→ Terry E FYI
Any comments?

WESTON
MANAGERS DESIGNERS CONSULTANTS

ROY F. WESTON, INC.
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708-918-4000

1 September 1992

Gary - I've attached a couple of minor comments. I think these folks should proceed with the study as planned.
Terry

Ms. Betty G. Lavis (HSRW-6J)
Project Manager
U.S. Environmental Protection Agency
77 West Jackson Blvd.
Chicago, Illinois 60604-3590

Re: Revised Pages of Test Plan - Phase I Treatability Study of Bioslurry Treatment Technology Moss-American Site - Milwaukee, WI.

Dear Ms. Lavis:

Roy F. Weston, Inc. (WESTON®), on behalf of the settling defendant, Kerr-McGee Chemical Corporation (KMCC), is hereby transmitting revisions to the above-referenced test plan . These revisions, presented in the format of highlighted revised pages, have been prepared in response to U.S. EPA's letter of 3 August 1992 and our group meeting of 13 August 1992.

We believe these revisions address each of the technical issues raised by the review comments, except for the U.S. EPA/WDNR comment related to manifesting of the treatability samples. It is WESTON's understanding that the treatability study samples designated for transport to IT Corporation and Bergmann USA Laboratories are not required to be manifested for the following reasons:

- The samples are being collected and transported for the sole purpose of conducting treatability studies.
- The samples are being collected and prepared for transportation by the sample collector (WESTON).
- Approximately 100 lbs. of each soil sample type will be packaged and labeled in a DOT type-17C, 20-gallon steel drum.
- Chain of custody documentation will be prepared and accompany each sample.
- A common commercial carrier (Consolidated Freightways, Inc., Federal Express Corp., etc.) will be utilized to transport the samples.

- The Bergmann USA and IT Corp. Laboratories are licensed with their respective state agencies, or have obtained the necessary exemptions for conducting the treatability studies.
- All waste residues and unused samples will be returned from the laboratory to the Moss-American site.

The requirements of the State of Wisconsin NR 605 Regulations, dated February 1991 (see enclosed) appear to confirm our understanding as being correct. On this basis, we request that the Agency provide further clarification and/or direction on this matter. Your immediate attention to this issue is requested, as we will be proceeding to the field on 14 September 1992 to collect and prepare the treatability study samples for shipment.

Very truly yours,

ROY F. WESTON, INC.

Gary J. Deigan
Senior Project Manager

Kurt S. Stimpson
Project Director

GJD/KSS/lh
Enclosures

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K. Brown, IT Corp
R. Traver, Bergmann USA

4. Except as provided in subd. 5, it is generated from the treatment, storage or disposal of a hazardous waste, including any sludge, spill residue, ash, emission control dust or leachate, and it is a waste which is listed under s. NR 605.09, contains a waste listed under s. NR 605.09, or is derived from a waste listed under s. NR 605.09, and it has not been excluded under s. NR 605.10.

5. It is a waste pickle liquor sludge derived from the lime stabilization treatment of spent pickle liquor from the iron and steel industry falling under the standard industrial classification (SIC) codes 331 and 332, and the sludge exhibits one or more of the characteristics of hazardous waste identified in s. NR 605.08.

Note: If waste pickle liquor sludge derived from the lime stabilization treatment of spent pickle liquor from the iron and steel industry falling under SIC codes 331 and 332 does not display one or more of the characteristics of hazardous waste identified in s. NR 605.08, it is not a hazardous waste.

6. It is a mixture of nonhazardous solid waste and a hazardous waste that is listed in s. NR 605.09 solely because it exhibits one or more of the characteristics of hazardous waste identified in s. NR 605.08, unless the resultant mixture no longer exhibits any characteristic of hazardous waste identified in s. NR 605.08.

Note: The process of mixing a nonhazardous solid waste and a hazardous waste may require a license under ch. NR 680 for hazardous waste treatment.

(2) A solid waste which is not excluded from regulation under s. NR 605.05 (1) becomes a hazardous waste when any of the following events occur:

(a) In the case of a waste listed in s. NR 605.09, when the waste first meets the listing description in s. NR 605.09.

(b) In the case of a mixture of solid waste and one or more listed hazardous wastes, when a hazardous waste listed in s. NR 605.09 is first added to the solid waste.

(c) In the case of any other solid waste, including a solid waste mixture, when the waste exhibits any of the characteristics identified in s. NR 605.08.

(3) A hazardous waste shall remain a hazardous waste unless and until it:

(a) No longer exhibits any of the characteristics of a hazardous waste identified in s. NR 605.08, or

(b) In the case of a waste which is listed under s. NR 605.09, contains a waste listed under s. NR 605.09, or is derived from a waste listed under s. NR 605.09, the waste is excluded under s. NR 605.10.

(c) Is no longer a solid waste.

NR 605.05 Exemptions. (1) Exemptions. (a) The following materials are excluded from regulation as hazardous wastes:

1. Household waste, including all of the following:

a. Waste that has been collected, transported, stored, treated disposed, recovered or reused, except if the hazardous waste in this stream is separated and accumulated for later treatment, storage or disposal by a person other than a member of the household where the waste is generated.

b. Waste accumulated by a municipality for 5 days or less in a clean sweep program as defined in s. NR 187.03(1). This exclusion for clean sweep programs does not apply to the household waste upon its removal from the accumulation area for further management.

Note: The accumulation, treatment, storage and disposal of household wastes which are not excluded under this paragraph are subject to regulation under chs. NR 600 to 685.

2. Waste that is treated, stored, disposed or otherwise managed by a resource recovery facility managing municipal solid waste, if such facility:

a. Receives and burns only:

1) Household waste, and

2) Solid waste from commercial or industrial sources that does not contain hazardous waste; and

b. Does not accept hazardous waste and the owner or operator of the facility has established contractual requirements or other appropriate notification or inspection procedures to assure that hazardous waste is not received at or burned in the facility:

3. Cement kiln dust waste.

4. Solid wastes generated by any of the following and which are returned to the soils as fertilizers:

a. The growing and harvesting of agricultural crops.

b. The raising of animals, including animal manures.

5. Discarded wood or wood products which fail the test for the characteristic of EP toxicity given in s. NR 605.08 (5) and are not a hazardous waste for any other reason, if the waste is generated by persons who utilize arsenical-treated wood and wood products for the intended end use of these materials.

6. Polychlorinated biphenyls (PCBs) regulated under ch. NR 157.

7. Fly ash waste, bottom ash waste, slag waste and flue gas emission control waste generated primarily from the combustion of coal or other fossil fuels.

8. Drilling fluids, produced waters, and other wastes associated with the exploration, development or production of crude oil, natural gas or geothermal energy.

9. Wastes which fail the test for the characteristic of EP toxicity because chromium is present or are listed in s. NR 605.09 due to the presence of chromium, which do not fail the test for the characteristic of EP toxicity for any other constituent or are not listed due to the presence of any other constituent, and which do not fail the test for any other characteristic, if it is shown by a waste generator or waste generators that:

a. The chromium in the waste is exclusively, or nearly exclusively, trivalent chromium; and

b. The waste is generated from an industrial process which used trivalent chromium exclusively, or nearly exclusively, and the process does not generate hexavalent chromium; and

c. The waste is typically and frequently managed in non-oxidizing environments.

10. Specific wastes which meet the standard in subd. 8., as long as they do not fail the test for the characteristic of EP toxicity, and do not fail the test for any other characteristic are:

a. Chrome (blue) trimmings generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; through-the-blue; and shearling:

b. Chrome (blue) shavings generated by the following subcategories of the leather tanning and finishing industry; hair pulp/chrome tan/retan/ wet finish; retan/wet finish; no beamhouse; through-the-blue; and shearling.

c. Buffing dust generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; and through-the-blue.

d. Sewer screenings generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; through-the-blue; and shearling.

e. Wastewater treatment sludges generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; through-the-blue; and shearling.

f. Wastewater treatment sludges generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; and through-the-blue.

g. Waste scrap leather from the leather tanning industry, the shoe manufacturing industry and other leather product manufacturing industries.

h. Wastewater treatment sludges from the production of titanium dioxide pigment using chromium-bearing ores by the chloride process.

11. Mining overburden returned to the mine site.

12. Solid waste from the extraction, beneficiation and processing of ores and minerals, including coal, phosphate rock and the overburden from the mining of uranium ore.

14. By-products exhibiting a characteristic of hazardous waste that are reclaimed and complies with pars. (c) and (d).

Note: This exclusion does not apply to listed by products included in s. NR 605.09.

15. Domestic sewage.

16. Any mixture of domestic sewage and other wastes that passes through a sewer system to a publiclyowned treatment works for treatment. "Domestic sewage" means untreated sanitary wastes that pass through a sewer system.

(b) The following hazardous wastes are not subject to the requirements of chs. NR 610 to 685 when they are recycled and if the generator complies with pars. (c) and (d):

1. Scrap metal that is legitimately recovered or reclaimed.

2. Industrial ethyl alcohol that is legitimately recovered or reclaimed, except that:

a. A person initiating a shipment for legitimate recovery or reclamation in a foreign country, and any intermediary arranging for the shipment, shall comply with the requirements applicable to a primary exporter in ss. NR 615.12(1) (a), (j) 1. to 4., 6. and 7., and (k) to (n), export the materials only upon consent of the receiving country and conforming with the EPA acknowledgment of consent, and provide a copy of the EPA acknowledgment of consent for the shipment to the transporter transporting the shipment for export;

b. Transporters transporting a shipment for export may not accept a shipment if the transporter knows the shipment does not conform to the EPA acknowledgment of consent, shall ensure that a copy of the EPA acknowledgment of consent accompanies the shipment and shall ensure that it is delivered to the facility designated by the person initiating the shipment:

(c) Generators of wastes that are excluded under pars. (a) 12. and (b) shall demonstrate, at the department's request, compliance with the terms of the exclusions by providing the following information:

1. The name, location and address of the recycling facility;

2. A description of the waste, hazardous waste number and waste quantity;

3. A detailed description of the recycling process and how the waste is used as an ingredient in the process;

4. A demonstration that there is a market or disposition of the waste; and

Note: An example of a demonstration of a market or disposition would be a contract showing the recycling facility uses the recyclable waste material as an ingredient in a production process.

5. Documentation that the recycling facility has the necessary equipment to conduct the recycling activity.

(d) The exclusions included in pars. (a) 12. and (b) do not apply to wastes that are used in a manner constituting disposal or speculatively accumulated. Wastes that are used in a manner constituting disposal or speculatively accumulated are hazardous waste and shall be managed in accordance with all the requirements of chs. NR 600 to 685.

(2) Generation of waste in product or raw material units. A hazardous waste which is generated in a product or raw material storage tank, a product or raw material vehicle, railroad freight car, vessel, a product or raw material pipeline, or in a manufacturing process unit or an associated non-waste-treatment manufacturing unit, is not subject to regulation under chs. NR 600 to 685 until it exits the unit in which it was generated, unless the unit is a surface impoundment or unless the hazardous waste remains in the unit more than 90 days after the unit ceases to be operated for manufacturing, or for storage or transportation of product or raw materials. In accordance with s. NR 615.05 (4) (a) 4., the date upon which each period of accumulation begins after the unit ceases to be operated for manufacturing, or for storage or transportation of product or raw materials, shall be clearly marked and visible for inspection on each unit.

(3) Samples. (a) Except as provided in par. (b), a sample of solid waste or a sample of water, soil or air which is collected for the sole purpose of testing to determine its characteristics or composition is not subject to regulation under chs. NR 600 to 685 when the sample is being:

1. Transported to a laboratory for the purpose of testing;

2. Transported back to the sample collector after testing;

3. Stored by the sample collector before transport to a laboratory for testing;

4. Stored in a laboratory before testing;

5. Stored in a laboratory after testing but before it is returned to the sample collector; or

6. Stored temporarily in the laboratory after testing for a specific purpose.

Note: An example of a specific purpose would be storage until conclusion of a court case or enforcement action where further testing of the sample may be necessary.

(b) In order to qualify for the exemption in par. (a)1. and 2., a sample collector shipping samples to a laboratory and a laboratory returning samples to a sample collector shall:

1. Comply with DOT, U.S. postal service (USPS) or any other applicable shipping requirements; or

2. Comply with the following requirements, if the sample collector determines that DOT, USPS or other shipping requirements do not apply to the shipment of the sample:

a. Assure that the following information accompanies the sample: the sample collector's name, mailing address and telephone number; the laboratory name, address and telephone number; the quantity of the sample; the date of shipment; and a description of the sample; and

b. Package the sample so that it does not leak, spill or vaporize from its packaging.

(c) This exemption does not apply if the laboratory determines that the waste is hazardous but the laboratory no longer meets any of the conditions stated in par. (a).

(4) Treatability studies samples. (a) Except as provided in par. (b), persons who generate or collect samples for the purpose of conducting treatability studies are not subject to any requirement of chs. NR 610 to 699 when:

1. The sample is being collected and prepared for transportation by the generator or sample collector;

2. The sample is being accumulated or stored by the generator or sample collector prior to transportation to a laboratory or testing facility;

3. The sample is being transported to the laboratory or testing facility for the purpose of conducting a treatability study; or

4. The sample shipment is accompanied by a manifest, according to the requirements of s. NR 615.08.

(b) The exemption in par. (a) is applicable to samples of hazardous waste being collected and shipped for the purpose of conducting treatability studies if:

1. The generator or sample collector uses in treatability studies no more than 1000 kg of any non-acute hazardous waste, 1 kg of acute hazardous waste, or 250 kg of soils, water or debris contaminated with acute hazardous waste for each process being evaluated for each generated waste stream;

2. The mass of each sample shipment does not exceed 1000 kg of non-acute hazardous waste, 1 kg of acute hazardous waste or 250 kg of soils, water or debris contaminated with acute hazardous waste;

3. The sample is packaged so that it does not leak, spill or vaporize from the package during shipment and meet the following requirements:

a. The transportation of each sample shipment complies with ch. NR 620, U.S. Department of Transportation (DOT), U.S. Postal Service (USPS) and any other applicable shipping requirement;

b. If the DOT, USPS or other shipping requirements do not apply to the shipment of the sample, the following information must accompany the sample;

1) The name, mailing address and telephone number of the originator of the sample;

2) The name, address and telephone number of the facility that will perform the treatability study;

3) The quantity of the sample;

4) The date of shipment; and

5) A descriptions of the sample, including its EPA hazardous waste number.

4. The sample is shipped to a laboratory or testing facility which:

a. Is exempt under s. NR 605.05(5);

b. Has an operating license, interim license, variance or waiver from the department;

c. Is shipped to an out-of-state laboratory or facility that has an applicable exemption, operating license, interim license, variance or waiver which has been granted by EPA or an authorized state; and

5. The generator or sample collector maintains the following records for a period ending 3 years after completion of the treatability study:

a. Copies of the manifest and any other required shipping documents;

b. A copy of the contract with the facility conducting the treatability study; and

c. Documentation showing:

1) The amount of waste shipped under this exemption;

2) The name, address and EPA identification number of the laboratory or testing facility that received the waste;

3) The date that the shipment was made; and

4) Whether or not unused samples and residues were returned to the generator.

6. The generator reports the information required under subd. 5.c. in its annual report.

(c) 1. The department may grant requests, on a case-by-case basis, for quantity limits in excess of those specified in par. (b) 1., for up to an additional 500 kg of non-acute hazardous waste, 1 kg of acute hazardous waste and 250 kg of soils, water and debris contaminated with acute hazardous waste, to conduct further treatability study evaluation when:

a. There has been an equipment or mechanical failure during the conduct of a treatability study;

b. There is a need to verify the results of a previously conducted treatability study;

c. There is a need to study and analyze alternative techniques within a previously evaluated treatment process; or

d. There is a need to do further evaluation of an ongoing treatability study to determine final specifications for treatment.

2. The additional quantities allowed are subject to all the provisions in sub. (4)(a) and (b)2. to 6.

3. The generator or sample collector shall apply to the department and provide the following information:

a. The reason why the generator or sample collector requires an additional quantity of sample for the treatability study evaluation and the amount needed;

b. Documentation accounting for all samples of hazardous waste from the waste stream which have been sent for or undergone treatability studies including;

1) The date each previous sample from the waste stream was shipped;

2) The quantity of each previous shipment;

3) The laboratory or testing facility to which it was shipped;

4) What treatability study processes were conducted on each sample shipped, and

5) A summary of the results of each treatability study.

c. A description of the technical modifications or change in specification that shall be evaluated and the expected results;

d. If further study is being required due to equipment or mechanical failure, information concerning the reason for the failure or breakdown and what procedures or equipment improvements have been made to protect against further breakdowns; and

e. Other information that the department considers necessary.

(5) Samples undergoing treatability studies at laboratories and testing facilities. Samples undergoing treatability studies and the laboratory or testing facility conducting treatability studies, to the extent the facilities are not otherwise subject to the requirements of chs. NR 600 to NR 685, are not subject to any requirement of chs. NR 600 to NR 685 if the conditions of pars. (a) to (k) are met. A mobile treatment unit may qualify as a testing facility subject to pars. (a) to (k). Where a group of mobile treatment units are located at the same site, the limitations specified in pars. (a) to (k) apply to the entire group of mobile treatment units collectively as if the group were one mobile treatment unit.

(a) No less than 45 days before conducting treatability studies, the facility shall notify the department, in writing, that it intends to conduct treatability studies under this subsection.

(b) The laboratory or testing facility conducting the treatability study shall have an EPA identification number.

(c) No more than a total of 250 kg of "as received" hazardous waste is subject to initiation of treatment in all treatability studies in any single day. "As received" waste refers to the waste as received in the shipment from the generator or sample collector.

(d) The quantity of "as received" hazardous waste stored at the facility for the purpose of evaluation in treatability studies does not exceed 1000 kg, the total of which may include 500 kg of soils, water or debris contaminated with acute hazardous waste or 1 kg of acute hazardous waste. This quantity limitation does not include:

1. Treatability study residues; and

2. Treatment materials, including nonhazardous solid waste, added to "as received" hazardous waste.

(e) No more than 90 days have elapsed since the treatability study for the sample was completed, or no more than one year has elapsed since the generator or sample collector shipped the sample to the laboratory or testing facility, whichever date first occurs.

(f) The treatability study does not involve the placement of hazardous waste on the land or open burning of hazardous waste.

(g) The facility maintains records for 3 years following completion of each study that show compliance with the treatment rate limits and the storage time and quantity limits. The following specific information shall be included for each treatability study conducted:

1. The name, address and EPA identification number of the generator or sample collector of each waste sample;

2. The date the shipment was received;

3. The quantity of waste accepted;

4. The quantity of "as received" waste in storage each day;

5. The date the treatment study was initiated and the amount of "as received" waste introduced to treatment each day;

6. The date the treatability study was conducted;

7. The date any unused sample or residues generated from the treatability study were returned to the generator or sample collector or, if sent to a designated facility, the name of the facility and the EPA identification number.

(h) The facility keeps, on-site, a copy of the treatability study contract and shipping papers associated with the transport of treatability study samples to and from the facility for a period ending 3 years from the completion date for each treatability study.

(i) The facility prepares and submits a report to the department by March 15 of each year that estimates the number of studies and amount of waste expected to be used in treatability studies during the current year and includes the following information for the previous calendar year:

1. The name, address and EPA identification number of the facility conducting the treatability studies;

2. The types, by process, of treatability studies conducted;

3. The names and addresses of persons for whom studies have been conducted, including their EPA identification numbers;

4. The total quantity of waste in storage each day;

5. The quantity and types of waste subjected to treatability studies;

6. When each treatability study was conducted;

7. The final disposition of residues and unused sample from each treatability study.

(j) The facility determines whether any unused sample or residues generated by the treatability study are hazardous waste under s. NR 605.07 and, if so, are subject to chs. NR 600 to NR 685, unless the residues and unused samples are returned to the sample originator under the s. NR 605.05(4) exemption.

(k) The facility notifies the department, by letter, when the facility is no longer planning to conduct any treatability studies at the site.

NR 605.06 Residues of hazardous waste in empty containers. (1) Any hazardous waste that is remaining in either an empty container or an inner liner removed from an empty container, that meet the criteria in sub. (3), (4) or (5), is not subject to regulation under chs. NR 600 to 685.

(2) Any hazardous waste in either a container that is not empty or an inner liner removed from a container that is not empty, as specified in sub. (3) to (5), is subject to regulation under chs. NR 600 to 685.

(3) A container or an inner liner removed from a container that has held any hazardous waste, except a waste that is a compressed gas or that is listed as an acute hazardous waste in s. NR 605.09 (2) (a), table II or (b), table III, or identified in table IV s. NR 605.09 (3) (b), is empty if all wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container; and

Note: Examples of commonly employed practices would be pouring, pumping and aspirating.

(a) No more than 2.5 centimeters (one inch) of residue remains on the bottom of the container or inner liner, or

(b) No more than 3% by weight of the total capacity of the container remains in the container or inner liner if the container is less than or equal to 110 gallons in size, or

(c) No more than 0.3% by weight of the total capacity of the container remains in the container or inner liner if the container is greater than 110 gallons in size.

(4) A container that has held a hazardous waste that is a compressed gas is empty when the pressure in the container approaches atmospheric pressure.

(5) A container or an inner liner removed from a container that has held an acute hazardous waste listed in s. NR

TABLE 5
Batch Slurry Study Sampling and Analysis Schedule

Treatment No. 1-6	Analysis									Volume Removed	Frequency
	PAH	BTX	TOC	N&P	DO	pH	TS	VS	Micro		
Aqueous	100 mL	50 mL	10 mL	20 mL	1 mL*	--				370 mL	3/Treatment
Slurry							20 mL	--	10 mL	30 mL	3/Treatment
Solids	20 g	10 g									3/Treatment
Total										400 mL	

PAH - Polycyclic aromatic hydrocarbons
BTX - Benzene-toluene-xylene
TOC - Total organic carbon
N&P - Ammoniacal nitrogen and ortho-phosphate
DO - Dissolved oxygen

TS - Total solids
mL - milliliter
g - grams
VS - Volatile solids
Micro - Microbial enumerations

* - Dissolved oxygen concentrations will be determined daily during the first two weeks of the investigation and weekly thereafter.

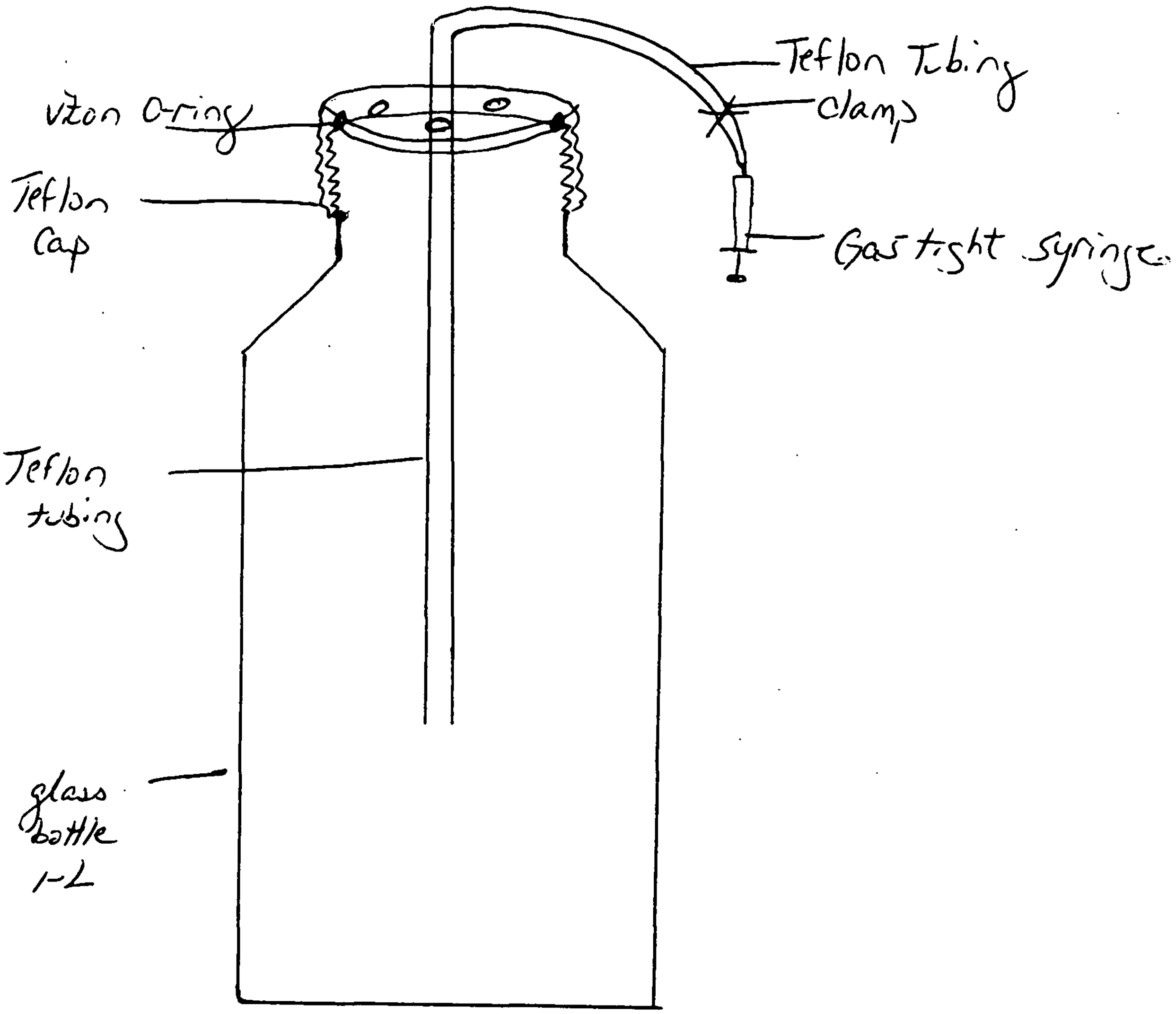
TABLE 10
Analytical Methods

Analyses	Method
TOC (Aqueous Phase)	BAC SOP
TOC (Soils)	Standard Method 5310 B
PAH	Modified EPA Method 8310
BTX	Modified EPA Method 8020
Ammoniacal Nitrogen	Standard Method 4500-NH_3 F
Ortho-Phosphate	Standard Method 4500-P E
TS/VS	Standard Method 2540 G
Plate Counts	BAC SOP
Air Sampling	EPA Method 18/NIOSH Method 5506
pH	~~Standard Method 4500 H^+-E~~ BAC SOP
Oxygen	Modified, galvanic cell
Particle Size	ASTM D422

INTERNATIONAL TECHNOLOGY CORPORATION

By SB Date 8/24/92 Subject Batch Study Vessels Sheet No. 1 of 1

Chkd. By ___ Date ___ Proj. No. 408491.001



4.0 Experimental Design and Procedures

The test material employed in the batch and bioslurry reactor studies will be collected from the Moss-American site. Two samples will be collected, with one composite soil sample containing carcinogenic polycyclic aromatic hydrocarbons (CPAH) in the range of 300 to 600 milligrams per kilogram (mg/kg) and one sample containing CPAH in the range of 1,000 to 1,500 mg/kg. Initial characterization of the samples will be conducted immediately following sample collection. Test parameters will include bulk density, particle size distribution, porosity, moisture, liquid/plastic limits, pH, total organic carbon (TOC), and total heterotrophs and ~~polycyclic aromatic hydrocarbons (PAH)~~ anthracene-degrading microbial populations.

4.1 Sample Procurement

The two composite soil samples will be shipped to IT Corporation's (IT) Biotechnology Applications Center (BAC) via a licensed ~~certified~~, commercial carrier. Approximately 75 pounds (lb) of each soil sample will be collected for the execution of the treatability testing; total soil mass required is approximately 150 lb. Appropriate shipping documentation presented in Appendix A will accompany all samples sent to the BAC. All samples will be shipped to the following address:

IT Corporation
Biotechnology Applications Center
9041 Executive Park Drive, Suite 309
Knoxville, Tennessee 37923
Attention: Kandi Brown

Following the receipt of the soil, the containers will be visually inspected and sample volumes recorded. All samples received at the BAC are automatically logged into a sample tracking system and given independent sample identification numbers. All treatability study samples will be refrigerated at 4°C. The operating temperature of the refrigeration unit is maintained at 4°C, with this temperature being verified biweekly.

Once receipt of the samples has been properly documented, a representative composite of the two samples will be prepared. Equal volumes (by weight) of both soil samples will be composited in ventilated hoods and thoroughly mixed. Mixing will be accomplished manually. Following composition, 500 grams (g) of the composite will be submitted to the analytical laboratory for analysis. Analysis will include bulk density, particle size distribution, porosity, moisture, liquid/plastic limits, pH, TOC, and total heterotrophs and ~~polycyclic aromatic hydrocarbons (PAH)~~ anthracene-degrading microbial populations. All volumes of soil removed from the composited fraction will be logged on Sample Collection Logs (Appendix B). The remaining volume of composited soil will stored at 4°C.

4.2 Batch Slurry Testing

The batch slurry study will be performed for 6 weeks. The six treatments described in Table 3 will be evaluated during the batch study. As stated in Chapter 3.0, the objective of this study is to determine the impact of solids loading on operation, provide supporting data for bioslurry reactor operation, and establish preliminary substrate utilization rates.

Treatments 1 and 2 are nutrient- and oxygen-amended treatments containing 20 percent contaminated solids. Treatments 3 and 4 are also nutrient- and oxygen-amended treatments evaluating a 30 percent solids loading. Treatments 5 and 6 will serve as the biologically inhibited controls for the study; analysis of these treatments will be used to determine abiotic losses of target compounds from the treatments. Biologically inhibited controls will be established through the addition of 250 to 500 milligrams per liter (mg/L) of mercuric chloride. Treatments 1 and 2, 3 and 4, and 5 and 6 are duplicates. All treatments will be covered with aluminum foil to protect from light exposure.

The batch study will be conducted in sterile, glass, sealed, 1-liter (L) bottles. The sample collection port on the containers consists of Teflon™ tubing inserted through a Teflon™ ~~stopper~~ cap positioned in the neck of the bottle. Sample collection port connections will be sealed using Viton O-rings and leak tested before the initiation of the study. Samples will be withdrawn through the Teflon™ tubing using a gas-tight syringe. Hydrocarbon-free air will be introduced into the treatments following sample collection in order to prevent the creation of a vacuum.

Soils will be submitted to Eimco Process Equipment Company (Eimco) for initial testing to determine the appropriate slurry density and particle size required for bioslurry treatment. The Eimco Standard Operating Procedure (SOP) for the determination of slurry density is provided in Appendix C. Following the determination of the optimum slurry density and particle size, site soils will be prepared for treatment. Soils will be slurried and screened to the recommended particle size prior to batch or bioslurry testing.

The effect of screening activities on the PAH concentration will be evaluated through the comparison of PAH concentrations determined prior to sample shipment and the batch study t, analysis of PAH concentrations. The PAH analytical testing prior and following sieving will employ the same analytical method for uniformity.

Composited soils~~, screened to a representative particle size of less than 1 millimeter (mm) in diameter,~~ will be placed in the bottles at solids densities of 20 and 30 weight percent. To achieve accurate solids loading, three 280-g and three 420-g aliquots of soil (dry weight) will be weighed and placed into six, 2-L glass containers. Sterile distilled/deionized water will then be used to fluidize the samples and bring the final volume to 1.4 L. Approximately 400 mL of this volume will be submitted for initial analysis. The remaining portion will be placed in 1-L vessels and initially maintained with zero headspace. Each vessel will contain a sterile stir bar to aid in mixing during sample collection.

The treatment containers will be placed on a magnetic stir plate and vigorously mixed during the collection of Week-3 and Week-6 samples. Initial determination of the slurry pH and macronutrient, i.e., ammoniacal nitrogen and ortho-phosphate, concentrations will be completed. The slurry pH will be adjusted to 7.0 using either 1 Normal (N) hydrochloric acid or 1 N sodium hydroxide.

The treatment macronutrient and dissolved oxygen concentrations will be maintained at the operating conditions presented in Table 4. Macronutrient concentrations will be controlled through the addition of ammonium chloride and potassium phosphate to each treatment during the charging of the treatment vessels. These compounds will be added based on the initial characterization of the treatability test composite. The target carbon:nitrogen:phosphorous (C:N:P) ratio is 100:10:1. At these levels, nutrient concentrations are not expected to limit biological activity during the 6-week investigation. If nutrient addition is required, macronutrients will be added in dry form directly to the treatments through the sample collection port.

Dissolved oxygen concentrations will be maintained at the target concentration of 3 mg/L. This target was set to approximate values that could be practically achieved in a full-scale bioslurry reactor system. Dissolved oxygen measurements will be made weekly during the course of the investigation using a modified, galvanic-cell, oxygen probe (Graves, et al., 1992). Approximately 1 milliliter (mL) of sample will be collected from each treatment and submitted for this analysis. The dissolved oxygen concentration in the treatment vessel will be maintained between 1 and 3 mg/L. This concentration will be confirmed through daily analysis during the first two weeks of the study. The monitoring of dissolved oxygen concentration will be modified to weekly, following the first two weeks of the batch testing.

Dissolved oxygen concentrations will be maintained in the treatments through the addition of hydrogen peroxide and continual mixing on a modified-tube rotator. A hydrogen peroxide concentration of 1,000 mg/L will not be exceeded to avoid the potential of microbial toxicity. Hydrogen peroxide is used during this study as a consequence of the equipment configuration and will not be used in the bioslurry reactor study or for full-scale treatment.

A tube rotator modified to accommodate 1-L bottles was chosen over conventional sparging and agitation systems due to improved suspension of the treatment solids, conservation of volatile fractions, and more consistent suspended solids concentrations due to reduced solids adsorption at the liquid/air interface. Following preparation, the treatments will be placed on the modified-tube rotator, rotated at 200 revolutions per minute (rpm), and maintained at room temperature throughout the course of the study. The room temperature will be routinely measured with a mercury thermometer, wall-mounted near the modified-tube rotator. The temperature will be recorded weekly in a laboratory notebook dedicated solely to the investigation.

The sampling schedule for the batch slurry study is presented in Table 5. Approximately 400 mL of slurry will be collected during each of the three sampling periods. Approximately 30 mL of the well-mixed slurry will be submitted for analysis. The remaining 370 mL of the sample volume will be separated under quiescent conditions and analyzed for contaminants in the aqueous and solid phases. Aqueous and solids phases will be gravimetrically separated with the aqueous phase separated by decanting.

The analytical parameters monitored at study initiation, Week 3, and Week 6 in the aqueous phase of each treatment are PAH, benzene, toluene, xylenes (BTX), macronutrients, pH, oxygen, and TOC. The slurry phase will be monitored for total solids (TS) and VS concentrations and microbial density of heterotrophic bacteria and anthracene degraders. The soil fraction of each treatment will be monitored for PAH and BTX concentrations.

The preliminary substrate utilization rates determined during the batch slurry investigation will be used to confirm the selection of retention time set points proposed for the bioslurry reactor study. In addition, performance data generated during this investigation will be evaluated to determine the appropriate solids loading for the bioslurry reactor.

4.3 Bioslurry Reactor Study

Due to the similarity of activated sludge and bioslurry reactor systems, conventional acronyms such as waste activated sludge (WAS) and return activated sludge (RAS) will be used to describe the slurry recycle system in the laboratory-scale bioslurry reactor.

4.3.1 Process Description

A 60-L, stainless steel, Eimco Biolift™ slurry reactor will be employed during this 3-month study and will operate in continuous flow mode. The process flow diagram (PFD) for the reactor system is presented in Figure 1. Figure 2 illustrates the internal design of the reactor. The influent waste stream will be continuously stirred and fluidized in a closed container before introduction in the reaction vessel. Feed will be introduced to the reaction vessel (Bioreactor T-6) at an average daily flow rate of 2 liters per day (L/day).

At this daily flow rate, the bioslurry reactor hydraulic retention time (HRT) will be maintained at 30 days. Following aeration, the treated slurry will be pumped to the system clarifier. The clarifier will be covered to reduce the emission of volatile compounds. The treated slurry will be maintained under quiescent conditions during clarification to allow for gravitational settling. Effluent will be removed from the clarifier to the effluent container.

During the steady-state operation of a completely mixed, continuous-flow reactor, the contaminant concentration in the effluent is equal to the concentration in the reactor (Benefield and Randall, 1980). Therefore, solids collected from the bioslurry reactor are considered to represent the final remediated product. Clarified water in the effluent container will be manually recycled to mix with the influent feed. Recycling of the process effluent will be conducted to more accurately simulate full-scale operations. A portion of the settled solids in the clarifier will then be returned to the aeration vessel to manipulate and control the biological solids retention time (BSRT), with the remaining portion removed from the system as WAS.

Before charging the reactor, the creosote-impacted soil composite (nonfluidized) will be screened to a representative particle size of less than 1.0 mm in diameter. The purpose of soil screening is to minimize mechanical problems in the laboratory reactor. The influent slurry will be prepared in 20-L portions and placed in a closed container. The slurry will be continuously stirred to reduce the separation of solids. The percent solids concentration of the feed will be determined based on Week-3 data from the batch slurry study and the maximum carbon loading attainable in a bioslurry system.

Pumping of system materials will be accomplished through the use of Randolph™ pumps that efficiently handle solid and semi-solid materials. Pump flow rates will be checked and calibrated daily. The SOP for bioreactor flow calibration is provided in Appendix C. For streams that require low flow rates, i.e., RAS stream, pumping operations will be controlled via a timer allowing for higher flow rates over reduced periods of time.

Reactor operating conditions will be maintained at room temperature, 3 mg/L dissolved oxygen, and pH 7. Dissolved oxygen will be supplied to the unit via the sparging of breathing quality air, and system pH will be maintained through manual additions of 1 N hydrochloric acid or 1 N sodium hydroxide to the reaction vessel.

The system BSRT set point is 40 days. Operation at this set point will determine compliance with effluent standards during optimum operation. The operating set point will be maintained for a period equal to 3 times the BSRT value to ensure collection of data generated during steady-state operation. If the results generated during operation at the 40-day BSRT set point are favorable, continued operation at a 5-day set point to bracket the bioslurry reactor performance range may be conducted.

The BSRT set point will be maintained through a mass balance of the system solids. Following the determination of TS and VS concentrations in the RAS, mixed liquor in the reactor, and effluent, the volume of WAS will be calculated based on Equation 2 of Section 4.4.2. It is assumed that the solids concentration in the WAS is equal to the concentration of the RAS stream. If TS and VS measurements are not available for each sample point, the previous measurement will be employed in the calculation of waste solids. For the purpose of mass balance, the sample volume removed from the reactor is also considered as WAS. The system biomass recycle rate will be initially set at approximately 10 percent of the influent feed rate, e.g., 0.2 L/day. This ratio has been demonstrated effective for bioslurry reactor applications (Marks, et al., 1991).

All operational set points are listed below:

• Feed flow	2 L/day
• HRT	30 days

• Temperature	Room temperature
• Dissolved oxygen	3 mg/L
• pH	7 - 8
• Agitation	500 rpm
• BSRT	≥30 days
• Reactor volume	60 L
• Return activated sludge	0.2 L/day.

Volatilization of influent constituents will be quantified in the reactor system. The influent waste container and clarifier are covered to minimize the loss of contaminants to the atmosphere and reduce employee exposure to the waste. Volatilization that will occur during waste aeration and mixing will be controlled through carbon adsorption (see Figure 1). Bioslurry reactor headspace sampling will be conducted and quantified to assist in the calculation of the system's materials balance.

Following the completion of the bioslurry reactor study, the influent feed container, bioslurry reactor, clarifier, system tubing (Viton), and the effluent container will be solvent extracted and analyzed for CPAH. Extraction will be completed to determine the quantity of contaminants that were adsorbed in the system, rather than biodegraded.

4.3.2 Analytical Schedule

The operating conditions for temperature, dissolved oxygen, and pH will be monitored daily. All reactor sampling points illustrated on the PFD will be identified and color-coded. For clarification of the following text, sample identifiers are defined in Table 6 and labeled in Figure 1. All mixed liquor reactor samples will be collected from the second sampling port located on the side of the bioslurry reactor (S2).

The sampling schedule for the bioslurry reactor study is presented in Table 7. The influent waste stream (S1) will be characterized for PAH concentrations in the aqueous and solids phase twice per week. The slurry will be analyzed for TS and VS concentrations twice per week.

The reactor slurry will be collected from Sample Port S2. The reactor slurry particle size will be monitored once a week to determine its impact on the release of soil-bound contaminants. The monitoring of particle size is important due to the effect of stirred-tank reactors internal hydrodynamics that influence both the particle size and the liquid-phase mass transfer coefficient. In general, large particles result in diffusional limitations on the ingress of substrate, thereby, effecting the overall specific rate of reaction (Atkinson and Mavituna, 1983).

The reactor slurry phase will also be monitored twice weekly for TS and VS concentrations. Microbial enumerations of total heterotrophs and anthracene degraders will be conducted once per week. The analysis will be conducted on slurry grab samples collected from Sample Port S2. Analytical methods describing the techniques used to determine microbial populations are provided in Chapter 6.0.

The reactor aqueous-phase macronutrient concentrations will be monitored once per week. The macronutrient concentrations will be controlled based on maintaining a C:N:P ratio of 100:10:1. Macronutrients will be directly added in batch to the influent feed.

Aqueous- and solid-phase PAH and TOC concentrations in the reaction vessel will be monitored twice weekly (S2). The BTX concentration of the aqueous and solids phase will be determined once per week. The PAH content of the aqueous and solids phase will be measured in the RAS stream once per week.

In order to accurately determine the system BSRT, TS and VS concentrations of the RAS will be determined twice weekly in the slurry phase collected through Sample Port S3. Due to expected variance in the VS measurement, TS concentrations will be used to calculate the BSRT value. In addition, the TS and VS concentrations in the clarified effluent will also be monitored twice weekly (S4).

Volatilization of contaminants must be monitored to complete the mass balance of carbon in the system. Air monitoring for volatiles and semivolatiles will be conducted weekly.

Headspace constituents will be determined through the analysis of air sampled through Z-2. Analysis of headspace samples is thoroughly discussed in Chapter 6.0. Analysis of carbon adsorption materials will not be performed.

Complete mixing of the reactor solids will be verified periodically during the 40-day BSRT set point. Verification will be accomplished through the analysis of sample TS concentrations. Samples will be extracted from the three sample ports located on the side of the bioslurry reactor. The three ports represent three potentially distinct zones of the slurry. The bottom sample port will provide sample material from within the rake-mixing zone. The middle port will provide sample material from within the most well-mixed zone. Finally, the top sample port will provide sample material of any oil phase that may be present. Analysis of the samples for TS concentration will then determine the mixing efficiency of the reactor system. If mixing is found to be extremely nonuniform, the agitation speed or airlift system will be altered and complete mixing will be rechecked.

Sample logs will be maintained in a bound laboratory notebook, that is solely dedicated to this project. The logs will document volumes removed or added so the system HRT can be accurately calculated.

Performance data, i.e., effluent solids quality, generated during the completion of the bioslurry investigation will be used to determine compliance with the mandated CPAH target concentrations. The performance data will also be used to establish HRT and BSRT set points for operation and, thereby, establish the pilot-scale design. In addition, the need for physical/chemical pretreatment will be evaluated based on adherence to cleanup criteria.

4.4 Biokinetic Calculations

Operation of laboratory scale reactors in this treatability study will rely upon the total solids levels in the test reactors as the control parameter.

4.4.1 Batch Slurry Study

Equations 1 through 3 were derived from equations presented by Benefield and Randall, 1980. The preliminary specific substrate utilization rates (q) based on TOC and CPAH utilization per unit biomass will be determined in the batch study using the following equation:

$$q = \frac{(S_i - S_f)/\Delta t}{X} \qquad \text{(Equation 1)}$$

Where:

q = specific substrate utilization rate (hr^{-1})
S_i = Initial substrate concentration (mg/L)
S_f = Final substrate concentration (mg/L)
Δt = Time elapsed (hours)
X = TS concentration in slurry (mg/L).

4.4.2 Bioslurry Reactor Study

The BSRT (day) of the laboratory-scale system will be approximated through mass balance of the system solids:

$$BSRT = \frac{XV}{Q_w X_r + (Q - Q_w) X_e} \qquad \text{(Equation 2)}$$

Where:

X = TS concentration in the aeration vessel (mg/L)
V = Volume of the aeration vessel (L)
Q_w = WAS flow rate (L/day)
X_r = TS concentration in RAS (mg/L)
Q = Influent flow rate (L/day)
X_e = TS concentration in system effluent (mg/L).

The HRT of a bioreactor is mathematically determined by dividing the volume of the reactor by the influent flow rate. Under recycle conditions, the BSRT exceeds HRT, consequently control of HRT at 30 days with recycle will result in BSRT values greater than or equal to 30 days.

The RAS recycle ratio will be determined in the laboratory-scale investigation using the following equation:

$$Q_R = \frac{QX - Q_W X_r}{X_r - X} \qquad \text{(Equation 3)}$$

Where:

Q_R = Recycle ratio
Q = Influent feed flow rate (L/day)
X = TS concentration in the aeration basin (mg/L)
Q_W = WAS flow rate (L/day)
X_r = RAS TS concentration (mg/L).

6.0 Sampling and Analysis

All treatability testing will be completed in the Biotechnology Applications Center (BAC) laboratory located in Knoxville, Tennessee. This facility holds a special exemption from the State of Tennessee that permits execution of treatability studies. The BAC laboratory operates in accordance with an approved Chemical Hygiene Plan (CHP). All activities at the BAC conform to the standards set forth in the CHP.

~~All analyses conducted for the target compounds~~ Target compound analyses will use United States Environmental Protection Agency (U.S. EPA)-approved methods, or modifications thereof. Polynuclear aromatic hydrocarbons (PAH) concentrations will be determined using modified U.S. EPA Method 8310. The benzene, toluene, xylene (BTX) concentration will be determined using U.S. EPA Method 8020. Modifications of EPA methods will be made to accommodate the collection of smaller sample volumes during the batch slurry investigation. The methods will also be employed during the bioslurry reactor study for uniformity. Aqueous and solids phases will be separated gravimetrically and submitted for analysis.

U.S. EPA Method 8310 will be modified for sample extraction of the solids phase with methylene chloride. Following extraction, the sample will be analyzed by high performance liquid chromatography (HPLC) equipped with a florescence detector. The aqueous-phase will be directly injected into the HPLC and analyzed by a ultraviolet (UV) detector at 255 nanometers (nm).

The precision and accuracy and detection limits for target compound analyses using the modified-EPA methods will be determined prior to study initiation. A minimum quality control (QC) performance study will be conducted to determine any site-specific interferences which may increase the difficulty of sample analysis. Impacted soils from the Moss

American site will be employed in the QC study.

Table 8 illustrates detection limits achieved during the analysis of standards, soils collected from a coal-coking waste lagoon, and a manufactured gas plant site using this methodology and the equipment listed in Chapter 5.0. Analysis of these compounds was conducted by IT Corporation (IT) at the University of Tennessee Center for Environmental Biotechnology using an HPLC equipped with florescence and photo-diode detectors. Matrix spikes and blanks will be analyzed in at least 10 percent of the samples collected for PAH and BTX analysis. These samples will be analyzed to determine the method recovery efficiency.

Total solids (TS) and volatile solids (VS) measurements will be made in accordance with Standard Method 2540G (Clesceri, et.al., 1989). This method is applicable to determining TS and VS fractions in solid and semisolid samples.

Aqueous-phase ammoniacal nitrogen will be determined using an ion-selective electrode method (Standard Method 4500-NH_3 F). Analysis of ortho-phosphate will be completed using the ascorbic acid Standard Method 4500-P E. A Standard Operating Procedure (SOP) for ortho-phosphate analysis is provided in Appendix C.

Total organic carbon (TOC) measurements in the aqueous phase will be made using a Dohrmann DC-80 TOC Analyzer. The persulfate-ultraviolet oxidation Standard Method 5310 C is used for this determination. A BAC SOP for this measurement is shown in Appendix C. Total carbon (TC) concentrations in the treated and untreated soils will also be determined using the Dohrmann DC-80 TOC Analyzer. The combustion-infrared Standard Method 5310 B will be used for this analysis.

The total heterotrophic microbial enumeration analyses will be performed by the IT BAC in Knoxville, Tennessee and will follow the SOP for plate count techniques. To assess the activity of the PAH-degrading bacteria, activity against anthracene will be determined by spraying selected plates with a 0.5 percent anthracene solution (acetone as the carrier). The carrier evaporates leaving a white anthracene film on the surface of the plate. As bacterial colonies metabolize the anthracene, clear zones are observed around the colonies. Anthracene was chosen because it is a general indicator of activity against PAH. The spray plate method is not useful for higher molecular weight PAH.

The slurry-phase pH will be determined using ~~Standard Method 4500-H$^+$-B~~ BAC SOP No. BAC014 which was derived from U.S. EPA Method 150.1 and Methods of Soil Analysis Part 2, Second Edition, pp 206 - 207. The oxygen concentration in the slurry will be determined using a modified, galvanic-cell, oxygen probe (Graves, et al., 1992). The slurry phase particle size will be determined using ASTM Method D422.

Table 9 presents the precision/accuracy and detection limits expected for each analytical method. The stated detection limits may be altered if analytical interferences are present. These interferences will be identified, precision/accuracy checked, and detection limits confirmed during the minimal QC performance study. Table 9 will updated following the completion of the QC study. Table 10 summarizes all methods used during the treatability studies.

6.1 Air Monitoring

Air sampling will be conducted following guidelines of U.S. EPA Method 18 and National Institute of Occupational Safety and Health (NIOSH) Method 5506 for measurement of PAH. The air sampling train will consist of a Teflon™ probe, a 47-millimeter (mm) Teflon™ membrane filter, and an XAD-2 sorbent sampling tube. The filter and the XAD-2 tube will be connected with a minimal length of Teflon™ tubing (1 to 2 inches). The XAD-2 tube will be a prepared glass tube with XAD-2 resin packed in two portions. The front and back portions will contain 150 and 75 milligrams (mg) of XAD-2, respectively. The glass tube ends will be flame sealed.

Sample volume will be measured using a 2 liters per minute (L/min) Singer dry gas meter. The sample will be collected at a constant rate of 250 cubic centimeters per minute (cm^3/min) for 24 hours. The detection limits for the semivolatile compounds will be determined during the course of the investigation. Analyses will be conducted by gas chromatography/mass spectrometer (GC/MS) in accordance with the procedures of Method 8270 of Test Methods for Evaluating Solids Wastes, Physical/ Chemical Methods, U.S. EPA SW 846.

A U.S. EPA Method TO-14 sampling system will be used to measure the volatile organics. The air sampling system used to collect volatile off-gas samples will consist of a stainless steel Summa™ polished canister, Milaflow pneumatic flow controller (10 cm^3/min), and nickel tubing. Summa™ polished canisters have been used in several ambient studies to collect samples for volatile organic carbon (VOC) analyses. These studies have shown that the canisters are well suited for collecting air samples for VOC analysis and that VOC levels do not deteriorate in the canisters during reasonable holding times.

Canister samples will be analyzed in a Finnigan Model OWA 1050 GC/MS system with a quadruple MS. This system will be equipped with a Tekmar Model 5000 cryogenic concentrator and sample introduction system.

9.0 Health and Safety

9.1 Hazard Analysis

The creosote-impacted soils used in this study contain polycyclic aromatic hydrocarbons (PAH), including benzene and naphthalene. Appendix D contains the Material Safety Data Sheets (MSDS) for these two materials.

Creosote is a yellow to black liquid with a tarry odor. It is a combustible liquid with a flashpoint of approximately 160°F. Exposure to creosote vapors may cause moderate irritation of the nose and throat. Liquid contact may cause severe eye burns, and reddening and itching of skin. Prolonged contact with skin may cause second-degree burns.

The benzene soluble fraction of creosote is carcinogenic, and repeated exposure has been associated with an increased risk of developing cancer of the lungs, skin, bladder, and kidneys. Pregnant women may be especially susceptible to exposure effects associated with creosote volatiles.

The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for creosote, benzene-soluble fraction, is 0.2 milligrams per cubic meter (mg/m^3) of air based on an 8-hour exposure. The major potential routes of exposure to PAH are respiratory via inhalation of vapors and skin absorption via skin contact with the waste or waste-contaminated equipment.

The task involving the greatest potential exposure to PAH is handling and transferring the waste into both the batch and bioslurry reactors. Other tasks involving potential exposure to PAH are sample collection/handling and decontamination of equipment. Engineering controls will be utilized to reduce or eliminate the potential for exposure to vapors. The engineering controls include use of laboratory exhaust hoods for all sample preparation and the use of carbon adsorption on the exhaust of the sealed bioslurry reactor.

Copies of the MSDS will be distributed to all personnel working on this project for review. Additionally, the MSDS will be posted near the bioslurry reactor, where personnel have access to the hazard information before entering the project area.

In addition to the hazards associated with the contaminants to be treated, the health effects of reagents used during treatment and testing must also be identified. These reagents include anthracene which will be used during microbial enumeration determinations, mercuric chloride which will be applied to biologically inhibit treatments during batch testing, hydrogen peroxide which will be used as an oxygen source during batch testing, methylene chloride and polyvinyl pyrrolidone (PVP) will be used as solvents during sample analysis, ammonium chloride and potassium phosphate which will be used to supply nutrients during both investigations, phos ver 3 which will be used during ortho-phosphate concentration measurements, and hydrochloric acid and sodium hydroxide which will be used to adjust the pH of batch treatments and the bioslurry soil suspension. Use of the most toxic of these reagents will be limited to chemical fume hoods. MSDS for these reagents will also be distributed to all personnel working on this project and are included in Appendix D of this document.

Anthracene, a colorless solid with violet fluorescence, has a weak aromatic odor and, in dust form, may be irritating to eyes, nose and throat. If inhaled, anthracene will cause coughing or difficult breathing. In solid form, anthracene may be irritating to skin and eyes. If anthracene is swallowed, unconsciousness or convulsions may result. Organs which are targeted from overexposure to anthracene include the respiratory system, bladder, kidneys and skin. The OSHA PEL for anthracene is 0.2 mg/m^3 based on an eight-hour exposure.

Mercuric chloride is a very violent poison and comes in crystals, white granules, or powder form. The compound is not flammable, but produces poisonous gases when heated. Mercuric chloride may be fatal if swallowed. The compound is highly toxic and corrosive to mucous membranes. If ingested, mercuric chloride may cause severe nausea, vomiting, renal damage, and prostration. Mercuric chloride is frequently fatal in 1 to 2 gram doses. Mercuric chloride overexposure targets organs such as the respiratory system, central nervous system, kidneys, skin, and eyes. The OSHA PEL ceiling is 0.1 mg/m^3 which should not be exceeded at any time.

A 30 percent hydrogen peroxide solution is a clear, colorless liquid and a strong oxidizer. All efforts should be made to avoid contact with skin and eyes. Rubber gloves and goggles should be used when handling. Contamination of the compound from metal, dust, etc. should be avoided. Contact of hydrogen peroxide with combustible materials may result in spontaneous combustion. In case of contact, immediately flush effected area with plenty of water for at least 15 minutes. If chemical gets into eyes, seek immediate medical attention. OSHA PEL for hydrogen peroxide is 1.4 mg/m^3 and Immediate Danger to Life and Health (IDLH) of 104.29 mg/m^3. Skin, eyes, and the respiratory system are targeted organs of hydrogen peroxide exposure.

Methylene chloride is a colorless liquid with a chloroform-like odor. It is a gas above 104°F producing nonflammable vapors when mixed with air. Methylene chloride is incompatible with strong oxidizers; caustics; chemically active metals such as aluminum, magnesium, powders, potassium and sodium; and concentrated nitric acid. The OSHA PEL for methylene chloride is 1,736.19 mg/m^3 with a ceiling of 2,000 mg/m^3 (5 minimum/maximum peaks in two hours). American Conference of Governmental Industrial Hygienists (ACGIH) lists methylene chloride as a A2, suspected human carcinogen. At any detectable concentration, National Institute of Occupational Safety and Health (NIOSH) recommends the use of self-contained breathing apparatus that has a full-face piece and is operated in a pressure-demand or other positive-pressure mode. Methylene chloride is a systemic poisoner with targeted organs being the central nervous system, cardiovascular system, skin, and eyes. OSHA recommends supplied air/self-contained breathing apparatus if the concentration is 0.1 mg/m^3.

Ammonium chloride is colorless, odorless crystals or cryst masses; or a white granular powder. The compound has a cooling, saline taste, which is somewhat hygroscopic. In dust form, ammonium chloride may be irritating to eyes, nose, and throat. If inhaled, the compound will cause coughing or difficulties in breathing. In solid form, ammonium chloride is irritating to skin and eyes. If swallowed, the compound may cause unconsciousness or convulsions. The OSHA PEL is a time-weighted average (TWA) of 10 mg/m^3 and an short-term exposure limit (STEL) of 20 mg/m^3. Inhalation of ammonium chloride fumes will cause irritation in the respiratory system. If ingested, the compound will irritate the mouth and stomach. The compound may also cause skin and eye irritation.

Dibasic potassium phosphate is an odorless white, somewhat hygroscopic granule. There are no expected health hazards if this compound is inhaled. No adverse effects from skin contact and eye contact are expected; however, dust may cause mechanical irritation. In accordance with good industrial and personal hygiene and safety practice, avoid all unnecessary exposure and promptly remove from skin, eyes, and clothing.

PVP, an odorless white powder, is a suspected carcinogen. Extreme precautions should be taken in the handling and storage of this material. Gloves, safety goggles and other protective clothing should be used when handling. The compound should only be used in a chemical fume hood. All efforts to avoid breaking dust or skin contact should be made. If ingested, the compound has a possible risk of irreversible effects.

Phos Ver 3 is odorless whiter powder which may emit toxic fumes in fire. Conditions to avoid are heat, flames, exposure to light or moisture; contamination with phosphates; and contact with oxidizers, dyes, alkalines, iron or copper. Phos Ver 3 may be corrosive to eyes, wet skin, and the respiratory tact. The main route of compound exposure is ingestion and inhalation. Overexposure causes burns, may effect enzyme activity, may cause anemia, and gout or liver damage; the targeted organ for overexposure is the liver.

Hydrochloric acid, a solution of hydrogen chloride gas in water, may be colored yellow by traces of iron, chlorine, and organic matter. Contact with skin and eyes should be avoided. Concentrated solutions cause severe burns and possible permanent visual damage. Dermatitis and photosensitization may result from industrial contact. If inhaled, coughing, choking, inflammation and ulceration of the respiratory tract may occur. Ingestion of hydrochloric acid may result in corrosion of mucous membranes, esophagus, and stomach; dysphagia;

nausea; vomiting; and diarrhea. Circulatory collapse and death may also occur. The OSHA PEL for hydrochloric acid is 7 mg/m^3 with an IDLH of 149.28 mg/m^3. OSHA recommends at 74.64 mg/m^3 that supplied air, self-contained breathing apparatus chemical cartridge respirator with cartridge for compounds of concern.

Sodium hydroxide is a caustic soda, fused solid with cryst fracture. The compound rapidly adsorbs carbon dioxide and water from air. Sodium hydroxide is very corrosive to animals and vegetable tissue and to aluminum metal in the presence of moisture. The compound generates considerable heat while dissolving, or when the solution is mixed with an acid. Skin and eye contact should be avoided. If sodium hydroxide is ingested, vomiting, prostration, and collapse may occur. If ingested do not attempt to evacuated the stomach. Inhalation of sodium hydroxide dust or concentrated mist may cause damage to respiratory tract. The OSHA PEL states that sodium hydroxide has a ceiling of 2 mg/m^3 and an IDLH of 250 mg/m^3. OSHA recommends at 50 mg/m^3 that a powered, air-purifying respirator with a dust and mist filter shall be used. If the concentration reaches 100 mg/m^3, a self-contained breathing apparatus with a full-facepiece or supplied-air respirator with full-facepiece should be used.

9.2 Personal Protective Equipment

The level of personal protective equipment (PPE) used during the charging of the bioslurry reactor will be determined following an assessment of screening activities. If the exposure monitoring indicates that contaminants are present at one-half the PEL, then Level C PPE will be used. If the contaminant concentration is less than one-half the PEL or not detected, Level D PPE will be employed.

If Level C PPE is determined to be appropriate for handling and transferring waste into the reactor or decontaminating the interior of the reactor or equipment, then it will be employed. Level C PPE will consist of:

- Full-face air-purifying respirator with organic vapor high-efficiency particulate air (HEPA) cartridges

- Viton gloves - outer; latex gloves - inner
- Rubber apron or polyethylene-coated Tyvek coveralls
- Work uniforms
- Steel-toed shoes.

Level D protection will be used for activities conducted within the laboratory exhaust hood. If Level D protection is shown to be appropriate for the treatability tasks, it will be employed. Level D PPE will include:

- Safety glasses with side shields (goggles when collecting liquid samples)
- Viton gloves - outer; latex gloves - inner (when collecting samples)
- Steel-toed shoes
- Laboratory coat or polyethylene-coated Tyvek coveralls

9.3 Respiratory Protection Program

A comprehensive respiratory protection program has been established by IT Corporation (IT). This program is mandated in all locations where use of such equipment is intended to lessen the potential for adverse health affects to an employee.

As part of the respiratory training program, each employee is instructed in the following elements:

- Nature of the respiratory hazard on the work site and the appraisal of potential consequences if the respiratory protection is not utilized

- Use and proper fit of the respirator

- Cleaning, disinfecting, inspecting, maintenance, and storing of the respirator

- Proper selection, capabilities, and limitations of PPE.

Routinely used respiratory equipment will be inspected, cleaned, and disinfected daily to help ensure proper hygiene practices. An inspection of these breathing devices will include the following:

- Examination of the head straps for breaks, loss of elasticity, broken or malfunctioning buckles, and other attachments

- Examination of the facepiece for excessive dirt, cracks, tears, distortion, holes, or inflexibility

- Examination of the exhalation and inhalation valves for any foreign material, cracks, tears, or distortion in the valve. Additional checks will be made to inspect for proper insertion, defective valve covers, or improper installation

- Examination of air-purifying elements for incorrect cartridge, expired shelf-life of the cartridge, or cracks or dents in the cartridge or cartridge holder

- Examination of proper insertion of the cartridges into the facepiece and a check of the gaskets inside the cartridge holder.

When respiratory protection is required, respiratory cartridges will be changed daily. All respirators will be inspected prior to each day's use. If broken or malfunctioning parts are found during the cleaning process, these parts will be replaced or new respiratory equipment will be issued to the user.

The respiratory protective equipment will be stored in an area protected from any mechanical damage. The protection area will guard against dust, heat, excessive moisture, or damage by chemical contact. The storage area for the respirators should be in a readily accessible location.

The following guidelines apply to the use and storage of respirators.

- Only employees who have been trained to wear and maintain respirators properly will be allowed to use respiratory protection.

- Selection of respirators, as well as any decisions regarding upgrading or downgrading of respiratory protection, will be made by the health and safety officer or his designee.

- Positive and negative pressure tests will be performed each time the respirator is donned.

- Only employees who have been fit tested within the last 12 months will be allowed to work in atmospheres where respirators are required. Subcontractors will provide certificates of respirator fit tests completed within the last 12 months for each employee on site.

- Respirator users will be instructed in the proper use and limitations of respirators.

- If an employee has difficulty in breathing during the fit test or during use, he will be evaluated medically to determine if he can wear a respirator safely while performing assigned tasks.

- No employee will be assigned to tasks requiring the use of respirators if, based upon the most recent examination, a physician determines that the health or safety of the employee will be impaired by respirator use.

- Contact lenses will not be worn while using any type of respiratory protection.

- Respirators will be cleaned and sanitized daily after use.

- Respirators will be stored in a convenient, clean, and sanitary location on site.

- Respirators will be inspected during cleaning. Worn or deteriorated parts will be replaced.

- Facial hair that might interfere with a good facepiece seal or proper operation of the respirator is prohibited.

- The IT project manager will review the respiratory protection program to ensure that employees are properly wearing and maintaining their respirators and that the respiratory protection is adequately protecting the employees.

- The health and safety officer and the project manager will evaluate the respiratory protection program routinely to ensure the continuing effectiveness.

- Respirators used for emergency response will be inspected weekly by the health and safety coordinator.

9.4 General Work Practices

The following work practices will be adhered to during the course of project activities. At least one copy of these procedures will be available at the treatability study work site.

- Contaminated protective equipment, such as respirators, hoses, boots, etc., will not be removed from the regulated work area until it has been cleaned or properly packaged and labeled.
- Legible and understandable precautionary labels that display identity and appropriate hazard warning will be prominently affixed to containers of contaminated scrap, waste, debris, and clothing.
- Removal of PAH-contaminated material from protective clothing or equipment by flowing, shaking, or any other means that disperse contaminated material into the air is prohibited.
- No food or beverages will be present or consumed in the treatability study work area.
- No tobacco products will be present or used, and cosmetics will not be applied in the treatability study work area.
- Employees will wash their hands and face before eating, drinking, smoking or applying cosmetics.
- PAH-contaminated materials will be stored in tightly-closed containers in well-ventilated areas.
- Containers will be moved only with the proper equipment and will be secured to prevent dropping or loss of control during transport.
- Emergency equipment will be located outside storage areas in readily accessible locations that will remain minimally contaminated with PAH.
- All areas that have been determined as uncontaminated inside the regulated area will be clearly marked as such. No personnel, equipment, etc. will be in these areas until they have been decontaminated.

9.5 Personnel Training

All personnel at the Biotechnology Applications Center (BAC) facility receive at least 40 hours of OSHA health and safety training. OSHA training includes a minimum of 24 hours of initial off-site training and a minimum of 8 hours annual refresher training. This includes instruction on exits, fire extinguishers, handwashing, safety showers, and eye wash stations. Supervisors receive an additional 8 hours of health and safety training. All personnel also receive 8 hours annual health and safety training, which meets the requirements of OSHA regulations included in 29 CFR 1910.120. Only personnel who have had qualitative fit tests and annual fit tests thereafter will be allowed to work in areas where respirators are required.

Upon BAC receipt of the creosote-impacted soils, a hazards communications meeting will be held to inform employees of project-specific contaminants and the project technical scope of work.

9.6 Medical Surveillance

A preassigned health assessment will be required for all personnel working with toxic substances. This examination will include a previous work medical history. It will be followed by annual medical examinations, which will update and document any accidental exposures. All IT employees participate in an annual medical surveillance program. This medical surveillance program meets the requirement of the OSHA regulations included in 29 CFR 1910.120.

9.7 Spill Prevention and Containment

The primary spill prevention method that will be enforced throughout this project will minimize the quantity of toxic materials used for experimentation. Any visible quantity of spilled liquid (slurry) waste from the reactor operations must be cleaned up immediately with spill-absorbing pads located in the work area. These pads will be collected in sealable cans and stored for disposal. After the visible quantity is absorbed, the contaminated work surface will be wiped repeatedly with water-soaked rags and dried. Spills on concrete will be absorbed with a sweeping compound.

Major spills, fire, or explosions will necessitate response in accordance with the IT BAC Chemical Hygiene Plan (CHP). The laboratory CHP is maintained in an area readily accessible to all employees. If an emergency situation arises, the first duty of project personnel is to alert all affected personnel and then contact the facility emergency coordinator.

At the end of the pilot-scale investigation, any remaining liquids or solids will be poured into the waste container supplied by project personnel. The waste container will be properly identified as a satellite waste collection container and labeled for the type of waste it contains with an appropriate hazard warning. Questions on the proper disposal method should be directed to the appropriate project personnel.

Mallinckrodt

Material Safety Data

Emergency Phone Number: 314-982-5000

Mallinckrodt, Inc., Science Products Division, P.O. Box M, Paris, KY 40361.

MERCURIC CHLORIDE

PRODUCT IDENTIFICATION:

Synonyms: Mercury bichloride; corrosive sublimate

Formula CAS No.: 7487-94-7

Molecular Weight: 271.50

Chemical Formula: $HgCl_2$

Hazardous Ingredients: Not applicable.

PRECAUTIONARY MEASURES

DANGER! MAY BE FATAL IF SWALLOWED.
HARMFUL IF INHALED OR ABSORBED THROUGH SKIN.
CAUSES BURNS. MERCURY COMPOUNDS AFFECT THE KIDNEYS AND CENTRAL NERVOUS SYSTEM.

Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Do not get in eyes, on skin, or on clothing.
Wash thoroughly after handling.

EMERGENCY/FIRST AID

In all cases call a physician immediately. If swallowed, induce vomiting immediately by giving two glasses of water, or milk if available and sticking finger down throat. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes.
SEE SECTION 5.

DOT Hazard Class: Poison-B

SECTION 1 Physical Data

Appearance: White crystals or powder.
Odor: Odorless.
Solubility: 7.4g in 100g of water.
Boiling Point: 302°C (576°F), sublimes.
Melting Point: 277°C (531°F), sublimes
Specific Gravity: 5.4
Vapor Density (Air = 1): No information found.
Vapor Pressure (mm Hg): 1.3 @ 236°C.
Evaporation Rate: No information found.

SECTION 2 Fire and Explosion Information

Fire:
Not considered to be a fire hazard.

Explosion:
Not considered to be an explosion hazard.

Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

SECTION 3 Reactivity Data

Stability:
Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:
Mercury vapor and toxic chloride fumes may be emitted when heated to decomposition.

Hazardous Polymerization:
This substance does not polymerize.

Incompatibilities:
Reacts violently with potassium and sodium.

SECTION 4 Leak/Spill Disposal Information

Ventilate area of leak or spill. Clean-up personnel require protective clothing and respiratory protection from dust.

Spills: Pick up and place in a suitable container for reclamation or disposal in a method that does not generate dust.

Disposal: Whatever cannot be saved for reclamation may be disposed in a RCRA approved hazardous waste facility. Do not flush to the sewer.

Ensure compliance with local, state and federal regulations.

Effective Date: 11-14-85 Supersedes 01-28-85

SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhalation:
May cause irritation to the mucous membranes, coughing, and headaches. May be absorbed through inhalation; symptoms may parallel ingestion.

Ingestion:
Highly Toxic! May cause burning of the mouth and pharnyx, abdominal pain, vomiting, and bloody diarrhea. May be followed by a rapid and weak pulse, shallow breathing, paleness, exhaustion, and collapse. Delayed death may occur from renal failure.

Skin Contact:
May cause irritation, skin burns, dermatitis, or sensitivity. May be absorbed through the skin, symptoms may parallel ingestion.

Eye Contact:
May cause irritation or ulceration of conjunctiva and cornea.

Chronic Exposure:
Chronic exposure through any route can produce central nervous system damage. May cause muscle tremors, personality and behavior changes, metallic taste, loosening of the teeth, digestive disorders, skin rashes and kidney damage.

Aggrevation of Pre-existing Conditions:
Persons with nervous disorders, or impaired kidney or respiratory function,or a history of allergies or a known sensitization to mercury may be more susceptible to the effects of the substance.

B. FIRST AID

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:
If swallowed, induce vomiting immediately by giving two glasses of water, or milk if available and sticking finger down throat. Call a physician immediately. Never give anything by mouth to an unconscious person.

Skin Exposure:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician.

Eye Exposure:
Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA (RTECS, 1982)

Oral rat LD50: 1 mg/kg. Irritation data: skin rabbit 500mg/24H severe; eye rabbit 50ug/24H severe. Mutation data references cited. Reproductive effects references cited.

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:
-ACGIH Threshold Limit Value (TLV):
0.1 mg(Hg)/m^3 (TWA) (skin).

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommended Practices", most recent edition, for details.

Personal Respirators: (NIOSH Approved)
If the TLV is exceeded, a dust/mist respirator with chemical goggles may be worn, in general, up to ten times the TLV. Consult respirator supplier for limitations. Alternatively, a supplied air full facepiece respirator or airlined hood may be worn.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Contact lenses should not be worn when working with this material. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect from physical damage and direct sunlight. Wear special protective equipment (Sec. 6) for maintainence break-in or where exposures may exceed established exposure levels. Wash hands, face, forearms and neck when exiting restricted areas. Shower, dispose of outer clothing, change to clean garments at the end of the day. Avoid cross-contamination of street clothes. Wash hands before eating and do not eat, drink, or smoke in workplace.

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Mallinckrodt
Material Safety Data
Emergency Phone Number: 314-982-5000

Mallinckrodt provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. Individuals receiving this information must exercise their independent judgment in determining its appropriateness for a particular purpose.

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Mallinckrodt, Inc., Science Products Division, P.O. Box M, Paris, KY 43061.

Addendum to Material Safety Data Sheet

REGULATORY STATUS

This Addendum Must Not Be Detached from the MSDS

Identifies SARA 313 substance(s)

Any copying or redistribution of the MSDS must include a copy of this addendum

(Chem.Key: MERCC)

Hazard Categories for SARA
Section 311/312 Reporting

Acute	Chronic	Fire	Pressure	Reactive
X	X			

Product or Components of Product:	SARA EHS Sect. 302 RQ (lbs.)	SARA EHS Sect. 302 TPQ (lbs.)	SARA Section 313 Chemicals Name List	SARA Section 313 Chemicals Chemical Category	CERCLA Sec.103 RQ (lbs.)	RCRA Sec. 261.33
MERCURIC CHLORIDE (7487-94-7)	1	500*	No	Mercury compound	No	No

SARA Section 302 EHS RQ: Reportable Quantity of Extremely Hazardous Substance, listed at 40 CFR 355.
SARA Section 302 EHS TPQ: Threshold Planning Quantity of Extremely Hazardous Substance. An asterisk (*) following a Threshold Planning Quantity signifies that if the material is a solid and has a particle size equal to or larger than 100 micrometers, the Threshold Planning Quantity = 10,000 LBS.
SARA Section 313 Chemicals: Toxic Substances subject to annual release reporting requirements listed at 40 CFR 372.65.
CERCLA Sec. 103: Comprehensive Enviromental Response, Compensation and Liability Act (Superfund). Releases to air, land or water of these hazardous substances which exceed the Reportable Quantity (RQ) must be reported to the National Response Center, (800-424-8802); Listed at 40 CFR 302.4
RCRA: Resource Conservation and Reclamation Act. Commercial chemical product wastes designated as acute hazards and toxic under 40 CFR 261.33

ULTRA *Scientific* 250 SMITH STREET, NO. KINGSTOWN, RI 02852
Telephone (401) 294-9400
"The Research Company"

MATERIAL SAFETY DATA SHEET

DATE: 7/1/91 ANTHRACENE PAGE 1

SECTION I PRODUCT IDENTIFICATION

Catalog Number: RAH-002 Name: Anthracene
CAS #: 120-12-7 Molecular Formula: $C_{14}H_{10}$
Synonyms: p-naphthalene; green oil; anthracene oil

SECTION II TOXICITY HAZARD DATA

RTECS # N/A No Toxicity Data Available

SECTION III PHYSICAL DATA

M.Pt.: 217°C B.Pt.: 345°C Density: 1.24
Appearance: white powder; colorless crystals

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Pt.: N/A Combustible
Extinguishing Media: Carbon dioxide, dry chemical powder, or water spray

SECTION V HEALTH HAZARD DATA

Contains carcinogen(s) or cancer suspect agent(s)
Irritant
All chemicals should be considered hazardous - direct physical contact should be avoided.

FIRST AID: In case of eye or skin contact, flush with copious amounts of water. If inhaled remove to fresh air - give oxygen, if necessary. Contact physician.

SECTION VI REACTIVITY DATA

Low reactivity

SECTION VII SPILL OR LEAK PROCEDURES

Spills or leaks: Due to the small quantity involved, spills or leaks should not pos a significant problem. A leaking bottle may be placed in a plastic bag and normal disposal procedures followed. Liquid samples may be absorbed on vermiculite or sand.

Waste disposal: Burn in a chemical incinerator equipped with an afterburner and scrubber. Observe all federal, state, and local laws concerning disposal.

SECTION VIII PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Use appropriate OSHA/MSHA approved safety equipment. Wear chemical goggles, face shield, gloves, and chemical resistant clothing such as a laboratory coat and/or a rubber apron to prevent contact with eyes, skin, and clothing. Keep tightly closed, and store in a cool, dry place.

SECTION IX SPECIAL PRECAUTIONS AND COMMENTS

This material should only be used by those persons trained in the safe handling of hazardous chemicals.

The above information is believed to be correct, but does not purport to be all inclusive. This data should be used only as a guide in handling the material. ULTRA SCIENTIFIC, INC. shall not be held liable for any damage resulting from handling or from contact with the above product.

MALLINCKRODT

Material Safety Data Sheet

Mallinckrodt, Inc. Science Products Division, P.O. Box M Paris, KY 40361

Emergency Telephone Number: 314-982-5000

POTASSIUM PHOSPHATE DIBASIC ANHYDROUS

PRODUCT IDENTIFICATION:

Synonyms: Potassium hydrogen phosphate; potassium phosphate dibasic anhydrous; phosphoric acid, dipotassium salt

Formula CAS No.: 7758-11-4

Molecular Weight: 174.18

Chemical Formula: K_2HPO_4

Hazardous Ingredients: Not applicable.

PRECAUTIONARY MEASURES

As part of good industrial and personal hygiene and safety procedure, avoid all unnecessary exposure to the chemical substance and ensure prompt removal from skin, eyes and clothing.

EMERGENCY/FIRST AID

SEE SECTION 5.

DOT Hazard Class: Not Regulated

SECTION 1 Physical Data

Appearance: Deliquescent white crystals or powder.

Odor: Odorless.

Solubility: 167g/100g water @ 20°C.

Boiling Point: Not applicable.

Melting Point: Decomposes.

Specific Gravity: 2.34

Vapor Density (Air=1): No information found.

Vapor Pressure (mm Hg): No information found.

Evaporation Rate: No information found.

SECTION 2 Fire and Explosion Information

Fire:
Not considered to be a fire hazard.

Explosion:
Not considered to be an explosion hazard.

Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

SECTION 3 Reactivity Data

Stability:
Stable under ordinary conditions of use and storage.
Slightly hygroscopic.

Hazardous Decomposition Products:
When heated to decomposition it emits highly toxic fumes of phosphorous oxides.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
No incompatibility data found.

SECTION 4 Leak/Spill Disposal Information

Ventilate area of leak or spill. Clean-up personnel may require respiratory protection from dust.

Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

Disposal: Whatever cannot be saved for reclamation may be delivered to an approved waste disposal facility.

Ensure compliance with local, state and federal regulations.

SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhalation:
Not expected to be a health hazard.

Ingestion:
Large doses may cause vomiting, nausea, tingling sensation of the hands and feet, and disturbance in heart rhythms.

Skin Contact:
No adverse effects expected.

Eye Contact:
No adverse effects expected but dust may cause mechanical irritation.

Chronic Exposure:
No information found.

Aggrevation of Pre-existing Conditions:
No information found.

B. FIRST AID

Inhalation:
Not expected to require first aid measures.

Ingestion:
If large amounts were swallowed, give water to drink and get medical advice.

Skin Exposure:
Wash exposed area with soap and water. Get medical advice if irritation develops.

Eye Exposure:
Wash thoroughly with running water. Get medical advice if irritation develops.

C. TOXICITY DATA (RTECS, 1986)

No LD50/LC50 information found relating to normal routes of occupational exposure.

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:
None established.

Ventilation System:
In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.

Personal Respirators: (NIOSH Approved)
For conditions of use where exposure to the dust is apparent, a dust/mist respirator may be worn. For emergencies, a self-contained breathing apparatus may be necessary.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Safety glasses. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage.

POPHO

MALLINCKRODT

Material Safety Data Sheet

Mallinckrodt, Inc. Science Products Division, P.O. Box M Paris, KY 40361

Emergency Telephone Number: 314-982-5000

HYDROGEN PEROXIDE SOLUTION, 30%

PRODUCT IDENTIFICATION:

Synonyms: Peroxide; 100 volume peroxide

Formula CAS No.: 7722-84-1

Molecular Weight: 34.01

Chemical Formula: H_2O_2

Hazardous Ingredients: Hydrogen peroxide

PRECAUTIONARY MEASURES

DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE.
CAUSES SEVERE BURNS. HARMFUL IF SWALLOWED OR INHALED.

Do not get in eyes, on skin, or on clothing.
Avoid breathing mist.
Keep from contact with clothing and other combustible materials.
Do not store near combustible materials.
Use with adequate ventilation.
Wash thoroughly after handling.

EMERGENCY/FIRST AID

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. For eyes, get medical attention. If swallowed, give water or milk to drink. Get medical attention immediately. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. Get medical attention for any breathing difficulty. In all cases call a physician.
SEE SECTION 5.

DOT Hazard Class: Oxidizer

SECTION 1 Physical Data

Appearance: Clear, colorless liquid.

Odor: Acrid odor.

Solubility: Infinitely soluble in water.

Boiling Point: 108°C (226°F)

Melting Point: -25°C (-13°F)

Specific Gravity: 1.11

Vapor Density (Air=1): (Air=1) 1.17

Vapor Pressure (mm Hg): 25 at 30°C (86°F)

Evaporation Rate: (BuAc=1): <1

SECTION 2 Fire and Explosion Information

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Increases the flammability of combustible, organic and readily oxidizable materials.

Explosion:
Contact with oxidizable substances may cause extremely violent combustion. Drying of concentrated hydrogen peroxide on clothing or other combustible materials may cause fire or explosion.

Fire Extinguishing Media:
Water spray may be used to extinguish surrounding fire and cool exposed containers. Water spray will also reduce fume and irritant gases.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

SECTION 3 Reactivity Data

Stability:
Unstable. Unstable with heat, may result in dangerous pressures. A strong oxidizer, reacts violently upon contact with many organic substances, particularly textile and paper.

Hazardous Decomposition Products:
Decomposes to water and oxygen with rapid heat release. Use vented containers. The solution can decompose violently upon heating.

Hazardous Polymerization:
This substance does not polymerize.

Incompatibilities:
Heat, reducing agents, organic materials, dirt, alkalies, rust, and many metals. Spontaneous combustion may occur on standing in contact with readily flammable materials.

SECTION 4 Leak/Spill Disposal Information

CAUTION! Caustic material. Causes fires with organic material. Ventilate area of leak or spill. Clean-up personnel require protective clothing. Contain and recover liquid when possible. Do not return spilled material to original container. Larger Spills: Dilute with a large amount of water and hold in a pond or dyked area until the H_2O_2 decomposes followed by discharge into a suitable treatment system. May be neutralized with sodium metabisulfite or sodium sulfite after diluting to 5-10% peroxide. Do not flush undiluted material to sewer. This oxidizing material can increase the flammability of adjacent combustible materials. Empty containers should be rinsed with water before discarding.

Ensure compliance with local, state and federal regulations.

NFPA Ratings: Health: 2 Flammability: 0 Reactivity: 1 Other: Oxidizer

SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhalation:
Vapors are corrosive and irritating to the respiratory tract. Inhalation of mist may burn the mucous membrane of the nose and throat.

Ingestion:
Corrosive and irritating to the mouth, throat, and abdomen. Large doses may cause symptoms of abdominal pain, vomiting, and diarrhea as well as blistering or tissue destruction.

Skin Contact:
Irritating in contact with the skin. Symptoms include discoloration of skin and pain.

Eye Contact:
Vapors are very corrosive and irritating to the eyes. Symptoms include pain, redness and blurred vision. Splashes may cause tissue destruction.

Chronic Exposure:
No information found.

Aggrevation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

B. FIRST AID

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.

Ingestion:
If swallowed, give water or milk to drink. Get medical attention immediately. Never give anything by mouth to an unconscious person.

Skin Exposure:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician immediately.

Eye Exposure:
Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA (RTECS, 1986)

No LD50/LC50 information found relating to normal routes of occupational exposure. Tumorigenic data cited.

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):
1 ppm (TWA)
-ACGIH Threshold Limit Value (TLV)
1 ppm (TWA)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommendc Practices", most recent edition, for details.

Personal Respirators: (NIOSH Approved)
If the TLV is exceeded a full facepiece chemical cartridge respirator may be worn, in general, up to 100 times the TLV or the maximum use concentration specified by the respirator supplier, whichever is less. Alternatively, a supplied air full facepiece respirator or airlined hood may be worn.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Contact lenses should not be worn when working with this material. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Store in a cool, well-ventilated dark area separated from combustible substances, reducing agents, strong bases, organics. Suggest rotation of stock. Containers must be vented, but check periodically for bulging containers which can burst from pressure. Protect containers from physical damage and contamination. Contamination from any source (dust, metals) may cause rapid decomposition with generation of large quantities of oxygen gas and high pressures. Rinse empty containers thoroughly with clean water.

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MATERIAL SAFETY DATA SHEET

EM SCIENCE
A DIVISION OF EM INDUSTRIES
11 WOODCREST
CHERRY HILL, N.J. 08034-0395

PREPARATION DATE ....: OCT 27, '87

INFORMATION PHONE NUMBER.:
(609) 354-9200
CHEMTREC EMERGENCY NUMBER:
1-800-424-9300

NFPA HAZARD RATINGS

HEALTH .....: 2
FLAMMABILITY ...: 0
REACTIVITY : 0
SPECIAL HAZARDS.: N/A

SECTION I - GENERAL INFORMATION

CATALOG NUMBER(S): 1141 1142 1143 1144 1145
AX1269 AX1270 AX1272 AX1275 AX1276
CHEMICAL NAME....: AMMONIUM CHLORIDE
TRADE NAME.......: SAL AMMONIAC
C.A.S. NUMBER....: 12125-02-9
CHEMICAL FAMILY..: INORGANIC SALT
FORMULA..........: NH4CL
MOLECULAR WEIGHT.: 53.50
DOT SHIPPING NAME: N/A
DOT NUMBER.......: N/A

SECTION II - HAZARDOUS INGREDIENTS

-NONE OTHER THAN SPECIFIED PRODUCT

SECTION III- PHYSICAL DATA

BOILING POINT (C 760 MM HG).: N/A
MELTING POINT (C)...........: SUBLIME
SPECIFIC GRAVITY(H.2.O = 1)....: 1.53
VAPOR PRESSURE..(MM HG).......: N/A 20C
PERCENT VOLATILE BY VOL (%)..: N/A
VAPOR DENSITY (AIR=1)........: N/A
EVAPORATION RATE (BUAC=1).....: N/A
SOLUBILITY IN WATER (%).......: 27%
APPEARANCE AND ODOR...........: WHITE, ODORLESS GRANULES
OR CRYSTALLINE POWDER

SECTION IV - FIRE & EXPLOSION HAZARD DATA

FLASH POINT (F).......: NOT COMBUSTIBLE
FLAMMABLE LIMITS LEL %.: N/A
FLAMMABLE LIMITS UEL %.: N/A
EXTINGUISHING MEDIA....:
WATER FOG OR SPRAY

WEAR GOGGLES OR FACE SHIELD

FIRE FIGHTING PROC.....:
WEAR SELF-CONTAINED BREATHING APPARATUS

FIRE & EXPL. HAZARDS...:
-THERMAL DECOMPOSITION PRODUCES HIGHLY TOXIC FUMES

SECTION V - HEALTH HAZARD DATA (ACUTE AND CHRONIC)

ACGIH TLV/OSHA PEL (TWA).......:
10 MG/CU.M. (TWA)   OSHA-PEL: NONE ESTABLISHED

TOXICITY DATA...................:
-ORL-RAT LD50: 1650 MG/KG   ORL-DOG LDLO: 600 MG/KG

SYMPTOMS OF EXPOSURE ....:
-HARMFUL IF SWALLOWED; IRRITATING TO SKIN, EYES, AND RESPIRATORY PASSAGES BY CONTACT OR INHALATION
EYE IRRITATION CAN BE SEVERE
FUMES RESULTING FROM HEATING OF MATERIAL ARE PRINCIPAL HAZARD

MEDICAL COND. AGGRAVATED BY EXP: DATA NOT AVAILABLE.

ROUTES OF ENTRY.................: INHALATION, INGESTION OR SKIN CONTACT.

CARCINOGENICITY.................: SEE COMMENTS, SECTION X; IF NO INFORMATION APPEARS, THE MATERIAL IS NOT LISTED AS A CANCER CAUSING AGENT.

EMERGENCY FIRST AID.............:
SKIN: WASH THOROUGHLY WITH SOAP AND WATER
EYES: IMMEDIATELY FLUSH THOROUGHLY WITH LARGE AMOUNTS OF WATER
INHALATION: REMOVE TO FRESH AIR; GIVE ARTIFICIAL RESPIRATION IF BREATHING HAS STOPPED
INGESTION: DO NOT INDUCE VOMITING; GET IMMEDIATE MEDICAL ASSISTANCE
GET MEDICAL ASSISTANCE FOR ALL CASES OF OVEREXPOSURE

SECTION VI - REACTIVITY DATA

STABILITY.................: YES

CONDITIONS TO AVOID .....:
-EXTREME HEAT; AVOID ANY ACTION THAT CREATES DUSTING (DISPERSION OF FINE PARTICLES INTO AIR)

MATERIALS TO AVOID.......: ( ) WATER   (X) ACIDS
( ) BASES   ( ) CORROSIVES   (X) OXIDIZERS
(X) OTHER (SPECIFY)-STRONG ALKALIES, SILVER SALTS, CYANIDES, BRF3

HAZARDOUS POLYMERIZATION.: DATA NOT AVAILABLE.

HAZARDOUS DECOMPOSITION..: -HYDROGEN CHLORIDE AND AMMONIA GAS

SECTION VII - ENVIRONMENTAL PROTECTION PROCEDURES

SPILL RESPONSE:
-TAKE UP AND CONTAINERIZE FOR PROPER DISPOSAL
FLUSH AREA WITH WATER

WASTE DISPOSAL: TO BE PERFORMED IN COMPLIANCE WITH ALL CURRENT LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII - SPECIAL PROTECTION INFORMATION

VENTILATION, RESPIRATORY PROTECTION, PROTECTIVE CLOTHING, EYE PROTECTION:
-MATERIAL SHOULD BE HANDLED OR TRANSFERRED IN AN APPROVED FUME HOOD

OR WITH ADEQUATE VENTILATION
PROTECTIVE GLOVES (NEOPRENE, PVC OR EQUIVALENT) SHOULD BE WORN TO PREVENT SKIN CONTACT
SAFETY GLASSES WITH SIDE SHIELDS SHOULD BE WORN AT ALL TIMES

SECTION IX - SPECIAL PROTECTION INFORMATION

HANDLING & STORAGE ....:
-KEEP CONTAINER CLOSED TIGHTLY
STORE IN A COOL, DRY AREA
DO NOT BREATHE DUST
DO NOT GET IN EYES, ON SKIN OR ON CLOTHING
DO NOT TAKE INTERNALLY
WASH THOROUGHLY AFTER HANDLING

WORK/HYGIENIC PRACTICES: WASH THOROUGHLY AFTER HANDLING. DO NOT TAKE INTERNALLY. EYE WASH AND SAFETY EQUIPMENT SHOULD BE READILY AVAILABLE.

SECTION X - OTHER INFORMATION

COMMENTS..................:
-TESTS ON LABORATORY ANIMALS INDICATE MATERIAL MAY PRODUCE ADVERSE MUTAGENIC EFFECTS

REV. 1/87

N/A
REVISION HISTORY.........: 08/01/81, N/A
OCT 27, '87
N/A = NOT AVAILABLE:

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IT CORPORATION
312 DIRECTORS DRIVE
KNOXVILLE TN 37923

EMERGENCY PHONE 1-314-771-5765

DATE: 11/25/91
CUST#: 6-083-43580
PO#:

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

STOCK #: PVP-360
PRODUCT #: P3254
CAS #:9003-39-8

NAME: POLYVINYLPYRROLIDONE AV. MOL. WT. 360,000

SYNONYMS

AGENT AT 717 * ALBIGEN A * ALDACOL Q * AT 717 * BOLINAN * 1-ETHENYL-2-PYRROLIDINONE POLYMERS * GANEX P 804 * HEMODESIS * HEMODEZ * K15 * K25 * K25 (POLYMER) * K30 * K30 (POLYMER) * K60 * K60 (POLYMER) * K90 * K115 * K115 (POLYAMIDE) * KOLLIDON * KOLLIDON 17 * KOLLIDON 25 * KOLLIDON 30 * LUVISKOL * LUVISKOL K30 * LUVISKOL K90 * MPK 90 * NCI C60582 * NEOCOMPENSAN * PERAGAL ST * PEREGAL ST * PERISTON * PERISTON-N * PEVISTON * PLASDONE * PLASDONE K-26/28 * PLASDONE K 29-32 * PLASDONE XL * PLASMOSAN * POLYCLAR AT * POLYCLAR H * POLYCLAR L * POLY(1-(2-OXO-1-PYRROLIDINYL)ETHYLENE) * POLYVIDONE * POLY(N-VINYLBUTYROLACTAM) * POLY(VINYLPYRROLIDINONE) * POLY(N-VINYLPYRROLIDINONE) * POLY(1-VINYLPYRROLIDINONE) * POLYVINYLPYRROLIDONE * POVIDONE * POVIDONE (USP XIX) * PROTAGENT * PVP * PVP 40 * PVP-K 15 * PVP-K 30 * PVP-K 60 * PVP-K 90 * PVPP * 2-PYRROLIDINONE, 1-ETHENYL, HOMOPOLYMER * 2-PYRROLIDINONE, 1-VINYL-, POLYMERS * 143 RP * SUBTOSAN * VINISIL * N-VINYLBUTYROLACTAM POLYMER * VINYLPYRROLIDINONE POLYMER * N-VINYLPYRROLIDINONE POLYMER * N-VINYLPYRROLIDONE POLYMER * VINYLPYRROLIDONE POLYMER *

TOXICITY HAZARDS

RTECS NO: TR8370000
POLY(1-VINYL-2-PYRROLIDINONE) HOMOPOLYMER

TOXICITY DATA

ORL-RAT LD50:100 GM/KG	FAONAU 53A,486,74
IPR-MUS LD50:12 GM/KG	FAONAU 53A,486,74
UNR-MUS LD50:16 GM/KG	KHFZAN 19,212,85
ORL-RBT LD50:1040 MG/KG	VETNAL 61(12),68,85
ORL-GPG LD50:100 GM/KG	FAONAU 53A,486,74

REVIEWS, STANDARDS, AND REGULATIONS
IARC CANCER REVIEW:ANIMAL LIMITED EVIDENCE IMEMDT 19,461,79
IARC CANCER REVIEW:HUMAN NO ADEQUATE DATA IMEMDT 19,461,79
IARC CANCER REVIEW:GROUP 3 IMSUDL 7,56,87
EPA TSCA CHEMICAL INVENTORY, JUNE 1990
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, MARCH 1991

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

HEALTH HAZARD DATA

ACUTE EFFECTS
HARMFUL IF SWALLOWED.
MAY BE HARMFUL IF INHALED.
MAY BE HARMFUL IF ABSORBED THROUGH THE SKIN.
MAY CAUSE EYE IRRITATION.
MAY CAUSE SKIN IRRITATION.

CHRONIC EFFECTS
POSSIBLE CARCINOGEN.

CONTINUED ON NEXT PAGE

MATERIAL SAFETY DATA SHEET

DATE: 11/25/91
CUST#: 6-083-43580
PO#:

PRODUCT #: P3254
CAS #:9003-39-8

NAME: POLYVINYLPYRROLIDONE AV. MOL.
WT. 360,000

------------------ HEALTH HAZARD DATA -----------------

FIRST AID
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES.
FLUSH SKIN WITH WATER.
IF INHALED, REMOVE TO FRESH AIR.
IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.
CALL A PHYSICIAN.

-------------------- PHYSICAL DATA --------------------

APPEARANCE AND ODOR
WHITE POWDER

------------ FIRE AND EXPLOSION HAZARD DATA -----------

EXTINGUISHING MEDIA
WATER SPRAY.
CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.
SPECIAL FIREFIGHTING PROCEDURES
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.
UNUSUAL FIRE AND EXPLOSIONS HAZARDS
EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

------------------- REACTIVITY DATA -------------------

INCOMPATIBILITIES
STRONG OXIDIZING AGENTS
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
THERMAL DECOMPOSITION MAY PRODUCE CARBON MONOXIDE, CARBON DIOXIDE, AND NITROGEN OXIDES.

--------------- SPILL OR LEAK PROCEDURES --------------

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
CHEMICAL SAFETY GOGGLES.
USE PROTECTIVE CLOTHING, GLOVES AND MASK.
SWEEP UP, PLACE IN A BAG AND HOLD FOR WASTE DISPOSAL.
AVOID RAISING DUST.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.
WASTE DISPOSAL METHOD
DISSOLVE OR MIX THE MATERIAL WITH A COMBUSTIBLE SOLVENT AND BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ---

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT

CONTINUED ON NEXT PAGE

MATERIAL SAFETY DATA SHEET

DATE: 11/25/91
CUST#: 6-083-43580
PO#:

PRODUCT #: P3254
CAS #:9003-39-8

NAME: POLYVINYLPYRROLIDONE AV. MOL. WT. 360,000

--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ---

GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.
SAFETY SHOWER AND EYE BATH.
USE ONLY IN A CHEMICAL FUME HOOD.
DO NOT BREATHE DUST.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
POSSIBLE CARCINOGEN.
KEEP TIGHTLY CLOSED.
STORE IN A COOL DRY PLACE.

LABEL PRECAUTIONARY STATEMENTS
HARMFUL
HARMFUL IF SWALLOWED.
POSSIBLE RISK OF IRREVERSIBLE EFFECTS.
POSSIBLE CARCINOGEN.
WEAR SUITABLE PROTECTIVE CLOTHING.
DO NOT BREATHE DUST.

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 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.

MSDS DATE: 12/28/90
CHANGE NO.: 8745

For Assistance, Contact:
Regulatory Affairs Dept.
PO Box 907 Ames, IA 50010
(800) 227-4224

HACH COMPANY
PO BOX 907
AMES, IA 50010

Emergency Telephone #
Rocky Mountain Poison Ctr.
(303) 623-5716

I. PRODUCT IDENTIFICATION

PRODUCT NAME: PhosVer ® 3
CAS NO.: NA CHEMICAL NAME: Not applicable
FORMULA: Not applicable CHEMICAL FAMILY: Not applicable

II. INGREDIENTS

Potassium Pyrosulfate
PCT: <80 CAS NO.: 7790-62-7 SARA: NOT LISTED
TLV: Not established PEL: Not established
HAZARD: Aqueous solution is strongly acidic

L-Ascorbic Acid
PCT: <25 CAS NO.: 50-81-7 SARA: NOT LISTED
TLV: Not established PEL: Not established
HAZARD: May cause irritation

Sodium Molybdate
PCT: <5 CAS NO.: 7631-95-0 SARA: NOT LISTED
TLV: 5 mg/M3 as Mo PEL: 5 mg/M3 as Mo
HAZARD: Moderately toxic; may cause irritation

Other components, each
PCT: <1 CAS NO.: NA SARA: NOT LISTED
TLV: Not applicable PEL: Not applicable
HAZARD: Not applicable

Any component of this mixture not specifically listed (eg. "other components") is not considered to present a carcinogen hazard.

III. PHYSICAL DATA

STATE: solid APPEARANCE: White powder ODOR: None
SOLUBILITY IN: WATER: Soluble ACID: Soluble OTHER: Not determined
BOILING POINT: NA MELTING PT.: 190C SPEC GRAVITY: 2.17
pH: of 5% soln = 1.1 VAPOR PRESSURE: Not applicable
VAPOR DENSITY (air=1): NA EVAPORATION RATE: NA
METAL CORROSIVITY - ALUMINUM: 0.108 in /yr STEEL: 0.322 in/yr
STABILITY: See Conditions to Avoid
STORAGE PRECAUTIONS: Store in a cool, dry, dark place.

IV. FIRE, EXPLOSION HAZARD AND REACTIVITY DATA

FLASH PT.: Not applicable METHOD: NA
FLAMMABILITY LIMITS - LOWER: NA UPPER: NA
SUSCEPTIBILITY TO SPONTANEOUS HEATING: None
SHOCK SENSITIVITY: None AUTOIGNITION PT.: ND
EXTINGUISHING MEDIA: water, carbon dioxide, or dry chemical
FIRE/EXPLOSION HAZARDS: May emit toxic fumes in fire
HAZARDOUS DECOMP. PRODUCTS: May emit toxic fumes of sulfur oxides in fire
OXIDIZER: No NFPA Codes: Health: 2 Flammability: 1 Reactivity: 0
CONDITIONS TO AVOID: Heat, flames, exposure to light or moisture, contamination with phosphates; contact with oxidizers, dyes, alkalies, iron or copper

V. HEALTH HAZARD DATA

THIS PRODUCT MAY BE: corrosive to eyes, wet skin and respiratory tract.
ACUTE TOXICITY: Moderately toxic
ROUTES OF EXPOSURE: ingestion, inhalation
TARGET ORGANS: liver
CHRONIC TOXICITY: Not determined
ROUTES OF EXPOSURE: Not determined
TARGET ORGANS: Not determined
CANCER INFORMATION: carcinogenicity testing in progress for a component of this product
ROUTES OF EXPOSURE: Not determined
TARGET ORGANS: Not determined
OVEREXPOSURE: Causes burns. May affect enzyme activity, induce copper deficiency, may cause anemia, gout or liver damage. May cause loss of coordination and appetite, listlessness or diarrhea.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Chronic respiratory conditions, blood disease, gout may be aggravated by exposure to molybdenum compounds.

VI. PRECAUTIONARY MEASURES

Caution. Protect from light.
Protect from moisture
Avoid contact with eyes, skin and clothing
Do not breathe dust.
Wash thoroughly after handling.

PROTECTIVE EQUIPMENT: fume hood, rubber gloves, safety glasses, lab coat

VII. FIRST AID

EYE AND SKIN CONTACT: Immediately flush eyes with water for 15 minutes. Cal physician. Remove contaminated clothing. Wash skin with soap and plenty c water.
INGESTION: Do NOT induce vomiting. Give 1 - 2 glasses of water. Call a physician immediately. Never give anything by mouth to an unconscious person.
INHALATION: Remove to fresh air. Give artificial respiration if necessary. Call physician.

VIII. SPILL AND DISPOSAL PROCEDURES

IN CASE OF SPILL OR RELEASE: Cover the contaminated surface with sodium bicarbonate or a soda ash-slaked lime mixture (50-50). Mix and add water if necessary to form a slurry. Scoop up slurry and wash the site with soda ash solution. The neutralized slurry may contain sufficient heavy metal concentration to require landfilling or treatment at an EPA approv· site.
DISPOSE OF IN ACCORDANCE WITH ALL FEDERAL, STATE, AND LOCAL REGULATIONS.

IX. TRANSPORTATION DATA

D.O.T. PROPER SHIPPING NAME: Corrosive Solid, N.O.S. (Potassium Pyrosulfate)
HAZARD CLASS: Corrosive Material ID: UN1759

I.C.A.O. PROPER SHIPPING NAME: Corrosive Solid, N.O.S. (Potassium Pyrosulpte)
HAZARD CLASS: 8 ID: UN1759 GROUP: II

I.M.O. PROPER SHIPPING NAME: Corrosive Solid, N.O.S. (Potassium Pyrosulphe te)
HAZARD CLASS: 8 ID: UN1759 GROUP: II

X. REFERENCES

1) TLV's Threshold Limit Values and Biological Exposure Indices for 1988-1989. American Conference of Governmental Industrial Hygienists, 1988.
2) Air Contaminants, Federal Register, Vol. 54, No. 12, Thursday, January 19, 1989. pp. 2332-2983.
3) In-house information
4) Technical judgment
5) NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. Cincinnati: Department of Health and Human Services, 1981.

aldrich chemical co.
P.O. Box 355, Milwaukee, Wisconsin 53201 USA

TWX: (910) 262-3052 Aldrichem MI
Telex: 26 843 Aldrich MI
FAX: (414) 273-4979

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312 DIRECTORS DR
KNOXVILLE TN 37923
MICHAEL KRSTICH

DATE: 06/26/89
CUST # 427195 P.O. #

MATERIAL SAFETY DATA SHEET

PAGE:

IDENTIFICATION

PRODUCT # 27056-3 NAME: **DICHLOROMETHANE, 99.9%, HPLC GRADE**
CAS # 75-09-2
MF: CH2CL2
SYNONYMS
AEROTHENE MM * CHLORURE DE METHYLENE (FRENCH) * DCM * DICHLOROMETHANE * DICHLOROMETHANE (DOT,OSHA) * METHANE DICHLORIDE * METHYLENE BICHLORIDE * METHYLENE CHLORIDE * METHYLENE CHLORIDE (ACGIH,DOT,OSHA) * METHYLENE DICHLORIDE * METYLENU CHLOREK (POLISH) * NARKOTIL * NCI-C50102 * R 30 * RCRA WASTE NUMBER U080 * SOLAESTHIN * SOLMETHINE * UN 1593 (DOT) *

TOXICITY HAZARDS

RTECS # PA8050000
METHANE, DICHLORO-
IRRITATION DATA

SKN-RBT 810 MG/24H SEV	EJTXAZ 9,171,76
SKN-RBT 100 MG/24H MOD	85JCAE -,88,86
EYE-RBT 162 MG MOD	EJTXAZ 9,171,76
EYE-RBT 10 MG MLD	TXCYAC 6,173,76
EYE-RBT 500 MG/24H MLD	85JCAE -,88,86

TOXICITY DATA

ORL-HMN LDLO:357 MG/KG	34ZIAG -,390,69
ORL-RAT LD50:1600 MG/KG	FAONAU 48A,94,70
IHL-RAT LC50:88000 MG/M3/30M	FAVUAI 7,35,75
IPR-RAT LD50:916 MG/KG	ENVRAL 40,411,86
IHL-MUS LC50:14400 PPM/7H	NIHBAZ 191,1,49
IPR-MUS LD50:437 MG/KG	AGGHAR 18,109,60
SCU-MUS LD50:6460 MG/KG	TXAPA9 4,354,62
UNR-MUS LD50:4770 MG/KG	ESKGA2 28,P31,82

REVIEWS, STANDARDS, AND REGULATIONS
ACGIH TLV-TWA 50 PPM 85INA8 5,391(86),86
ACGIH TLV-SUSPECTED CARCINOGEN 85INA8 5,391(86),86
IARC CANCER REVIEW:ANIMAL SUFFICIENT EVIDENCE IMEMDT 41,43,86
IARC CANCER REVIEW:ANIMAL INADEQUATE EVIDENCE IMEMDT 20,449,79
IARC CANCER REVIEW:HUMAN INADEQUATE EVIDENCE IMEMDT 41,43,86
IARC CANCER REVIEW:GROUP 2B IMSUDL 7,194,87
MSHA STANDARD-AIR:TWA 500 PPM (1750 MG/M3) DTLVS* 3,171,71
OSHAPEL:8H TWA 500 PPM;CL 1000 PPM;PK 2000 PPM/5M/2H FEREAC 54,2923,89
NIOSH REL TO METHYLENE CHLORIDE-AIR:TWA REDUCED TO LOWEST LEVEL MMWR** 37(S-7),19,88
EPA GENETOX PROGRAM 1988, POSITIVE: CELL TRANSFORM.-RLV F344 RAT EMBRYO
EPA GENETOX PROGRAM 1988, POSITIVE: HISTIDINE REVERSION-AMES TEST
EPA GENETOX PROGRAM 1988, POSITIVE: S CEREVISIAE GENE CONVERSION; S CEREVISIAE-HOMOZYGOSIS
EPA GENETOX PROGRAM 1988, POSITIVE: S CEREVISIAE-REVERSION
EPA GENETOX PROGRAM 1988, NEGATIVE: D MELANOGASTER SEX-LINKED LETHAL
EPA TSCA CHEMICAL INVENTORY, 1986
EPA TSCA 8(A) PRELIMINARY ASSESSMENT INFORMATION, FINAL RULE FEREAC 47,26992,82
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0680-0345;8EHQ-0180-0324
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, JANUARY 1989
NIOSH CURRENT INTELLIGENCE BULLETIN 46, 1986

MATERIAL SAFETY DATA SHEET

CATALOG # 27056-3 NAME: DICHLOROMETHANE, 99.9%, HPLC GRADE

NIOSH ANALYTICAL METHODS: SEE METHYLENE CHLORIDE, 1005
NTP CARCINOGENESIS STUDIES (INHALATION);CLEAR EVIDENCE:MOUSE,RAT NTPTR* NTP-TR-306,86
NTP CARCINOGENESIS STUDIES;ON TEST (TWO YEAR STUDIES), FEBRUARY 1989
OSHA ANALYTICAL METHOD #ID-59
MEETS CRITERIA FOR PROPOSED OSHA MEDICAL RECORDS RULE FEREAC 47,30420, 82

TARGET ORGAN DATA
PERIPHERAL NERVE AND SENSATION (PARESTHESIA)
BEHAVIORAL (ALTERED SLEEP TIME)
BEHAVIORAL (EUPHORIA)
BEHAVIORAL (SOMNOLENCE)
BEHAVIORAL (CONVULSIONS OR EFFECT ON SEIZURE THRESHOLD)
BEHAVIORAL (ATAXIA)
CARDIAC (CHANGE IN RATE)
LUNGS, THORAX OR RESPIRATION (TUMORS)
LIVER (LIVER FUNCTION TESTS IMPAIRED)
SKIN AND APPENDAGES (TUMORS)
SPECIFIC DEVELOPMENTAL ABNORMALITIES (MUSCULOSKELETAL SYSTEM)
SPECIFIC DEVELOPMENTAL ABNORMALITIES (UROGENITAL SYSTEM)
TUMORIGENIC (CARCINOGENIC BY RTECS CRITERIA)
TUMORIGENIC (EQUIVOCAL TUMORIGENIC AGENT BY RTECS CRITERIA)

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

----------------- HEALTH HAZARD DATA -----------------

ACUTE EFFECTS
HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN.
VAPOR OR MIST IS IRRITATING TO THE EYES, MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.
CAUSES SKIN IRRITATION.
EXPOSURE CAN CAUSE:
NAUSEA, DIZZINESS AND HEADACHE
MAY CAUSE NERVOUS SYSTEM DISTURBANCES.
CHRONIC EFFECTS
DAMAGE TO THE LIVER
DAMAGE TO THE KIDNEYS
POSSIBLE CARCINOGEN.
LABORATORY EXPERIMENTS HAVE SHOWN MUTAGENIC EFFECTS.
FIRST AID
IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS AMOUNTS OF WATER.
CONTAMINATION OF THE EYES SHOULD BE TREATED BY IMMEDIATE AND PROLONGED IRRIGATION WITH COPIOUS AMOUNTS OF WATER.
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.
CALL A PHYSICIAN.
WASH CONTAMINATED CLOTHING BEFORE REUSE.
ADDITIONAL INFORMATION
DICHLOROMETHANE IS METABOLIZED IN THE BODY PRODUCING CARBON MONOXIDE WHICH INCREASES AND SUSTAINS CARBOXYHEMOGLOBIN LEVELS IN THE BLOOD, REDUCING THE OXYGEN-CARRYING CAPACITY OF THE BLOOD.

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MATERIAL SAFETY DATA SHEET

PAGE:

CATALOG # 27056-3 NAME: DICHLOROMETHANE, 99.9%, HPLC GRADE

---PHYSICAL DATA---

MELTING POINT: -97 C
BOILING POINT: 39.8 C TO 40 C
SPECIFIC GRAVITY: 1.325
VAPOR DENSITY: 2.9
VAPOR PRESSURE: 340.0 MM @ 20 C
420.0 MM @ 25 C
APPEARANCE: COLORLESS LIQUID

--- FIRE AND EXPLOSION HAZARD DATA ---

AUTO IGNITION TEMP.: 1223 F
LOWER EXPLOSION LEVEL: 12%
UPPER EXPLOSION LEVEL: 19% @ 100 C
FLASH POINT: NONE

EXTINGUISHING MEDIA
NONCOMBUSTIBLE.
USE EXTINGUISHING MEDIA APPROPRIATE TO SURROUNDING FIRE CONDITIONS.

SPECIAL FIRE FIGHTING PROCEDURES
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.

UNUSUAL FIRE AND EXPLOSION HAZARDS
EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

--- REACTIVITY DATA ---

INCOMPATIBILITIES
ALKALI METALS
ALUMINUM
HEAT

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
CARBON MONOXIDE, CARBON DIOXIDE
HYDROGEN CHLORIDE GAS
PHOSGENE GAS

--- SPILL OR LEAK PROCEDURES ---

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
EVACUATE AREA.
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY RUBBER GLOVES.
ABSORB ON SAND OR VERMICULITE AND PLACE IN CLOSED CONTAINERS FOR DISPOSAL.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

WASTE DISPOSAL METHOD
THE MATERIAL SHOULD BE IGNITED IN THE PRESENCE OF SODIUM CARBONATE AND SLAKED LIME (CALCIUM HYDROXIDE). THE SUBSTANCE SHOULD BE MIXED WITH VERMICULITE AND THEN WITH THE DRY CAUSTICS, WRAPPED IN PAPER AND BURNED IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.

OBSERVE ALL FEDERAL, STATE & LOCAL LAWS.

--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ----

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.
USE ONLY IN A CHEMICAL FUME HOOD.
SAFETY SHOWER AND EYE BATH.
DO NOT BREATHE VAPOR.
AVOID CONTACT WITH EYES, SKIN AND CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.

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Aldrich Chemie N.V./S.A.
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Aldrich-Chemie GmbH & Co. KG
D-7924 Steinheim
Telephone: (07329) 870
Telex: 714838 Aldri D
FAX: (07329) 87139

MATERIAL SAFETY DATA SHEET

CATALOG # 27056-3 NAME: DICHLOROMETHANE, 99.9%, HPLC GRADE

READILY ABSORBED THROUGH SKIN.
WASH THOROUGHLY AFTER HANDLING.
TOXIC.
POSSIBLE CARCINOGEN.
IRRITANT.
NEUROLOGICAL HAZARD.
POSSIBLE MUTAGEN.
KEEP TIGHTLY CLOSED.
KEEP AWAY FROM HEAT AND OPEN FLAME.
STORE UNDER NITROGEN.
STORE IN A COOL DRY PLACE.

---------- ADDITIONAL PRECAUTIONS AND COMMENTS ---------

NOT APPLICABLE

---------------- REGULATORY INFORMATION ----------------

THIS PRODUCT IS SUBJECT TO SARA SECTION 313 REPORTING REQUIREMENTS.

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. ALDRICH 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.

MALLINCKRODT

Material Safety Data Sheet

Mallinckrodt, Inc. Science Products Division, P.O. Box M Paris, KY 40361

Emergency Telephone Number: 314-982-5000

HYDROCHLORIC ACID (10%-22%)

PRODUCT IDENTIFICATION:

Synonyms: Muriatic acid; hydrochloric acid diluted

Formula CAS No.: 7647-01-0

Molecular Weight: 36.46

Chemical Formula: HCl

Hazardous Ingredients: Hydrochloric acid

PRECAUTIONARY MEASURES

DANGER! CORROSIVE. CAUSES SEVERE BURNS.
MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED.

Do not get in eyes, on skin, or on clothing.
Avoid breathing mist.
Keep container closed.
Use with adequate ventilation.
Wash thoroughly after handling.
This substance is classified as a POISON under the Federal Caustic Poison Act.

EMERGENCY/FIRST AID

If swallowed, DO NOT INDUCE VOMITING! Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. In all cases call a physician.
SEE SECTION 5.

DOT Hazard Class: Corrosive Material

SECTION 1 Physical Data

Appearance: Clear, colorless liquid.

Odor: Odorless.

Solubility: Infinitely soluble in water.

Boiling Point: 101-103°C (214-217°F).

Melting Point: ca. -5 - -11°C (23-12°F).

Specific Gravity: ca. 1.15-1.10

Vapor Density (Air = 1): No information found.

Vapor Pressure (mm Hg): No information found.

Evaporation Rate: No information found.

SECTION 2 Fire and Explosion Information

Fire:
Not considered to be a fire hazard. May react with metals to release flammable hydrogen gas.

Explosion:
Not considered to be an explosion hazard.

Fire Extinguishing Media:
Water or water spray. Neutralize with soda ash or slaked lime.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

SECTION 3 Reactivity Data

Stability:
Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:
Emits toxic fumes of hydrogen chloride when heated to decomposition.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
A strong mineral acid, concentrated hydrochloric acid is highly reactive with strong bases, metals, metal oxides, hydroxides, amines, carbonates and other alkaline materials. Incompatible with materials such as cyanides, sulfides, sulfites, and formaldehyde.

SECTION 4 Leak/Spill Disposal Information

Clean-up personnel should wear protective clothing and respiratory equipment suitable for toxic or corrosive fluids or vapors. Isolate or enclose the area of the leak or spill. Small Spills: Neutralize with alkaline material (soda ash, lime, etc.) and flush with water. Larger spills and lot sizes: Provide forced ventilation to dissipate fumes. Neutralize with alkaline material, pick up with absorbent material (sand, earth, vermiculite). Dispose in a RCRA-approved waste facility.

Reportable Quantity (RQ)(CWA/CERCLA) : 5000 lbs.

Ensure compliance with local, state and federal regulations.

AD

NFPA Ratings: Health: 3 Flammability: 0 Reactivity: 0

SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhalation:
Corrosive! Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract.

Ingestion:
Corrosive! Swallowing hydrochloric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract. May cause nausea, vomiting, and diarrhea.

Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and discolor skin.

Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Splashes may cause severe burns and permanent eye damage.

Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth. Long term exposures seldom occur due to the corrosive properties of the acid.

Aggrevation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

B. FIRST AID

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Exposure:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Eye Exposure:
Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA (RTECS, 1986)

Hydrochloric acid: Inhalation rat LC50: 3124 ppm/1H
Oral rabbit LD50: 900 mg/kg Mutation references cited.

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
5 ppm (TWA) Ceiling
-ACGIH Threshold Limit Value (TLV):
5 ppm (TWA) Ceiling

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommended Practices", most recent edition, for details.

Personal Respirators: (NIOSH Approved)
If the TLV is exceeded a full facepiece chemical cartridge respirator may be worn, in general, up to 100 times the TLV or the maximum use concentration specified by the respirator supplier, whichever is less. Alternatively, a supplied air full facepiece respirator or airlined hood may be worn.

Skin Protection:
Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Contact lenses should not be worn when working with this material. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances.

……

MALLINCKRODT

Material Safety Data Sheet

Mallinckrodt, Inc. Science Products Division, P.O. Box M Paris, KY 40361

Emergency Telephone Number: 314-982-5000

Addendum to Material Safety Data Sheet

REGULATORY STATUS

This Addendum Must Not Be Detached from the MSDS

Identifies SARA 313 substance(s)

Any copying or redistribution of the MSDS must include a copy of this addendum

(Chem.Key: CHLAC)

Hazard Categories for SARA Section 311/312 Reporting .

Acute	Chronic	Fire	Pressure	Reactive
X	X			

Product or Components of Product:	SARA EHS Sect. 302 RQ (lbs.)	SARA EHS Sect. 302 TPQ (lbs.)	SARA Section 313 Chemicals Name List	SARA Section 313 Chemicals Chemical Category	CERCLA Sec.103 RQ (lbs.)	RCRA Sec. 261.33
HYDROCHLORIC ACID (10%-22%) codes: H151 H168 2608 The following percentages correspond one to one with the product codes given here.						
Hydrogen chloride (7647-01-0) 10%, 10%, 22%	1	500gas	Yes	No	5000 (HCl acid)	No

SARA Section 302 EHS RQ: Reportable Quantity of Extremely Hazardous Substance, listed at 40 CFR 355.
SARA Section 302 EHS TPQ: Threshold Planning Quantity of Extremely Hazardous Substance. An asterisk (*) following a Threshold Planning Quantity signifies that if the material is a solid and has a particle size equal to or larger than 100 micrometers, the Threshold Planning Quantity = 10,000 LBS.
SARA Section 313 Chemicals: Toxic Substances subject to annual release reporting requirements listed at 40 CFR 372.65.
CERCLA Sec. 103: Comprehensive Enviromental Response, Compensation and Liability Act (Superfund). Releases to air, land or water of these hazardous substances which exceed the Reportable Quantity (RQ) must be reported to the National Response Center, (800-424-8802); Listed at 40 CFR 302.4
RCRA: Resource Conservation and Reclamation Act. Commercial chemical product wastes designated as acute hazards and toxic under 40 CFR 261.33

Mallinckrodt
Material Safety Data

Emergency Phone Number: 314-539-1600

Mallinckrodt, Inc., Science Products Division, P.O. Box 800, Paris, KY 40362.

SODIUM HYDROXIDE, VOLUMETRIC SOLUTIONS

PRODUCT IDENTIFICATION:

Synonyms: Sodium hydroxide, 0.2 to 1.0 normal volumetric solutions

Formula CAS No.: 1310-73-2

Molecular Weight: 40.00

Chemical Formula: $NaOH$

Hazardous Ingredients: Not applicable.

PRECAUTIONARY MEASURES

WARNING! HARMFUL IF SWALLOWED. MAY CAUSE IRRITATION TO SKIN, EYES, RESPIRATORY TRACT AND GASTROINTESTINAL TRACT.

Avoid breathing mist.
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.

EMERGENCY/FIRST AID

If swallowed, DO NOT induce vomiting. Give large quantities of water or milk if available. Call a physician immediately. Never give anything by mouth to an unconscious person. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. If inhaled, remove to fresh air. Get medical attention for any breathing difficulty. In all cases call a physician.
SEE SECTION 5.

DOT Hazard Class: Corrosive Material

SECTION 1 Physical Data

Appearance: Clear, colorless solution.

Odor: Odorless.

Solubility: Miscible with water.

Boiling Point: ca. 100°C (212°F).

Melting Point: ca. 0°C (32°F).

Specific Gravity: 1.0-1.05

Vapor Density (Air=1): No information found.

Vapor Pressure (mm Hg): No information found.

Evaporation Rate: No information found.

SECTION 2 Fire and Explosion Information

Fire:
Not considered to be a fire hazard.

Explosion:
Not considered to be an explosion hazard.

Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.

Special Information:
Use protective clothing and breathing equipment appropriate for the surrounding fire.

SECTION 3 Reactivity Data

Stability:
Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:
None.

Hazardous Polymerization:
This substance does not polymerize.

Incompatibilities:
Acids, aluminum, tin and zinc metals.

SECTION 4 Leak/Spill Disposal Information

Caution! Floor and other surfaces may be slippery. Ventilate area of leak or spill. Clean-up personnel require protective clothing. Contain and recover liquid when possible. Spills: Absorb with vermiculite, dry sand, earth, or similar material for disposal as hazardous waste in a RCRA approved facility. Alternatively, spills can be neutralized with dilute acid and disposed of as non-hazardous waste. Reportable Quantity (RQ)(CWA/CERCLA): 1000 lbs. sodium hydroxide.

Ensure compliance with local, state and federal regulations.

SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhalation:
Mists are irritants to respiratory tract.

Ingestion:
Corrosive. Swallowing may cause burns of the mouth, throat and stomach.

Skin Contact:
Can be corrosive to skin. May cause irritation.

Eye Contact:
Corrosive to eye tissues. Can cause burns.

Chronic Exposure:
Prolonged contact can dehydrate and remove oils from skin.

Aggrevation of Pre-existing Conditions:
Persons with pre-existing skin disorders may be susceptible to these solutions.

B. FIRST AID

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.

Ingestion:
If swallowed, DO NOT induce vomiting. Give large quantities of water or milk if available. Call a physician immediately. Never give anything by mouth to an unconscious person.

Skin Exposure:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician immediately.

Eye Exposure:
Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA (RTECS, 1986)

Sodium Hydroxide: Irritation skin rabbit: 50 mg/24H severe Irritation eye rabbit: 50 mg/24H severe

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):
2 mg /m^3 Ceiling

-ACGIH Threshold Limit Value (TLV):
2 mg/m^3 Ceiling

Ventilation System:
In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.

Personal Respirators: (NIOSH Approved)
Not expected to require personal respirator usage.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing from solutions is possible. Contact lenses should not be worn when working with this material. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Keep in a tightly closed container. Store in a cool, dry, ventilated area. Protect against physical damage. Separate from acids and alkalies. Protect from freezing.

••

XIDEV

Addendum to Material Safety Data Sheet

REGULATORY STATUS

This Addendum Must Not Be Detached from the MSDS

Identifies SARA 313 substance(s)

Any copying or redistribution of the MSDS must include a copy of this addendum

(Chem.Key: XIDEV)

Hazard Categories for SARA
Section 311/312 Reporting

Acute	Chronic	Fire	Pressure	Reactive
X				

Product or Components of Product:	SARA EHS Sect. 302 RQ (lbs.)	SARA EHS Sect. 302 TPQ (lbs.)	SARA Section 313 Chemicals Name List	SARA Section 313 Chemicals Chemical Category	CERCLA Sec.103 RQ (lbs.)	RCRA Sec. 261.33
SODIUM HYDROXIDE, VOLUMETRIC SOLUTIONS codes: H361 H364 H380 H377 4693 The following percentages correspond one to one with the product codes given here.						
Sodium hydroxide (1310-73-2) 0.8%, 1.6%, 2%, 4%, 4%	No	No	Yes	No	1000	No

SARA Section 302 EHS RQ: Reportable Quantity of Extremely Hazardous Substance, listed at 40 CFR 355.
SARA Section 302 EHS TPQ: Threshold Planning Quantity of Extremely Hazardous Substance. An asterisk (*) following a Threshold Planning Quantity signifies that if the material is a solid and has a particle size equal to or larger than 100 micrometers, the Threshold Planning Quantity = 10,000 LBS.
SARA Section 313 Chemicals: Toxic Substances subject to annual release reporting requirements listed at 40 CFR 372.65.
CERCLA Sec. 103: Comprehensive Enviromental Response, Compensation and Liability Act (Superfund). Releases to air, land or water of these hazardous substances which exceed the Reportable Quantity (RQ) must be reported to the National Response Center, (800-424-8802); Listed at 40 CFR 302.4
RCRA: Resource Conservation and Reclamation Act. Commercial chemical product wastes designated as acute hazards and toxic under 40 CFR 261.33

Effective Date: 04-06-89 Supersedes 11-05-85

EIMCO
Process Equipment Company
A Baker Hughes Company

414 West 300 South
Salt Lake City, UT 84110
FAX: (801) 526-2425
Phone: (801) 526-2311

Technology & Development
Advertising

FAX TRANSMITTAL

TO:	Kandy Brown IT Corporation	**DATE:**	20 Aug 92
		PAGE 1 OF	3
		FAX #:	615/690-3826
FROM:	Doug Hanify	**DEPT.:**	T&D

SUBJECT: Soil Slurry Evaluation

MESSAGE: Attached is the SOP for determining the solids concentration that would be allowable in the reactor. Generally, we would generate a range of conditions based on different particle size fraction splits.

As we discussed the other day, one of the most important determinations to make would be concentration of hazardous contaminants in each particle size fraction. Additionally evaluating the washing efficiency ~~of~~ on these fractions would be very useful for the overall flowsheet development.

Please let me know if you have any questions, my number is 801/526-2422.

cc. G. Bray
R. Emmett

SOIL SLURRY EVALUATION
FOR USE IN THE
EIMCO BIOLIFT^R REACTOR

Description The following outlines a general procedure for the evaluation of soil slurries that are under consideration for biotreatment in the EIMCO Biolift Reactor. The purpose of this evaluation is to determine the largest particle size fraction to be suspended with a corresponding lower limit in slurry concentration.

Procedure

1. Wet screen approximately one kilogram of soil sample to pass a 200 mesh (75 μm) screen; this material comprises the fine fraction.
2. Thicken that "watery" slurry.
3. Decant the supernatant water from the fine slurry.
4. Dry the +200 mesh sample, this material is the coarse fraction. Vibrate the material on the shaker to make sure the fines have been removed. Add the -200 mesh material collected to the fine fraction.
5. Measure the solids concentration of the fine fraction.
6. Dry screen the +200 mesh portion to produce a sieve curve.
7. From the solids concentration of the fine fraction determine the mass of dry solids in the slurry.
8. Using available data relating contaminant concentration versus particle size, decide on the largest particle size fraction to be suspended.
9. Add up the total mass of coarse solids to be suspended.
10. Establish the ratio of mass of fine solids to coarse solids.
11. Using the solids concentration of the fine slurry, and adding the coarse solids to be suspended, produce a very thick slurry. This slurry does need to be pumpable.

12. Pour the slurry into a cylinder and let it settle for approximately 10 minutes. Observe the sample for a water layer to break out and monitor if there is an obvious layer of coarse solids building up on the bottom.

13. After about 10 minutes, slowly pour the slurry into a beaker, tipping the cylinder to a maximum angle of 10° above horizontal for 20 to 30 seconds, and observe how much, if any, sediment remains on the bottom of the cylinder.

14. If there is a small amount of sediment on the bottom of the cylinder, then add enough water to the slurry to decrease the solids concentration by approximately 5%.

15. Pour that diluted slurry back into the cylinder.

16. Continue to repeat steps 12 to 14 until a distinct sediment layer has formed on the bottom of the cylinder.

17. The concentration of solids that was the "thinnest" that did not allow coarse solids to settle out within the 10 minutes should be used as the target slurry concentration.

Note: It is recommended that the above procedure be performed by EIMCO's Technology and Development staff prior to utilizing the Biolift^R Reactor in a soil remediation flowsheet.

INTERNATIONAL TECHNOLOGY CORPORATION

IT Biotechnology Applications Center
pH Analysis
Standard Operating Procedure

NUMBER: BAC014

Approved By:

Duane Graves 3/13/92

Duane Graves, Ph.D. (Date)
Process Development Supervisor

James J. King 3/13/92

James J. King (Date)
General Manager/QA Officer

KLB/03-92/SMC/pH.sop

Regional Office
312 Directors Drive • Knoxville, Tennessee 37923 • 615-690-3211

IT Corporation is a wholly owned subsidiary of International Technology Corporation

STANDARD OPERATING PROCEDURE

pH ANALYSIS

1.0 Equipment

- 40-milliliter (mL) glass vial
- pH meter with reference electrode
- pH 4, 7, and 10 standardization buffers
- 5-mL pipette
- Deionized (DI) water.

2.0 Procedure

1. Weigh 5 grams (g) of air-dried soil into the 40-mL vial or place 10 mL of aqueous sample into a vial.

2. With the pipette, add 5 mL of DI water.

3. Mix thoroughly for 10 seconds.

4. Let stand for 10 minutes.

5. Calibrate the pH meter with the standardization buffers.

6. Insert the pH electrode into the soil suspension and swirl gently.

7. Read the pH on the calibrated pH meter. Record as soil pH in water.

8. Procedure derived from U.S. EPA Method 150.1 and Methods of Soil Analysis Part 2, Second Edition, pp 206-207.

IT Biotechnology Applications Center
Bioreactor Flow Calibration
Standard Operating Procedure

NUMBER: BAC026

Approved by:

Duane Graves 8/24/92

Duane Graves, Ph.D. (Date)

for JJK 8/24/92

James J. King (Date)
General Manager/QA Officer

STANDARD OPERATING PROCEDURE

BIOREACTOR FLOW CALIBRATION

1.0 Principle

Procedure describes the method for calibrating bioreactor flow rates. The calibration of flow rates assures adequate control of the system biological solids retention time (BSRT) and hydraulic retention time (HRT) during operation.

2.0 Equipment

- Graduated cylinders
- Masterflex™ and Randolph™ pumps
- Tubing
- Stopwatch

3.0 Procedure

1. Bioreactor flow rates maintained by pumps rather than gravity should be calibrated daily to ensure accurate operation of the system.

2. All flow rates for influent feed, effluent waste, waste activated sludge (WAS), return activated sludge (RAS), and various recycle flows should be documented in the laboratory notebook prior to system startup. If flow rates are changed during the course of the bioreactor investigation, the change in rates for all flows, as well as the change in retention times, should be documented and approved by the project manager and witnessed by laboratory technicians maintaining the system.

3. All pumps should be maintained and calibrated in accordance with the manufacture's requirements.

4. The calibration of pumps and flow rates should be manually checked using graduated cylinders and a stopwatch.

5. Place tubing into graduated cylinder. Note volume of material in cylinder and begin timing using a stopwatch. Record volume of cylinder following one minute. Calculate flow rate in milliliters per minute (mL/min) and record in laboratory notebook. Repeat the process for all system flows.

6. If the measured flow is not accurate, manually adjust the pump speed and remeasure the flow rate. Repeat the process for all system flows.

7. Record all initial flow rates, all calibrated flow rates, and any additional observations or changes made during calibration.

4.0 Calculations

Report calculated flow rates in mL/min.

5.0 Quality Control Requirements

Record all flow rates measured, as well as adjusted in the laboratory notebook dedicated to the specific project in operation. Have all calculations peer reviewed. Documentation of the review is the dated signature at the bottom of the notebook page.