	Total Solids	Water % (by KF)	DIPA, mg/kg	Ammonia (as N)
FW 129	RE05-S1-G01	5	Feed	1800 D	510	2310 (2)	1070	19200	---	---	58% (9)	---	---	---
FW 130	RE05-S1-G02	5	Feed	2100 D	620	2720 (2)	1310	---	---	---	58% (9)	---	---	---
FW 140	RE05-S6-G01	5	DIPA	0.99 U	0.99 U	< 1.98	2.69	895 mg/l	84 mg/l	< 5 mg/l	84 mg/l	5.7	---	---
FW 151	RE05-S3(F)-G01	5	Treated Solids	3.7	0.37 JP	4.07 (1)	21.1	2450 (11)	---	---	92% (9)	---	1.1	---
FW 152	RE05-S3(F)-G02	5	Treated Solids	7.9	2.5 U	7.9	32.2	2450 (11)	---	---	92% (9)	---	---	---
FW 181	RE05-S14-G01	5	Decontamination Water	---	---	---	---	---	6960 mg/l	1890 mg/l	8850 mg/l	---	---	---
FW 163	RPV1-S4-G01	4 - 5	Oil/DIPA	8800 D	2100 P	10900 (1)	2870	46700	---	22200 mg/l	---	---	---	---
FW 164	RPV1-S4-G01	4 - 5	Oil/DIPA	7200 D	1600 P	8800 (1)	2700	244000	---	23300 mg/l	---	---	---	---
FW 165	RPV1-S5-G01	4 - 5	Product Water	1.0 ug/l U	1.0 ug/l U	< 2.0 ug/l	17.6 ppq	105	306 mg/l	17.5 mg/l	324 mg/l	---	< 0.5 mg/l	---
FW 166	RPV1-S5-G02	4 - 5	Product Water	1.0 ug/l U	1.0 ug/l U	< 2.0 ug/l	16.6 ppq	74.3	266 mg/l	20.0 mg/l	286 mg/l	---	< 0.5 mg/l	---
FW 167	RPV1-S6-G01	4 - 5	DIPA	0.37 JP	0.99 U	0.37 (1)	0.788	303	148 mg/l	< 5 mg/l	148 mg/l	9.0	---	---
FW 168	RPV1-S10-G01	4 - 5	Oil	25000 D	7800 PD	32800 (1)	15000 (13)	---	---	---	---	---	72100 mg/kg	158 mg/kg
FW 169	RPV1-S10-G02	4 - 5	Oil	50000 D	16000 D	66000 (3)	14700 (13)	---	---	---	---	---	74100 mg/kg	188 mg/kg

(1) Estimated data. Result is calculated as the sum of detected contentrations for arochlors 1242 and 1254.
(2) The total mg/kg is derived from taking arochlor 1242 from the dilution injection and 1254 from the original injection because neither injection has both arochlors in the proper range at the same time.
(3) The total mg/kg is derived from the dilution injection. The original injection was out of range.
(9) Total Solids are from PCB, SVOC, TEF, and/or metals data sheet.
(11) Sample not analyzed for O&G. Used value from Batch #4.
(13) Values are corrected for % solids, and may therefore be high.

CRTI Batches 1 - 4 (Optimization)

FW ID Number	Sample ID Number	CRTI Batch	Sample Description	PCB Arochlor 1242, mg/kg	PCB Arochlor 1254, mg/kg	Total PCBs, mg/kg	PCDD/PCDF TEFs, ppt	O&G, mg/kg	TDS, mg/L	TSS, mg/L	Total Solids	Water % (by KF)	DIPA, mg/kg	Ammonia (as N)
FW 121	RC01-S11-G01	1	CRTI De-chlorinated Product	1.0 ug/l J	0.70 ug/l J	1.7 ug/l (1)	---	---	---	---	---	---	---	---
FW 122	RC01-S13-G01	1	Scrubber Water	2.0 ug/l U	2.0 ug/l U	<4.0 ug/l	---	---	---	---	---	---	---	214000 mg/l
FW 123	RC01-S12-G01	1	NH3 Water	0.99 mg/l U	0.99 mg/l U	< 1.98 mg/l	1.32	---	---	---	---	---	---	---
FW 141	RC02-S12-G01	2	NH3 Water	0.37 ug/l JP	1.0 ug/l U	0.37 ug/l (1)	---	---	---	---	---	---	---	---
FW 142	RC02-S12-G01	2	NH3 Water	0.9 JP	0.66 JP	1.56 (1)	0.828	---	---	---	---	---	---	---
FW 143	RC02-S13-G01	2	Scrubber Water	20 ug/l U	20 ug/l U	31 ug/l (4)	---	---	---	---	---	---	---	227000 mg/l
FW 144	RE02-S15-G01	2	Decontamination Solvent	---	---	---	---	---	1060 mg/l	100 mg/l	1160 mg/l	---	---	---
FW 155	RC03-S12-G01	3	NH3 Water	0.81 ug/l J	1.0 ug/l U	0.81 ug/l (1)	---	---	---	---	---	---	---	---
FW 156	RC03-S12-G01	3	NH3 Water	26	9.9 U	26 (1)	52300	---	---	---	---	---	---	---
FW 157	RC03-S13-G01	3	Scrubber Water	20 ug/l U	20 ug/l U	< 40 ug/l	---	---	---	---	---	---	---	---
FW 158	RC03-S15-G01	3	Decontamination Solvent	---	---	---	---	---	8660	108	8770 mg/l	---	---	---
FW 185	RC04-S12-G01	4	NH3 Water	20 ug/l U	20 ug/l U	< 40 ug/l	---	---	---	---	---	---	---	---
FW 186	RC04-S12-G01	4	NH3 Water	19 E 30 D	0.99 U 9.9 U	30	1.67	---	---	---	---	---	---	---
FW 187	RC04-S13-G01	4	Scrubber Water	12 ug/l U	12 ug/l U	< 24 ug/l	---	---	---	---	---	---	---	---
FW 188	RC04-S13-G02	4	Scrubber Water	20 ug/l U	20 ug/l U	< 40 ug/l	---	---	---	---	---	---	---	---
FW 189	RC04-S15-G02	4	Decontamination Solvent	---	---	---	---	---	---	416 mg/l	---	---	---	---
FW 190	RC04-S15-G01	4	Decontamination Solvent	---	---	---	---	---	---	336 mg/l	---	---	---	---

(1) Estimated data. Result is calculated as the sum of detected contentrations for arochlors 1242 and 1254.
(4) Sample FW143 has detectable PCB, at 31 ug/l, only for arochlor 1260.
(9) Total Solids are from PCB, SVOC, TEF, and/or metals data sheet.

CRTI Batches 5, 6, & 7 (Verification)

FW ID Number	Sample ID Number	CRTI Batch	Sample Description	PCB Arochlor 1242, mg/kg	PCB Arochlor 1254, mg/kg	Total PCBs, mg/kg	PCDD/PCDF TEFs, ppt	O&G, mg/kg	TDS, mg/L	TSS, mg/L	Total Solids	Water % (by KF)	DIPA, mg/kg	Ammonia (as N)
FW 193	RC05-S11-G01	5	Treated Product	3.7 J	1.4 JP	5.1 (1)	855 pg/l	---	---	4270 mg/l	---	74%	9.1 mg/kg	1980 mg/l
FW 195	RC05-S12-G01	5	NH3 Water	20 ug/l U	20 ug/l U	< 40 ug/l	---	---	---	---	---	---	---	---
FW 196	RC05-S12-G01	5	NH3 Water	0.99 U	0.99 U	< 1.98	0.87	---	---	---	---	---	---	---
FW 197	RC05-S13-G01	5	Scrubber Water	1.7 ug/l U	1.7 ug/l U	13 ug/l (5)	---	---	---	---	---	---	---	---
FW 198	RC05-S13-G02	5	Scrubber Water	1.7 ug/l U	1.7 ug/l U	12 ug/l (6)	---	---	---	---	---	---	---	---
FW 199	RC05-S15-G01	5	Decontamination Solvent	---	---	---	---	---	2430 mg/l	44 mg/l	2470 mg/l	---	---	---
FW 200	RE05-S15-G02	5	Decontamination Solvent	---	---	---	---	---	2940 mg/l	45 mg/l	2980 mg/l	---	---	---
FW 203	RC06-S12-G01	6	NH3 Water	2.0 ug/l U	2.0 ug/l U	< 4.0 ug/l	---	---	---	---	---	---	---	---
FW 204	RC06-S12-G01	6	NH3 Water	0.99 U	0.99 U	< 1.98	1.21	---	---	---	---	---	---	---
FW 205	RC06-S13-G01	6	Scrubber Water	2.0 ug/l U	2.0 ug/l U	3.7 ug/l (7)	---	---	---	---	---	---	---	---
FW 206	RC06-S15-G01	6	Decontamination Solvent	---	---	---	---	---	13900 mg/l	616 mg/l	14500 mg/l	---	---	---
FW 208	RC06-S11-G01	6	Treated Product	1.3 J	4.0 U	1.3 (1)	11.5 pg/l	---	---	2790 mg/l	---	71%	200 mg/kg	4600 mg/l
FW 210	RC07-S11-G01	7	Treated Product	1.9 J	1.1 JP	3.0 (1)	1.49	---	---	20400 mg/l	---	56%	520 mg/kg	33500 mg/l
FW 213	RC07-S12-G01	7	NH3 Water	0.99 U	0.99 U	< 1.98	118	---	---	---	---	---	---	---
FW 214	RC07-S13-G01	7	Scrubber Water	15 ug/l JP	20 ug/l U	83 ug/l (8)	---	---	---	---	---	---	---	197000 mg/l
FW 215	RC07-S15-G01	7	Scrubber Water	---	---	---	---	---	2980 mg/l	64 mg/l	3040 mg/l	---	---	---

(1) Estimated data. Result is calculated as the sum of detected contentrations for arochlors 1242 and 1254.

(5) Sample FW197 has detectable PCB, at 13 ug/l, only for arochlor 1260.
(6) Sample FW198 has detectable PCB, at 12 ug/l, only for arochlor 1260.
(7) Sample FW205 has detectable PCB, at 3.7 ug/l, only for arochlor 1260.
(8) Sample FW214 has 15 ug/l JP arochlor 1242 plus 68 ug/l arochlor 1260.
(9) Total Solids are from PCB, SVOC, TEF, and/or metals data sheet.

Attachment 2

TCLP Analysis Results

FW-60	RCC Treated Solids Batch #1
FW-68	RCC Treated Solids Batch #2
FW-126 and 127	RCC Treated Solids Batch #4
FW-151	RCC Treated Solids Batch #5

Table 4-4: TCLP Regulatory Limits Summary

TCLP Volatile Organics	MCL (mg/L)
Vinyl Chloride	0.2
1,1-Dichloroethene	0.7
2-Butanone	200
Chloroform	6
Carbon Tetrachloride	0.5
Benzene	0.5
1,2-Dichloroethane	0.5
Trichloroethene	0.5
Tetrachloroethene	0.7
Chlorobenzene	100

TCLP Semivolatile Organics	MCL (mg/L)
1,4-Dichlorobenzene	7.5
2-Methylphenol	200
3- & 4-Methylphenol	200
Hexachloroethane	3
Nitrobenzene	2
Hexachlorobutadiene	0.5
2,4,6-Trichlorophenol	2
2,4,5-Trichlorophenol	400
2,4-Dinitrotoluene	0.13
Hexachlorobenzene	0.13
Pentachlorophenol	100
Pyridine	5

TCLP Herbicides	MCL (mg/L)
2,4-D	10
Silvex (2,4,5-TP)	1

TCLP Organochlorine Pesticides	MCL (mg/L)
Lindane	0.4
Heptachlor	0.008
Heptachlor Epoxide	0.008
Endrin	0.02
Methoxychlor	10
Chlordane (technical)	0.03
Toxaphene	0.5

TCLP Metals	MCL (mg/L)
Arsenic	5
Barium	100
Cadmium	1
Chromium	5
Lead	5
Selenium	1
Silver	5

TCLP Mercury	MCL (mg/L)
Mercury	0.2

TCLP PESTICIDE ORGANICS ANALYSIS DATA SHEET

FW-60

PE01-S3(8)-601

Lab Name: COMPUCHEM ENV. CORP. Contract:

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00206

Matrix: (soil/water) WATER Lab Sample ID: 807913

Sample wt/vol: 200 (g/mL) ML Lab File ID: ______

% Moisture: ______ decanted: (Y/N)___ Date Received: 06/10/96

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 06/24/96

Concentrated Extract Volume: 10000 (uL) Date Analyzed: 07/11/96

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	5.0	U
11104-28-2	Aroclor-1221	10	U
11141-16-5	Aroclor-1232	5.0	U
53469-21-9	Aroclor-1242	7.0	P
12672-29-6	Aroclor-1248	5.0	U
11097-69-1	Aroclor-1254	5.0	U
11096-82-5	Aroclor-1260	5.0	U

1B

TCLP **SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET**

EPA SAMPLE NO.

FW-60

RE01-S3(8)-601

Lab Name: CompuChem Env. Corp.   Contract: OLM03-REVS

Lab Code: COMPU   Case No.: 31884   SAS No.:   SDG No.: 00201

Matrix: (soil/water) WATER   Lab Sample ID: 807912

Sample wt/vol: 200 (g/mL) mL   Lab File ID: GH007912A60

Level: (low/med) LOW   Date Received: 06/10/96

% Moisture: ______ decanted: (Y/N)___   Date Extracted: 06/25/96

Concentrated Extract Volume: 1000 (uL)   Date Analyzed: 06/26/96

Injection Volume: 2.0 (uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	50	U
111-44-4	bis(2-Chloroethyl)ether	50	U
95-57-8	2-Chlorophenol	50	U
541-73-1	1,3-Dichlorobenzene	50	U
106-46-7	1,4-Dichlorobenzene	50	U
95-50-1	1,2-Dichlorobenzene	50	U
95-48-7	2-Methylphenol	50	U
108-60-1	2,2'-oxybis(1-Chloropropane)	50	U
106-44-5	4-Methylphenol	50	U
621-64-7	N-Nitroso-di-n-propylamine	50	U
67-72-1	Hexachloroethane	50	U
98-95-3	Nitrobenzene	50	U
78-59-1	Isophorone	50	U
88-75-5	2-Nitrophenol	50	U
105-67-9	2,4-Dimethylphenol	50	U
111-91-1	bis(2-Chloroethoxy)methane	50	U
120-83-2	2,4-Dichlorophenol	50	U
120-82-1	1,2,4-Trichlorobenzene	50	U
91-20-3	Naphthalene	50	U
106-47-8	4-Chloroaniline	50	U
87-68-3	Hexachlorobutadiene	50	U
59-50-7	4-Chloro-3-methylphenol	50	U
91-57-6	2-Methylnaphthalene	50	U
77-47-4	Hexachlorocyclopentadiene	50	U
88-06-2	2,4,6-Trichlorophenol	50	U
95-95-4	2,4,5-Trichlorophenol	120	U
91-58-7	2-Chloronaphthalene	50	U
88-74-4	2-Nitroaniline	120	U
131-11-3	Dimethylphthalate	50	U
208-96-8	Acenaphthylene	50	U
606-20-2	2,6-Dinitrotoluene	50	U
99-09-2	3-Nitroaniline	120	U
83-32-9	Acenaphthene	50	U

TCLP

1C
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW-60

Lab Name: CompuChem Env. Corp.   Contract: OLM03-REVS

Lab Code: COMPU   Case No.: 31884   SAS No.:   SDG No.: 00201

RE01-53(8)-G01

Matrix: (soil/water) WATER   Lab Sample ID: 807912

Sample wt/vol: 200 (g/mL) mL   Lab File ID: GH007912A60

Level: (low/med) LOW   Date Received: 06/10/96

% Moisture: ______ decanted: (Y/N)___   Date Extracted: 06/25/96

Concentrated Extract Volume: 1000(uL)   Date Analyzed: 06/26/96

Injection Volume: 2.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
51-28-5	2,4-Dinitrophenol	120	U
100-02-7	4-Nitrophenol	120	U
132-64-9	Dibenzofuran	50	U
121-14-2	2,4-Dinitrotoluene	50	U
84-66-2	Diethylphthalate	50	U
7005-72-3	4-Chlorophenyl-phenylether	50	U
86-73-7	Fluorene	50	U
100-01-6	4-Nitroaniline	120	U
534-52-1	4,6-Dinitro-2-methylphenol	120	U
86-30-6	N-nitrosodiphenylamine (1)	50	U
101-55-3	4-Bromophenyl-phenylether	50	U
118-74-1	Hexachlorobenzene	50	U
87-86-5	Pentachlorophenol	120	U
85-01-8	Phenanthrene	50	U
120-12-7	Anthracene	50	U
86-74-8	Carbazole	50	U
84-74-2	Di-n-butylphthalate	15	JB
206-44-0	Fluoranthene	50	U
129-00-0	Pyrene	50	U
85-68-7	Butylbenzylphthalate	50	U
91-94-1	3,3'-Dichlorobenzidine	50	U
56-55-3	Benzo(a)anthracene	50	U
218-01-9	Chrysene	50	U
117-81-7	bis(2-Ethylhexyl)phthalate	7	J
117-84-0	Di-n-octylphthalate	50	U
205-99-2	Benzo(b)fluoranthene	50	U
207-08-9	Benzo(k)fluoranthene	50	U
50-32-8	Benzo(a)pyrene	50	U
193-39-5	Indeno(1,2,3-cd)pyrene	50	U
53-70-3	Dibenzo(a,h)anthracene	50	U
191-24-2	Benzo(g,h,i)perylene	50	U

(1) - Cannot be separated from Diphenylamine

TCLP

1F
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

FW-60

RE01-S3(8)-G01

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00201

Matrix: (soil/water) WATER Lab Sample ID: 807912

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH007912A60

Level: (low/med) LOW Date Received: 06/10/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:06/25/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 06/26/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 5

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	5.25	46	J
2.	CYCLOHEXENONE (BC)	6.52	12	JB
3.	UNKNOWN (BC)	6.70	14	JB
4.	UNKNOWN CARBOXYLIC ACID (BC)	6.92	13	JB
5.	UNKNOWN	9.09	13	J
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TCLP INORGANIC ANALYSES DATA SHEET

FW-60

b Name: COMPUCHEM_ENV._CORP. Contract: ILM03.0

RE01-S3(8)-601

b Code: COMPU Case No.: 31884 SAS No.: SDG No.: 211

trix (soil/water): WATER Lab Sample ID: 807914

vel (low/med): LOW Date Received: 06/10/96

Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	2570		E	P
7440-36-0	Antimony	28.9	B		P
7440-38-2	Arsenic	20.5			P
7440-39-3	Barium	712			P
7440-41-7	Beryllium	0.67	B		P
7440-43-9	Cadmium	161			P
7440-70-2	Calcium	251000			P
7440-47-3	Chromium	110			P
7440-48-4	Cobalt	10.3	B		P
7440-50-8	Copper	208			P
7439-89-6	Iron	1090			P
7439-92-1	Lead	1280			P
7439-95-4	Magnesium	47100			P
7439-96-5	Manganese	363			P
7439-97-6	Mercury	0.20	U	N	CV
7440-02-0	Nickel	201		E	P
7440-09-7	Potassium	43200		E	P
7782-49-2	Selenium	3.6	B		P
7440-22-4	Silver	0.70	U		P
7440-23-5	Sodium	1070000		E	P
7440-28-0	Thallium	3.7	U		P
7440-62-2	Vanadium	27.3	B		P
7440-66-6	Zinc	20700			P
	Cyanide				NR

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lor After: COLORLESS Clarity After: CLEAR Artifacts:

mments:

TCLP PESTICIDE ORGANICS ANALYSIS DATA SHEET

FW68

RE02-53(F)

Lab Name: COMPUCHEM ENV. CORP. Contract:

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00206

Matrix: (soil/water) WATER Lab Sample ID: 807923

Sample wt/vol: 200 (g/mL) ML Lab File ID: ________

% Moisture: ______ decanted: (Y/N)___ Date Received: 06/~~10~~12/96 CEE 7/19/96

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted:06/24/96

Concentrated Extract Volume: 10000(uL) Date Analyzed: 07/11/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	5.0	U
11104-28-2	Aroclor-1221	10	U
11141-16-5	Aroclor-1232	5.0	U
53469-21-9	Aroclor-1242	4.0	P
12672-29-6	Aroclor-1248	5.0	U
11097-69-1	Aroclor-1254	5.0	U
11096-82-5	Aroclor-1260	5.0	U

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TCLP SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW68

RE02-S3(F)

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00201

Matrix: (soil/water) WATER Lab Sample ID: 807922

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH007922A60

Level: (low/med) LOW Date Received: 06/12/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:06/25/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 06/26/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	50	U
111-44-4	bis(2-Chloroethyl)ether	50	U
95-57-8	2-Chlorophenol	50	U
541-73-1	1,3-Dichlorobenzene	50	U
106-46-7	1,4-Dichlorobenzene	50	U
95-50-1	1,2-Dichlorobenzene	50	U
95-48-7	2-Methylphenol	50	U
108-60-1	2,2'-oxybis(1-Chloropropane)	50	U
106-44-5	4-Methylphenol	50	U
621-64-7	N-Nitroso-di-n-propylamine	50	U
67-72-1	Hexachloroethane	50	U
98-95-3	Nitrobenzene	50	U
78-59-1	Isophorone	50	U
88-75-5	2-Nitrophenol	50	U
105-67-9	2,4-Dimethylphenol	50	U
111-91-1	bis(2-Chloroethoxy)methane	50	U
120-83-2	2,4-Dichlorophenol	50	U
120-82-1	1,2,4-Trichlorobenzene	50	U
91-20-3	Naphthalene	50	U
106-47-8	4-Chloroaniline	50	U
87-68-3	Hexachlorobutadiene	50	U
59-50-7	4-Chloro-3-methylphenol	50	U
91-57-6	2-Methylnaphthalene	50	U
77-47-4	Hexachlorocyclopentadiene	50	U
88-06-2	2,4,6-Trichlorophenol	50	U
95-95-4	2,4,5-Trichlorophenol	120	U
91-58-7	2-Chloronaphthalene	50	U
88-74-4	2-Nitroaniline	120	U
131-11-3	Dimethylphthalate	50	U
208-96-8	Acenaphthylene	50	U
606-20-2	2,6-Dinitrotoluene	50	U
99-09-2	3-Nitroaniline	120	U
83-32-9	Acenaphthene	140	

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.TCLP SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW68

RE02-S3(F)

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00201

Matrix: (soil/water) WATER Lab Sample ID: 807922

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH007922A60

Level: (low/med) LOW Date Received: 06/12/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted: 06/25/96

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 06/26/96

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
51-28-5	2,4-Dinitrophenol	120	U
100-02-7	4-Nitrophenol	120	U
132-64-9	Dibenzofuran	140	
121-14-2	2,4-Dinitrotoluene	50	U
84-66-2	Diethylphthalate	5	JB
7005-72-3	4-Chlorophenyl-phenylether	50	U
86-73-7	Fluorene	250	
100-01-6	4-Nitroaniline	120	U
534-52-1	4,6-Dinitro-2-methylphenol	120	U
86-30-6	N-nitrosodiphenylamine (1)	50	U
101-55-3	4-Bromophenyl-phenylether	50	U
118-74-1	Hexachlorobenzene	50	U
87-86-5	Pentachlorophenol	120	U
85-01-8	Phenanthrene	580	E
120-12-7	Anthracene	79	
86-74-8	Carbazole	95	
84-74-2	Di-n-butylphthalate	39	JB
206-44-0	Fluoranthene	400	E
129-00-0	Pyrene	290	
85-68-7	Butylbenzylphthalate	50	U
91-94-1	3,3'-Dichlorobenzidine	50	U
56-55-3	Benzo(a)anthracene	83	
218-01-9	Chrysene	74	
117-81-7	bis(2-Ethylhexyl)phthalate	83	
117-84-0	Di-n-octylphthalate	50	U
205-99-2	Benzo(b)fluoranthene	60	X
207-08-9	Benzo(k)fluoranthene	60	X
50-32-8	Benzo(a)pyrene	24	J
193-39-5	Indeno(1,2,3-cd)pyrene	8	J
53-70-3	Dibenzo(a,h)anthracene	50	U
191-24-2	Benzo(g,h,i)perylene	6	J

(1) - Cannot be separated from Diphenylamine

TCLP

1F
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

FW68

RE02-S3(F)

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00201

Matrix: (soil/water) WATER Lab Sample ID: 807922

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH007922A60

Level: (low/med) LOW Date Received: 06/12/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted: 06/25/96

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 06/26/96

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

Number TICs found: 33

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	5.31	90	J
2.	UNKNOWN (BC)	5.59	36	JB
3.	CYCLOHEXENOL (BC)	6.00	16	JB
4.	UNKNOWN (BC)	6.73	23	JB
5.	UNKNOWN	8.58	16	J
6.	UNKNOWN (BC)	9.10	26	JB
7.	UNKNOWN	11.15	14	J
8.	UNKNOWN	11.22	12	J
9. 827-54-3	NAPHTHALENE, 2-ETHENYL-	11.44	12	NJ
10. 121-33-5	VANILLIN	11.52	26	NJ
11. 613-46-7	2-NAPHTHALENECARBONITRILE	12.50	12	NJ
12.	UNKNOWN	13.08	17	J
13.	UNKNOWN	13.41	22	J
14.	UNKNOWN	13.44	27	J
15.	UNKNOWN PAH	13.51	16	J
16. 7320-53-8	DIBENZOFURAN, 4-METHYL-	13.56	28	NJ
17.	SUBSTITUTED NAPHTHALENE	13.89	18	J
18. 613-31-0	ANTHRACENE, 9,10-DIHYDRO-	14.00	18	NJ
19. 1730-37-6	9H-FLUORENE, 1-METHYL-	14.19	35	NJ
20.	UNKNOWN	14.42	15	J
21.	UNKNOWN	14.61	23	J
22. 132-65-0	DIBENZOTHIOPHENE	14.67	79	NJ
23. 2444-68-0	ANTHRACENE, 9-ETHENYL-	15.34	14	NJ
24.	METHYLANTHRACENE	15.67	52	J
25.	METHYLPHENANTHRENE	15.72	68	J
26.	UNKNOWN PAH	15.86	83	J
27. 35465-71-5	2-PHENYLNAPHTHALENE	16.17	58	NJ
28.	DIMETHYLPHENANTHRENE	16.59	18	J
29.	UNKNOWN	16.65	24	J
30.	UNKNOWN	16.95	19	J

TCLP

1F
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

FW68 –

RE02 -S3(F)

Lab Name: CompuChem Env. Corp.   Contract: OLM03-REVS

Lab Code: COMPU   Case No.: 31884   SAS No.:   SDG No.: 00201

Matrix: (soil/water) WATER   Lab Sample ID: 807922

Sample wt/vol: 200 (g/mL) mL   Lab File ID: GH007922A60

Level: (low/med) LOW   Date Received: 06/12/96

% Moisture: ______ decanted: (Y/N)___   Date Extracted: 06/25/96

Concentrated Extract Volume: 1000(uL)   Date Analyzed: 06/26/96

Injection Volume: 2.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ____

Number TICs found: 33

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	BENZOFLUORENE	17.77	15	J
2.	BENZOFLUORENE	17.89	16	J
3.	BENZOFLUORANTHENE	21.47	22	J
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TCLP SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW68DL

PE02-S3(F)

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00201

Matrix: (soil/water) WATER Lab Sample ID: 807922

Sample wt/vol: 200 (g/mL) mL Lab File ID: GD007922B60

Level: (low/med) LOW Date Received: 06/12/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:06/25/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 06/27/96

Injection Volume: 2.0(uL) Dilution Factor: 3.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	150	U
111-44-4	bis(2-Chloroethyl)ether	150	U
95-57-8	2-Chlorophenol	150	U
541-73-1	1,3-Dichlorobenzene	150	U
106-46-7	1,4-Dichlorobenzene	150	U
95-50-1	1,2-Dichlorobenzene	150	U
95-48-7	2-Methylphenol	150	U
108-60-1	2,2'-oxybis(1-Chloropropane)	150	U
106-44-5	4-Methylphenol	150	U
621-64-7	N-Nitroso-di-n-propylamine	150	U
67-72-1	Hexachloroethane	150	U
98-95-3	Nitrobenzene	150	U
78-59-1	Isophorone	150	U
88-75-5	2-Nitrophenol	150	U
105-67-9	2,4-Dimethylphenol	150	U
111-91-1	bis(2-Chloroethoxy)methane	150	U
120-83-2	2,4-Dichlorophenol	150	U
120-82-1	1,2,4-Trichlorobenzene	150	U
91-20-3	Naphthalene	150	U
106-47-8	4-Chloroaniline	150	U
87-68-3	Hexachlorobutadiene	150	U
59-50-7	4-Chloro-3-methylphenol	150	U
91-57-6	2-Methylnaphthalene	150	U
77-47-4	Hexachlorocyclopentadiene	150	U
88-06-2	2,4,6-Trichlorophenol	150	U
95-95-4	2,4,5-Trichlorophenol	380	U
91-58-7	2-Chloronaphthalene	150	U
88-74-4	2-Nitroaniline	380	U
131-11-3	Dimethylphthalate	150	U
208-96-8	Acenaphthylene	150	U
606-20-2	2,6-Dinitrotoluene	150	U
99-09-2	3-Nitroaniline	380	U
83-32-9	Acenaphthene	160	D

TCLP

1C
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW68DL

RE02-S3(F)

Lab Name: CompuChem Env. Corp.   Contract: OLM03-REVS

Lab Code: COMPU   Case No.: 31884   SAS No.:   SDG No.: 00201

Matrix: (soil/water) WATER   Lab Sample ID: 807922

Sample wt/vol: 200 (g/mL) mL   Lab File ID: GD007922B60

Level: (low/med) LOW   Date Received: 06/12/96

% Moisture: ______ decanted: (Y/N)___   Date Extracted: 06/25/96

Concentrated Extract Volume: 1000(uL)   Date Analyzed: 06/27/96

Injection Volume: 2.0(uL)   Dilution Factor: 3.0

GPC Cleanup: (Y/N) N   pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
51-28-5	2,4-Dinitrophenol	380	U
100-02-7	4-Nitrophenol	380	U
132-64-9	Dibenzofuran	140	DJ
121-14-2	2,4-Dinitrotoluene	150	U
84-66-2	Diethylphthalate	150	U
7005-72-3	4-Chlorophenyl-phenylether	150	U
86-73-7	Fluorene	250	D
100-01-6	4-Nitroaniline	380	U
534-52-1	4,6-Dinitro-2-methylphenol	380	U
86-30-6	N-nitrosodiphenylamine (1)	150	U
101-55-3	4-Bromophenyl-phenylether	150	U
118-74-1	Hexachlorobenzene	150	U
87-86-5	Pentachlorophenol	380	U
85-01-8	Phenanthrene	730	D
120-12-7	Anthracene	72	DJ
86-74-8	Carbazole	66	DJ
84-74-2	Di-n-butylphthalate	47	DBJ
206-44-0	Fluoranthene	400	D
129-00-0	Pyrene	310	D
85-68-7	Butylbenzylphthalate	150	U
91-94-1	3,3'-Dichlorobenzidine	150	U
56-55-3	Benzo(a)anthracene	77	DJ
218-01-9	Chrysene	73	DJ
117-81-7	bis(2-Ethylhexyl)phthalate	92	DJ
117-84-0	Di-n-octylphthalate	150	U
205-99-2	Benzo(b)fluoranthene	62	DXJ
207-08-9	Benzo(k)fluoranthene	55	DXJ
50-32-8	Benzo(a)pyrene	22	DJ
193-39-5	Indeno(1,2,3-cd)pyrene	150	U
53-70-3	Dibenzo(a,h)anthracene	150	U
191-24-2	Benzo(g,h,i)perylene	150	U

(1) - Cannot be separated from Diphenylamine

FORM I SV-2   OLM03.0

TCLP

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

FW68DL

RE02-83(F)

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00201

Matrix: (soil/water) WATER Lab Sample ID: 807922

Sample wt/vol: 200 (g/mL) mL Lab File ID: GD007922B60

Level: (low/med) LOW Date Received: 06/12/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:06/25/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 06/27/96

Injection Volume: 2.0(uL) Dilution Factor: 3.0

GPC Cleanup: (Y/N) N pH: ____

Number TICs found: 12

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	5.26	82	JD
2.	UNKNOWN (BC)	5.53	38	JBD
3. 65-85-0	BENZOIC ACID	9.06	120	NJD
4. 7320-53-8	DIBENZOFURAN, 4-METHYL-	13.55	35	NJD
5.	METHYLFLUORENE	14.19	35	JD
6. 132-65-0	DIBENZOTHIOPHENE	14.66	72	NJD
7.	METHYLPHENANTHRENE	15.67	49	JD
8.	METHYLANTHRACENE	15.72	53	JD
9.	UNKNOWN	15.85	93	JD
10. 35465-71-5	2-PHENYLNAPHTHALENE	16.16	39	NJD
11.	BENZOFLUORENE	17.77	46	JD
12.	BENZOFLUORENE	17.88	37	JD
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TCLP INORGANIC ANALYSES DATA SHEET

FW68

ab Name: COMPUCHEM_ENV._CORP._____ Contract: ILM03.0___

RE02-S3(F)

ab Code: COMPU_ Case No.: 31884_ SAS No.: ______ SDG No.: 211___

atrix (soil/water): WATER Lab Sample ID: 807924

evel (low/med): LOW__ Date Received: 06/12/96

Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	2890		E	P
7440-36-0	Antimony	17.1	B		P
7440-38-2	Arsenic	8.9	B		P
7440-39-3	Barium	565			P
7440-41-7	Beryllium	0.62	B		P
7440-43-9	Cadmium	172			P
7440-70-2	Calcium	250000			P
7440-47-3	Chromium	167			P
7440-48-4	Cobalt	17.5	B		P
7440-50-8	Copper	1000			P
7439-89-6	Iron	423			P
7439-92-1	Lead	890			P
7439-95-4	Magnesium	37400			P
7439-96-5	Manganese	281			P
7439-97-6	Mercury	0.20	U	N	CV
7440-02-0	Nickel	694		E	P
7440-09-7	Potassium	39400		E	P
7782-49-2	Selenium	7.5			P
7440-22-4	Silver	0.70	U		P
7440-23-5	Sodium	1060000		E	P
7440-28-0	Thallium	5.6	B		P
7440-62-2	Vanadium	10.4	B		P
7440-66-6	Zinc	21900			P
	Cyanide				NR

olor Before: COLORLESS Clarity Before: CLEAR_ Texture: ______

olor After: COLORLESS Clarity After: CLEAR_ Artifacts: ______

omments:

TCLP

1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW126

R E 04-S3(F)-G01

Lab Name: COMPUCHEM ENV. CORP. Contract:

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00247

Matrix: (soil/water) WATER Lab Sample ID: 808333

Sample wt/vol: 200 (g/mL) ML Lab File ID: ______

% Moisture: ______ decanted: (Y/N)___ Date Received: 06/19/96

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 06/25/96

Concentrated Extract Volume: 10000(uL) Date Analyzed: 07/09/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	------Aroclor-1016	5.0	U
11104-28-2	------Aroclor-1221	10	U
11141-16-5	------Aroclor-1232	5.0	U
53469-21-9	------Aroclor-1242	5.0	U
12672-29-6	------Aroclor-1248	5.0	U
11097-69-1	------Aroclor-1254	5.0	U
11096-82-5	------Aroclor-1260	5.0	U

FORM I PEST OLM03.0

TCLP

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW126

RE04-S3(F)-G01

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 808332

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH008332A05

Level: (low/med) LOW Date Received: 06/19/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:06/25/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 06/28/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	35	J
111-44-4	bis(2-Chloroethyl)ether	50	U
95-57-8	2-Chlorophenol	50	U
541-73-1	1,3-Dichlorobenzene	50	U
106-46-7	1,4-Dichlorobenzene	50	U
95-50-1	1,2-Dichlorobenzene	50	U
95-48-7	2-Methylphenol	50	U
108-60-1	2,2'-oxybis(1-Chloropropane)	50	U
106-44-5	4-Methylphenol	50	U
621-64-7	N-Nitroso-di-n-propylamine	50	U
67-72-1	Hexachloroethane	50	U
98-95-3	Nitrobenzene	50	U
78-59-1	Isophorone	50	U
88-75-5	2-Nitrophenol	50	U
105-67-9	2,4-Dimethylphenol	50	U
111-91-1	bis(2-Chloroethoxy)methane	50	U
120-83-2	2,4-Dichlorophenol	50	U
120-82-1	1,2,4-Trichlorobenzene	50	U
91-20-3	Naphthalene	50	U
106-47-8	4-Chloroaniline	50	U
87-68-3	Hexachlorobutadiene	50	U
59-50-7	4-Chloro-3-methylphenol	50	U
91-57-6	2-Methylnaphthalene	50	U
77-47-4	Hexachlorocyclopentadiene	50	U
88-06-2	2,4,6-Trichlorophenol	50	U
95-95-4	2,4,5-Trichlorophenol	120	U
91-58-7	2-Chloronaphthalene	50	U
88-74-4	2-Nitroaniline	120	U
131-11-3	Dimethylphthalate	50	U
208-96-8	Acenaphthylene	50	U
606-20-2	2,6-Dinitrotoluene	50	U
99-09-2	3-Nitroaniline	120	U
83-32-9	Acenaphthene	50	U

1C

TCLP SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW126

RE04-S3(F)-G01

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 808332

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH008332A05

Level: (low/med) LOW Date Received: 06/19/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:06/25/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 06/28/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
51-28-5	2,4-Dinitrophenol	120	U
100-02-7	4-Nitrophenol	120	U
132-64-9	Dibenzofuran	50	U
121-14-2	2,4-Dinitrotoluene	50	U
84-66-2	Diethylphthalate	8	J
7005-72-3	4-Chlorophenyl-phenylether	50	U
86-73-7	Fluorene	50	U
100-01-6	4-Nitroaniline	120	U
534-52-1	4,6-Dinitro-2-methylphenol	120	U
86-30-6	N-nitrosodiphenylamine (1)	50	U
101-55-3	4-Bromophenyl-phenylether	50	U
118-74-1	Hexachlorobenzene	50	U
87-86-5	Pentachlorophenol	120	U
85-01-8	Phenanthrene	50	U
120-12-7	Anthracene	50	U
86-74-8	Carbazole	50	U
84-74-2	Di-n-butylphthalate	34	J
206-44-0	Fluoranthene	50	U
129-00-0	Pyrene	50	U
85-68-7	Butylbenzylphthalate	50	U
91-94-1	3,3'-Dichlorobenzidine	50	U
56-55-3	Benzo(a)anthracene	50	U
218-01-9	Chrysene	50	U
117-81-7	bis(2-Ethylhexyl)phthalate	50	U
117-84-0	Di-n-octylphthalate	50	U
205-99-2	Benzo(b)fluoranthene	50	U
207-08-9	Benzo(k)fluoranthene	50	U
50-32-8	Benzo(a)pyrene	50	U
193-39-5	Indeno(1,2,3-cd)pyrene	50	U
53-70-3	Dibenzo(a,h)anthracene	50	U
191-24-2	Benzo(g,h,i)perylene	50	U

(1) - Cannot be separated from Diphenylamine

TCLP

1F

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

FW126

RE04-S3(F)-601

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 808332

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH008332A05

Level: (low/med) LOW Date Received: 06/19/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted: 06/25/96

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 06/28/96

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 23

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	4.60	44	J
2.	UNKNOWN KETONE	4.79	11	J
3.	UNKNOWN (BC)	4.84	34	JB
4.	UNKNOWN	5.33	13	J
5.	UNKNOWN	5.41	14	J
6.	UNKNOWN	5.81	20	J
7.	UNKNOWN	6.58	12	J
8.	UNKNOWN	7.18	10	J
9.	UNKNOWN	7.25	16	J
10.	UNKNOWN	7.32	12	J
11.	UNKNOWN	7.78	18	J
12. 65-85-0	BENZOIC ACID	7.86	11	NJ
13.	UNKNOWN ALCOHOL	8.00	33	J
14.	UNKNOWN	8.24	31	J
15.	UNKNOWN	8.55	12	J
16.	UNKNOWN	8.77	15	J
17.	UNKNOWN KETONE	9.07	11	J
18.	UNKNOWN	9.31	14	J
19.	UNKNOWN SUBSTITUTED PROPANOI	9.39	65	J
20. 621-59-0	BENZALDEHYDE, 3-HYDROXY-4-ME	9.75	64	NJ
21.	UNKNOWN SUBSTITUTED PROPANOI	10.99	16	J
22.	LABORATORY ARTIFACT	15.29	12	J
23.	UNKNOWN	17.90	28	J
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FORM I SV-TIC OLM03.0

1B

TCLP **SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET**

EPA SAMPLE NO.

FW127

RE04-33(F)-G02

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 808336

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH008336A05

Level: (low/med) LOW Date Received: 06/19/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted: 06/25/96

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 06/28/96

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	50	U
111-44-4	bis(2-Chloroethyl)ether	50	U
95-57-8	2-Chlorophenol	50	U
541-73-1	1,3-Dichlorobenzene	50	U
106-46-7	1,4-Dichlorobenzene	50	U
95-50-1	1,2-Dichlorobenzene	50	U
95-48-7	2-Methylphenol	50	U
108-60-1	2,2'-oxybis(1-Chloropropane)	50	U
106-44-5	4-Methylphenol	50	U
621-64-7	N-Nitroso-di-n-propylamine	50	U
67-72-1	Hexachloroethane	50	U
98-95-3	Nitrobenzene	50	U
78-59-1	Isophorone	50	U
88-75-5	2-Nitrophenol	50	U
105-67-9	2,4-Dimethylphenol	50	U
111-91-1	bis(2-Chloroethoxy)methane	50	U
120-83-2	2,4-Dichlorophenol	50	U
120-82-1	1,2,4-Trichlorobenzene	50	U
91-20-3	Naphthalene	50	U
106-47-8	4-Chloroaniline	50	U
87-68-3	Hexachlorobutadiene	50	U
59-50-7	4-Chloro-3-methylphenol	50	U
91-57-6	2-Methylnaphthalene	50	U
77-47-4	Hexachlorocyclopentadiene	50	U
88-06-2	2,4,6-Trichlorophenol	50	U
95-95-4	2,4,5-Trichlorophenol	120	U
91-58-7	2-Chloronaphthalene	50	U
88-74-4	2-Nitroaniline	120	U
131-11-3	Dimethylphthalate	50	U
208-96-8	Acenaphthylene	50	U
606-20-2	2,6-Dinitrotoluene	50	U
99-09-2	3-Nitroaniline	120	U
83-32-9	Acenaphthene	50	U

1C

EPA SAMPLE NO.

TCLP SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

FW127

RE04-33(F)-602

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 808336

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH008336A05

Level: (low/med) LOW Date Received: 06/19/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted: 06/25/96

Concentrated Extract Volume: 1000 (uL) Date Analyzed: 06/28/96

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
51-28-5	2,4-Dinitrophenol	120	U
100-02-7	4-Nitrophenol	120	U
132-64-9	Dibenzofuran	50	U
121-14-2	2,4-Dinitrotoluene	50	U
84-66-2	Diethylphthalate	50	U
7005-72-3	4-Chlorophenyl-phenylether	50	U
86-73-7	Fluorene	50	U
100-01-6	4-Nitroaniline	120	U
534-52-1	4,6-Dinitro-2-methylphenol	120	U
86-30-6	N-nitrosodiphenylamine (1)	50	U
101-55-3	4-Bromophenyl-phenylether	50	U
118-74-1	Hexachlorobenzene	50	U
87-86-5	Pentachlorophenol	120	U
85-01-8	Phenanthrene	50	U
120-12-7	Anthracene	50	U
86-74-8	Carbazole	50	U
84-74-2	Di-n-butylphthalate	50	U
206-44-0	Fluoranthene	50	U
129-00-0	Pyrene	50	U
85-68-7	Butylbenzylphthalate	50	U
91-94-1	3,3'-Dichlorobenzidine	50	U
56-55-3	Benzo(a)anthracene	50	U
218-01-9	Chrysene	50	U
117-81-7	bis(2-Ethylhexyl)phthalate	50	U
117-84-0	Di-n-octylphthalate	50	U
205-99-2	Benzo(b)fluoranthene	50	U
207-08-9	Benzo(k)fluoranthene	50	U
50-32-8	Benzo(a)pyrene	50	U
193-39-5	Indeno(1,2,3-cd)pyrene	50	U
53-70-3	Dibenzo(a,h)anthracene	50	U
191-24-2	Benzo(g,h,i)perylene	50	U

(1) - Cannot be separated from Diphenylamine

1F

TCLP

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

FW127

RE04-S3(F)-G02

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 808336

Sample wt/vol: 200 (g/mL) mL Lab File ID: GH008336A05

Level: (low/med) LOW Date Received: 06/19/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:06/25/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 06/28/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 6

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	4.62	22	J
2.	UNKNOWN	7.29	13	J
3. 529-20-4	BENZALDEHYDE, 2-METHYL-	8.29	10	NJ
4. 123-08-0	BENZALDEHYDE, 4-HYDROXY-	9.44	16	NJ
5. 121-33-5	VANILLIN	9.79	46	NJ
6.	LABORATORY ARTIFACT	15.33	11	J
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U.S. EPA - CLP

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TCLP **INORGANIC ANALYSES DATA SHEET**

EPA SAMPLE NO.

FW127

Lab Name: COMPUCHEM_ENV._CORP. Contract: ILM03.0

PE 04-53(F)-602

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 252

Matrix (soil/water): WATER Lab Sample ID: 808338

Level (low/med): LOW Date Received: 06/19/96

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	4780		N	P
7440-36-0	Antimony	32.3	B		P
7440-38-2	Arsenic	19.6			P
7440-39-3	Barium	871			P
7440-41-7	Beryllium	0.59	B		P
7440-43-9	Cadmium	152			P
7440-70-2	Calcium	217000			P
7440-47-3	Chromium	322			P
7440-48-4	Cobalt	16.1	B		P
7440-50-8	Copper	1910			P
7439-89-6	Iron	2090			P
7439-92-1	Lead	414		N	P
7439-95-4	Magnesium	36600			P
7439-96-5	Manganese	297			P
7439-97-6	Mercury	18.6			CV
7440-02-0	Nickel	376			P
7440-09-7	Potassium	38800		E	P
7782-49-2	Selenium	10.6			P
7440-22-4	Silver	19.2			P
7440-23-5	Sodium	1120000			P
7440-28-0	Thallium	6.0	B		P
7440-62-2	Vanadium	83.9			P
7440-66-6	Zinc	21900			P
	Cyanide				NR

Color Before: BROWN Clarity Before: Texture: MEDIUM

Color After: YELLOW Clarity After: Artifacts:

Comments:

U.S. EPA - CLP

TCLP 1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

FW126

RE 64-53(F)-G01

Lab Name: COMPUCHEM_ENV._CORP.

Contract: ILM03.0

Lab Code: COMPU_

Case No.: 31884_

SAS No.:

SDG No.: 252

Matrix (soil/water): WATER

Lab Sample ID: 808334

Level (low/med): LOW

Date Received: 06/19/96

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	7580		N	P
7440-36-0	Antimony	33.2	B		P
7440-38-2	Arsenic	20.9			P
7440-39-3	Barium	1350			P
7440-41-7	Beryllium	1.2	B		P
7440-43-9	Cadmium	198			P
7440-70-2	Calcium	264000			P
7440-47-3	Chromium	377			P
7440-48-4	Cobalt	16.0	B		P
7440-50-8	Copper	1340			P
7439-89-6	Iron	2620			P
7439-92-1	Lead	663		N	P
7439-95-4	Magnesium	45500			P
7439-96-5	Manganese	355			P
7439-97-6	Mercury	8.6			CV
7440-02-0	Nickel	428			P
7440-09-7	Potassium	40100		E	P
7782-49-2	Selenium	11.4			P
7440-22-4	Silver	4.0	B		P
7440-23-5	Sodium	853000			P
7440-28-0	Thallium	5.2	B		P
7440-62-2	Vanadium	84.2			P
7440-66-6	Zinc	29000			P
	Cyanide				NR

Color Before: BROWN

Clarity Before:

Texture: MEDIUM

Color After: YELLOW

Clarity After:

Artifacts:

Comments:

1D

TCLP PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW127

RE04-53(A)G02

Lab Name: COMPUCHEM ENV. CORP. Contract:

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00247

Matrix: (soil/water) WATER Lab Sample ID: 808337

Sample wt/vol: 200 (g/mL) ML Lab File ID: ______

% Moisture: ______ decanted: (Y/N)___ Date Received: 06/19/96

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 06/25/96

Concentrated Extract Volume: 10000(uL) Date Analyzed: 07/09/96

Injection Volume: 2.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ____ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	5.0	U
11104-28-2	Aroclor-1221	10	U
11141-16-5	Aroclor-1232	5.0	U
53469-21-9	Aroclor-1242	5.0	U
12672-29-6	Aroclor-1248	5.0	U
11097-69-1	Aroclor-1254	5.0	U
11096-82-5	Aroclor-1260	5.0	U

TCLP PESTICIDE ORGANICS ANALYSIS DATA SHEET

FW1S1

RE05-S3(F)-G01

Lab Name: COMPUCHEM ENV. CORP.   Contract:

Lab Code: COMPU   Case No.: 31884   SAS No.:   SDG No.: 00247

Matrix: (soil/water) WATER   Lab Sample ID: 809178

Sample wt/vol: 200 (g/mL) ML   Lab File ID: ______

% Moisture: ______ decanted: (Y/N) ___   Date Received: 06/21/96

Extraction: (SepF/Cont/Sonc) SEPF   Date Extracted: 07/08/96

Concentrated Extract Volume: 10000 (uL)   Date Analyzed: 07/12/96

Injection Volume: 2.0 (uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ____   Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
12674-11-2	Aroclor-1016	5.0	U
11104-28-2	Aroclor-1221	10	U
11141-16-5	Aroclor-1232	5.0	U
53469-21-9	Aroclor-1242	5.4	P
12672-29-6	Aroclor-1248	5.0	U
11097-69-1	Aroclor-1254	5.0	U
11096-82-5	Aroclor-1260	5.0	U

FORM I PEST   OLM03.0

1B

TCLP SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW151

RE05-S3(F)-G01

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 809177

Sample wt/vol: 1000 (g/mL) mL Lab File ID: GDJ09177A02

Level: (low/med) LOW Date Received: 06/21/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:07/09/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 07/15/96

Injection Volume: 2.0(uL) Dilution Factor: 10.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	100	U
111-44-4	bis(2-Chloroethyl)ether	100	U
95-57-8	2-Chlorophenol	100	U
541-73-1	1,3-Dichlorobenzene	100	U
106-46-7	1,4-Dichlorobenzene	100	U
95-50-1	1,2-Dichlorobenzene	100	U
95-48-7	2-Methylphenol	100	U
108-60-1	2,2'-oxybis(1-Chloropropane)	100	U
106-44-5	4-Methylphenol	100	U
621-64-7	N-Nitroso-di-n-propylamine	100	U
67-72-1	Hexachloroethane	100	U
98-95-3	Nitrobenzene	100	U
78-59-1	Isophorone	100	U
88-75-5	2-Nitrophenol	100	U
105-67-9	2,4-Dimethylphenol	100	U
111-91-1	bis(2-Chloroethoxy)methane	100	U
120-83-2	2,4-Dichlorophenol	100	U
120-82-1	1,2,4-Trichlorobenzene	100	U
91-20-3	Naphthalene	100	U
106-47-8	4-Chloroaniline	100	U
87-68-3	Hexachlorobutadiene	100	U
59-50-7	4-Chloro-3-methylphenol	100	U
91-57-6	2-Methylnaphthalene	100	U
77-47-4	Hexachlorocyclopentadiene	100	U
88-06-2	2,4,6-Trichlorophenol	100	U
95-95-4	2,4,5-Trichlorophenol	250	U
91-58-7	2-Chloronaphthalene	100	U
88-74-4	2-Nitroaniline	250	U
131-11-3	Dimethylphthalate	100	U
208-96-8	Acenaphthylene	100	U
606-20-2	2,6-Dinitrotoluene	100	U
99-09-2	3-Nitroaniline	250	U
83-32-9	Acenaphthene	100	U

TCLP

1C
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FW151

RE05-S3(F)-G01

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 809177

Sample wt/vol: 1000 (g/mL) mL Lab File ID: GDJ09177A02

Level: (low/med) LOW Date Received: 06/21/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:07/09/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 07/15/96

Injection Volume: 2.0(uL) Dilution Factor: 10.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
51-28-5	2,4-Dinitrophenol	250	U
100-02-7	4-Nitrophenol	250	U
132-64-9	Dibenzofuran	100	U
121-14-2	2,4-Dinitrotoluene	100	U
84-66-2	Diethylphthalate	100	U
7005-72-3	4-Chlorophenyl-phenylether	100	U
86-73-7	Fluorene	100	U
100-01-6	4-Nitroaniline	250	U
534-52-1	4,6-Dinitro-2-methylphenol	250	U
86-30-6	N-nitrosodiphenylamine (1)	100	U
101-55-3	4-Bromophenyl-phenylether	100	U
118-74-1	Hexachlorobenzene	100	U
87-86-5	Pentachlorophenol	250	U
85-01-8	Phenanthrene	100	U
120-12-7	Anthracene	100	U
86-74-8	Carbazole	100	U
84-74-2	Di-n-butylphthalate	100	U
206-44-0	Fluoranthene	100	U
129-00-0	Pyrene	100	U
85-68-7	Butylbenzylphthalate	100	U
91-94-1	3,3'-Dichlorobenzidine	100	U
56-55-3	Benzo(a)anthracene	100	U
218-01-9	Chrysene	100	U
117-81-7	bis(2-Ethylhexyl)phthalate	100	U
117-84-0	Di-n-octylphthalate	100	U
205-99-2	Benzo(b)fluoranthene	100	U
207-08-9	Benzo(k)fluoranthene	100	U
50-32-8	Benzo(a)pyrene	100	U
193-39-5	Indeno(1,2,3-cd)pyrene	100	U
53-70-3	Dibenzo(a,h)anthracene	100	U
191-24-2	Benzo(g,h,i)perylene	100	U

(1) - Cannot be separated from Diphenylamine

1F

EPA SAMPLE NO.

TCLP SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

FW151

RE05-S8(F)-G01

Lab Name: CompuChem Env. Corp. Contract: OLM03-REVS

Lab Code: COMPU Case No.: 31884 SAS No.: SDG No.: 00242

Matrix: (soil/water) WATER Lab Sample ID: 809177

Sample wt/vol: 1000 (g/mL) mL Lab File ID: GDJ09177A02

Level: (low/med) LOW Date Received: 06/21/96

% Moisture: ______ decanted: (Y/N)___ Date Extracted:07/09/96

Concentrated Extract Volume: 1000(uL) Date Analyzed: 07/15/96

Injection Volume: 2.0(uL) Dilution Factor: 10.0

GPC Cleanup: (Y/N) N pH: ____

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 1

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN CARBOXYLIC ACID	4.61	28	J
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
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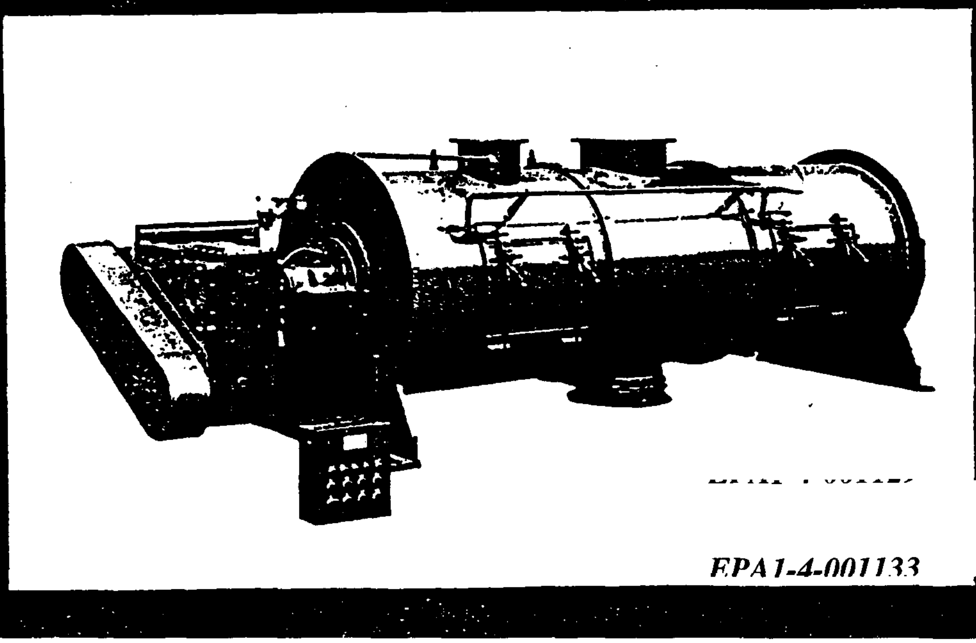
27.				
28.				
29.				
30.				

Attachment 3

Littleford Brochure

Littleford

mixers and mixing systems



Littleford mixers and mixing systems

Mixing Technology

At Littleford, mixer design is based on a thorough knowledge and understanding of processing requirements within the industries we serve which include chemical, plastics, pharmaceutical, food, cosmetic, forest products, to name a few.

Littleford has designed and engineered an advanced line of mixers and mixing systems that combine degrees of speed, precision, efficiency and versatility not previously obtainable in a single mixing unit. Whether for batch or continuous material processing, Littleford equipment enables the user to have complete analytical control over the mixing operation, eliminating guesswork in preparing your products and formulations.

The key to success in Littleford mixers is the unique action created by the movement of the

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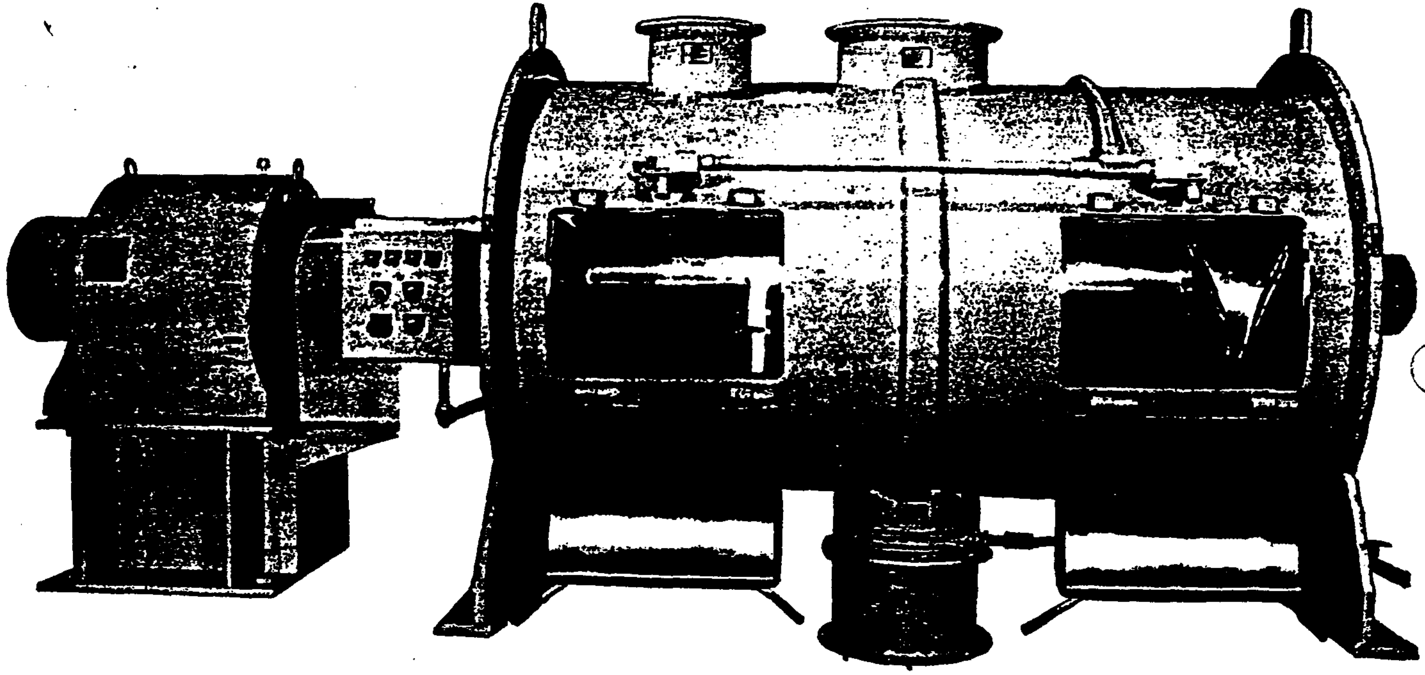
FKM-2000E



Littleford FKM Series Batch Mixers

FKM Series batch mixers are widely used throughout the process industries for product applications that include solids to solids, liquid to solids, and paste or pseudoplastic materials mixing applications.

Littleford offers these mixers in standard sizes from 11 cu. 300 liters to 283 cu. ft./8,000 liters and larger.

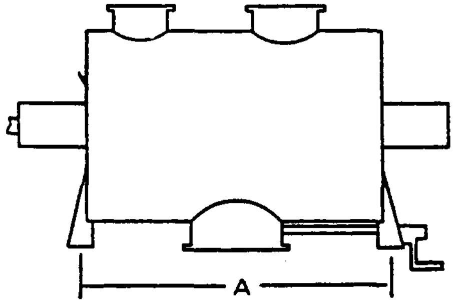
FKM Mixer Construction

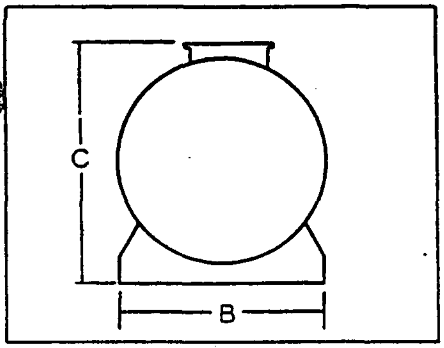
Littleford FKM Series mixers consist of a horizontal mixing cylinder, mixing elements mounted to horizontal main shaft, charging port located on top of mixer, contour access doors at the front of the mixer with electrical limit switches, discharge opening at the bottom of the mixer, mixer base, complete power and drive assembly, processing electrical controls designed to meet the customer's specific requirements.

FKM Mixer Operation

The unique mixing action of the Littleford FKM Series mixer is accomplished by a horizontal shaft which revolves at a high rate of speed, rapidly projecting and hurling the mix materials away from the vessel wall into free space — filling the entire vessel. This mixing action causes the materials to crisscross in the direction of the vessel walls and inversely back again, providing a high volume rate of material transfer throughout the entire length mixing elements that produce intense, but gentle intermingling of the materials of the mix in a mechanically fluidized bed. The mixing elements are arranged at intervals on the mixer shaft and their size, number, arrangement, geometric shape and peripheral speed are designed to force the product into appropriate components of axial and radial motion.

Fluidized Bed Mixing Action — *shown at 1/200 second exposure*





Standard Sizes of FKM Series Mixers

Model No.	TOTAL CAPACITY* Liters	Gallons	Cu. Ft.	APPROX. VESSEL DIMENSIONS A	B	C
FKM-300D	300	79	11	44″ 1120	29″ 740	35″ 890
FKM-600D	600	159	22	55″ 1400	36″ 910	43″ 1090
FKM-1200D	1,200	317	42	104″ 2640	36″ 910	43″ 1090
FKM-1200E	1,200	317	42	73″ 1850	45″ 1140	50″ 1270
FKM-2000D	2,000	530	71	123″ 3120	45″ 1140	51″ 1300
FKM-2000E	2,000	530	71	85″ 2160	52″ 1320	60″ 1520
FKM-3000D	3,000	792	106	123″ 3120	52″ 1320	60″ 1520
FKM-4200D	4,200	1,109	148	142″ 3610	58″ 1470	68″ 1730
FKM-8000D	8,000	2,113	283	165″ 4190	70″ 1780	80″ 2030

*Working capacity depends on the process and is normally between 50 and 70% of the total capacity.

NOTE: All dimensions are nominal. Figures shown in color are millimeters.

of the vessel. This blending action is the result of the special mixing element shape and speed within the enclosed vessel which transmits energy to the mass of material in the form of particle speed with a minimum impact and subsequent degradation, even with fragile materials.

The mechanically fluidized bed of particles is the basis of Littleford mixing efficiency and accuracy on a full range of materials including combinations with diverse specific gravities as well as other problems such as liquid incorporation and heat transfer.

The FKM Series mixer can be constructed with a variety of openings to facilitate the charging of materials, liquids and other processing aids. Easy access cleanout doors are located on the side of the mixer.

Liquid Addition Option — The Littleford FKM Series mixer is designed to allow for the incorporation of liquids into dry solids during the mix cycle. Since the basic incorporation of ingredients is largely a function of the agitation rate of the mass, the mechanically fluidized bed action — particularly when combined with Littleford's integral high-speed blending choppers — changes problem applications into simple, normal daily production operations providing controlled agglomeration, quality finished products with a minimum of equipment and handling.

Liquids (or plastic materials) may be introduced with or without installed spray or atomization attachments depending upon the specific application, with the amount of liquid limited only by that quantity which the product will accept while remaining in a free-flowing physical state.

Littleford mixers and mixing systems

Excellent Heat Transfer

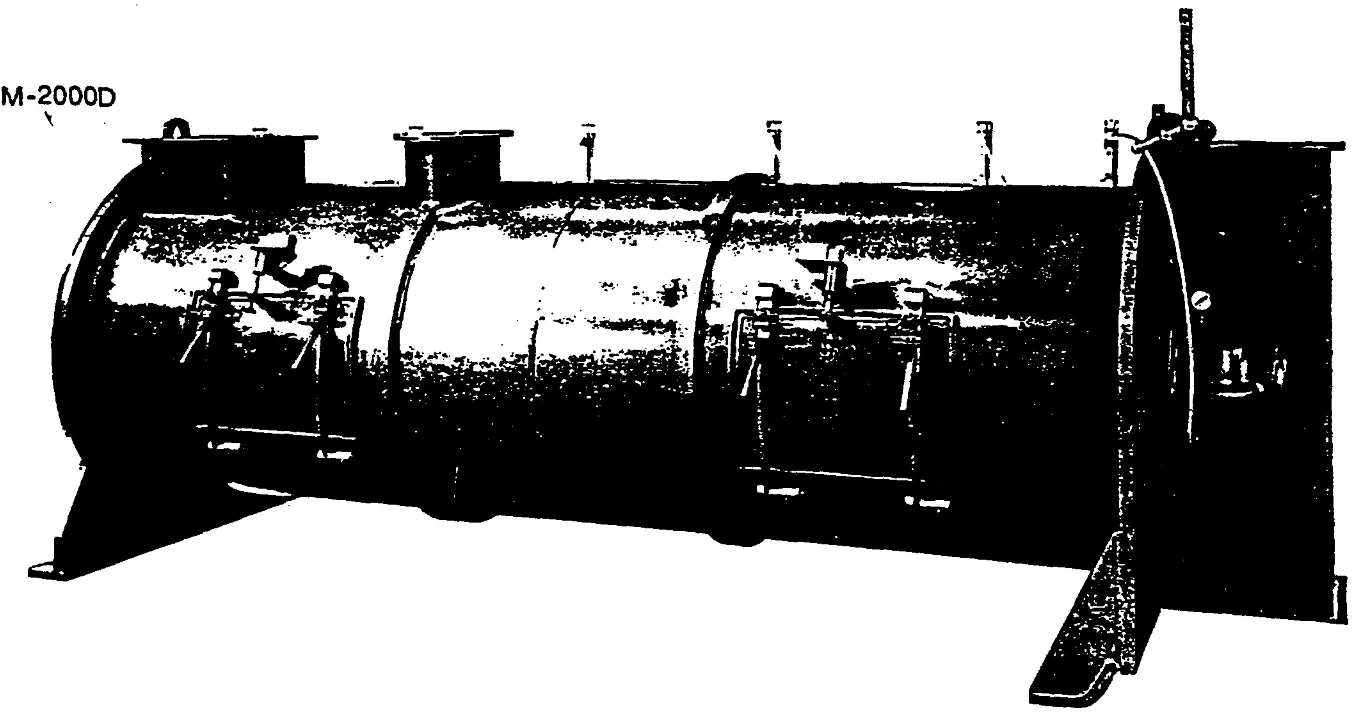
The unique mixing action of Littleford equipment described on the previous pages creates a mechanically fluidized bed of particles in constant motion, assuring absolute axial and radial mixing. This action, which exposes tremendous surface area of the mix, results in direct contact between particles, and provides associated momentum and heat transfer between particles, eliminating temperature gradients. As a consequence, heat transfer rates are at the highest obtainable level.

In applications where heat transfer is extremely critical, the jacketed Littleford mixer is one of the most efficient heat transfer vessels available.

Split-Seal Feature

The Littleford Split Seal Assembly meets the needs of the food and

KM-2000D



Littleford KM Series Continuous Mixers

KM Series continuous mixers are primarily used where high volume production is a prerequisite in the processing of dry products, and dry products with liquids in surface coating applications.

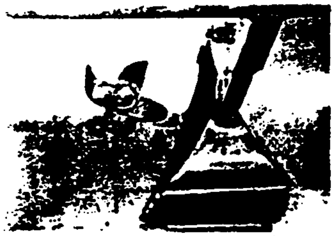
Standard sizes are 11 cu. ft./300 liters to 283 cu. ft. /8,000 liters and larger.

KM Mixer Construction

In general, the construction of the KM Series continuous mixer is very similar to Littleford's FKM Series batch mixer. The horizontal cylinder and mixing element shaft move the product from the charging end to the discharge end in a minimum of retention time.

KM Mixer Operation

Littleford's KM Series continuous mixers are charged through a port mounted on the top side of the charging end of the mixer. Typical working level of the product is nominally 50% of total capacity. As in the case of the FKM Series batch mixers, Littleford's advanced mixing elements put the product into three-dimensional motion, resulting in a superior mix achieved during a short retention period. Discharge of product is through an adjustable weir valve at the opposite end of the mixer from where the product was charged. Wide access doors in the front of the mixer make cleaning and maintenance fast and simple operations.



Optional high-speed blending choppers, available on FM/FKM/KM Series mixers, enhance mixing action by controlling particle size and trace ingredient dispersion... usually without the need for additional process steps and equipment.

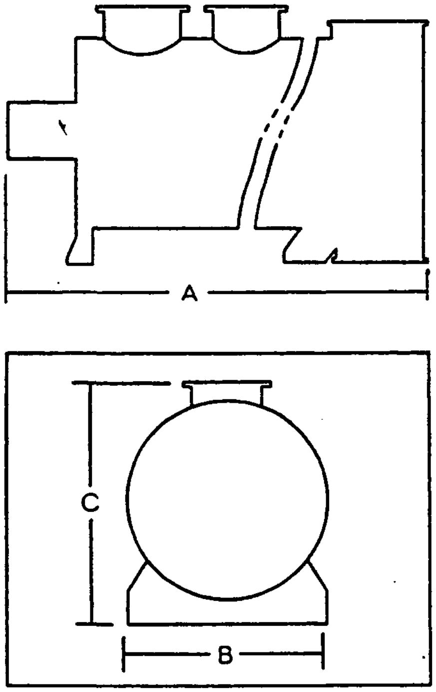
pharmaceutical process industries for an easily cleaned and maintained mixer shaft seal. It is designed to conform to the rigid requirements of the USDA, BISSC and 3-A codes.

The seal can be disassembled, cleaned and reassembled in minutes without the need for special tools, and without disturbing bearings or drive components. This seal can be adapted for vacuum operation if needed.

This packing seal system coupled with the outboard mounted bearings of the mixer virtually eliminate any possibility of cross contamination between the bearings and the mix.

Air Seal Feature

Littleford mixers may easily be fitted with air purge shaft seals for applications that require keeping the product away from the seal area.



Standard Sizes of KM Series Mixers

Model No.	TOTAL CAPACITY* Liters	Gallons	Cu. Ft.	APPROX. VESSEL DIMENSIONS A	B	C
KM-300D	300	79	11	76″ 1930	25″ 640	30″ 760
KM-600D	600	159	21	95″ 2410	30″ 760	35″ 890
KM-1200D	1,200	317	42	117″ 2970	36″ 914	43″ 1090
KM-2000D	2,000	530	71	138″ 3510	46″ 1170	51″ 1300
KM-3000D	3,000	792	106	140″ 3560	53″ 1350	60″ 1520
KM-4200D	4,200	1,109	148	163″ 4140	59″ 1500	68″ 1730
KM-8000D	8,000	2,113	283	192″ 4880	70″ 1780	80″ 2030

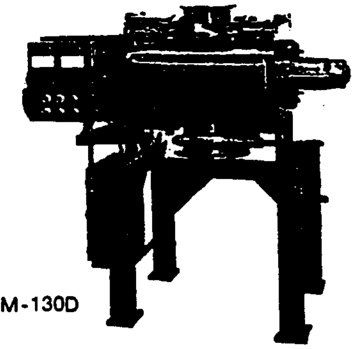
*Working capacity depends on the process and is normally between 50 and 70% of the total capacity.

NOTE: All dimensions are nominal. Figures shown in color are millimeters.

Littleford FM Series Batch Mixers

FM Series batch mixers, with charging/cleanout doors located on top of the unit, are produced especially for laboratory, pilot, and small scale production usage. They are intended for mixing dry materials (pulverized and granular), dry materials with liquids (surface coating), and liquids and pseudo-plastic products. Standard sizes of FM Series mixers are the FM-50, FM-130D and FM-300D with total volumes of 1.8 cu. ft./ 50 liters, 4.6 cu. ft./130 liters and 10.6 cu. ft./300 liters, respectively. Working volume can vary, depending on product being processed.

Essentially, the FM Series mixers are constructed and operate on the same principle as the larger FKM Series batch mixers.


FM-130D

Model No.	TOTAL CAPACITY* Liters	Gallons	Cu. Ft.	APPROX. VESSEL DIMENSIONS Length	Width	Height
FM-50	50	13	1.8	61″ 1550	48″ 1220	36″ 910
FM-130D	130	34	4.6	30″ 760	24″ 610	29″ 740
FM-300D	300	79	10.6	44″ 1120	29″ 740	35″ 890

*Working capacity depends on the process and is normally between 50 and 70% of the total capacity.

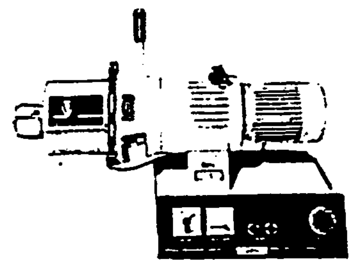
NOTE: All dimensions are nominal. Figures shown in color are millir

Littleford mixers and mixing systems

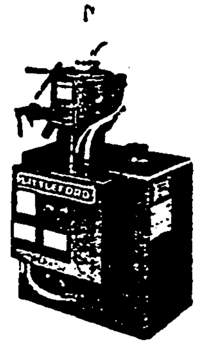
Littleford Laboratory Mixers

Littleford offers four lab size mixers in 5, 20, 50 and 130 liter sizes, based on the mixing principles found in the FM/FKM/KM line of horizontal mixers. A 10 liter vertical bowl, high-intensity laboratory mixer, similar to the Littleford W Series high-intensity mixer, is available too.

All Littleford laboratory mixers are useful for determining scale-up information and/or for testing prototype materials prior to commitment of production runs. Additionally, the lab mixers can be used in conjunction with production units already installed in your plant for quality control purposes.



M-5-G



W-10

Model No.	TOTAL CAPACITY* Liters	Gallons	Cu. Ft.	APPROX. VESSEL DIMENSIONS Length	Width	Height
M-5-G	5	1.3	.18	32″ 820	21″ 520	24″ 600
M-20-G	20	5.3	.71	38″ 950	18″ 450	30″ 745
FM-50	50	13	1.8	61″ 1550	48″ 1220	36″ 910
FM-130	130	34	4.6	30″ 760	24″ 610	29″ 740
W-10	10	2.6	.35	30″ 760	23″ 580	36″ 910

*Working capacity depends on the process and is normally between 50 and 70% of the total capacity.

NOTE: All dimensions are nominal. Figures shown in color are millimeters.

Trial Demonstration Program

Your Littleford representative can arrange for the rental of a trial demonstration mixer for testing in your own plant. Our Trial Demonstration Program offers potential customers in the process industry a unique opportunity to test a Littleford mixer in their own manufacturing environment. The FM-130 mixer, available through this program, is suitable for use in various applications and can be used to determine scale-up information for manufacturing capabilities of larger production units.

Through the Trial Demonstration Program, you are able to determine the processing advantages and efficiencies of the Littleford mixer without large commitments of research and development funds.

Littleford Testing Program

Littleford Bros., Inc. maintains a modern, well-equipped Technical Center in Florence, Kentucky, for mixer evaluation and initial development by customers and prospects. We welcome you to "Put Us to the Test".

Included in the Technical Center's equipment are mixers, reactors, dryers, granulators, and compounders of various designs and sizes for batch and continuous processing and support equipment such as vacuum and compressed air systems. Also available are recirculating hot oil, recirculating hot and chilled water systems, as well as scales and instruments for product preparation, monitoring and initial evaluation.

We are confident that you will find the data compiled during the test program to be valuable and useful in assessing Littleford processing equipment for your application. We look forward to assisting you during the test program.

Littleford

Other Littleford Processing Equipment

Outside of the basic batch and continuous mixers described on the preceding pages, Littleford designs, engineers and manufactures a number of more specialized pieces of processing equipment for various industries. Here, briefly described, are these Littleford products.

W Series High-Intensity Mixer — used in applications requiring high shear and high-intensity mixing action such as color concentrate blending, plasticized PVC, and pipe and siding applications. Standard capacities: 6 cu. ft./180 liters, 21 cu. ft./600 liters, 42 cu. ft./1,200 liters.

MGT Series Vertical Mixer/Granulator — provides the pharmaceutical, cosmetic and food industries with a precision mixer/granulator that is easily cleaned. Standard capacities: 2.5 cu. ft./70 liters to 42 cu. ft./1,200 liters.

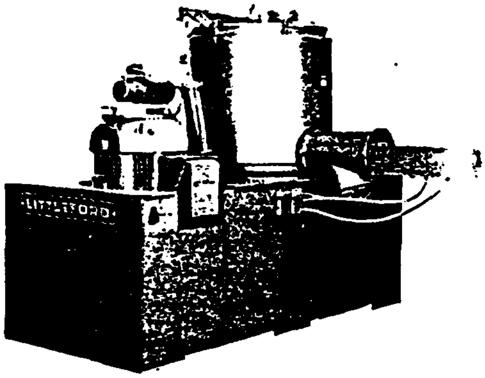
DVT Series Polyphase Processor — is a sophisticated chemical processor providing multi-processing capabilities in a single pressure vessel. Standard capacities: up to 882 cu. ft./25,000 liters.

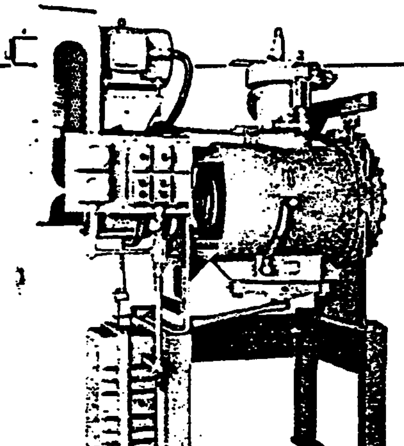
Littleford Vacuum Dryer — results in uniformly dried, lump-free products of exceptional quality in economical drying times. This vessel promotes drying at much lower temperatures than conventional atmospheric dryers. Standard capacities: 5 cu.ft./130 liters to 282 cu. ft./8,000 liters.

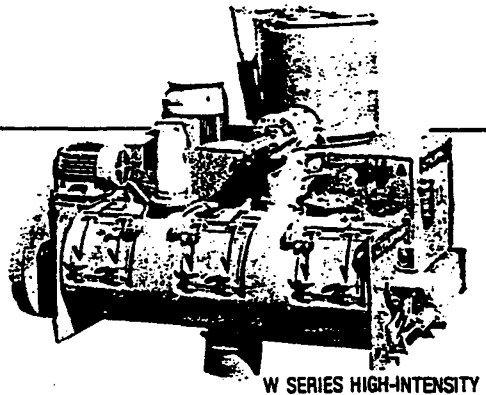
EK Series Particleboard Blenders — result in glue savings through more efficient resin-to-wood dispersion, without sacrificing quality.

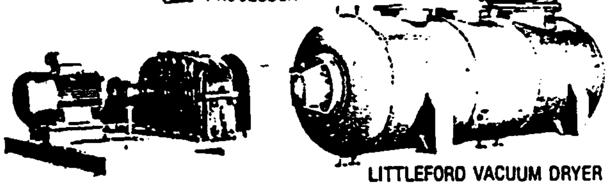
W Series High-Intensity PVC Compounder and **K Series Matched Cooler** — combine for the efficient compounding and cooling of rigid PVC, flexible PVC and other materials. Standard capacities: 1,000 to 9,000 lbs. per hr.

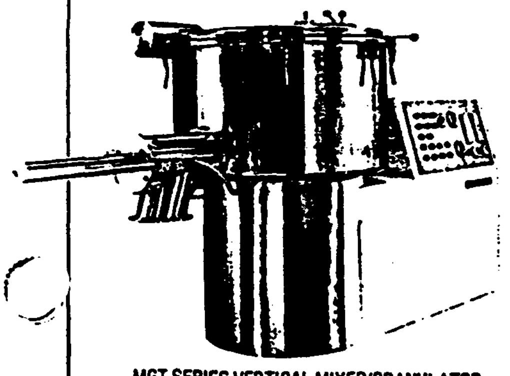
LCC Littleford PVC Compounding Center — is an integrated, prefabricated system for the continuous, high-volume production of dry PVC compound. Standard capacities: 1,000 to 9,000 lbs. per hr.

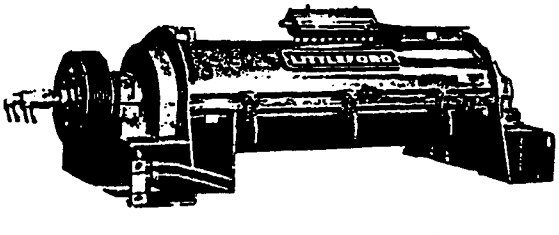

W SERIES HIGH-INTENSITY MIXER

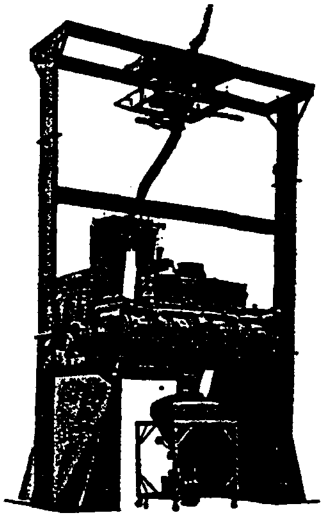

DVT SERIES POLYPHASE PROCESSOR


W SERIES HIGH-INTENSITY PVC COMPOUNDER AND K SERIES MATCHED COOLER


LITTLEFORD VACUUM DRYER


MGT SERIES VERTICAL MIXER/GRANULATOR


EK SERIES PARTICLEBOARD BLENDERS


LCC LITTLEFORD PVC COMPOUNDING CENTER

Attachment 4

Significant MSDSs

Help Catalogs Search Order List Prev Topic Next Topic TOC Contents

Diisopropylamine

**** MATERIAL SAFETY DATA SHEET ****

Diisopropylamine
07610

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Diisopropylamine
Catalog Numbers:
    02412 4, 02412-4
Synonyms:
    DIPA, N-(methylethyl)-2-propanamine
Company Identification: Fisher Scientific
    1 Reagent Lane
    Fairlawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	Einecs#
108-18-9	DIISOPROPYLAMINE	100	203-558-5

Hazard Symbols: XI F
Risk Phrases: 11 36/37/38

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: Colourless liquid. Flash Point: 21_F.
Target Organs: None.

Potential Health Effects

Eye:
- Causes eye irritation.
- Rapidly penetrates eye tissue.
- Exposure to concentrations between 25 and 50 ppm may cause disturbances of vision described as "haziness".

Skin:
- Causes skin irritation.
- May be absorbed through the skin.

Ingestion:
- Harmful if swallowed.
- Causes gastrointestinal irritation with nausea, vomiting and diarrhea.

Inhalation:
- Causes respiratory tract irritation.

Chronic:
- Prolonged or repeated skin contact may cause dermatitis.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
- Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids.
- Get medical aid.

Skin:
- Get medical aid.
- Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:
- Do NOT induce vomiting.
- If victim is conscious and alert, give 2-4 cupfuls of milk or water.
- Never give anything by mouth to an unconscious person.
- Get medical aid.

Inhalation:
- Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
- Get medical aid.

Notes to Physician:
- Extensive flushing of the eye is recommended. Diisopropylamine rapidly penetrates eye tissue.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.
Vapors can travel to a source of ignition and flash back.
Extremely flammable. Material will readily ignite at room temperature.

Extinguishing Media:

For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam.
Use water spray to cool fire-exposed containers.
Water may be ineffective.
This material is lighter than water and insoluble in water. The fire could easily be spread by the use of water in an area where the water cannot be contained.

Autoignition Temperature: 600.F (315.56.C)
Flash Point: 21.F (-6.11.C)
Explosion Limits, Lower: 0.8
Upper: 7.1

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equpiment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Remove all sources of ignition.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Use with adequate ventilation.
Ground and bond containers when transferring material.
Avoid contact with eyes, skin, and clothing.
Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, sparks or open flames.
Keep container tightly closed.
Avoid ingestion and inhalation.

Storage:

Keep away from heat and flame.
Keep away from sources of ignition.
Keep from contact with oxidizing materials.
Store in a cool, dry, well-ventilated area away from incompatible substances.
Keep containers tightly closed.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
DIISOPROPYLAMINE	5 ppm ; 21 mg/m3	5 ppm TWA; 20 mg/m3 TWA	5 ppm TWA; 20 mg/m3 TWA

OSHA Vacated PELs:
DIISOPROPYLAMINE:
5 ppm TWA; 20 mg/m3 TWA

Personal Protective Equipment

Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133.

Skin:
Wear appropriate gloves to prevent skin exposure.

Clothing:
Wear appropriate protective clothing to minimize contact with skin.

Respirators:
Follow the OSHA respirator regulations found in 29CFR 1010.134. Always use a NIOSH-approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Liquid
Appearance:	Colourless liquid.
Odor:	Ammonia-like odor.
pH:	12.3
Vapor Pressure:	60 mm Hg @ 20 C
Vapor Density:	3.5
Evaporation Rate:	5.8 (butyl acetate=1)
Viscosity:	0.4 mPa s 20 C
Boiling Point:	84.C
Freezing/Melting Point:	-61.C
Decomposition Temperature:	Not available.

Solubility:	Slight soluble in water.
Specific Gravity/Density:	.722
Molecular Formula:	C6H15N
Molecular Weight:	101.1117

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Incompatible materials, ignition sources.
Incompatibilities with Other Materials:
Acids and oxidizing agents.
Hazardous Decomposition Products:
Nitrogen oxides, carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 108-18-9: IM4025000
LD50/LC50:
CAS# 108-18-9: Inhalation, mouse: LC50 =4200 mg/m3/2H; Inhalation, rat: LC50 =4800 mg/m3/2H; Oral, mouse: LD50 = 2120 mg/kg; Oral, rabbit: LD50 = 4700 mg/kg; Skin, rabbit: LD50 = >10 gm/kg.
Carcinogenicity:
DIISOPROPYLAMINE -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT

Shipping Name: DIISOPROPYLAMINE
Hazard Class: 3
UN Number: UN1158
Packing Group: II

IMO

Shipping Name: DIISOPROPYLAMINE
Hazard Class: 3.2
UN Number: 1158
Packing Group: 2

IATA

Shipping Name: DIISOPROPYLAMINE
Hazard Class: 3
UN Number: 1158
Packing Group: 2

RID/ADR

Shipping Name: DIISOPROPYLAMINE
Dangerous Goods Code: 3(22B)
UN Number: 1158

Canadian TDG

Shipping Name: DIISOPROPYLAMINE
Hazard Class: 3
UN Number: UN1158
Other Information: FLASHPOINT -6C

**** SECTION 15 - REGULATORY INFORMATION ****

A. Federal

TSCA

CAS# 108-18-9 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA/SARA

Section 302 (RQ)

None of the chemicals in this material have an RQ.

Section 302 (TPQ)

None of the chemicals in this product have a TPQ.

Section 313

No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous

Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

B. State

DIISOPROPYLAMINE can be found on the following state right to know lists: California, New Jersey, Florida, Pennsylvania, Minnesota, Massachusetts.

California No Significant Risk Level:
None of the chemicals in this product are listed.

C. International

Canada

CAS# 108-18-9 is listed on Canada's DSL/NDSL List.
CAS# 108-18-9 is listed on Canada's Ingredient Disclosure List.

European Labeling in Accordance with EC Directives

Hazard Symbols: XI F

Risk Phrases:

R 11 Highly flammable.
R 36/37/38 Irritating to eyes, respiratory system and skin.

Safety Phrases:

S 16 Keep away from sources of ignition - No smoking.
S 9 Keep container in a well-ventilated place.

Exposure Limits:

OEL-AUSTRALIA:TWA 5 ppm (20 mg/m3);Skin. OEL-BELGIUM:TWA 5 ppm (21 mg/m3);Skin. OEL-DENMARK:TWA 5 ppm (20 mg/m3);Skin. OEL-FINLAND:STEL 5 ppm (20 mg/m3);Skin. OEL-FRANCE:TWA 5 ppm (20 mg/m3);Skin. OEL-THE NETHERLANDS:TWA 5 ppm (20 mg/m3);Skin. OEL-THE PHILIPPINES:TWA 5 ppm (20 mg/m3);Skin. OEL-RUSSIA:STEL 5 mg/m3;Skin. OEL-SWITZERLAND:TWA 5 ppm (20 mg/m3);Skin. OEL-UNITED KINGDOM:TWA 5 ppm (20 mg/m3);Skin JAN9. OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV. OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

**** SECTION 16 - ADDITIONAL INFORMATION ****

Additional Information:
No additional information available.

MSDS Creation Date: June 6, 1995

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes.

Section 1. - - - - - - - - - Chemical Identification - - - - - - - - - -

CATALOG #: Z7534
NAME: AMMONIA ANHYDROUS

Section 2. - - - - - Composition/Information on Ingredients - - - - - -

CAS #: 7664-41-7
EC NO: 231-635-3

SYNONYMS

AM-FOL * AMMONIA (ACGIH,OSHA) * AMMONIA ANHYDROUS * AMMONIA, ANHYDROUS, LIQUEFIED (DOT) * AMMONIAC (FRENCH) * AMMONIACA (ITALIAN) * AMMONIA GAS * AMMONIAK (GERMAN) * AMMONIA SOLUTIONS, RELATIVE DENSITY 50% AMMONIA (DOT) * AMONIAK (POLISH) * NITRO-SIL * R 717 * SPIRIT OF HARTSHORN * UN1005 (DOT) *

Section 3. - - - - - - - - - - Hazards Identification - - - - - - - - -

LABEL PRECAUTIONARY STATEMENTS

CORROSIVE
CAUSES BURNS.
HARMFUL BY INHALATION, IN CONTACT WITH SKIN AND IF SWALLOWED.
IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.
TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING.
WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.

Section 4. - - - - - - - - - - First-Aid Measures - - - - - - - - - -

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.
ASSURE ADEQUATE FLUSHING OF THE EYES BY SEPARATING THE EYELIDS WITH FINGERS.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.
IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.
CALL A PHYSICIAN.
DISCARD CONTAMINATED CLOTHING AND SHOES.

Section 5. - - - - - - - - - Fire Fighting Measures - - - - - - - - - -

EXTINGUISHING MEDIA

DO NOT EXTINGUISH BURNING GAS IF FLOW CANNOT BE SHUT OFF IMMEDIATELY.
USE WATER SPRAY OR FOG NOZZLE TO KEEP CYLINDER COOL. MOVE CYLINDER AWAY FROM FIRE IF THERE IS NO RISK.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.
DANGER: CORROSIVE AND TOXIC LIQUID AND GAS UNDER PRESSURE.
NONFLAMMABLE GAS.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

FORMS EXPLOSIVE MIXTURES IN AIR.

EXPLOSIVE HYDROGEN GAS.
REDUCING AGENT.

Section 6. - - - - - - - - Accidental Release Measures - - - - - - - - -

EVACUATE AREA.
SHUT OFF ALL SOURCES OF IGNITION.
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY RUBBER GLOVES.
COVER WITH DRY-LIME, SAND, OR SODA ASH. PLACE IN COVERED CONTAINERS USING NON-SPARKING TOOLS AND TRANSPORT OUTDOORS.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

Section 7. - - - - - - - - - - - Handling and Storage - - - - - - - - - - -

REFER TO SECTION 8.
ADDITIONAL INFORMATION
DISPERSIONS OF SODIUM IN VOLATILE SOLVENTS BECOME PYROPHORIC WHEN THE SOLVENT EVAPORATES.

Section 8. - - - - - - Exposure Controls/Personal Protection - - - - - -

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.
SAFETY SHOWER AND EYE BATH.
USE ONLY IN A CHEMICAL FUME HOOD.
FACESHIELD (8-INCH MINIMUM).
AVOID INHALATION.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
KEEP TIGHTLY CLOSED.
CORROSIVE.
KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME.
DO NOT ALLOW CONTACT WITH WATER.
AIR SENSITIVE
STORE IN A COOL DRY PLACE.

Section 9. - - - - - - - Physical and Chemical Properties - - - - - - -

APPEARANCE AND ODOR
SILVERY METAL
PHYSICAL PROPERTIES

MELTING POINT:	97.8 C
VAPOR PRESSURE:	1MM 440 C
SPECIFIC GRAVITY:	0.968

Section 10. - - - - - - - - - -Stability and Reactivity - - - - - - - - -

INCOMPATIBILITIES
OXIDIZING AGENTS
SENSITIVE TO AIR
REACTS VIOLENTLY WITH:
WATER
ACIDS
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
NATURE OF DECOMPOSITION PRODUCTS NOT KNOWN.

Section 9. - - - - - - - Physical and Chemical Properties - - - - - - -

APPEARANCE AND ODOR
  COLORLESS GAS
PHYSICAL PROPERTIES
  BOILING POINT: -33 C
  MELTING POINT: -78 C
  EXPLOSION LIMITS IN AIR:
    UPPER 25%
    LOWER 15%
  AUTOIGNITION TEMPERATURE: 1203 F 649C
  VAPOR PRESSURE: 4802MM 15.5 C 8.75ATM 21 C
  VAPOR DENSITY: .6

Section 10. - - - - - - - - - -Stability and Reactivity - - - - - - - - -

INCOMPATIBILITIES
  HALOGENS
  ACID CHLORIDES
  ACIDS
  ACID ANHYDRIDES
  OXIDIZING AGENTS
  CHLOROFORMATES
  GALVANIZED IRON
  REACTS WITH:
  ZINC
  COPPER
  TIN
  AND THEIR ALLOYS.
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
  AMMONIA

Section 11. - - - - - - - - - - Toxicogical Information - - - - - - - -

ACUTE EFFECTS
  HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN.
  MATERIAL IS EXTREMELY DESTRUCTIVE TO TISSUE OF THE MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT, EYES AND SKIN.
  INHALATION MAY BE FATAL AS A RESULT OF SPASM, INFLAMMATION AND EDEMA OF THE LARYNX AND BRONCHI, CHEMICAL PNEUMONITIS AND PULMONARY EDEMA.
  SYMPTOMS OF EXPOSURE MAY INCLUDE BURNING SENSATION, COUGHING, WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA AND VOMITING.
RTECS #: BO0875000
  AMMONIA
TOXICITY DATA

IHL-HMN LCLO:5000 PPM/5M	TABIA2 3,231,33
UNR-MAN LDLO:132 MG/KG	85DCAI 2,73,70
IHL-RAT LC50:2000 PPM/4H	34ZIAG -,607,69
IHL-MUS LC50:4230 PPM/1H	FEPRA7 41,1568,82
IHL-CAT LC50:7 GM/M3/1H	JIHTAB 26,29,44
IHL-RBT LC50:7 GM/M3/1H	JIHTAB 26,29,44

TARGET ORGAN DATA
  PERIPHERAL NERVE AND SENSATION (FLACCID PARALYSIS WITHOUT ANESTHESIA)
  SENSE ORGANS AND SPECIAL SENSES (ULCERATED NASAL SEPTUM)
  SENSE ORGANS AND SPECIAL SENSES (CONJUNCTIVA IRRITATION)
  BEHAVIORAL (EXCITEMENT)
  LUNGS, THORAX OR RESPIRATION (CHANGE IN TRACHEA OR BRONCHI)
  GASTROINTESTINAL (TUMORS)
  TUMORIGENIC (CARCINOGENIC BY RTECS CRITERIA)

S:27
TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING.
S:36/37/39
WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.

REVIEWS, STANDARDS, AND REGULATIONS
OEL=MAK
NOHS 1974: HZD 68765; NIS 7; TNF 381; NOS 9; TNE 3325
NOES 1983: HZD 68765; NIS 179; TNF 23017; NOS 79; TNE 262032; TFE 34622
EPA TSCA SECTION 8(B) CHEMICAL INVENTORY
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, APRIL 1995

Section 16. - - - - - - - - - - Other Information - - - - - - - - - - -

OEL-THE NETHERLANDS:TWA 25 PPM (18 MG/M3) JAN93
OEL-THE PHILIPPINES:TWA 50 PPM (30 MG/M3) JAN93
OEL-POLAND:TWA 20 MG/M3;STEL 20 MG/M3 JAN93
OEL-RUSSIA:TWA 25 PPM;STEL 20 MG/M3 JAN93
OEL-SWEDEN:TWA 25 PPM (18 MG/M3);STEL 50 PPM (35 MG/M3) JAN93
OEL-SWITZERLAND:TWA 25 PPM (18 MG/M3);STEL 50 PPM (36 MG/M3) JAN93
OEL-THAILAND:TWA 50 PPM (35 MG/M3) JAN93
OEL-TURKEY:TWA 25 PPM (35 MG/M3) JAN93
OEL-UNITED KINGDOM:TWA 25 PPM (18 MG/M3);STEL 35 PPM (27 MG/M3) JAN93
OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA CHECK ACGIH TLV
OEL IN NEW ZEALAND, SINGAPORE, VIETNAM CHECK ACGIH TLV
NIOSH REL TO AMMONIA-AIR:10H TWA 25 PPM;STEL 35 PPM
NIOSH* DHHS #92-100,92
NOHS 1974: HZD 05250; NIS 363; TNF 115139; NOS 198; TNE 1168429
NOES 1983: HZD 05250; NIS 270; TNF 42116; NOS 174; TNE 805962; TFE 287974
EPA GENETOX PROGRAM 1988, INCONCLUSIVE: D MELANOGASTER SEX-LINKED LETHAL
EPA TSCA SECTION 8(B) CHEMICAL INVENTORY
ON EPA IRIS DATABASE
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, APRIL 1995
NIOSH ANALYTICAL METHOD, 1994: AMMONIA, 6015
OSHA ANALYTICAL METHOD #ID-164
OSHA ANALYTICAL METHOD #ID-188

U.S. INFORMATION
THIS PRODUCT IS SUBJECT TO SARA SECTION 313 REPORTING REQUIREMENTS.

Section 16. - - - - - - - - - - Other Information - - - - - - - - - - -

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA, ALDRICH, FLUKA SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE.

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

Section 6. - - - - - - - - Accidental Release Measures - - - - - - - - -

EVACUATE AREA AND KEEP PERSONNEL UPWIND.
WEAR FULL PROTECTIVE EQUIPMENT SUCH AS, A BUTYL RUBBER CHEMICAL-PROOF AIR SUIT, WITH BREATHING AIR SUPPLIED.
SHUT OFF LEAK IF THERE IS NO RISK.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

Section 7. - - - - - - - - - - Handling and Storage - - - - - - - - - - -

REFER TO SECTION 8.

ADDITIONAL INFORMATION

WARNING: AMMONIA REACTS VIOLENTLY, OR PRODUCES EXPLOSIVE PRODUCTS WITH ALL FOUR HALOGENS AND WITH SOME OF THE INTERHALOGENS SUCH AS BROMINE PENTAFLUORIDE, CHLORINE TRIFLUORIDE. IT REACTS WITH SOME HEAVY METALS AND THEIR SALTS (I.E. MERCURY, SILVER, GOLD) TO PRODUCE MATERIALS OF A SOMETIMES UNKNOWN COMPOSITION THAT ARE SHOCK-SENSITIVE AND MAY EXPLODE WHEN DRY. AT AMBIENT TEMPERATURE, AMMONIA GAS REACTS EXOTHERMICALLY WITH CALCIUM, BUT IF WARMED THE LATTER BECOMES INCANDESCENT. REACTION OF AMMONIA WITH 2-NITRO, 4-NITRO OR 2,4-DINITRO CHLOROBENZENE MAY RESULT IN VIOLENT RUNAWAY REACTIONS PRODUCING HIGH INTERNAL PRESSURES CAUSING RUPTURE OF EQUIPMENT. REACTION WITH TELLURIUM TETRABROMIDE OR TETRACHLORIDE FORMS TELLURIUM NITRIDE WHICH EXPLODES ON HEATING. THIOTRITHIAZYL CHLORIDE RAPIDLY ABSORBED AMMONIA GAS AND THEN EXPLODED. A HEATED MIXTURE OF STIBINE AND AMMONIA EXPLODES. TETRAMETHYLAMMONIUM AMIDE DECOMPOSES EXPLOSIVELY AT AMBIENT TEMPERATURE IN THE PRESENCE OF AMMONIA. THIOCARBONYL AZIDE THIOCYANATE REACTS EXPLOSIVELY WITH AMMONIA GAS. AMMONIA GAS REACTS VIOLENTLY WHEN MIXED WITH: MAGNESIUM PERCHLORATE, POTASSIUM CHLORATE, NITRYL CHLORIDE, DICHLORINE OXIDE, CHROMYL CHLORIDE, CHROMIUM TRIOXIDE, TRIOXYGEN DIFLUORIDE, NITRIC ACID, HYDROGEN PEROXIDE, AMMONIUM PERSULFATE, NITRIC OXIDE, NITROGEN DIOXIDE, PENTABORANE, BORON TRIHALIDES, CHLORINE AZIDE OR CHLOROFORMAMIDINIUM NITRATE.

Section 8. - - - - - - Exposure Controls/Personal Protection - - - - - -

CHEMICAL SAFETY GOGGLES.
COMPATIBLE CHEMICAL-RESISTANT GLOVES.
NIOSH/MSHA-APPROVED RESPIRATOR IN NONVENTILATED AREAS AND/OR FOR EXPOSURE ABOVE THE ACGIH TLV.
MECHANICAL EXHAUST REQUIRED.
SAFETY SHOWER AND EYE BATH.
DO NOT BREATHE GAS.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
CORROSIVE.
TOXIC.
KEEP TIGHTLY CLOSED.
CYLINDER TEMPERATURE SHOULD NOT EXCEED 125 F(52 C).
STORE AND USE WITH ADEQUATE VENTILATION.
PROTECT FROM MOISTURE.
USE WITH EQUIPMENT RATED FOR CYLINDER PRESSURE, AND OF COMPATIBLE MATERIALS OF CONSTRUCTION. CLOSE VALVE WHEN NOT IN USE AND WHEN EMPTY.
MAKE SURE CYLINDER IS PROPERLY SECURED WHEN IN USE OR STORED.
WARNING: SUCK-BACK INTO CYLINDER MAY CAUSE RUPTURE.
USE BACK-FLOW-PREVENTIVE DEVICE IN PIPING.

EXPLOSIVE HYDROGEN GAS.
REDUCING AGENT.

Section 6. - - - - - - - - Accidental Release Measures - - - - - - - - -

EVACUATE AREA.
SHUT OFF ALL SOURCES OF IGNITION.
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY RUBBER GLOVES.
COVER WITH DRY-LIME, SAND, OR SODA ASH. PLACE IN COVERED CONTAINERS USING NON-SPARKING TOOLS AND TRANSPORT OUTDOORS.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

Section 7. - - - - - - - - - - - Handling and Storage - - - - - - - - - - -

REFER TO SECTION 8.
ADDITIONAL INFORMATION
DISPERSIONS OF SODIUM IN VOLATILE SOLVENTS BECOME PYROPHORIC WHEN THE SOLVENT EVAPORATES.

Section 8. - - - - - - Exposure Controls/Personal Protection - - - - - -

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.
SAFETY SHOWER AND EYE BATH.
USE ONLY IN A CHEMICAL FUME HOOD.
FACESHIELD (8-INCH MINIMUM).
AVOID INHALATION.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
KEEP TIGHTLY CLOSED.
CORROSIVE.
KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME.
DO NOT ALLOW CONTACT WITH WATER.
AIR SENSITIVE
STORE IN A COOL DRY PLACE.

Section 9. - - - - - - - Physical and Chemical Properties - - - - - - -

APPEARANCE AND ODOR
  SILVERY METAL
PHYSICAL PROPERTIES
  MELTING POINT: 97.8 C
  VAPOR PRESSURE: 1MM 440 C
  SPECIFIC GRAVITY: 0.968

Section 10. - - - - - - - - - -Stability and Reactivity - - - - - - - - -

INCOMPATIBILITIES
  OXIDIZING AGENTS
  SENSITIVE TO AIR
  REACTS VIOLENTLY WITH:
  WATER
  ACIDS
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
  NATURE OF DECOMPOSITION PRODUCTS NOT KNOWN.

ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS) DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.

Section 12. - - - - - - - - - - Ecological Information - - - - - - - - - -

DATA NOT YET AVAILABLE.

Section 13. - - - - - - - - - - Disposal Considerations - - - - - - - - -

CAUTION: NO-RETURN CYLINDER. DO NOT REUSE. EMPTY CYLINDER WILL CONTAIN HAZARDOUS RESIDUE. FOLLOW PROPER DISPOSAL TECHNIQUES.
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

Section 14. - - - - - - - - - - - Transport Information - - - - - - - - -

CONTACT SIGMA CHEMICAL COMPANY FOR TRANSPORTATION INFORMATION.

Section 15. - - - - - - - - - - Regulatory Information - - - - - - - - - -

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EUROPEAN INFORMATION
  EC INDEX NO:                       007-001-00-5
  R:34
  CAUSES BURNS.
  R:20/21/22
  HARMFUL BY INHALATION, IN CONTACT WITH SKIN AND IF SWALLOWED.
  S:26
  IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF
  WATER AND SEEK MEDICAL ADVICE.
  S:27
  TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING.
  S:36/37/39
  WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE
  PROTECTION.
REVIEWS, STANDARDS, AND REGULATIONS
  OEL=MAK
  ACGIH TLV-TWA 25 PPM; STEL 35 PPM            85INA8 6,58,91
  MSHA STANDARD-AIR:TWA 25 PPM (18 MG/M3)
   DTLVS* 3,11,71
  OSHA PEL (GEN INDU):8H TWA 50 PPM (35 MG/M3)
   CFRGBR 29,1910.1000,94
  OSHA PEL (CONSTRUC):8H TWA 50 PPM (35 MG/M3)
   CFRGBR 29,1926.55,94
  OSHA PEL (SHIPYARD):8H TWA 50 PPM (35 MG/M3)
   CFRGBR 29,1915.1000,93
  OSHA PEL (FED CONT):8H TWA 50 PPM (35 MG/M3)
   CFRGBR 41,50-204.50,94
  OEL-ARAB REPUBLIC OF EGYPT:TWA 25 PPM (18 MG/M3) JAN93
  OEL-AUSTRALIA:TWA 25 PPM (18 MG/M3);STEL 35 PPM (27 MG/M3) JAN93
  OEL-AUSTRIA:TWA 50 PPM (35 MG/M3) JAN93
  OEL-BELGIUM:TWA 25 PPM (17 MG/M3);STEL 35 PPM (24 MG/M3) JAN93
  OEL-CZECHOSLOVAKIA:TWA 20 MG/M3;STEL 40 MG/M3 JAN93
  OEL-DENMARK:TWA 25 PPM (18 MG/M3) JAN93
  OEL-FINLAND:TWA 25 PPM (18 MG/M3);STEL 40 PPM (30 MG/M3) JAN93
  OEL-FRANCE:TWA 25 PPM (18 MG/M3);STEL 50 PPM (36 MG/M3) JAN93
  OEL-GERMANY:TWA 50 PPM (35 MG/M3) JAN93
  OEL-HUNGARY:TWA 18 MG/M3;STEL 27 MG/M3 JAN93
  OEL-INDIA:TWA 25 PPM (18 MG/M3);STEL 35 PPM (27 MG/M3) JAN3
  OEL-JAPAN:TWA 25 PPM (17 MG/M3) JAN93
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S:27
TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING.
S:36/37/39
WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.

REVIEWS, STANDARDS, AND REGULATIONS
OEL=MAK
NOHS 1974: HZD 68765; NIS 7; TNF 381; NOS 9; TNE 3325
NOES 1983: HZD 68765; NIS 179; TNF 23017; NOS 79; TNE 262032; TFE 34622
EPA TSCA SECTION 8(B) CHEMICAL INVENTORY
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, APRIL 1995

Section 16. - - - - - - - - - - Other Information - - - - - - - - - - - -

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA, ALDRICH, FLUKA SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE.