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May 2, 1986

Ms. Anne Marie McManus
Malcolm Pirnie, Inc.
3619 Packard Road
Niagara Falls, New York 14303

Dear Ms. McManus,

Enclosed you will find three documents concerning the Bengart & Memel site in Buffalo, New York.

- Bengart and Memel Soil Screen for PCB Concentrations which presents the analytical results along with detailed procedures
- Proposal for Chemical Decontamination of PCB Contaminated Soils at the Bengart & Memel site in Buffalo, New York which outlines the technical aspects of the procedure
- Comparison of Laboratory and Field Data in the Chemical Decontamination of Dioxin Contaminated Soils which was presented by Robert L. Peterson, P. E. before the Division of Environmental Chemistry, American Chemical Society in New York, New York, April 1986

This literature is simultaneously being sent to the USEPA and the NYSDEC, so a schedule should be negotiated in the near future. In any event this brings you up to date with the activities here at Galson Research Corp. If you have any questions or comments, please call either me or Robert Peterson.

Sincerely,

Carl Novosad

Carl Novosad

Galson Research Corporation

PROPOSAL FOR CHEMICAL DECONTAMINATION OF PCB CONTAMINATED SOILS AT THE BENGART AND MEMEL SITE IN BUFFALO, NEW YORK

Galson Research Corporation, E. Syracuse, NY

SUMMARY OF THE PROPOSAL

One hundred sixty-six drums of soil at the Bengart & Memel site in Buffalo, NY have been analyzed for PCB concentration. Ninety-four contain PCB levels in excess of 50 parts per million. It is proposed to decontaminate the soil in these drums using the Galson Terraclene-Cl process. The Terraclene-Cl technology has already been successfully tested under EPA sponsorship using Bengart & Memel soil in both laboratory and pilot scale demonstrations.

The Terraclene-Cl process entails the mixing and heating of a liquid reagent/contaminated soil mixture until the PCBs in the soil decompose to lower toxicity, water soluble materials. The reagent components are dimethyl sulfoxide (DMSO), polyethylene glycol 400 (PEG), triethylene glycol methyl ether and highers (TMH), and potassium hydroxide (KOH).

The treatment scheme to be used at Bengart and Memel makes use of standard equipment to lower design costs, minimize construction time and expedite the completion of the project. New open top 55 gallon drums with double bunged lids will be used as the reaction vessels. The drums currently holding the soil have been inspected and are not adequate for processing, being neither watertight nor sealable with a standard drum lid. Therefore, it will be necessary to move the soil to new drums before the processing can take place. Figures 1,2,3 and 4 on the following pages show the details of the processing equipment.

Soil decontamination using the Terraclene-Cl process involves 6 steps;

1. Transfer contaminated soil to new drums.
2. Add reagent to reaction drums.
3. Attach heaters, insulation, and vent lines to the reaction drums.
4. Allow drum contents to heat and react.
5. Decant excess reagent from drums.
6. Seal drums and either neutralize or dispose of as caustic waste.

The transfer of soil requires a funnel to prevent spillage (figure 2); if dust is a problem, the soil can be wetted with glycol before the transfer. The reaction drums will be filled to near capacity with contaminated soil, supersaturated with reagent (20% reagent by weight), and sealed with a standard lid. The equipment to be attached to each drum for processing (see Figure 1) includes a drum heater and insulation, a thermometer (3/4" bung) and a vapor vent (2" bung). The vapor containment system (figure 1) will accept up to 16 drums. The drums will be held at the reaction temperature for 24-48 hours. Following a cool down period, the excess reagent will be decanted (figure 3) and recycled. The decontaminated soil will then be either neutralized or made ready for landfilling as an alkaline waste.

Figure 1. - Vapor Control System

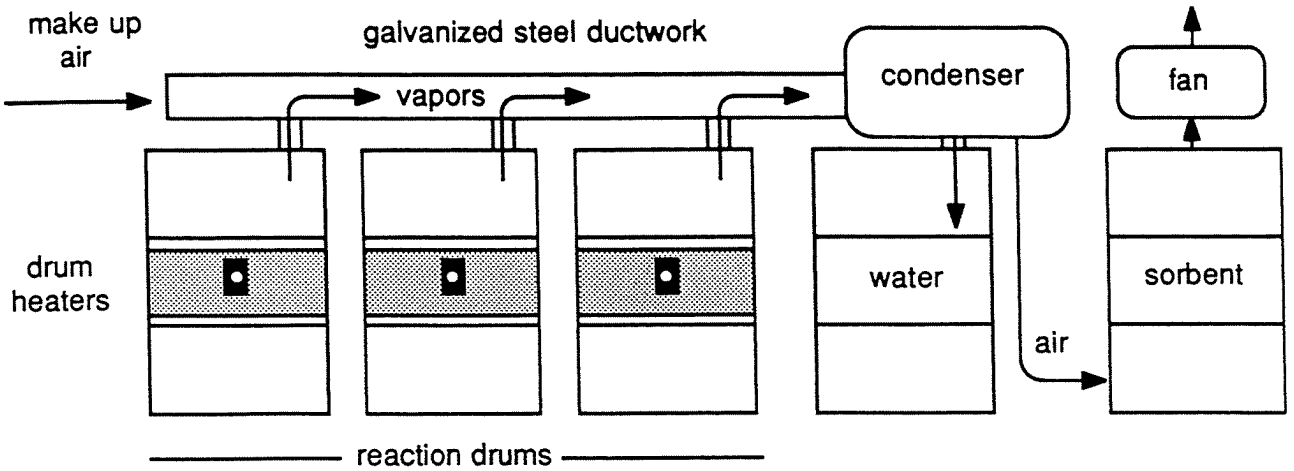


Figure 2. - Simplified Process Diagram

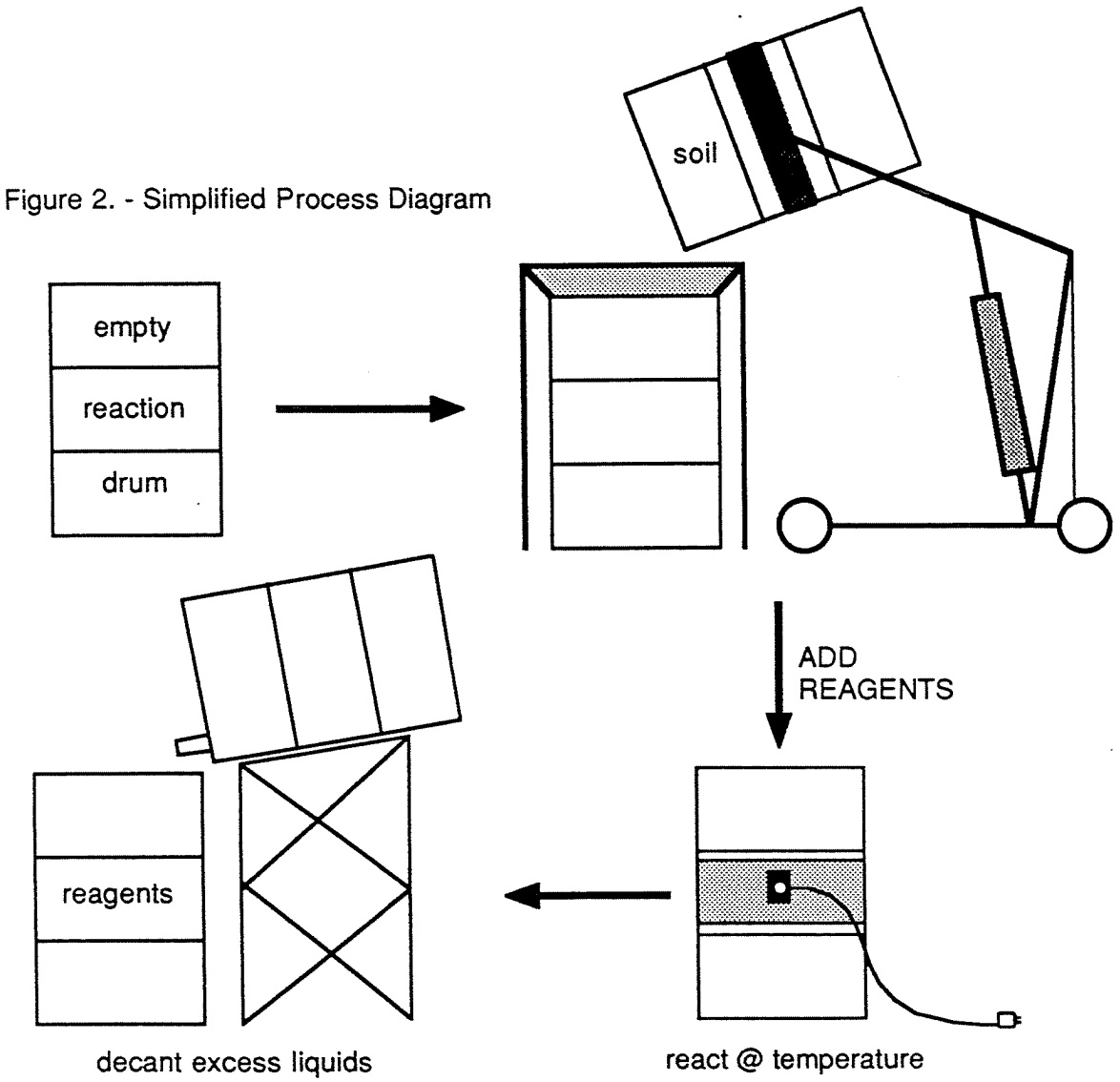


Figure 3. - Drum Valve System for Reagent Drainage

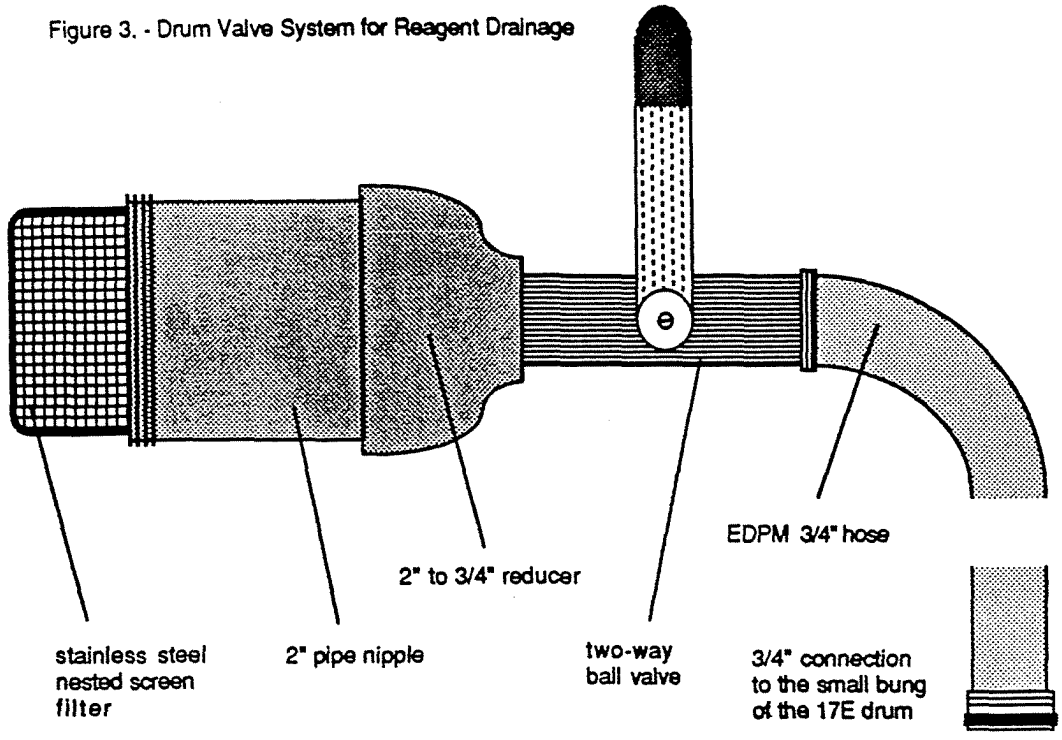
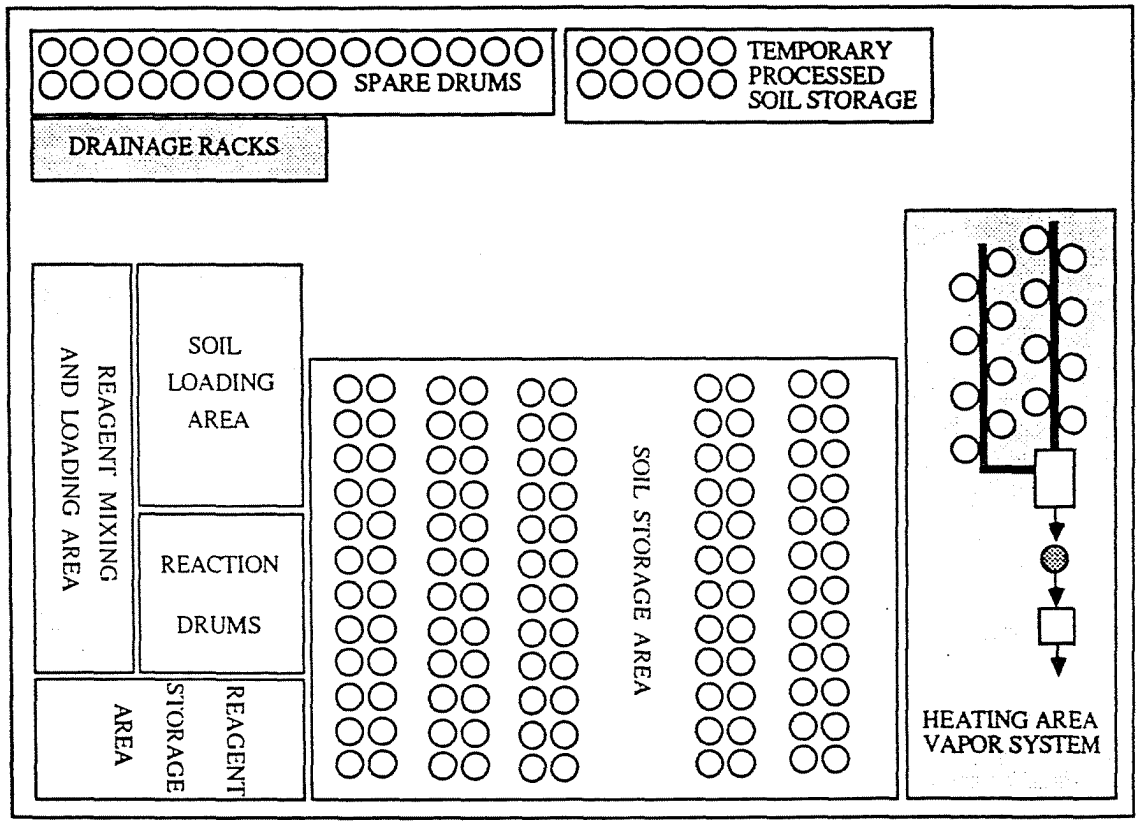


Figure 4. - Planned Warehouse Layout



- SPILL CONTROL AREAS

COMPARISON OF LABORATORY AND FIELD TEST DATA IN THE CHEMICAL DECONTAMINATION OF DIOXIN CONTAMINATED SOILS

R. Peterson, E. Milicic, C. Novosad, Galson Research Corporation, East Syracuse, NY,
C. Rogers, United States Environmental Protection Agency, Cincinnati, OH

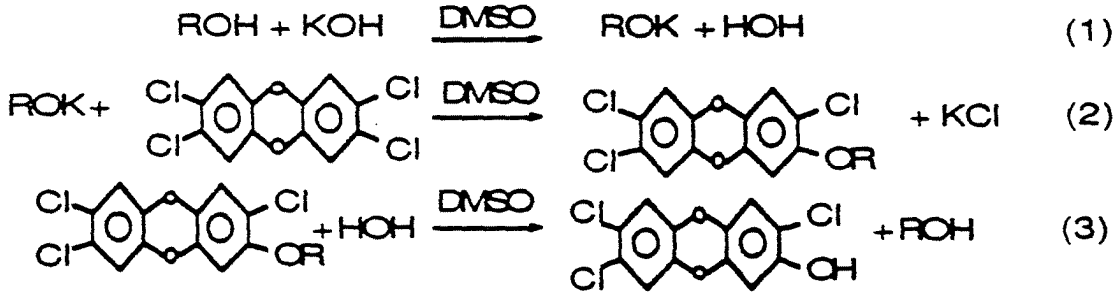
Galson Research Corporation has developed a series of patented (1) processes for chemical decontamination of soils contaminated with halogenated aromatics, including polychlorinated dibenzo-p-dioxins (PCDDs), chlorinated benzenes, polychlorinated biphenyls and similar materials. These processes allow reduction of PCDD levels to < 1 part per billion (ppb) in as little as two hours at moderate temperatures and pressures.

Introduction

Chemical decontamination is an alternative to thermal processing or landfilling of soils contaminated with polychlorinated dibenzo-p- dioxins (PCDDs) or other aromatic halides such as chlorobenzenes or polychorinated biphenyls (PCBs). Chemical decontamination, like incineration, involves changes to the chemical structure of the dioxin molecule. While chlorinated dioxins are thermally stable, they readily dechlorinate to water soluble compounds under relatively mild conditions of temperature and pressure. For example, chlorinated dioxins in oil are readily reduced to the ppt level within 15 minutes at 80 degrees C. by reacting them to a compound which is no longer oil soluble. In soils processing, the dioxin is dechlorinated to a water soluble form which is then leached from the soil using countercurrent extraction with water. Dechlorination also affects the toxicity of the dioxin, with dioxins containing fewer than three chlorine atoms generally showing low toxicity (2).

Process Chemistry

The proposed mechanism for these reactions is shown below using 2,3,7,8 tetrachlorodibenzo-p-dioxin as an example;



An alkali metal hydroxide, usually potassium hydroxide (KOH) is reacted with an alcohol or glycol such as polyethylene glycol 400 (PEG 400) to form an alkoxide. The alkoxide reacts with one of the chlorine atoms on the chlorinated dioxin to produce an ether and the alkali metal salt. This dechlorination may proceed to complete dechlorination, although replacement of a single chlorine is sufficient to make the reaction products water soluble. The ether formed by the dechlorination may degrade to a phenol form or may remain as the ether, depending on the reaction conditions. The processing is carried out using dimethyl sulfoxide (DMSO) as a solvent. The DMSO catalyzes the reaction by increasing the base strength of the alkoxide. In addition, the DMSO aids in the extraction of the PCDD from the soil.

Toxicity Considerations

Chemical decontamination of soil is a two stage process;

1. Dechlorinate PCDD to lower toxicity/ water soluble form
2. Wash excess reagents and PCDD products from soil

A major concern in this type of processing involves the toxicity of any reagents and/or reaction products which may inadvertently be left in the decontaminated soil after treatment. Some toxicity data on reagents used in the process are shown in Table I, along with comparison values for sodium chloride and 2,3,7,8 TCDD.

Table I - Toxicity of Reagents and Comparison Materials

Material	LD50, Oral-rat (3)
polyethylene glycol 400	27,500 mg/kg
dimethyl sulfoxide	17,500 mg/kg
sodium chloride (comparison value)	3,000 mg/kg
2,3,7,8 TCDD (comparison value)	0.022 mg/kg

The reagents used in this process are some five times less toxic than table salt, and roughly six orders of magnitude less toxic than 2,3,7,8 TCDD, the dioxin isomer of major concern. Polyethlyene glycol 400 is an FDA approved material for use in foods and cosmetics. Dimethyl sulfoxide is a naturally occurring material in foods such a potatoes, milk and coffee at the part per million level. Expected residual levels of these materials in soil are not expected to be a serious concern.

Toxicity testing of the reacted aromatic halides is currently underway with EPA sponsorship. Structural assessment of the theoretical toxicity of the reaction products is favorable, ie the known reaction products would not be expected to show significant toxicity. Results of the Ames test for mutagenicity are negative, ie the reaction products do not demonstrate carcinogenic potential. Bioaccumulation tests also produced negative results, which is not surprising given the water solubility of these reaction products. Acute toxicity tests are currently (April, 1986) in progress.

Process Description

The decontamination of soil proceeds in a series of six process steps.

1. Combine equal masses of soil and reagent to form a slurry
2. Mix and heat soil/reagent slurry to 100-180 °C
3. Allow to react 1-5 hours
4. Decant excess reagent
5. Wash soil 2-3 times with water
6. Discharge decontaminated soil

This process is shown in diagram form below;

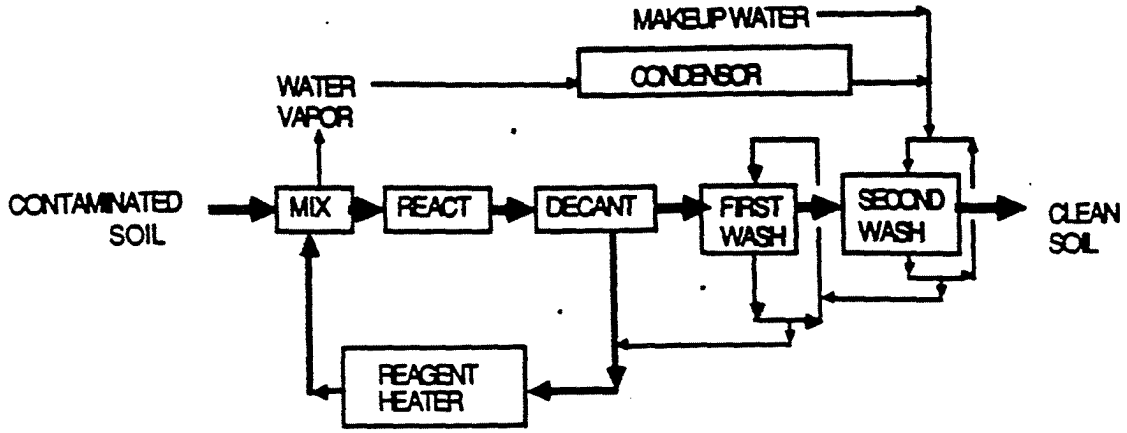


Figure 1 - Soil Decontamination Process

All of the process steps can be conducted in a single agitated reactor. The number of wash steps required will depend on the effectiveness of each wash step and on the degree of reagent recovery required.

Results of Tests to Date

Three series of tests using dioxin contaminated soil have been conducted to date: laboratory tests at high and low rates of agitation and field tests at low agitation only. Each set is discussed separately.

Laboratory Testing - High agitation

Initial laboratory tests used 250 g. soil samples spiked to a nominal concentration of 2000 parts per billion (ppb) of 1,2,3,4 TCDD. The 1,2,3,4 isomer was used in place of the 2,3,7,8 TCDD isomer to simplify experimental and safety procedures. These tests used an electrically heated 1000 mL three neck flask equipped with a reflux condenser and high torque agitator to provide a high degree of mixing.

In the initial series of experiments a Teflon paddle was used with the agitator. Analysis of the treated soil samples revealed the presence of an unknown halogenated contaminant which was later determined to be partially decomposed Teflon. The combination of reagent and erosion from the soil had broken down the Teflon used in the agitator. This interference required some additional sample cleanup. Changing to a glass paddle solved the problem for laboratory testing.

Treated samples were analyzed by three different labs using either gas chromatography/mass spectroscopy (GC/MS) or GC/MS/MS methods. Analysis by gas chromatography alone was unsuccessful, partly due to the Teflon interferences previously noted. The results of this initial testing are summarized below, with all samples having a nominal initial concentration of 2200 parts per billion;

Table II - Results of Laboratory Testing with High Agitation
Initial Concentration 2200 ppb

Reaction Temperature, °C	Reaction Time, Hours	Final TCDD Concentration, ppb
260	4	<1
150	2	<1
100	2	<0.2
70	0.5	15
70	2	<1
50	2	29
25	2	36

These tests indicated that while reaction rates for soils were lower than those obtained in oil tests, the overall reaction times were reasonable for large scale application.

Laboratory Testing - Low Agitation

After design of the field test equipment, it became apparent that the degree of agitation obtained in the initial laboratory tests was not going to be achieved in the field. Therefore, tests were conducted at a low rate of agitation to provide a prediction of the probable results of field testing. This testing used a flask equipped with a condenser and inserted into a heated oil bath. Agitation was provided by manually swirling the flask and contents at periodic intervals. Soil for this test was the same soil to be used for field testing, and contained 2,3,7,8 TCDD. Analyses were made using GC/MS/MS techniques. The results of testing are shown in Table III.

Table III - Results of Laboratory Testing at Low Agitation, 125 °C

Reaction time, hours	TCDD level, ppb
0	175
1.5	15.1
4.25	2.06
7.0	0.3

These data indicate that the reaction time for samples with low rates of mixing are on the order of 2-3 times longer than those for samples with high rates of mixing, but still well below 8 hours.

Field Test Results

Field testing for this test series consisted of a series of runs using 30 kg. soil samples taken from a dioxin site in Mississippi. Herbicide Orange had been stored at this site, with some spillage, causing soil contamination.

Test equipment for this series of tests is shown in Figure 2 below;

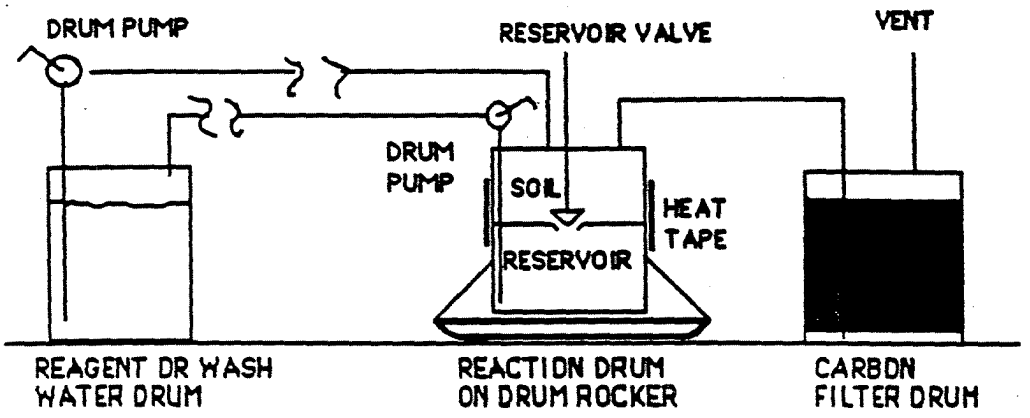


Figure 2 - Apparatus for Field Soils Processing

A 55 gallon drum was modified by the addition of a steel plate halfway down the drum. The plate was pierced by a valve and by a tap to allow pumping of liquids out of the reservoir. The steel plate was sealed with a silicone sealant around the perimeter of the plate. Contaminated soil and reagents were added to the drum by weight. The drum was then covered and a vent line attached between the drum and a carbon filter. A heat tape was wrapped around the drum and the entire drum was insulated with fiberglass. The insulated drum was placed on a drum rocker and rocked from side to side to mix the soil and reagent during heating and reaction. The results of the testing are shown in Table IV.

Table IV - Results of Field Testing

Reaction time, hours	TCDD level, ppb	
	Initial	Final
1.0	154	37.3
2.5	356	10.7
6.5	equipment failure	

The equipment failure occurred at the seal around the perimeter of the steel plate holding the soil/reagent slurry out of the reservoir. In the 6.5 hour run this seal failed, allowing the reagent to separate from the soil and stop the reaction. As noted in the laboratory testing, the reagent is very corrosive to polymers, including Teflon. Seal material selection will be studied in depth prior to scaleup of this process.

Discussion of Laboratory and Field Data

The data from the three series of tests is summarized in Figure 3 below;

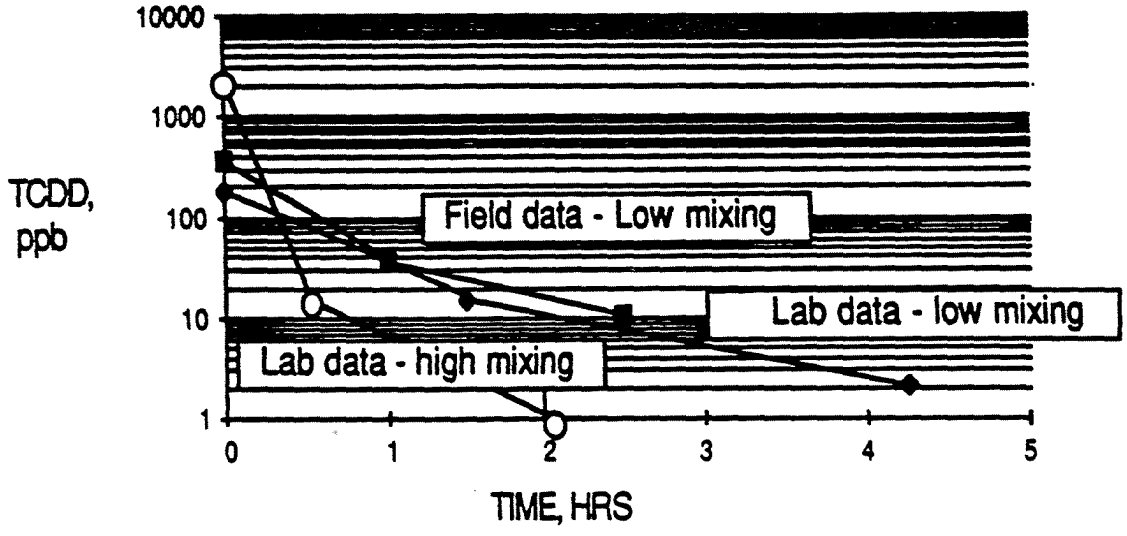


Figure 3 - Results of Soils Processing

Three points can be noted from these data;

1. For each reaction, an initial rate of reaction is followed by a second lower rate of reaction, vs. the single line reaction plot expected for a single order reaction.
2. The laboratory data for the high mixing case indicate a higher rate of reaction than for the lower rate of mixing. This difference is primarily in the initial reaction rate, while the secondary reaction rate is closer to that for the low mixing case.
3. The rates of reaction for field tests and for laboratory tests at low agitation rates are very similar.

The bimodal reaction rate is characteristic for soils treated by this process but not for oil treatment where a single line reaction plot is observed. This dual reaction rate may be due to the heterogeneity of soils. Organics on soils may be adsorbed on the surface of the soil particles, in the micropores of the soil or even wrapped up in the helical humic structures present in some soils. A bimodal reaction rate would be consistent with a process where extraction of the dioxin from the soil into the reagent is the rate limiting step. Extraction of dioxin from the micropores would be expected to be much slower than from the surface of the soil particles. This is consistent with overall rate data showing that the rate of reaction is much higher for liquids than for soils, indicating an extraction limited process.

The micropore/soil surface phenomenon may also explain why the high mixing case shows a much greater difference in initial and final reaction rates than those for the low mixing case. Despite the fact that the soil for all tests came from the same site, the soils for the high mixing case were spiked with dioxin on the same day as the soil was processed. By contrast, the low mixing case soils had weathered for more than five years. It may be that weathering may change the micropore/soil surface distribution of the adsorbed dioxin, possibly by differential volatilization of the dioxin from the surface or by successive displacement of the dioxin by other materials.

The low mixing data for laboratory and field data show a very high degree of correlation. If placed on a normalized graph, these data fall on a single line, as shown below;

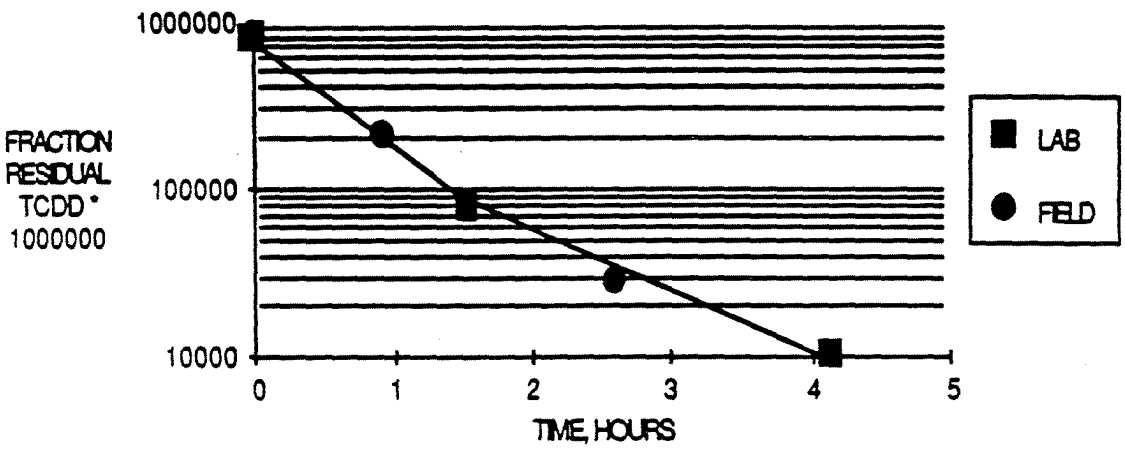


Figure 4 - Comparison of Laboratory and Field Data at Low Agitation

This indicates that the 100:1 scaleup of the process was successful in demonstrating that the procedure is not strongly dependent on sample size.

Conclusions

The results of this study can be summarized as follow;

1. Chemical decontamination of dioxin contaminated soils can reduce dioxin levels to < 1 ppb under laboratory conditions using either high or low rates of agitation.
2. Increasing rates of agitation yield increasing rates of reaction, although other factors may also be involved.
3. Field test data at low rates of agitation are very comparable to laboratory data at low rates of agitation.

Acknowledgments

This work has been sponsored by the United States Air Force and by the United States Environmental Protection Agency under EPA contract 68-03-321.

References.

1. Peterson, U. S. Patent 4,574,013, March 4, 1986.
2. Esposito et. al., EPA-600/2-80-197, p. 187
3. Niosh Registry of Toxic Effects of Chemical Substances, 1981-2

Bengart and Memel Soil Screen

for PCB Concentrations

Jointly Sponsored by the
United States Environmental Protection Agency
and
Air Force Engineering and Services Laboratory
Contract #68-13-3219

Issued: May 2, 1986

Carl Novosad
Environmental Engineer

Galson Research Corporation
East Syracuse, New York

Summary of Conclusions and Recommendations

There are 166 drums of PCB tainted soil at the Bengart & Memel site in Buffalo, New York. Galson Research Corporation obtained samples from each of the drums and analyzed the soil for PCB concentrations. Ninety-four of these drums have been determined to be above the 50 parts per million PCB concentration which classifies them as hazardous waste.

The McGraw-Edison PCB field test procedure was performed on every sample. Modifications to the procedure, such as substituting certain laboratory quality equipment for the supplied equipment, were necessary to bring the method up to the required level of precision. Any samples that hovered near the 50 ppm concentration subsequently received gas chromatographic analysis for confirmation. As a self-contained unit for testing soils, the use of the field test kit should be relegated to situations where the information required is of a qualitative nature or where the anticipated concentrations are much higher or lower than the point of interest, e. g. 50 ppm. Another possible application would be to quickly determine which sampling areas are worthwhile for more rigorous sampling and analysis by GC. For the Bengart & Memel study, the modified field test procedure was useful for screening the extremely high and low concentration samples.

Many factors make Bengart & Memel an excellent site for Galson Research to perform a full-scale, demonstration cleanup. The concentrations are not so high as to be an excessive risk for workers, the amount of soil is sufficient to adjust and optimize the process yet not so much as to have an exorbitant cost, and the work area is sheltered and large. Galson Research has prepared a proposal specifically for the Bengart & Memel cleanup. The proposal will be issued concurrently with this report.

Bengart & Memel Soil Screen For PCBs

Background

Bengart & Memel, Inc. a wholesaler of non-ferrous scrap metals, was originally founded in 1950 in Buffalo, New York. From about 1950 through 1978 Bengart & Memel received and dismantled transformers and capacitors and inadvertently disposed of some of the PCB (polychlorinated biphenyl) and PCB-contaminated waste into the soil. In the mid-1970s, soil samples from the property were found to contain PCBs which subsequently prompted the New York State Department of Environmental Conservation to issue a Consent Order for remediation. The Consent Order would be satisfied if the concentration were reduced below 50 parts per million.

Seven sites on the property were found to have a PCB content in excess of 50 ppm. These sites ranged in depth from 6 to 24 inches and were defined to be 10 feet in diameter about the point where the soil core sample was taken. As part of the remedial program, this soil was excavated and placed in 55 gallon steel drums.

Rather than blindly treat all of the soil as hazardous waste, analytical testing to weed out those drums that require no decontamination was carried out as a cost effective measure. Certain factors indicated that the concentrations might not be so high as previously suspected. The pilot studies conducted by GRC on site during August 1985 utilized four drums of what was thought to be the highest concentration soils. Analysis of eleven samples of this soil gave an average PCB concentration of 38 ppm which was far less than the expected 100+ ppm. The contaminated soil may have been diluted with relatively clean soil during the excavation.

Site Sampling Procedure

Due to the heterogeneity of the soil, a rigorous sampling plan was implemented to insure the most representative subsample possible. Samples were collected with trowels and spoons and placed in a one quart wide mouth jar. Five small, core-type samples were obtained from different spots in the drum, ideally in a star pattern as shown in

Figure 1. In many cases, it was necessary to work around large pieces of rock, wood, and other debris. Approximately 6 inches of the surface soil was removed before any soil was collected; objects larger than 1 inch in diameter were not included in the sample. Labels with six digit sample numbers (beginning with 017001) were printed in triplicate to eliminate any confusion in identification. Identical labels were attached to the drum, the corresponding sample jar, and the logbook. Comments on the condition of each drum were noted in the logbook.

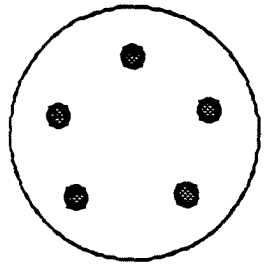


Figure 1.
Drum sampling pattern

Rationale for the use of the PCB Field Test Kit

One hundred and sixty-six drums of potentially PCB contaminated soil were sampled at the Bengart & Memel site. If each of these drums could be screened using a quick method, many of the extremely high or low concentration soils could probably be categorized (as requiring treatment or non-hazardous) without the more expensive gas chromatograph analyses. Once the number of drums which require decontamination has been determined, a clean-up procedure can be devised. The performance of the McGraw-Edison PCB field test kit will also be assessed for possible future use.

Procedure

The McGraw-Edison PCB field test kit provides a means by which either PCB contaminated oil or soil can be quantified. The test procedure is based on the chemical destruction of PCB molecules to form chloride ions, which are extracted and measured with a specific ion electrode (probe). To bring the quality of the apparatus up to the required level, certain alterations were implemented to improve precision. The original operating instructions appear in the appendix.

The field test kit was cleaned and calibrated at the start of each day's testing. Calibration of the probe was made at two points; 0 millivolts was set with the supplied "zero" solution and 100 mV with the "slope" solution. The probe was then ready for use and placed in the "rinse" vial. (McGraw-Edison does not disclose the specific chemical makeup of their supplies.) The calibration was checked periodically during the testing, though no adjustments were ever necessary.

The reaction vials were prepared by using a volumetric pipet to transfer 3 milliliters of "reaction solvent" to an empty vial. One milliliter of the black "reaction fluid" was added with the supplied eppendorf pipetor. Due to the rapid degradation of the reaction fluid, the prepared reaction vials were either used that day or discarded.

Each sample jar was shaken twice to mix the soil, once before shipping and again before the transfer, to insure that the field kit tests and any subsequent GC analyses are coordinated. Small amounts (≈1 gram) of soil were taken from different locations in the jar and placed in a tared scintillation vial. The final soil samples ranged between 5 and 9 grams in mass (1/3 of the total vial volume) and devoid of any gravel/rocks/debris larger than one quarter inch in diameter.

An amount of "soil extractant" equal in weight to the soil was added to the soil vial. The vial was sealed and vigorously shaken for 30 seconds; the extraction time between solvent addition and reaction was noted in the logbook for each sample.

After an hour of settling/extraction, 1 ml of the extract was transferred to a labeled reaction vial. The vial was sealed and shaken for 20 seconds. Five milliliters of the "extraction fluid" was added to the vial and shaken for 15 seconds. The resulting emulsion quickly separated into two layers; the calibrated probe was removed from the "rinse" vial, wiped clean with a tissue, and inserted into the lower layer (the "extraction fluid"). Accurate analysis required the probe/extractant to equilibrate for about 3 minutes with occasional gentle stirring. The millivolt reading was recorded in the notebook and the probe was wiped clean and replaced in the "rinse" vial.

Quality Assurance / Quality Control

Before any of the drum samples were analyzed, the field test kit was calibrated using a sieved soil composite collected from the Bengart & Memel site. This soil had been analyzed by GC and shown to have a PCB concentration of 83 ppm as Aroclor 1260. Dilutions of this soil were made with soil which had been analyzed and shown to be PCB free. The analysis by the field test kit on the clean soil indicated concentrations below the detection limit (<4 ppm). The two primary purposes of the calibration study were to determine the relative importance of certain parameters (e. g. settling period, reaction fluid degradation, solvent to soil ratio, and probe equilibration period), and to familiarize the analyst with the procedures. The numerical data from this study is trivial as many variables were juggled to quickly gain an intuitive feel for the kit. Fourteen samples were analyzed in this study; the results appear in the appendix.

McGraw-Edison provided no set extraction time frame stating only, "Allow the soil to settle." even though the settling was an incremental process. To test the effect of different extraction times two separate reactions were performed using the same vial of soil/extractant. Seven of the eight tests showed a positive correlation with longer contact time giving higher concentrations of PCB (the results appear in the appendix). To negate this variable the exact extraction time was noted in the logbook for each sample and was almost always one hour.

Modifications to the operating procedures supplied by McGraw-Edison were necessary to reduce as many of the variables as possible. Many of the assumptions made by McGraw-Edison affected accuracy, such as neglecting the variability of vial weights which ranged from 15.75 grams to 16.50 grams. Use of a Mettler balance (readouts to .0001 gram) rather than the supplied field equal arm balance improved precision. Volumetric pipets were substituted for the supplied pipetors whenever possible. The equivalency tables (mV to ppm) are based on the assumption that the soil weight and the soil extraction solvent weight are equal. The exact dilution ratio for each sample is included in the field test kit spreadsheet in the appendix. Results from four samples which were aborted due to incorrect solvent addition are also included to underscore the importance of the dilution ratio.

Some variability in the results are expected and can be attributed to: the inherent lack of uniformity of soil, and the unsophisticated nature of the kit. Although as many alterations to the kit as were reasonable were made to improve precision, limiting the kit's flaws can reach the point of diminishing returns.

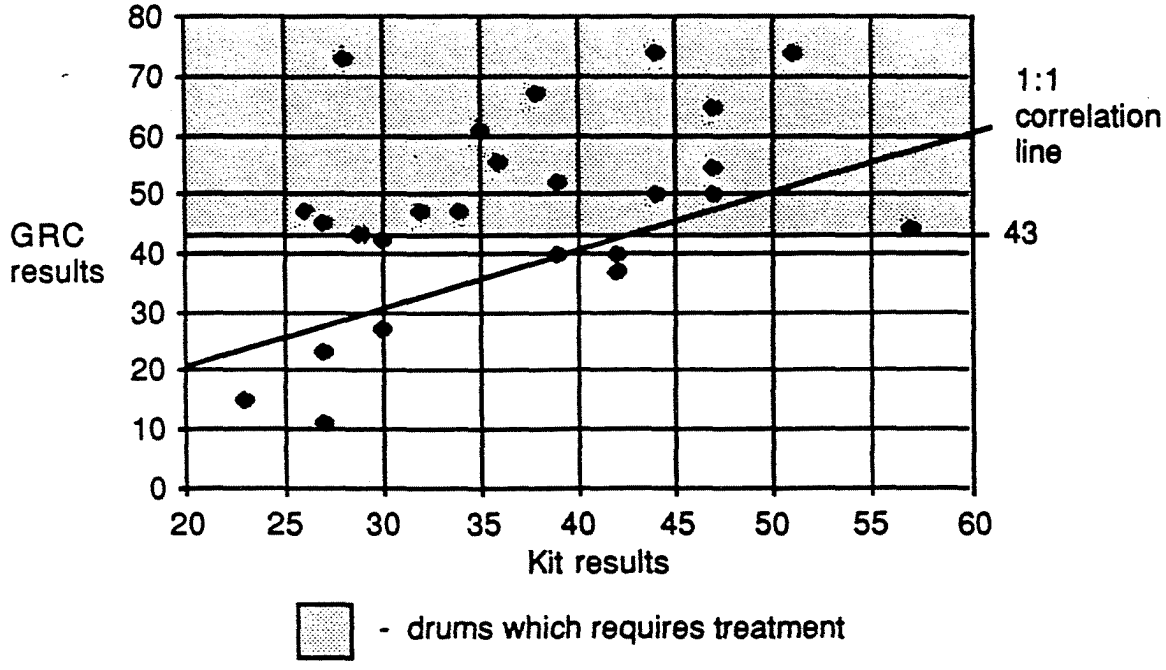
Painstaking care in all aspects of this operation (sampling, prep and analysis) was essential for useful results -- a small change in the probe reading can translate into a large change in PCB concentration (in the 200 ppm range, a one millivolt increment equals between 16 - 20 ppm as 1260). It should be noted that the kit defines the readouts as the maximum PCB content when computed as Aroclor 1242, however, GC analysis of this soil has shown the major Aroclor to be 1260.

Eight quality control samples were created (independently of the analyst) and tested along side the Bengart & Memel soils. The soil used for the QCs was a approximately 1:1 mix of a sandy test soil from Mississippi (provided to GRC by the EPA) which has been shown to PCB free and a commercial potting soil. Seven of the soils were spiked with Aroclor 1260 stock (in iso-octane) and one was spiked with Aroclor 1242. There was a difference in the settling characteristics, with far more suspended solids appearing in the Bengart & Memel soil than the QCs. The results from these QCs are included in the field test kit spreadsheet in the appendix.

Gas Chromatographic Analyses

Although many of the extremely high and low concentration samples could be classified by the kit alone, there were many borderline samples which required GC confirmation. Twenty-two samples ranging from 23 to 57 ppm by the kit were reanalyzed by Galson Research. Since no strong correlation was evident, all samples within a certain band were deemed to need GC reanalysis for an accurate judgement. All of the remaining samples between 25 and 60 ppm were sent to an outside laboratory (Carolina Chemists and Consultants, Inc.) for GC analysis. Of the 30 samples which had concentrations less than 50 ppm by the kit, none were found to be over 50 by CCC. The results from both labs are shown graphically in Figures 2 & 3, and are included in the summary spreadsheet in the appendix. An additional graph, Figure 4, compares the results of the two labs.

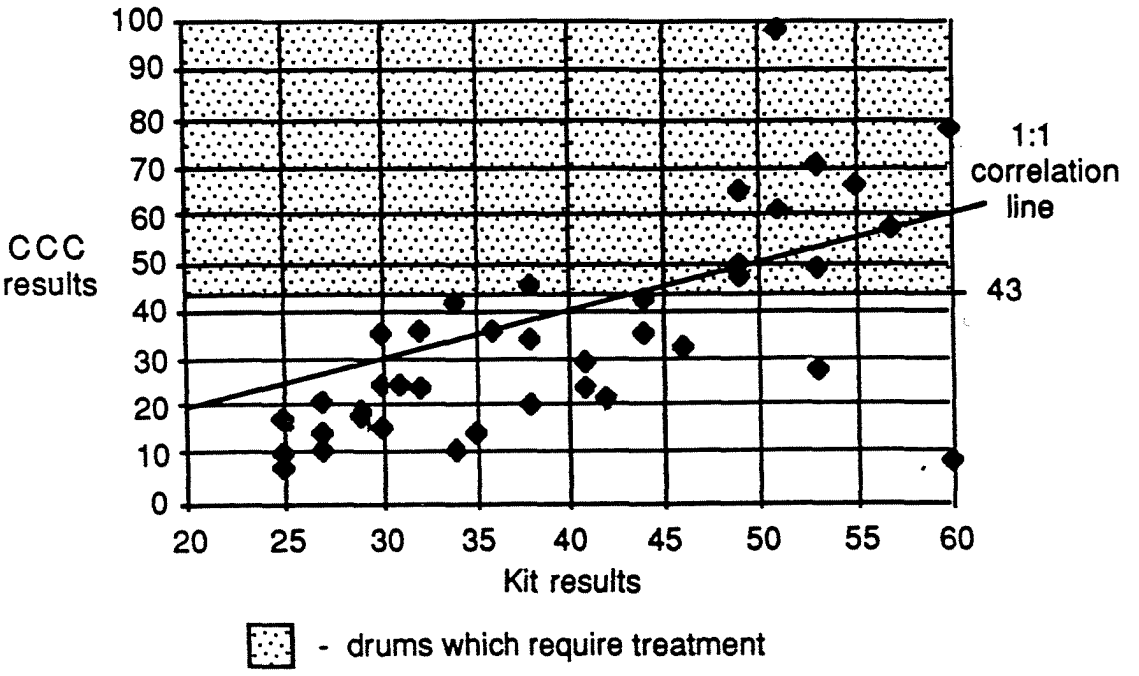
Figure 2. - Galson Research's GC Reanalyses of McGraw-Edison Kit Results



Kit results	GRC GC results	Kit results	GRC GC results
23	15	38	67
26	47	39 A	40
27	11	39 B	52
27	23	42 A	37
27	45	42 B	40
28	73	44	50
29	43	44	74
30 A	27	47	50
30 B	42	47	54
32	47	47	65
34	47	51	74
35	61	57	44
36	55		

'A' and 'B' indicate GC duplicates from the same sample, results are in ppm.

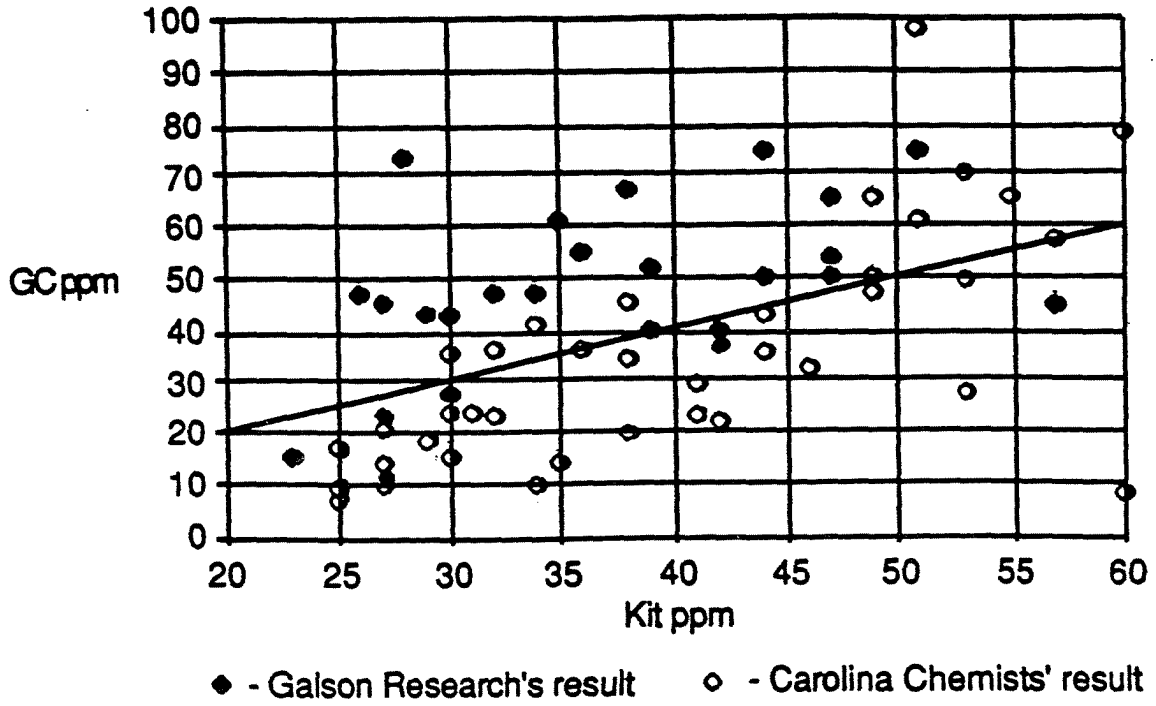
Figure 3 - Carolina Chemists' GC Reanalyses of McGraw-Edison Kit Results



Kit results	CCC results	Kit results	CCC results	Kit results	CCC results
25 A	7.1	31	24	44	42
25 B	9.8	32 A	23	46	32
25	9.5	32 B	29	49	47
25	16	32	36	49 A	50
25	17	34	10	49 B	65
27	10	34	41	51	61
27	14	35	14	51	98
27	21	36	36	53	27
29	16	38	20	53	49
29	18	38	34	53	70
29	19	38	45	55	66
30	15	41	29	57	57
30	24	42	22	60	7.8
30	35	44	35	60	78

'A' and 'B' indicate GC duplicates of the same sample, results are in ppm.

Figure 4. - Comparison of the Gas Chromatographic Analyses conducted by Galson Research and Carolina Chemists & Consultants



Three duplicates were performed by each lab with the average deviation from the mean being 13.5% for CCC and 12.9% for GRC. Using 14% applied to the cutoff point of 50 ppm, all drums 43 ppm and higher should be treated to insure that all the contaminated soil is correctly classified. This cutoff point is quite conservative considering that the analyzed samples consisted of sieved soil devoid of the heavy, non-porous debris (gravel, rocks and metal) which makes up a significant portion of the drum contents.

The kit deviation from the mean was computed for both the GRC and the CCC results. The average kit deviation was 35% from the GRC values and 43% from CCC. Some of the differences between the GRC/kit and CCC/kit correlations may be due to the different analytical methods which were employed; GRC used a Hall detector while CCC used an ECD and GRC extracted 50 gram samples with 1:4 methanol/hexane while CCC extracted 20 grams with iso-octane. Of the 61 samples reanalyzed by GC (GRC and CCC combined), 14 kit results were overruled for a 77% correct rate in the 23 to 60 ppm range. None of the samples were analyzed by both GRC and CCC.

Conclusions and Recommendations

The modified McGraw-Edison PCB field test kit proved to be a useful tool in the soil screening process. The basic operations are easy to learn, but user familiarity and experience are essential. Some aspects of the procedure are not precisely documented and whatever method is used must be adhered to meticulously for valid and consistent results. When used as a self-contained unit in the field, the kit would be most applicable to situations where the information required is of a qualitative nature or where the majority of the concentrations are suspected to be higher or lower than the point of interest. In the case of the Bengart & Memel site, the average sieved soil concentration was close to 50 ppm.

The table below contains a summary of the drum classification and the means of determination.

	KIT	GRC GC	CCC GC	TOTAL
REQUIRES TREATMENT	67	17	10	94
NO TREATMENT NEEDED	38	5	29	72

The next phase of the operation is the actual cleanup. Many factors make Bengart & Memel an excellent site for Galson Research to demonstrate the efficacy of its decontamination technology. The concentrations are not so high as to be an excessive risk for workers, the amount of soil is sufficient to adjust and optimize the process yet not so much as to have an exorbitant cost, and the work area is sheltered and large. Galson Research is aware of the idiosyncracies of the Bengart & Memel situation and will issue a proposal for the site cleanup.

Appendix

Bengart Memel Soil Screen Results

Sample#	kit mV	ppm by kit	ppm by GRIC GC	ppm by CCC GC	TREAT?
851017001	74	138			YES
851017002	100	51		98	YES
851017003	89	78			YES
851017004	87	84			YES
851017005	78	119			YES
851017006	78	119			YES
851017007	99	53		70	YES
851017008	95	62			YES
851017009	94	64			YES
851017010	76	128			YES
851017011	76	128			YES
851017012	78	119			YES
851017013	94	64			YES
851017014	75	133			YES
851017015	90	75			YES
851017016	91	72			YES
851017017	112	32		36	NO
851017018	108	38		45	YES
851017019	68	174			YES
851017020	43, 31	452, 715			YES
851017021	104	44		35	NO
851017022	97	57		57	YES
851017023	89	78			YES
851017024	90	75			YES
851017025	99	53		49	YES
851017026	92	69			YES
851017027	48	374			YES
851017028	85	91			YES
851017029	98	55		66	YES
851017030	104	44		42	NO
851017031	100	51		61	YES
851017032	101	49		50, 65	YES
851017033	65	195			YES
851017034	70	161			YES
851017035	85	91			YES
851017036	85	91			YES
851017037	94	64			YES
851017038	109	36		36	NO
851017039	104	44	50		YES
851017040	114	30		35	NO
851017041	59	245			YES
851017042	80	110			YES
851017043	82	102			YES
851017044	91	72			YES
851017045	65	195			YES
851017046	77	123			YES
851017047	114	30		24	NO
851017048	111	34		41	NO
851017049	122	22			NO
851017050	117	27		10	NO
851017051	121	23			NO
851017052	121	23			NO
851017053	94	64			YES
851017054	89	78			YES
851017055	132	15			NO
851017056	121	23	15		NO

Bengart Memel Soil Screen Results

Sample#	kit mV	ppm by kit	ppm by GRC GC	ppm by CCC GC	TREAT?
851017057	124	20			NO
851017058	117	27	11		NO
851017059	122	22			NO
851017060	110	35	61		YES
851017061	117	27	23		NO
851017062	102	47	65		YES
851017063	69	167			YES
851017064	94	64			YES
851017065	97	57	44		YES
851017066	109	36	55		YES
851017067	102	47	54		YES
851017068	91	72			YES
851017069	88	81			YES
851017070	112	32	47		YES
851017071	92	69			YES
851017072	78	119			YES
851017073	94	64			YES
851017074	92	69			YES
851017075	91	72			YES
851017076	102	47	50		YES
851017077	111	34	47		YES
851017078	116	28	73		YES
851017079	129	17			NO
851017080	129	17			NO
851017081	104	44	74		YES
851017082	108	38	67		YES
851017083	89	78			YES
851017084	81	106			YES
851017085	96	60		78	YES
851017086	87	84			YES
851017087	95	62			YES
851017088	115	29		19	NO
851017089	145	9			NO
851017090	99	53		27	NO
851017091	85	91			YES
851017092	74	138			YES
851017093	85	91			YES
851017094	83	98			YES
851017095	120	24			NO
851017096	125	20			NO
851017097	140	11			NO
851017098	146	9			NO
851017099	118	26	47		YES
851017100	122	22			NO
851017101	100	51	74		YES
851017102	92	69			YES
851017103	143	10			NO
851017104	139	12			NO
851017105	124	20			NO
851017106	138	12			NO
851017107	115	29	43		YES
851017108	114	30	27, 42		NO
851017109	86	87			YES
851017110	96	60		8	NO
851017111	94	64			YES
851017112	80	110			YES

Bengart Memel Soil Screen Results

Sample#	kit mV	ppm by kit	ppm by GRC GC	ppm by CCC GC	TREAT?
851017113	93	67			YES
851017114	82	102			YES
851017115	126	19			NO
851017116	117	27		21	NO
851017117	132	15			NO
851017118	131	16			NO
851017119	94	64			YES
851017120	90	75			YES
851017121	95	62			YES
851017122	81	106			YES
851017123	128, 127	18, 18			NO
851017124	124	20			NO
851017125	129	17			NO
851017126	121	23			NO
851017127	107	39	40, 52		YES
851017128	142	10			NO
851017129	129	17			NO
851017130	117	27	45		YES
851017131	89	78			YES
851017132	108	38		34	NO
851017133	122	22			NO
851017134	112	32		23	NO
851017135	81	106			YES
851017136	125	20			NO
851017137	95	62			YES
851017138	105	42	37, 40		NO
851017139	115	29		16	NO
851017140	115	29		18	NO
851017141	106	41		29, 23	NO
851017142	103	46		32	NO
851017143	119	25		16	NO
851017144	131	16			NO
851017145	127	18			NO
851017146	129	17			NO
851017147	113	31		24	NO
851017148	111	34		10	NO
851017149	114	30		15	NO
851017150	119	25		7, 10	NO
851017151	119	25		17	NO
851017152	131	16			NO
851017153	129	17			NO
851017154	130	16			NO
851017155	110	35		14	NO
851017156	121	23			NO
851017157	105	42		22	NO
851017158	117	27		14	NO
851017159	119	25		10	NO
851017160	108	38		20	NO
851017161	135	13			NO
851017162	126	19			NO
851017163	78	119			YES
851017164	101	49		47	YES
851017165	86	87			YES
851017166	62	219			YES

PCB Field Test Kit Screen of Bengart Memel Soil

Sample #	vial tare	with soil	w/ solvent	soil wt.	solvent wt.	ratio	mV	ppm by ki
851017001	16.2586	21.7183	27.0510	5.4597	5.3327	1.02	74	138
851017002	16.0228	21.6535	27.2384	5.6307	5.5849	1.01	100	51
851017003	16.0475	21.3495	26.7401	5.3020	5.3906	0.98	89	78
851017004	16.1998	22.5220	28.6667	6.3222	6.1447	1.03	87	84
851017005	15.8561	21.1925	26.6670	5.3364	5.4745	0.97	78	119
851017006	16.0333	21.6356	27.1696	5.6023	5.5340	1.01	78	119
851017007	16.2399	22.6390	28.9530	6.3991	6.3140	1.01	99	53
851017008	16.4608	21.7441	26.9094	5.2833	5.1653	1.02	95	62
851017009	16.4077	22.8162	29.1148	6.4085	6.2986	1.02	94	64
851017010	15.8107	21.6332	27.6001	5.8225	5.9669	0.98	76	128
851017011	16.1682	21.9435	27.7670	5.7753	5.8235	0.99	76	128
851017012	16.1886	21.4430	26.6954	5.2544	5.2524	1.00	78	119
851017013	16.2727	23.8590	31.4237	7.5863	7.5647	1.00	94	64
851017014	16.3510	22.9784	29.7065	6.6274	6.7281	0.99	75	133
851017015	15.9085	22.6394	29.5824	6.7309	6.9430	0.97	90	75
851017016	16.2013	22.4307	28.5606	6.2294	6.1299	1.02	91	72
851017017	16.3722	22.8185	29.1184	6.4463	6.2999	1.02	112	32
851017018	16.1935	23.5738	30.8297	7.3803	7.2559	1.02	108	38
851017019	16.1353	24.5694	32.9201	8.4341	8.3507	1.01	68	174
851017020	16.2868	24.7883	33.1064	8.5015	8.3181	1.02	43.31	456. 715
851017021	15.9545	22.1347	28.2916	6.1802	6.1569	1.00	104	44
851017022	15.8297	22.7066	29.4961	6.8769	6.7895	1.01	97	57
851017023	15.9256	22.8949	29.9234	6.9693	7.0285	0.99	89	78
851017024	16.0575	22.8218	29.4990	6.7643	6.6772	1.01	90	75
851017025	16.1950	23.1539	30.2337	6.9589	7.0798	0.98	99	53
851017026	15.8636	22.6442	29.6823	6.7806	7.0381	0.96	92	69
851017027	16.2034	22.5699	28.9883	6.3665	6.4184	0.99	48	374
851017028	16.0379	23.7617	31.4863	7.7238	7.7246	1.00	85	91
851017029	16.0644	21.6729	27.3915	5.6085	5.7186	0.98	98	55
851017030	16.1858	23.8363	31.2731	7.6505	7.4368	1.03	104	44
851017031	15.8564	22.0726	28.2311	6.2162	6.1585	1.01	100	51
851017032	16.0893	23.3278	30.5636	7.2385	7.2358	1.00	101	49
851017033	16.0575	24.5620	33.1342	8.5045	8.5722	0.99	65	195
851017034	15.8499	24.3458	32.6464	8.4959	8.3006	1.02	70	161
851017035	16.0922	24.1142	32.0592	8.0220	7.9450	1.01	85	91
851017036	16.1536	24.3139	32.4874	8.1603	8.1735	1.00	85	91
851017037	15.9798	25.3102	34.4221	9.3304	9.1119	1.02	94	64
851017038	16.1890	25.5946	34.9135	9.4056	9.3189	1.01	109	36
851017039	16.1998	23.5188	30.8345	7.3190	7.3157	1.00	104	44
851017040	16.0661	23.0444	29.8905	6.9783	6.8461	1.02	114	30
851017041	16.1968	24.3209	32.4108	8.1241	8.0899	1.00	59	245
851017042	16.4149	25.2720	34.0919	8.8571	8.8199	1.00	80	110
851017043	16.2103	24.2957	32.5586	8.0854	8.2629	0.98	82	102
851017044	16.0620	23.9605	31.7889	7.8985	7.8284	1.01	91	72
851017045	16.1330	23.0656	30.0037	6.9326	6.9381	1.00	65	195
851017046	16.3377	24.4024	32.3011	8.0647	7.8987	1.02	77	123
851017047	16.1401	23.7398	31.1790	7.5997	7.4392	1.02	114	30
851017048	16.1509	23.7001	31.1957	7.5492	7.4956	1.01	111	34
851017049	16.2871	23.8175	31.2903	7.5304	7.4728	1.01	122	22
851017050	16.0200	22.7255	29.3345	6.7055	6.6090	1.01	117	27
851017051	16.1313	24.2061	32.2109	8.0748	8.0048	1.01	121	23
851017052	16.0010	22.7625	29.5528	6.7615	6.7903	1.00	121	23

PCB Field Test Kit Screen of Bengart Memel Soil

Sample #	vial tare	with soil	w/ solvent	soil wt.	solvent wt.	ratio	mV	ppm by kit
851017053	16.3969	24.8505	33.2664	8.4536	8.4159	1.00	94	64
851017054	16.0701	23.3952	30.8081	7.3251	7.4129	0.99	89	78
851017055	16.1830	24.4343	32.6908	8.2513	8.2565	1.00	132	15
851017056	15.8688	25.6930	35.3445	9.8242	9.6515	1.02	121	23
851017057	15.8832	22.7859	29.6266	6.9027	6.8407	1.01	124	20
851017058	15.8658	22.4661	29.0527	6.6003	6.5866	1.00	117	27
851017059	15.8492	22.6353	29.4007	6.7861	6.7654	1.00	122	22
851017060	15.7201	22.8548	29.7815	7.1347	6.9267	1.03	110	35
851017061	16.3759	22.6910	29.0863	6.3151	6.3953	0.99	117	27
851017062	16.1551	22.4604	28.7261	6.3053	6.2657	1.01	102	47
851017063	16.3687	23.2979	30.2460	6.9292	6.9481	1.00	69	167
851017064	16.2859	24.3449	32.3218	8.0590	7.9769	1.01	94	64
851017065	16.1330	24.4659	32.7821	8.3329	8.3162	1.00	97	57
851017066	16.1167	22.4756	28.8773	6.3589	6.4017	0.99	109	36
851017067	16.2448	22.3652	28.4276	6.1204	6.0624	1.01	102	47
851017068	15.7753	24.0101	32.2105	8.2348	8.2004	1.00	91	72
851017069	16.4993	22.9485	29.3761	6.4492	6.4276	1.00	88	81
851017070	16.3558	23.5530	30.7512	7.1972	7.1982	1.00	112	32
851017071	16.2243	24.0829	31.9574	7.8586	7.8745	1.00	92	69
851017072	16.0628	22.2947	28.5466	6.2319	6.2519	1.00	78	119
851017073	15.8920	22.9012	29.9898	7.0092	7.0886	0.99	94	64
851017074	15.8626	24.1485	32.4509	8.2859	8.3024	1.00	92	69
851017075	15.8911	22.7925	29.6636	6.9014	6.8711	1.00	91	72
851017076	16.3828	23.3598	30.3835	6.9770	7.0237	0.99	102	47
851017077	15.7798	23.1976	30.6697	7.4178	7.4721	0.99	111	34
851017078	16.2386	23.0469	29.8807	6.8083	6.8338	1.00	116	28
851017079	16.2132	22.0140	27.7601	5.8008	5.7461	1.01	129	17
851017080	16.3762	23.2759	30.0792	6.8997	6.8033	1.01	129	17
851017081	16.1765	23.1119	29.9856	6.9354	6.8737	1.01	104	44
851017082	16.4381	23.6825	30.8773	7.2444	7.1948	1.01	108	38
851017083	16.1642	23.2103	31.0050	7.0461	7.7947	0.90	89	78
851017084	15.8002	24.0198	32.1782	8.2196	8.1584	1.01	81	106
851017085	16.1614	24.5337	32.8840	8.3723	8.3503	1.00	96	60
851017086	16.2992	24.2531	32.1071	7.9539	7.8540	1.01	87	84
851017087	16.2530	24.1822	32.0347	7.9292	7.8525	1.01	95	62
851017088	16.0276	21.5180	26.9692	5.4904	5.4512	1.01	115	29
851017089	15.8621	21.3479	26.8298	5.4858	5.4819	1.00	145	9
851017090	16.1385	23.4286	30.6795	7.2901	7.2509	1.01	99	53
851017091	15.7586	23.7352	31.7396	7.9766	8.0044	1.00	85	91
851017092	16.1702	23.8915	31.5209	7.7213	7.6294	1.01	74	138
851017093	15.8053	22.0183	28.1975	6.2130	6.1792	1.01	85	91
851017094	16.0168	22.6761	29.2707	6.6593	6.5946	1.01	83	98
851017095	16.2358	22.2699	28.2001	6.0341	5.9302	1.02	120	24
851017096	15.7173	21.7134	27.5647	5.9961	5.8513	1.02	125	20
851017097	15.9813	22.3037	28.4779	6.3224	6.1742	1.02	140	11
851017098	15.7204	22.7165	29.6056	6.9961	6.8891	1.02	146	9
851017099	15.9622	22.3677	28.6591	6.4055	6.2914	1.02	118	26
851017100	15.8025	22.6235	29.3950	6.8210	6.7715	1.01	122	22
851017101	16.2750	23.0304	29.7088	6.7554	6.6784	1.01	100	51
851017102	15.8103	22.4431	29.0254	6.6328	6.5823	1.01	92	69
851017103	15.9116	22.2584	28.5778	6.3468	6.3194	1.00	143	10
851017104	16.1743	22.7189	29.3219	6.5446	6.6030	0.99	139	12

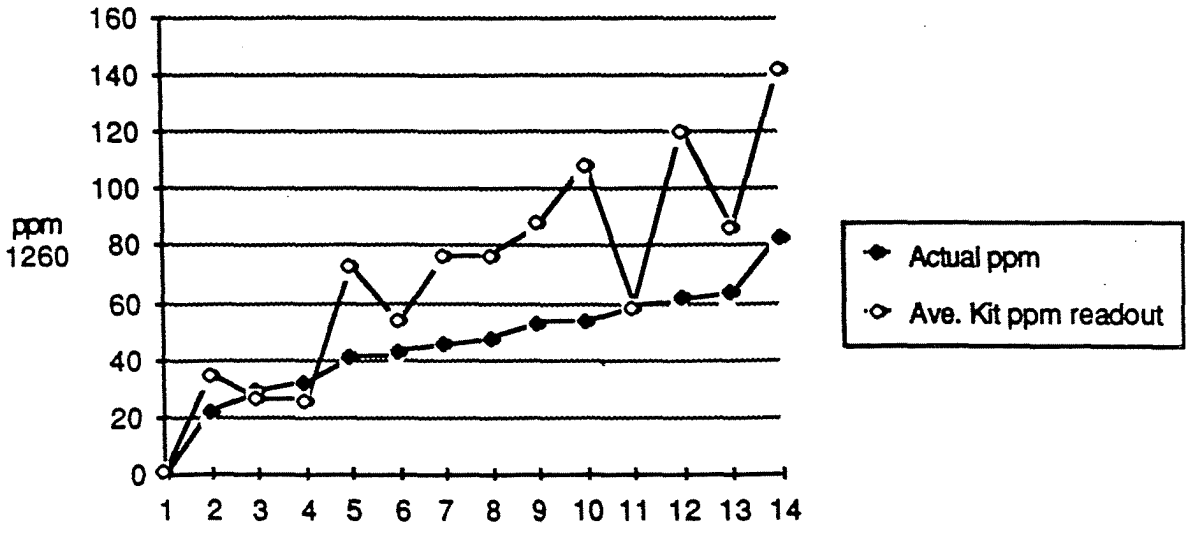
PCB Field Test Kit Screen of Bengart Memel Soil

Sample#	vial tare	with soil	w/ solvent	soil wt.	solvent wt.	ratio	mV	ppm by ki
851017105	15.8560	20.8434	26.0537	4.9874	5.2103	0.96	124	20
851017106	15.7979	23.7582	31.5932	7.9603	7.8350	1.02	138	12
851017107	15.8460	23.2853	30.6684	7.4393	7.3831	1.01	115	29
851017108	15.8197	21.7107	27.5134	5.8910	5.8027	1.02	114	30
851017109	16.2295	22.6181	28.9364	6.3886	6.3183	1.01	86	87
851017110	16.1722	22.3538	28.4337	6.1816	6.0799	1.02	96	60
851017111	16.2746	24.7527	33.2792	8.4781	8.5265	0.99	94	64
851017112	16.2307	23.5812	30.7922	7.3505	7.2110	1.02	80	110
851017113	15.9967	25.7754	35.4228	9.7787	9.6474	1.01	93	67
851017114	16.0901	25.2058	34.2731	9.1157	9.0673	1.01	82	102
851017115	15.8663	23.4312	30.9770	7.5649	7.5458	1.00	126	19
851017116	15.7920	23.2542	30.7084	7.4622	7.4542	1.00	117	27
851017117	16.3337	23.7694	31.1837	7.4357	7.4143	1.00	132	15
851017118	16.0677	22.7110	29.3704	6.6433	6.6594	1.00	131	16
851017119	15.8024	22.0073	28.2496	6.2049	6.2423	0.99	94	64
851017120	16.2010	23.0403	29.8237	6.8393	6.7834	1.01	90	75
851017121	16.0403	24.7555	33.4977	8.7152	8.7422	1.00	95	62
851017122	15.8143	24.5035	33.1329	8.6892	8.6294	1.01	81	106
851017123	15.7608	21.7235	27.7096	5.9627	5.9861	1.00	128,127	18, 18
851017124	15.8787	22.4480	29.0310	6.5693	6.5830	1.00	124	20
851017125	15.9239	22.5726	29.3424	6.6487	6.7698	0.98	129	17
851017126	15.8177	22.2300	28.6119	6.4123	6.3819	1.00	121	23
851017127	16.0999	23.5608	31.1063	7.4609	7.5455	0.99	107	39
851017128	15.8688	23.5370	31.2215	7.6682	7.6845	1.00	142	10
851017129	16.0812	22.7757	29.4521	6.6945	6.6764	1.00	129	17
851017130	15.9643	24.8118	33.6624	8.8475	8.8506	1.00	117	27
851017131	15.7518	24.6843	33.6272	8.9325	8.9429	1.00	89	78
851017132	15.9159	24.5037	33.0952	8.5878	8.5915	1.00	108	38
851017133	15.8366	22.2403	28.6164	6.4037	6.3761	1.00	122	22
851017134	16.1154	22.0041	27.8870	5.8887	5.8829	1.00	112	32
851017135	15.8862	24.3317	32.8117	8.4455	8.4800	1.00	81	106
851017136	16.3381	23.1727	30.0236	6.8346	6.8509	1.00	125	20
851017137	15.7925	23.0024	30.0774	7.2099	7.0750	1.02	95	62
851017138	15.8874	24.6693	33.4203	8.7819	8.7510	1.00	105	42
851017139	16.0383	22.8645	29.7004	6.8262	6.8359	1.00	115	29
851017140	16.0398	22.5214	28.9942	6.4816	6.4728	1.00	115	29
851017141	15.8713	23.0518	30.1725	7.1805	7.1207	1.01	106	41
851017142	16.1033	24.6265	33.4776	8.5232	8.8511	0.96	103	46
851017143	15.9130	23.1629	30.4015	7.2499	7.2386	1.00	119	25
851017144	16.0973	22.7528	29.3667	6.6555	6.6139	1.01	131	16
851017145	16.3392	24.0503	31.4962	7.7111	7.4459	1.04	127	18
851017146	16.0251	24.0503	32.2292	8.0252	8.1789	0.98	129	17
851017147	15.7632	23.3415	30.8517	7.5783	7.5102	1.01	113	31
851017148	15.7543	22.4494	29.0969	6.6951	6.6475	1.01	111	34
851017149	15.7828	21.3204	26.8598	5.5376	5.5394	1.00	114	30
851017150	15.9163	21.9527	27.9604	6.0364	6.0077	1.00	119	25
851017151	15.9363	22.6346	29.2559	6.6983	6.6213	1.01	119	25
851017152	15.7858	22.3297	28.8687	6.5439	6.5390	1.00	131	16
851017153	15.9235	23.7435	31.4812	7.8200	7.7377	1.01	129	17
851017154	16.3250	23.7620	31.2154	7.4370	7.4534	1.00	130	16
851017155	16.2195	23.7292	31.1706	7.5097	7.4414	1.01	110	35
851017156	16.2404	25.3165	34.3065	9.0761	8.9900	1.01	121	23

PCB Field Test Kit Screen of Bengart Memel Soil

Sample #	vial tare	with soil	w/ solvent	soil wt.	solvent wt.	ratio	mV	ppm by kit
851017157	15.8015	22.2722	28.7503	6.4707	6.4781	1.00	105	42
851017158	15.8365	22.1778	28.5253	6.3413	6.3475	1.00	117	27
851017159	16.0975	21.6680	27.3176	5.5705	5.6496	0.99	119	25
851017160	16.3573	22.1024	27.7927	5.7451	5.6903	1.01	108	38
851017161	15.8035	23.5285	31.2255	7.7250	7.6970	1.00	135	13
851017162	15.8141	23.5186	31.2135	7.7045	7.6949	1.00	126	19
851017163	16.0335	24.2784	32.5968	8.2449	8.3184	0.99	78	119
851017164	16.0721	24.1870	32.2470	8.1149	8.0600	1.01	101	49
851017165	16.0986	25.5441	34.5057	9.4455	8.9616	1.05	86	87
851017166	15.8574	24.1166	32.3248	8.2592	8.2082	1.01	62	219
QC1	16.0000	22.8616	29.6056	6.8616	6.7440	1.02	124	20
QC2	16.0000	23.3902	30.7472	7.3902	7.3570	1.00	93	67
QC3	16.0000	22.8546	29.7513	6.8546	6.8967	0.99	107	39
QC4	16.0000	23.6452	31.0952	7.6452	7.4500	1.03	104	44
QC5	16.0000	22.2680	28.5510	6.2680	6.2830	1.00	142	10
QC6	16.0000	22.5747	29.1771	6.5747	6.6024	1.00	132	15
QC7	16.0000	23.5640	30.9582	7.5640	7.3942	1.02	117	27
QC8	16.0000	23.6364	31.2216	7.6364	7.5852	1.01	136	13
QC 8 spiked with Aroclor 1242 instead of 1260								
Samples analyzed by the kit with an improper amount of extraction solvent.								
851017042	16.0245	24.5722	32.1210	8.5477	7.5488	1.13	94	64
851017113	15.8375	24.8740	30.9634	9.0365	6.0894	1.48	78	119
851017134	16.0518	21.8341	28.6783	5.7823	6.8442	0.84	102	47
851017136	15.7767	23.3451	32.7477	7.5684	9.4026	0.80	114.111	30, 34

McGraw-Edison PCB Field Test Kit Initial Calibration Study

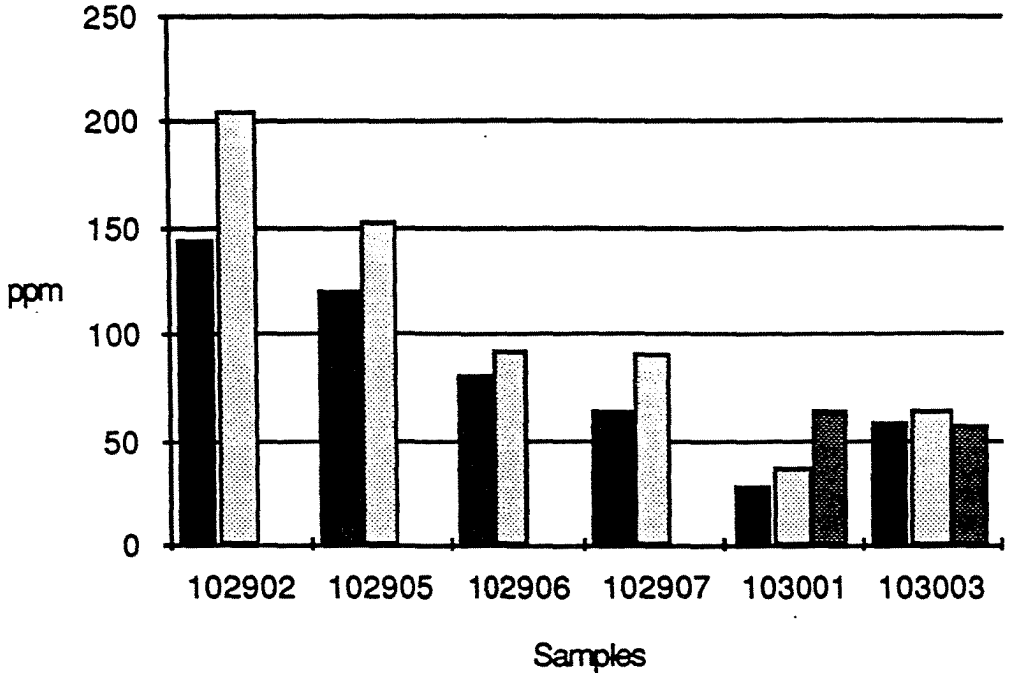


	Predicted concentration	Kit results	Average Kit result
1	0	<4*	<4
2	22	35	35
3	29	26	26
4	32	25	25
5	41	68, 78	73
6	42	(64, 76) (28, 36, 64)	54
7	45	64, 90	77
8	47	(76, 78)	77
9	53	(84, 92)	88
10	54	(96, 120)	108
11	59	(56, 58, 62)	59
12	61	(116, 124)	120
13	63	80, 92	86
14	83	116,116,120,144,152,205	142

Parentheses indicate duplicates/triplicates from the same extract

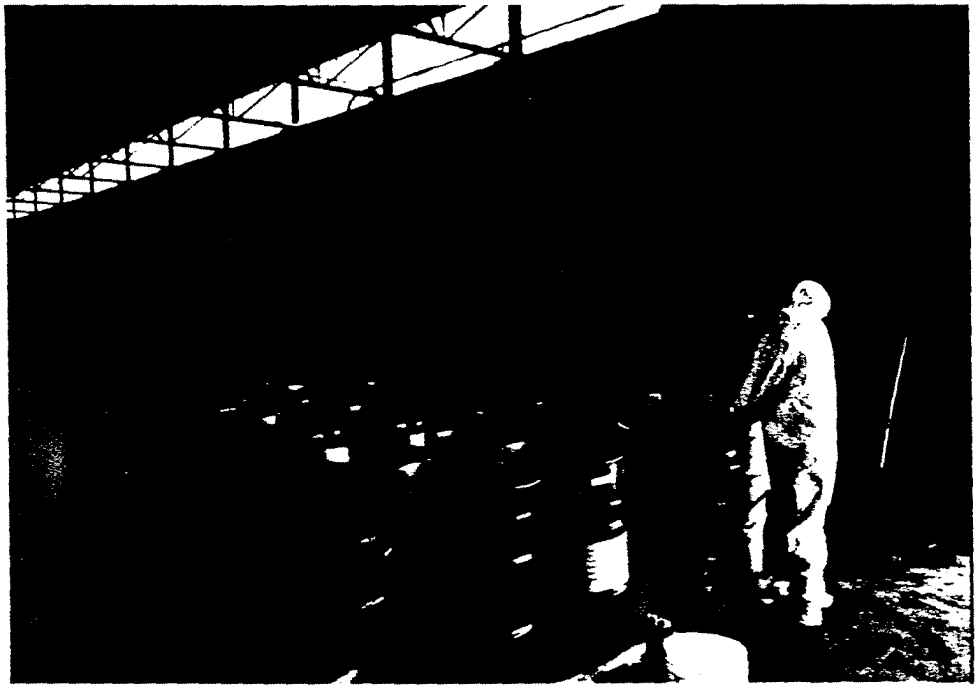
* - below the detection limit

Effect of Soil Extraction Time



Sample #	initial retention time	ppm	second retention	ppm
102902	0.5 hrs.	144	1 hr.	205
102905	0.5 hrs.	116	24 hrs.	152
102906	0.5 hrs.	80	24 hrs.	92
102907	0.5 hrs.	64	24 hrs.	90
103001a	1.5 hrs.	28	3 hrs.	36
103001b	1.5 hrs.	28	3 hrs.	64
103003a	1.5 hrs.	58	3 hrs.	62
103003b	1.5 hrs.	58	3 hrs.	56

Collection of soil samples on site



Entering data into the logbook

Drum conditions / Warehouse layout

PCB Field Test Kit

Operation Instructions

Bulletin
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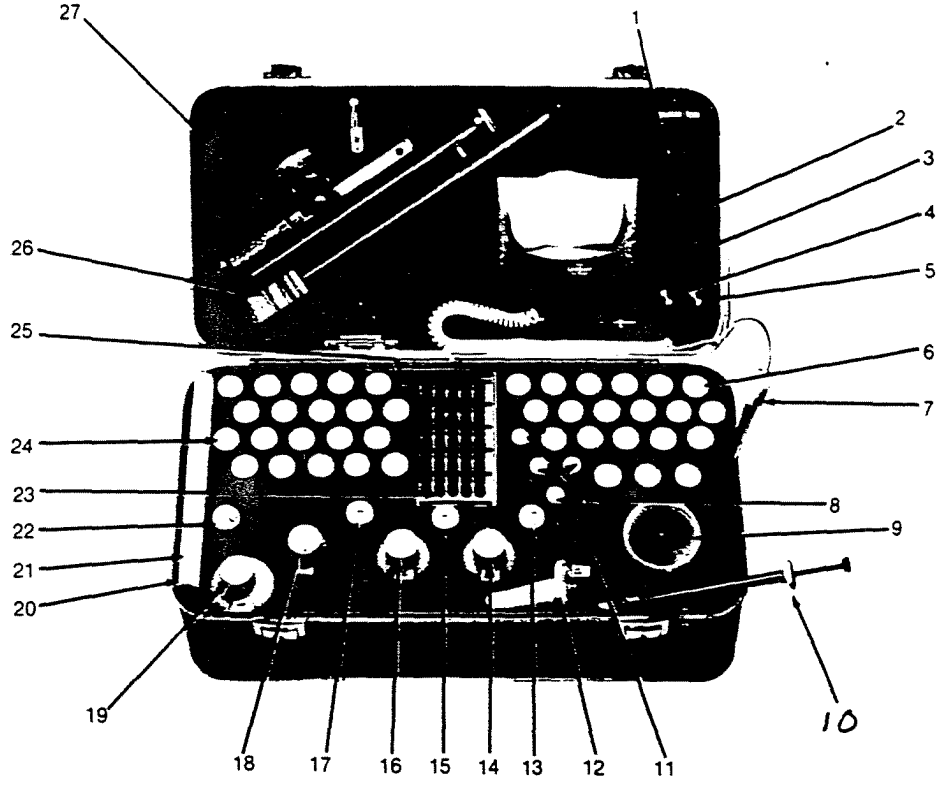
DESCRIPTION

The McGraw-Edison PCB Field Test Kit measures PCB contamination in the mineral oil used as fluid in electrical transformers. No special expertise is needed—any staff member can operate the kit.

The test procedure is based on the chemical destruction of PCB molecules to form chloride ions, which are extracted and measured with a specific ion electrode (probe). The chloride level relates to the original level of PCBs in the transformer oil.

Figure 1 shows the layout of the kit and identifies its components which include equipment for the collection and preparation of soil samples for testing. At shipment, the kit contains reagents and other expendable supplies sufficient to test samples, regardless of whether oil or soil. Replacement kits for expendable materials can be ordered as needed.

Please read this manual before attempting to use the PCB Field Test Kit. The manual first provides a checklist of good safety and disposal procedures. Later sections are arranged to guide the operator easily through the steps for setting up, calibrating, operating, cleaning up, and storing the kit; routine maintenance procedures are described together with the steps to which they apply. Instructions are provided for interpreting test results. A special section offers reminders and further recommendations to ensure successful testing. The final section describes possible operating problems and details the procedures for correcting them.



1. Digital display (probe response reading).
2. Lab tissues.*
3. On/off switch.
4. Zero control knob.
5. Slope control knob.
6. Reaction vials (20).*
7. Probe (specific ion electrode).**
8. Reaction fluid bottles (4).*
9. Waste container.*
10. 5-mL pipetor.**
11. Extraction-fluid bottle.*
12. 1-mL (1000-µL) pipetor.**
13. Slope-calibration vial.*
14. Slope-calibration solution stock bottle.*
15. Zero-calibration vial.*
16. Zero-calibration solution stock bottle.*
17. Rinse vial.*
18. Rinse-solution stock bottle.*
19. Soil extraction fluid and dropper (not shown).
20. User manuals and polishing strips.**
21. Permanent record sheets.*
22. Probe (electrode) filling solution stock bottle.**
23. Disposable pipet tips for 1-mL pipetor.*
24. Soil collection vials (20).
25. Balance support sleave.
26. Soil collection tool.
27. Soil sample balance.

* Replaced as part of the PCBR20 reagent kit.
** Replaced as a separate item, not included in PCBR20 Reagent Kit.

Figure 1.
PCB field test kit.

Care in following the procedures described in this manual will help provide reliable results and safe testing, and will help keep costs to a minimum.

These instructions do not claim to cover all details or variations in the equipment, procedure, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your McGraw-Edison Power Systems Division sales engineer.

SAFETY PRACTICES

Sampling and Testing

- Protect skin and eyes from exposure to transformer oil. Wear safety eyeglasses and other protective clothing.
- Prevent exposure to test kit chemicals. Always wear eye protection and use care. Always wash hands thoroughly after using kit.
- Do not eat or drink while using kit.
- Operate kit only in well-ventilated room or out of doors.
- Do not smoke during kit operation; do not use kit near sources of sparks or flame. Test kit contains solvents that are highly flammable.

Disposal

REACTION FLUID BOTTLES
Squirt rinse solution into each bottle to destroy contents. Dispose of bottles to trash.

LAB TISSUES
Dispose of lab tissues directly to trash.

CALIBRATION AND RINSE SOLUTIONS
Use tap water to flush solutions down sink drain.

REACTION VIALS
Dispose of used vials to flammable solvent waste container.

TRANSFORMER OIL SAMPLES
Dispose of unreacted samples to PCB or waste oil tank, as appropriate.

SETUP AND CALIBRATION

When to Calibrate

The PCB Field Test Kit must be calibrated each time it is set up for testing. Initial set up and calibration should take about 10 to 15 minutes.

Later calibration checks are needed to ensure optimal performance of the kit, and each should take only about five minutes. Check kit calibration at whichever of the following times comes sooner:

- Each time the kit is moved.
- After five tests have been completed.
- At the end of each hour.

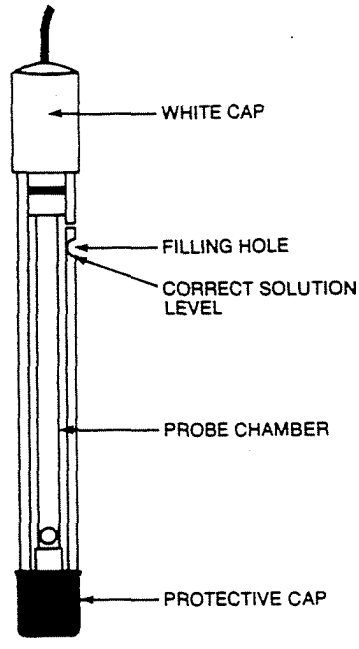
Check calibration more often if the kit is moved to a site with a considerable temperature difference. For example, if the kit were to be moved from inside a warm building to an outside site on a cold day, calibration would change as the kit adjusts to the new temperature. Therefore, rechecking after each hour or every five tests would not be sufficient.

Preparing the Probe

The probe (Figure 1, 7) is stored in the base of the kit. As the first step in setting up the kit, check the level of the probe filling solution in the probe chamber. The solution should just reach the filling hole, below the white cap (Figure 2). If the probe chamber is completely dry, see the section on Troubleshooting. If the level is low, but the chamber is **not** completely dry, fill the probe as follows:

1. Remove the protective cap from bottom of probe.
2. Hold the probe vertically with the white cap up.
3. Flip open the spout on the probe filling solution stock bottle (Figure 1, 22); insert the spout in the filling hole.
4. Squirt solution into the chamber until the level just reaches the filling hole.
5. With a clean lab tissue (Figure 1, 2), remove any excess solution and salt deposits from the outside of the probe.
6. Refer to Corrective Procedure 1, Steps 4 and 5 to renew the junction.

The kit is now ready for calibration.



Important: Always replace protective cap on end of probe when probe is not in use.

Figure 2.
Preparing the probe.

Calibrating the Kit

As you proceed through the following steps, take care that the various solutions and bottles do not become cross contaminated. Keep each bottle in its designated storage place in the kit. Keep each labeled lid with its own bottle.

1. Empty the rinse vial (Figure 1, 17) of any used solution. The waste container (Figure 1, 9) is provided for this purpose. Add fresh rinse solution (Figure 1, 18) to fill the rinse vial about three quarters of the way. Remove the protective cap from the bottom of the probe. With a fresh lab tissue, wipe accumulated salt from the outside of the probe.
2. Place the probe in the rinse vial. Turn on the meter and allow five minutes for the probe to equilibrate. During this period, occasionally swirl the probe **gently.**
3. Empty any used solution from the zero calibration vial (Figure 1, 15) into the waste container. Add fresh zero calibration solution (Figure 1, 16) to fill the zero calibration vial about three quarters of the way.
4. Empty any used solution from the slope calibration vial (Figure 1, 13) into the waste container. Add fresh slope calibration solution (Figure 1, 14) to fill the slope calibration vial about three quarters of the way.
5. After five minutes have passed, the digital display (Figure 1, 1) should give a probe response reading greater than 120 mV, indicating that the probe has equilibrated. Remove the probe from the rinse vial. With a fresh lab tissue, dry the probe and place it in the zero calibration vial. **Gently** swirl the probe for five to ten seconds. Allow two minutes for the probe to equilibrate; during this time occasionally (every 30 seconds or so) swirl the probe again. Adjust the zero control knob (Figure 1, 4) until the probe response reading is 000 mV. If the readings are erratic or if zero calibration cannot be made, refer to the section on Troubleshooting.
6. Remove the probe from the zero calibration vial. With a fresh lab tissue, dry the probe and place it in the rinse vial until the probe response reads greater than 120 mV.
7. Remove the probe from the rinse vial. With a fresh lab tissue, dry the probe and place it in the slope calibration vial. **Gently** swirl the probe for five to ten seconds. Allow two minutes for the probe to equilibrate, with occasional swirling. Adjust the slope control knob (Figure 1, 5) until the probe response reading is 100 mV.
8. Remove the probe from the slope calibration vial. With a fresh lab tissue, dry the probe and place it in the rinse vial.

The field test kit is now calibrated. For later calibration checks, repeat Step 1 and Steps 3–8. Step 2 does not need to be repeated.

SAFETY PRACTICES

Sampling and Testing

- Protect skin and eyes from exposure to transformer oil. Wear safety eyeglasses and other protective clothing.
- Prevent exposure to test kit chemicals. Always wear eye protection and use care. Always wash hands thoroughly after using kit.
- Do not eat or drink while using kit.
- Operate kit only in well-ventilated room or out of doors.
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Check calibration more often if the kit is moved to a site with a considerable temperature difference. For example, if the kit were to be moved from inside a warm building to an outside site on a cold day, calibration would change as the kit adjusts to the new temperature. Therefore, rechecking after each hour or every five tests would not be sufficient.

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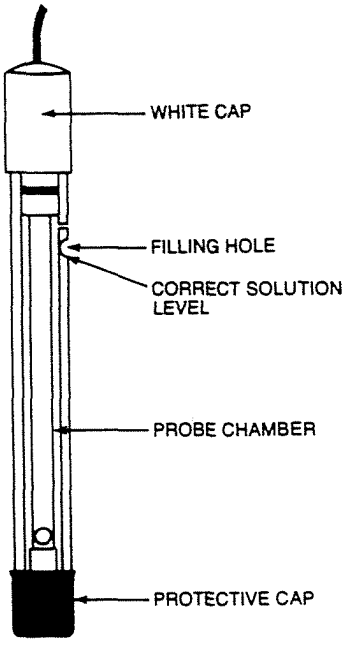
1. Remove the protective cap from bottom of probe.
2. Hold the probe vertically with the white cap up.
3. Flip open the spout on the probe filling solution stock bottle (Figure 1, 22); insert the spout in the filling hole.
4. Squirt solution into the chamber until the level just reaches the filling hole.
5. With a clean lab tissue (Figure 1, 2), remove any excess solution and salt deposits from the outside of the probe.
6. Refer to Corrective Procedure 1, Steps 4 and 5 to renew the junction.

The kit is now ready for calibration.



Important: Always replace protective cap on end of probe when probe is not in use.

Figure 2.
Preparing the probe.

Calibrating the Kit

As you proceed through the following steps, take care that the various solutions and bottles do not become cross contaminated. Keep each bottle in its designated storage place in the kit. Keep each labeled lid with its own bottle.

1. Empty the rinse vial (Figure 1, 17) of any used solution. The waste container (Figure 1, 9) is provided for this purpose. Add fresh rinse solution (Figure 1, 18) to fill the rinse vial about three quarters of the way. Remove the protective cap from the bottom of the probe. With a fresh lab tissue, wipe accumulated salt from the outside of the probe.
2. Place the probe in the rinse vial. Turn on the meter and allow five minutes for the probe to equilibrate. During this period, occasionally swirl the probe **gently**.
3. Empty any used solution from the zero calibration vial (Figure 1, 15) into the waste container. Add fresh zero calibration solution (Figure 1, 16) to fill the zero calibration vial about three quarters of the way.
4. Empty any used solution from the slope calibration vial (Figure 1, 13) into the waste container. Add fresh slope calibration solution (Figure 1, 14) to fill the slope calibration vial about three quarters of the way.
5. After five minutes have passed, the digital display (Figure 1, 1) should give a probe response reading greater than 120 mV, indicating that the probe has equilibrated. Remove the probe from the rinse vial. With a fresh lab tissue, dry the probe and place it in the zero calibration vial. **Gently** swirl the probe for five to ten seconds. Allow two minutes for the probe to equilibrate; during this time, occasionally (every 30 seconds or so) swirl the probe again. Adjust the zero control knob (Figure 1, 4) until the probe response reading is 000 mV. If the readings are erratic or if zero calibration cannot be made, refer to the section on Troubleshooting.
6. Remove the probe from the zero calibration vial. With a fresh lab tissue, dry the probe and place it in the rinse vial until the probe response reads greater than 120 mV.
7. Remove the probe from the rinse vial. With a fresh lab tissue, dry the probe and place it in the slope calibration vial. **Gently** swirl the probe for five to ten seconds. Allow two minutes for the probe to equilibrate, with occasional swirling. Adjust the slope control knob (Figure 1, 5) until the probe response reading is 100 mV.
8. Remove the probe from the slope calibration vial. With a fresh lab tissue, dry the probe and place it in the rinse vial.

The field test kit is now calibrated. For later calibration checks, repeat Step 1 and Steps 3–8. Step 2 does not need to be repeated.

Using the 1-mL Pipetor: Practice Step

If you are using the kit for the first time, **please read this section carefully before you continue.**

The 1-mL pipetor (Figure 1, 12) is designed to be used easily with one hand, and to eliminate the need to touch the disposable pipet tip. It will be helpful to pause and become familiar with features of the pipetor, and to practice using it.

Remove the pipetor from the case and hold the pipetor as shown in Figure 3. Fit the pipetor with a tip by pushing it snugly into one of the disposable pipet tips in the rack (Figure 1, 23).

Hold the pipetor upright with the tip down, and depress the plunger to the first stop, that is, until some resistance is felt. This stop is the fill position. Release the plunger slowly; this action will fill the tip with a measured volume (1-mL) of solution. During filling, approximately ½ in. of the pipet tip should be covered by liquid to allow for accurate measurement.

Depress the plunger past the first stop until resistance is again met. In this second position the plunger will dispense fluid from the tip.

Depress the plunger all the way to the final position to eject the pipet tip. (Eject used tips directly to the waste container.)

Remember three important points to prevent contamination of the pipetor:

- Always fit the pipetor with a tip before drawing up fluid. Always make sure the tip is **firmly** attached.
- Always release the plunger **slowly.** Abrupt release could bring fluid into the tip so rapidly that the fluid would contaminate the pipetor.
- Always hold the pipetor **vertically** (tip down) while the tip contains solution. Failure to do so will let the fluid run into the body of the pipetor and thus contaminate it.

Should the pipetor become contaminated, refer to the section on Troubleshooting.

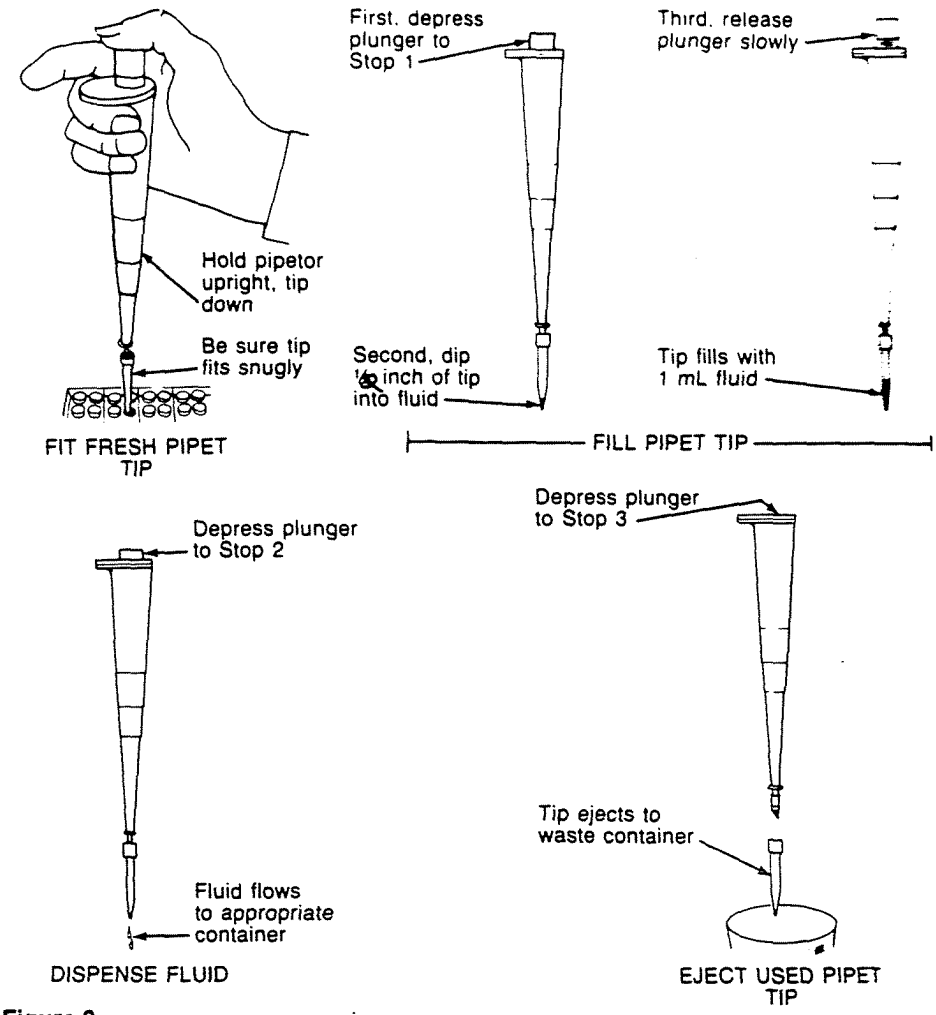
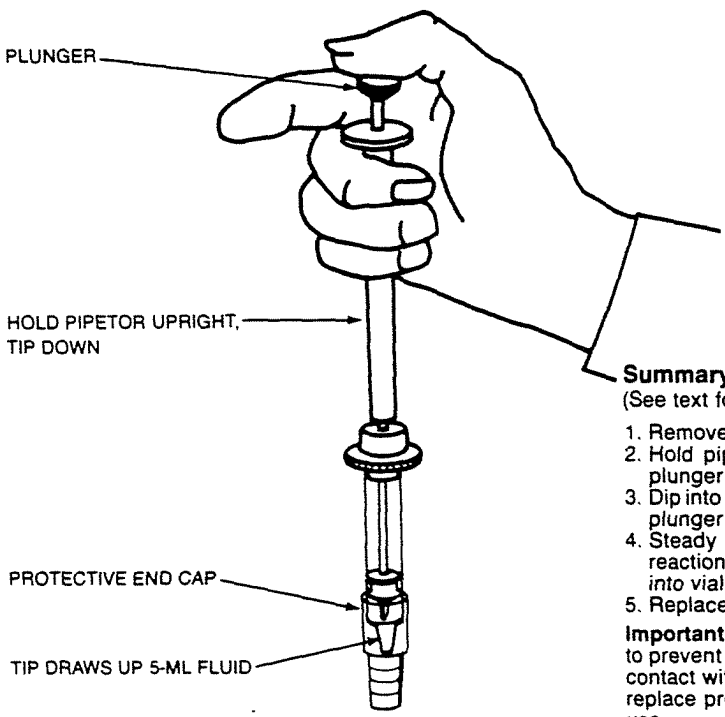


Figure 3.
Using the 1-mL pipetor.

Using the 5-mL Pipetor: Practice Step

If you are using the kit for the first time, **please read this section carefully before you continue.**

For the first testing step, the special 5-mL pipetor (Figure 1, 10) will be used. Remove the protective cap from the pipetor tip and hold the pipetor as shown in Figure 4. To fill the pipetor, depress the plunger fully, then release it slowly. This action will draw 5-mL of fluid into the tip; the tip should then be full. To dispense the solution, depress the plunger fully.



Summary:
(See text for details.)

1. Remove protective end cap.
2. Hold pipetor upright. Depress plunger fully.
3. Dip into extraction fluid; release plunger slowly.
4. Steady tip over (not touching) reaction vial; dispense contents into vial.
5. Replace protective end cap.

Important: Always steady pipetor to prevent contamination through contact with reaction vial. Always replace protective cap after each use.

Figure 4.
Using the 5-mL pipetor.

Be careful that the tip of the pipetor does not touch the reaction vial or its contents because the 5-ml pipetor does not have a disposable tip. Always steady the tip above the reaction vial during the transfer to prevent contamination. As a further guard against contamination, replace the protective end cap on the pipetor as soon as the transfer is completed. If the tip should become contaminated, rinse it thoroughly with rinse solution.

Preparing Reaction Vials

It may be convenient to prepare the reaction vials (Figure 1, 6) during calibration while the probe is equilibrating. As many vials as needed for one day's use can be prepared. At the end of the day, discard any prepared reaction vials that have not been used.

Each of the four reaction fluid bottles (Figure 1, 8) contains enough fluid for 12 tests. After a bottle has been opened, the fluid becomes unstable. If the bottle is more than half empty at the end of a test run, its contents should be discarded. Destroy the unused fluid by squirting some rinse solution into the bottle. The fluid will lose its black color and can then be discarded.

If necessary, refer to the previous section for instructions on operating the 1-mL pipetor.

1. Select a bottle of black reaction fluid and shake it. Select as many reaction vials as needed for the day's testing.
2. Uncap a reaction vial. Fit the 1-mL pipetor with a fresh tip from the pipet tip rack, making sure the tip is firmly attached. The same tip can be used to prepare all of one day's reaction vials.
3. Fill the pipet tip with reaction fluid from the shaken bottle. Dispense the fluid into the reaction vial. **(Remember, release the plunger slowly.)** Cap the reaction vial immediately.
4. When the desired number of reaction vials have been prepared, eject the used pipet tip to the waste container.

Each of the reaction vials contains a measured amount of solvent.

OPERATING THE KIT

Preparing Samples

1. Collect a representative sample of oil from the transformer. Label the sample and record identifying information on the Permanent Record Sheet (Figure 1, 21). Information such as serial number, location, and type of transformer will be important.
2. Select a prepared reaction vial and mark it to show that it will contain the sample collected in Step 1. Remove the cap from the vial.
3. Fit a fresh tip to the 1-mL pipetor. Fill the tip with oil from the sample. Dispense the oil into a prepared reaction vial and release the plunger only so far as the first stop. Draw up the contents of the vial and dispense them back into the vial two or three times, **remembering not to pass the first plunger stop** so that the pipetor will not be contaminated. This action flushes the pipet tip and ensures good transfer of the oil. **Be careful that the pipetor is held upright (tip down) and the plunger is slowly released.** Eject the used tip to the waste container.
4. Cap the reaction vial and shake briskly for 20 seconds. The fluid must remain black.
   - If the fluid turns brown or loses its black color, the sample may contain very high levels of PCB or may be contaminated with water or chlorinated solvent. Record the color change on the Permanent Record Sheet and send the original transformer oil sample (not the reacted sample) to a laboratory for alternative analysis.
   - If the fluid remains black, continue with the analysis.

Testing

1. Remove the protective end cap from the 5-mL pipetor. Fill the pipetor tip with 5-mL of extraction fluid from the extraction fluid bottle (Figure 1, 11). Steady the pipetor tip above the reaction vial and dispense the extraction fluid into the vial. Replace the protective cap on the tip of the pipetor.
2. Cap the reaction vial and shake it for ten seconds, then let it rest. In one to two minutes, the liquid in the vial will separate into two layers; allow the separation to become complete.
3. Uncap the reaction vial. Remove the probe from the rinse vial and wipe it dry with a fresh lab tissue. Insert the probe in the reaction vial contents so that the end passes through the top layer and into the bottom layer. Gently swirl the probe for ten seconds, being careful not to agitate the solution excessively. Allow two minutes for the probe to equilibrate, with occasional gentle swirling. Record the probe response on the Permanent Record Sheet.
4. Remove the probe from the reaction vial and wipe it dry with a fresh lab tissue. Place the probe back in the rinse vial. Swirl the probe until the probe response reading is stable. If the reading is less than 120 mV, discard the used rinse solution to the waste container and replace it with fresh solution. If the reading is greater than 120 mV, this same rinse solution can be used for the next sample. **Care in wiping the probe completely dry will extend the life of the rinse solution.**

SOIL TESTING

1. Prepare the Soil Collector

Remove the soil collection equipment from the lid of the kit. Assemble the collection tool by unscrewing the two side sections from their stored positions and screwing them onto the middle section. Remove the cap of a clean, empty soil collection vial (from the left side of the kit). Insert the vial into the collection tool, positioning the vial opening on the rubber pad over the sampling hole.

2. Set Up the Balance

Set up the balance rod (with the leveling bubble) in the reinforced hole in the back of the kit base. Adjust the kit to level the rod. Slip the balance crossbeam over the shaft (with the adjusting screw facing forward), allowing the beam to move freely on the knife edge. Balance the crossbeam by adjusting the weight located on the beam.

3. Collect Soil Sample

A soil sample is collected by striking the ground 10 to 15 times with the collection tool, or until the vial is one-third to one-half full (Figure 5).

Note: It is important to collect a representative sample in order to have an accurate test. Select a sample area appropriate to the size of the spill. Also, collect the samples over a pattern (such as an X).

Figure 5.
Collecting soil samples.

Draw a map of the site, documenting each sample location and the sampling pattern used. Also describe any site characteristics, such as discolored soil.

4. Extract the Soil

Place the lidless vial containing soil in one cup of the balance. Place another clean, empty vial in the other cup. Carefully add sufficient soil extraction solvent using the dispenser dropper into the empty vial to balance the vials. Add the solvent to the soil, cap the vial, and shake it vigorously for 30 seconds.

5. Measure the PCB

Allow the soil to settle. Attach a clean tip to the 1-mL pipetor, and then transfer 1-mL of extract to a prepared extraction vial. Continue the test as with oil testing. The maximum PCB content is four times the value obtained from the graph or table on the Permanent Record Sheet. For example, a 112-mV probe response for a soil analysis is 72 ppm PCB maximum (i.e., 4 X 18 ppm).

6. Laboratory Analysis

For confirmation once the site is determined to be cleaned up, final samples of the soil should be collected and taken to a laboratory for analysis.

INTERPRETING THE RESPONSE

The PCB Field Test Kit can be used to determine the range of PCB contamination and to estimate the actual PCB content. The Permanent Record Sheet is reproduced in Figure 6a. The probe response (horizontal axis) relates graphically to the PCB contamination level (vertical axis). The horizontal axis is a scale of 2-mV intervals. The vertical axis is a logarithmic scale (powers of 10) that shows PCB concentration in parts per million (as Aroclor 1242). The higher the probe response, the lower the PCB concentration.

Figure 6b reproduces the Equivalency Table appearing on the back of the Permanent Record Sheet. This table provides an alternative means of estimating PCB content.

PCB Contamination Range

The heavy vertical lines superimposed on the Permanent Record Sheet grid (Figure 6a) define the limits of five ranges of PCB contamination:

- Less than 50 ppm.
- TEST 50 ppm.
- 50 to 500 ppm.
- TEST 500 ppm.
- Greater than 500 ppm.

To determine the range of PCB contamination, find the point on the horizontal scale that corresponds to the probe response reading.

The kit cannot accurately classify samples with PCB levels close to 50 and 500 ppm. Therefore, readings in the two test ranges (TEST 50 and TEST 500) mean that original (unreacted) samples of the corresponding transformer oils should be sent to a laboratory for analysis.

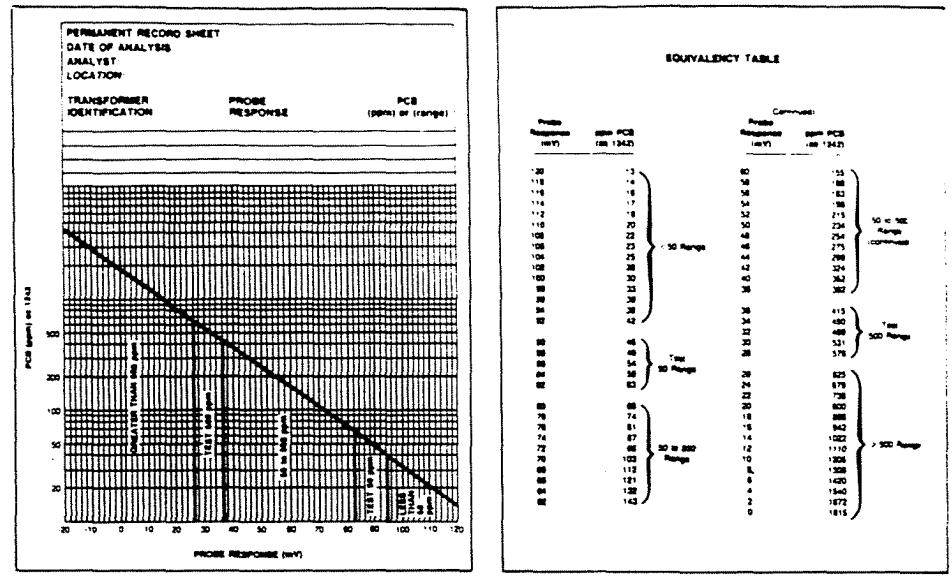


Figure 6.
Permanent Record Sheet: (a) front, (b) back.

Estimated PCB Content

The actual PCB content (although not the contamination range) will vary according to the Aroclor(s) causing the contamination. The PCB concentrations in the Permanent Record Sheet and the Equivalency Table are expressed in terms of Aroclor 1242. Other Aroclors, such as 1254 and 1260, may also contaminate transformer oil. The use of Aroclor 1242 as a standard eliminates the possibility of "false negatives" (identifying a 50 ppm sample as less than 50 ppm). Therefore, **the result of a PCB Field Test reading should be used only as an estimate of actual content.**

To estimate PCB content, find the point on the horizontal scale that corresponds to the probe response reading. Read carefully up from this point to a corresponding point on the curve (heavy diagonal line). Mark this last point on the curve, then read carefully across to the vertical scale for the value of the PCB content.

For example, a probe response of 000 mV would show that the sample contains an estimated 1900 ppm PCB (as Aroclor 1242). This reading would place the transformer oil in the range of greater than 500 ppm—that is, in the PCB-transformer category.

CLEAN-UP AND STORAGE

At the end of the day's testing, clean up carefully and make sure that the PCB Field Test Kit is stored properly.

1. Care in following this step will greatly reduce the need for probe maintenance, and will extend the life of the probe. Rinse the probe and dry it with a fresh lab tissue. **Firmly** replace the protective cap on the probe. Place the probe in its storage position in the base of the kit. **If the kit is to be stored for an extended period, it is recommended that the probe be drained:**
   Hold the body of the probe firmly and push it up into the white cap. Solution will run out and can be disposed of down a sink drain.
2. Dispose of used rinse, zero calibration, and slope calibration solutions to the waste container. Cap the rinse, zero, and slope vials; make sure that each has its own cap to prevent cross contamination. Store each vial in its designated storage hole.
3. If any reaction fluid bottle is more than half empty at the end of the test run, squirt rinse fluid into bottle to destroy its contents. Cap bottle and discard in trash.
4. Dispose of used reaction vials to a solvent waste container. These vials do not contain PCB, but they do contain flammable solvents.
   NOTE: If a colorless or brown solution resulted upon addition of reaction fluid, that solution and the original oil must be treated as PCBs for disposal purposes.
5. Insert the 1-mL pipetor in its position in the base of the kit.
6. Insert the 5-mL pipetor into its position in the base of the kit. Make sure the protective end cap is firmly in place.
7. Use tap water to flush fluid from the waste container down a sink drain. Dispose of used lab tissues to the trash.
8. Check to ensure that vials and bottles are tightly capped and stored in their proper places.
9. Turn off the meter and close the kit.

HINTS AND REMINDERS

Do not skimp on lab tissues or solutions. All these items are supplied in generous quantities and, except for probe filling solution, all are replaced together as one unit. Dispose of unused supplies from earlier units as indicated in the Safety Practices section.

An oil sample may be saved to use in routinely checking kit performance. A sample of an oil with a probe reading in the TEST 50 range is ideal. Save the oil in a clean vial, labeled with the probe response. On retesting, the sample should give the same response as that on the label, plus or minus 2 mV. Record each routine check on a Permanent Record Sheet.

Send TEST 50 and TEST 500 samples to a laboratory for analysis. Send the original oil in a labeled vial—**do not** send reacted oil.

Replace zero and slope calibration solutions before each calibration. Replace the rinse solution when the probe response reading is less than 120 mV.

Be careful in using the pipetors. Results will be inaccurate if measurements are faulty or if pipetors become contaminated.

Recheck calibration each time the kit is moved, after every hour, or after every five tests, whichever is sooner. Recheck more often if operating temperature has changed; if possible, allow the kit to adjust to a new temperature before beginning testing.

Be thorough in caring for the probe. Dry it well when it is removed from any solution. Rinse and dry it well between solutions. Always replace the protective cap before storing the probe. Drain the probe if it is to be stored for an extended period.

TROUBLESHOOTING

Routine maintenance for the PCB Field Test Kit involves only a few simple techniques. Those techniques are described as an integral part of overall setup and operation and need not be repeated here. This section addresses conditions under which corrective maintenance may be needed. Table 1 lists possible operating problems, with the procedures for correcting them. Where two or more procedures are listed for a given problem, all should be performed.

Table 1
Troubleshooting and Corrective Maintenance

Symptom	Cause	Corrective Procedure
Probe chamber is dry	—	1
Probe response is erratic	Sensing membrane is fouled or liquid junction is pour	2 and 3
Probe will not calibrate	Sensing membrane is fouled or liquid junction is poor	2 and 3
Digital display works only partly or not all all	Battery is weak or has failed	4
1-mL pipetor is contaminated	—	5
5-mL pipetor is contaminated	—	6
Probe response is not reproducible	Sensing membrane is fouled, liquid junction is poor, or pipetors are contaminated	2, 3, 5 and 6

Corrective Procedure 1: Filling a Dry Probe Chamber.

The probe chamber may have become dry during a long storage period, or it may have been drained for extended storage. Probe filling solution is used to fill the chamber:

1. Remove the protective cap from bottom of the probe. Hold the probe upright, with the white cap up.
2. Open the flip spout on the filling solution stock bottle. Insert the spout in the filling hole near the top of the probe. Squirt a small amount of solution into the probe chamber.
3. Tip the probe to moisten the O-ring (Figure 7) at the top of the probe chamber (just below the white cap). To ensure proper wetting of the O-ring, gently tap the probe against your hand.
4. Hold the probe body in one hand and push down on—but do not force—the white cap with the other hand. If the cap is difficult to move, repeat Steps 1 through 3 until it moves easily. As the probe body moves into the cap, the black cone protrudes from the bottom of the probe and solution should flow from the chamber out around the black cone (Figure 7).

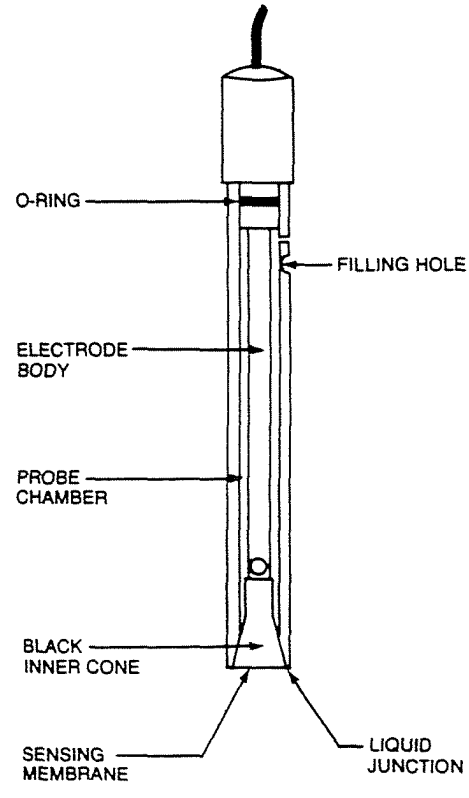


Figure 7.
Probe maintenance diagram.

Summary:
(See text for details.)

1. Remove protective cap from bottom of probe. Hold probe upright, white cap up.
2. Insert spout of filling solution bottle in filling hole and squirt small amount of solution into chamber.
3. Tip probe and tap gently against hand to moisten O-ring.
4. Hold probe upright. Without forcing, push white cap down over probe body. (If cap does not move easily, repeat Steps 1 and 3.) Black inner cone now protrudes from probe body and solution should flow out around cone.
5. Release white cap to retract cone. (If cone does not retract at once, repeat the entire procedure.)
6. Inspect liquid junction (area between retracted cone and clear yellow body); if not evenly wetted, repeat Steps 4 and 5.
7. Fill probe chamber until filling solution reaches filling hole.

5. Release the white cap and allow the cone to retract into the chamber. If the cone does not immediately return to its original position the O-ring may not be wet enough; in this case, repeat the entire procedure.
6. When the cone has been properly retracted, inspect the cone; the area between the black inner cone and the clear yellow body (the liquid junction) should be wetted evenly. If not, add more filling solution and repeat Steps 4–5.
7. Add filling solution so that it just reaches the filling hole.

Corrective Procedure 2: Polishing the Sensing Membrane

Plastic polishing strips are stored on a card in the literature pocket of the kit. Each strip has a dull (frosted) side and a glossy side. The dull side is used to polish the sensing membrane (Figure 7) of the probe:

Cut a one-inch length from one of the polishing strips, and moisten the dull side with a bead of rinse solution. Moisten the end of the probe in the rinse vial. With your thumb, hold the wet, dull side of the strip against the end of the probe and rotate the probe two or three times.

Corrective Procedure 3: Establishing Good Liquid Junction in the Probe

Good liquid junction (Figure 7) means proper wetting of the area at the bottom of the probe between the black inner cone and the clear yellow outer wall of the probe chamber. To establish good liquid junction:

Hold the probe body in one hand and push down on the white cap with the other hand until the body moves up into the cap. The black inner cone will protrude from the bottom of the probe and the solution should flow out around the cone. Release the body to establish good liquid junction. Refill the probe to the filling hole.

Corrective Procedure 4: Replacing the Battery

Kit electronics and digital display are powered by a nine-volt transistor battery housed under the faceplate. The battery should last for at least a year. When it does need replacement:

Disconnect the probe from the electronics installation. Remove the box of paper towels to provide easier access to the faceplate. Remove the mounting screws from the faceplate and work the plate out. Replace the battery and reassemble the other components.

Corrective Procedure 5: Cleaning the 1-mL Pipetor of Transformer Oil

The solvent in a reaction vial is used to remove transformer oil contamination from the 1-mL pipetor:

Dip the end of the pipetor into the solvent in a fresh reaction vial. Swirl the pipetor to remove surface contamination. Carefully draw some solvent into the pipetor to clean the inside, then discharge this solvent. Operate the plunger several times, drawing in and expelling air, until the inside of the plunger is dry.

Corrective Procedure 6: Cleaning the 5-mL Pipetor of Non-Transformer-Oil Contaminants

To clean the 5-mL pipetor when it has been contaminated by a source other than transformer oil:

Rinse thoroughly with rinse solution. Rinse again with tap water, if available. With a lab tissue, dry the pipetor thoroughly. Follow with a final cleaning with rinse solution and dry with a lab tissue.