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BACKGROUND DOCUMENT FOR THE LIQUID RELEASE TEST: SINGLE LABORATORY EVALUATION AND 1988 COLLABORATIVE STUDY

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TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

This report was prepared by Ms. Garrie L. Kingsbury, P.E., and Ms. Constance V. Wall of Research Triangle Institute (RTI) under EPA Contract No. 68-WO-0032, WA 12. The LRT developmental work, the Draft Protocol, and the 1987 and 1988 collaborative studies were performed by RTI under EPA Contract No. 68-01-7075, WA 76. Ms. Paula Hoffman was the Work Assignment Leader. Ms. Kingsbury served as Program Manager from November 1987 through November 1988. Mr. Joseph Evans served as Quality Assurance Coordinator for the project during the 1988 developmental work and collaborative study. The RTI project team also included Ms. Pam Overby, Ms. Donna Smith (Womack), Ms. Dana Greenwood, and Mr. Keith Leese. Professional geologist Mr. Robert Truesdale, also of RTI, assisted with the sorbent processing scheme and the early developmental work. Dr. Roy Borden, P.E., of North Carolina State University's Department of Civil Engineering performed the equipment calibrations. Mr. Franklin Smith and Mr. Michael Messner of RTI assisted with the collaborative study data evaluation.

1.0 INTRODUCTION

The Liquid Release Test (LRT) is a laboratory test method designed to determine whether or not liquid will be released from sorbents when they are subjected to a vertical load, as would be experienced by materials buried in a landfill. The LRT is an attribute test rather than a continuous variable measurement test. Thus, the result is either a release detected (sample fails the test) or no release detected (sample passes the test). This report describes the single-laboratory evaluation and the collaborative study conducted in 1988 to evaluate performance of the LRT Draft Protocol, and provides an assessment of the method based on the results of these tests. This test method was developed by the Research Triangle Institute (RTI) for the U.S. Environmental Protection Agency's (EPA's) Office of Solid Waste (OSW).

EPA developed the LRT to implement Section 3004 (c)(2) of the Resource Conservation and Recovery Act (RCRA), as amended in 1984, which requires EPA to issue regulations that "prohibit the disposal in landfills of liquids that have been absorbed in materials that biodegrade or that release liquids when compressed as might occur during routine landfill operations." Development of a method to determine releasable liquid began in 1985.

2.0 BACKGROUND

In December 1986, EPA proposed a liquid release test method using the zero head-space extractor (ZHE) to implement RCRA 3004 (c)(2) (FR, December 24, 1986). Subsequent evaluation of the proposed test revealed problems in repeatability for some types of sorbents. These problems were attributed to the ZHE's design. After an unsuccessful attempt to modify the ZHE to make it better suited for this application, EPA decided that a different test device was needed.

There are several reasons for abandoning the ZHE as the test device for determining releasable liquid. Problems associated with the device included small sample capacity, rough movement of the piston, and difficulty in cleaning. The sample size specification given in the proposed rule proved to be problematic in that the ZHE did not have sufficient capacity to hold 100 grams of certain low density sorbents. In addition, subsequent research determined that for certain sorbent/sorbate combinations, sample length or height had a significant effect on test results.

The ZHE requires a significantly longer test time (30 minutes) to match results obtained in 10-minute tests with other devices. A major concern was that the longer time requirement would prove disruptive and costly to off-site commercial landfills processing large numbers of containers.

The proposed approach to applying a compressed load to the sample was the use of a piston driven by compressed gases (e.g., air or nitrogen). Modifications made to the ZHE to shorten the test time and eliminate clean-up and operational problems (such as piston movement) precluded direct use of gas pressure to drive the ZHE piston.

A new test device to determine releasable liquids was developed, and, in 1987, RTI began work on a Draft Protocol to be used with it. This Draft Protocol was evaluated in a collaborative study involving seven laboratories in the fall of 1987. Results of the study showed an unacceptable number of false positives (releases observed due to direct contact between the filter and sample). For additional information, see the fall 1987 collaborative study report (RTI, 1988a).

During 1988, RTI continued the test development. Several improvements were implemented, including modification of the release detection filters and addition of a spacer grid to prevent sorbent contact with the filter. Additional testing was performed to determine the effect of temperature, sample height, and test duration, and to compare the method with the Paint Filter Liquids Test (PFLT; Method 9095).

The PFLT is used to determine whether or not free liquid is present in a waste. Unlike the LRT, the PFLT determination is made under only the force of gravity.

RTI completed the single-laboratory evaluation of the revised LRT method in the fall of 1988. A new collaborative study, again involving seven laboratories, was then conducted to enable further evaluation of the method.

2.1 THE TEST DEVICE

The test requires a device capable of applying a vertical load of 50 psi continuously to the top of a confined cylindrical sample. RTI used a test device developed by Associated Design and Manufacturing (ADM) of Alexandria, VA, in developing and evaluating the LRT Draft Protocol. This device, illustrated in Figure 1, consists of a sample holder, the pressure application device, blue papers to detect released liquid, supporting screens, and a spacing grid to prevent wicking. Other test devices were also tested in the collaborative study (see section 4.0 for discussion).

2.2 SUMMARY OF METHOD

A sample of the liquid-loaded sorbent is placed into the cylindrical sample holder to a height of 10 cm. A stainless-steel screen is placed on top of the sample; a stainless-steel grid and absorptive blue paper are placed over the screen. A simular screen, grid, and paper assembly is also provided at the bottom of the sample. The stainless-steel screen placed against the sample allows fluid to pass, but blocks the movement of solid particles from the sample. The stainless-steel grid provides a small air gap to prevent wicking of liquid from the sample onto the paper. A compressive force of 50 psi is applied for 10 minutes to the top of the sample. Release of liquid is indicated when a visible wet spot is observed on either

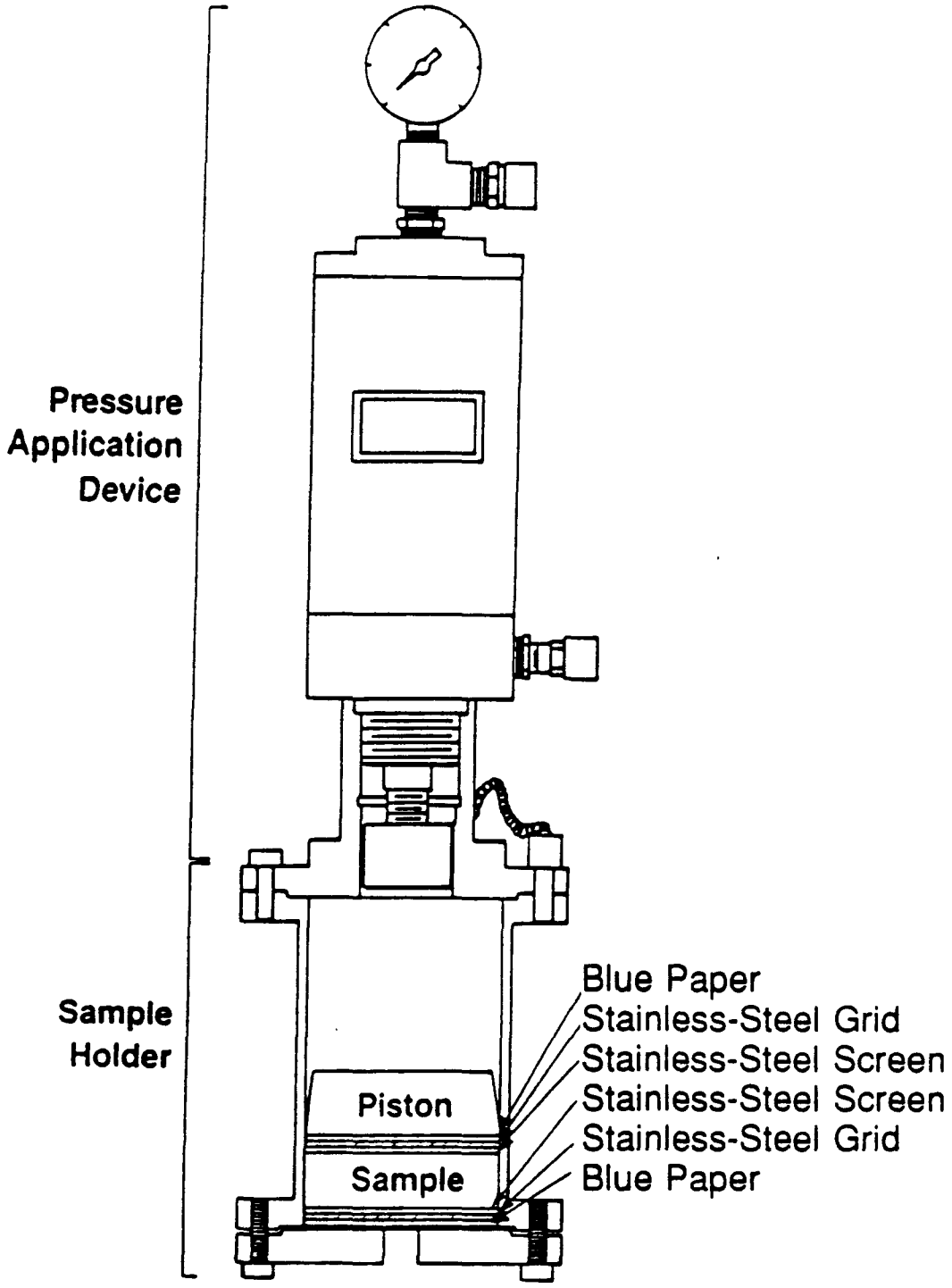


Figure 1. Test device for Liquid Release Test.

the top or the bottom blue paper. If the papers show no indication of liquid, the result is termed "no release."

The LRT is an attribute test rather than a continuous variable measurement test (i.e., the result is either a release detected or no release detected). The LRT Draft Protocol is presented in Appendix A.

2.3 SORBENTS AND SORBATES

The term "sorbent" refers to any solid material that is used to sorb liquid. The mechanism for sorption may be by liquid penetration into the inner structure of an absorbing material (absorbent) or by liquid adherence to the surface of an adsorbing material (adsorbent). Both absorption and adsorption are reversible processes, and many materials are capable of holding liquids by both processes. Only those sorbents that are nonbiodegradable were considered in developing the LRT.

The term "sorbate" refers to the liquid held by the solid sorbents. Properties of sorbates that influence sorption include viscosity, specific gravity, surface tension, solubility in water, and electrical properties.

2.4 RELATED TESTS

2.4.1 The Pressurized Concentration (PC) Level

The pressurized concentration (PC) is defined as the maximum liquid loading for a given sorbent/liquid combination that will not release liquid under the conditions of the landfill environment. The PC is expressed as the ratio of liquid to dry solids times 100 ([mass liquid]/[mass solid] x 100). EPA selected a pressure of 50 psi to simulate landfill overburden. For the LRT development and validation studies, the PC for each sorbent/liquid combination must be determined so that the LRT results can be compared to a reference point.

As part of the effort to develop the LRT, RTI also developed a procedure to establish the PC level. This procedure involves subjecting a sample containing excess liquid to a static load of 50 psi for an extended time period (usually several days). The weight loss of the

sample is monitored as excess liquid is released. The blue papers used to detect liquid releases are also monitored. The PC is the liquid loading in the sample when releases cease and the rate of weight loss approaches a constant low level of 0.01 g per hr or less. The procedure to determine the PC is given in Appendix B.

2.4.2 The Saturated Concentration (SC) Level

The saturated concentration (SC) level is the liquid loading for a given sorbent/liquid combination that will release free liquid at a rate of at least one drop (typically 0.1 mL) per minute. The SC level is determined under gravitational forces only (i.e., no static load is applied to the sample), and serves as a reference point for evaluating an upper bound for the liquid loading in test samples. Samples with liquid loading above the SC cannot be evaluated in the LRT because they would release liquid without applying a static load.

3.0 SINGLE-LABORATORY VALIDATION

The objective established by EPA for the validation study was to determine the liquid loading, if any, relative to the PC, at which the LRT gives consistent results. To validate the improved LRT protocol, RTI tested several sorbent/sorbate combinations and examined the effects of several possible variables on the test results. This work was carried out during the spring and summer of 1988.

3.1 SORBENTS AND SORBATES TESTED

Most of the LRT method validation tests were carried out with two sorbent/sorbate combinations: Floor Dry/water and Safe-Step/motor oil. These two combinations represent properties likely to be encountered in the materials subject to the LRT. Additional sorbents (Vermiculite, SND-M, and Imbiber Beads®) were also tested to demonstrate method performance. Properties of these sorbents are given in Table 1.

The sorbent/sorbate combinations tested were Vermiculite/0.01 N calcium sulfate; SND-M/water with 5% acetone; SND-M/diesel fuel; and Imbiber Beads®/diesel fuel. Properties of the various liquids that were tested are given in Table 2. Water was selected as a test liquid because it is present in so many liquid wastes. To simulate groundwater or surface water, calcium sulfate was added to the water used in testing Vermiculite. Motor oil and diesel fuel were selected to represent a broad spectrum of nonpolar organic solvents and petroleum products.

Imbiber Beads® were selected to represent the organic polymer sorbents that are used to sorb petroleum products and other organics. See section 3.8 for a discussion of the tests using Imbiber Beads®.

3.1.1 Sorbent Processing and Splitting

The sorbent materials used in the method validation experiments are distributed in relatively small quantities (typically 25-lb. bags or smaller). Because of the large number of tests needed to validate the method for a given sorbent, it was necessary to use material from

TABLE 1. SORBENT PROPERTIES*

CLASS OR PROPERTY	FLOOR DRY	SAFE-STEP	SND-M	VERMICULITE	IMBIBER BEADS®
Material Class	diatomite	sorbent clay	sorbent clay	expanded mineral	cross-linked polymer
Special Features	Granular	fine particles	fine particles	loose particles (compressible)	(poly t-butylstyrene spheres)
Bulk Density lb/ft^3	24 to 25**	37	29-36	5-10	38
Sorbent Density (no voids) (lb/ft^3)	156	137.2	137.2	149.7	59.9
Sorption Capacity (grams liquid per gram sorbent):					
with water	1.4	1.0	1.0	5.5	2.5
with aliphatic Hydrocarbon	1.1	0.7	0.7	3.5	16.3
with aromatic Hydrocarbon	2.1	0.8	0.8	4.5	18.3
Source	Eagle-Picher Minerals, Inc., Cincinnati, OH**	Andesite of California, Inc.	Oil Dry Corporation Chicago, IL		EMCO Little Rock, AR
Biodegradable	No	No	No	No	Undetermined

* Data are from EPA/600/2-87/047 (Melvold and Gibson, 1987), unless otherwise indicated

** Personal communication: Mr John R Craig, Eagle Picher, Inc., to Ms. Paula Hoffman, August 18, 1987.

TABLE 2. PROPERTIES OF TEST LIQUIDS

DESCRIPTION OR PROPERTY	WATER	MOTOR OIL	DIESEL FUEL	ACETONE (5%) IN WATER
Description of liquid used in collaborative study	Deionized Water	SAE 50 weight motor oil (Valvoline)	Clean liquid, yellow color; faint odor of petroleum hydrocarbon	Deionized water with 5% acetone, a polar organic solvent
Specific Gravity	1.00	0.89	0.86	0.99
Surface Tension	72 dynes/cm @ 25°C	-----	-----	55.5 dynes/cm @ 25°C
Kinematic Viscosity (Centipoise)	1.0 @ 20°C ~0.5 @ 55°C	325 @ 40°C 21-23 @ 100°C	3.1 @ 40°C	0.316 @ 25°C (for pure acetone)

several lots. RTI took special care in combining and blending the dry material from separate lots to provide a uniform matrix for testing. The total volume of dry sorbent was processed and then split into aliquots of the appropriate volume for testing. A riffle splitter was used for all splitting operations.

The splitting scheme used to obtain the individual samples of sorbent is shown in Figure 2. The first operation was to blend the material from different bags of sorbent. Individual bags of sorbent (labeled No. 1, No. 2,...No. n) were each split into four equivalent portions, labeled A, B, C, and D. After all bags were split in this way, all the portions labeled "A" were combined, and likewise for all the "B", "C", and "D" portions. This operation yielded four large equivalent portions of the subject sorbent.

The second operation was to split each portion repeatedly until samples of an appropriate size for testing (i.e., approximately 200 g) were obtained. Each sample was placed in a 1-L wide-mouth glass bottle, capped, and sealed with parafilm.

3.1.2 Sorbent Moisture Content

The moisture content of the various sorbents is not constant. It varies, depending on the type of sorbent and the lot. In order to control the total liquid loading in the mixtures tested, one must know the initial moisture content in the sorbent before addition of the test liquid.

In previous work using Floor Dry, the bulk material was air-dried prior to splitting so that the moisture content was essentially zero prior to the addition of sorbate. Because of the very large quantity of material needed for the 1988 method validation, it was not practical to dry the bulk sorbent completely before the blending and splitting operations. In addition, there was concern that if the sorbent were processed in a bone-dry condition, it would tend to sorb moisture from the air, the extent depending on the length of time the various samples were exposed to the ambient conditions. To take into account the inherent moisture, RTI processed the bulk material without drying and then estimated the average moisture content ([grams of water/grams of solid] x 100) for the split samples.

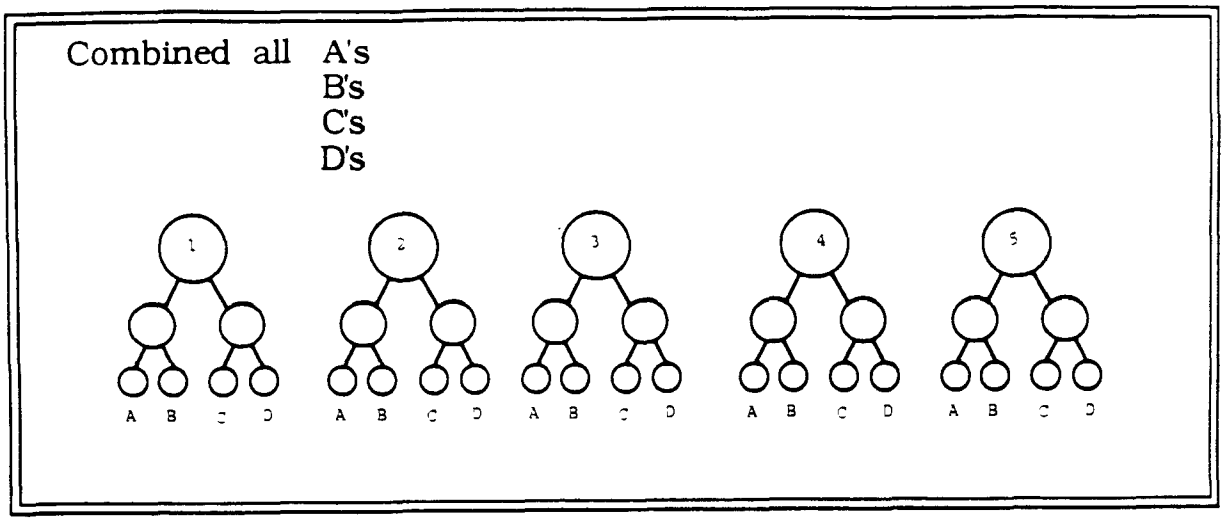


Figure 2. The splitting scheme used to obtain individual samples of sorbent for LRT testing.

To estimate the average moisture content, four of the sealed bottles of Floor Dry, each containing 200 grams of sorbent, were selected at random and tested to determine moisture content. These samples were weighed and then oven-dried at 93.3°C (200°F) for 24 hours. The cooled samples were weighed again. Heating was repeated until constant weight was attained (i.e., there was no further weight loss upon further heating). Moisture content for the four Floor Dry samples ranged from 1.00% to 1.35% and averaged 1.10%. The average moisture content of 1.10 was taken into account when the Floor Dry samples were prepared to achieve a specific liquid loading for the LRT validation testing.

3.2 EQUIPMENT CALIBRATION

Four ADM devices were used in the test validation experiments. These devices were calibrated prior to the test effort to ensure that the pressure application was correct. The procedure for calibration and the calibration data are given in Appendix C. All device calibrations were performed by Dr. Ray Borden of the North Carolina State University's Civil Engineering Laboratory.

3.3 SATURATED CONCENTRATION AND PRESSURIZED CONCENTRATION DETERMINATIONS

Tests were conducted to establish the SC and PC for each sorbent/sorbate combination. The procedures to determine the SC and PC are described below:

A pre-weighed, dry sorbent (e.g., 250 g Floor Dry; 450 g Safe-Step) is saturated for 24 hours in an excess amount of the sorbate. The sorbent is then placed in a pre-weighed dry LRT sample holder and allowed to drain under force of gravity for 15 minutes. The wet sorbent and sample holder are then weighed. The SC is the liquid loading in the sample ([grams liquid/grams solid] x 100) immediately following the gravity drain.

The sample holder with drained sorbent is placed in the pressure device. A static load of 50 psi is applied. After one hour, the compression on the sample holder is released. The sample and holder are re-weighed to determine the liquid weight loss. Dry filters are set in place, and the load is reapplied. The sample and holder are re-weighed at regular intervals. This is continued until no visible release is detected on the blue

papers. The test is concluded at this point. The rate of liquid loss is calculated. The PC level is the liquid loading in the sample when the rate of liquid loss reaches 0.01 g/hr or less.

In duplicate tests, good agreement was seen in the results obtained for Floor Dry/water, Safe-Step/motor oil, and Oil Dry/acetone (5% in water). The PC results for Vermiculite are questionable because small particles of sorbent were lost in one of the tests. The results of the PC determinations are summarized in Table 3. The raw data are provided in Appendix B along with the detailed procedure used for the determinations.

3.4 LRT RESULTS AT DIFFERENT LIQUID LOADING LEVELS

To validate the method, different sorbent/sorbate combinations were tested with liquid loadings above and below the PC level. Multiple samples were tested at each liquid loading level. Raw data for the LRTs performed for all sorbent/sorbate combinations are given in Appendix D.

The test results for Floor Dry with water and for Safe-Step with motor oil are presented in Figures 3 and 4, respectively. The LRT results for samples with liquid loadings well above the PC level show consistent releases. The experimentally determined SC levels and PC levels are also shown in these figures. For Floor Dry/water tests, all samples with liquid loading at or above 137 (1.1 times the PC level) gave releases. For Safe-Step/oil, all samples tested at liquid loadings at or above 32 (approximately 1.5 times the PC level) gave releases.

The test results for SND-M with diesel fuel are presented in Figure 5. These data show the pattern of releases versus no-releases spanning the range of liquid loading from 70 (0.7 g liquid per g solid) to 90 (0.9 g liquid per g solid). At a liquid loading of 70, none of the eight samples tested gave a release, whereas all nine samples tested at a liquid loading of 85 gave releases. Some of the samples with liquid loadings between 75 and 87 gave releases, and some did not. Only one anomalie was seen: in the six samples with liquid loading at 87, all but one gave releases.

TABLE 3. SATURATED CONCENTRATION (SC) AND PRESSURIZED CONCENTRATION (PC) FOR SORBENT/SORBATE COMBINATIONS*

SORBENT/SORBATE	PC Level	SC Level (approximate)
Floor Dry/Water	125.0 124.6	140
Safe-Step/Motor Oil	22 22	30
SND-M/Acetone (5% in water)	102.7 100.6	118
SND-M/ Diesel Fuel	ND**	ND**
Vermiculite/0.01 N Calcium Sulfate	150 (210)*	160

* The SC and PC are expressed as the ratio of grams of liquid to grams of solid, multiplied by 100. Refer to Appendix B for the raw data for each determination.

** Not determined.

* Result is questionable due to loss of particles with the liquid.

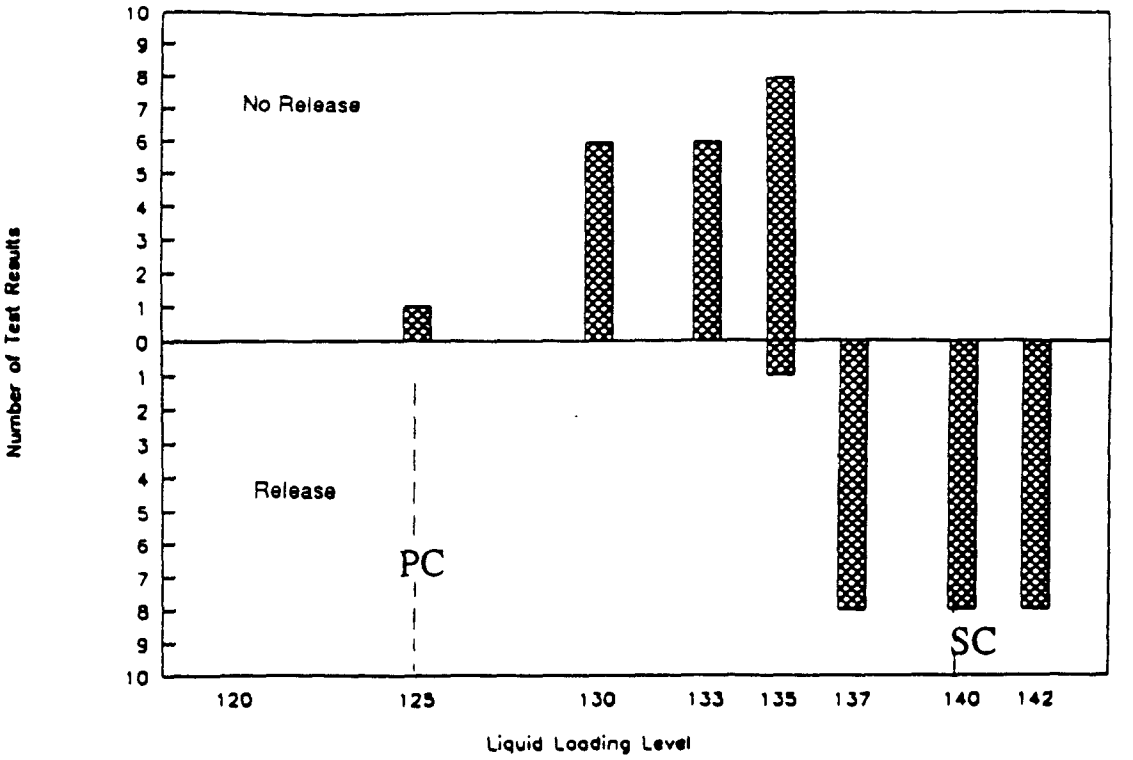


Figure 3. LRT results: Floor Dry/water.

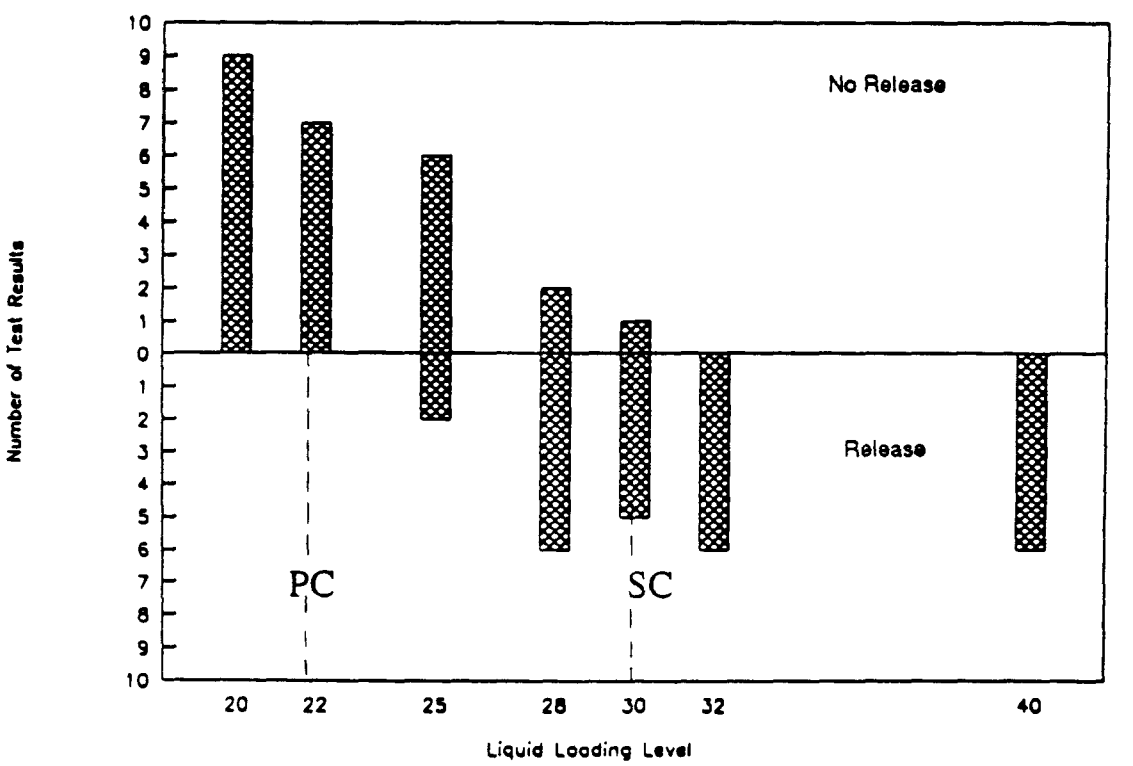


Figure 4. LRT results: Safe-Step/oil.

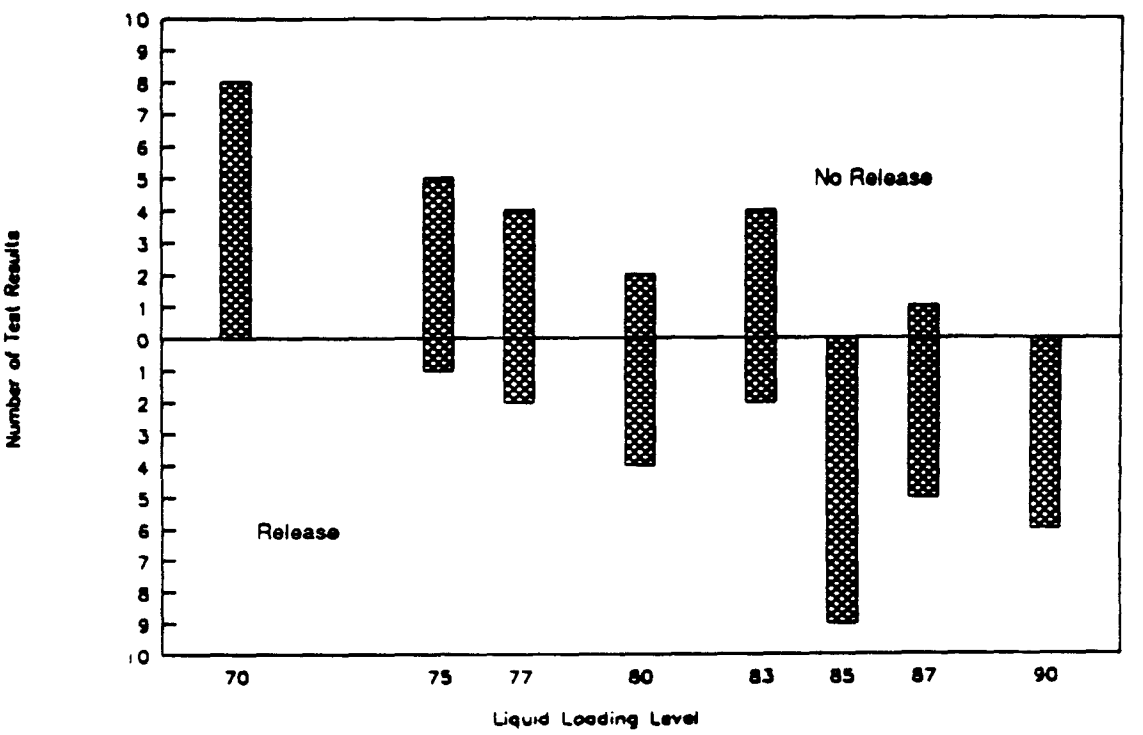


Figure 5. LRT results: SND-M/diesel.

The test results for SND-M with acetone (5% in water) and Vermiculite with 0.01 N calcium sulfate solution are presented in Figures 6 and 7, respectively. Even with the small number of samples of the SND-M/acetone combination tested, the pattern of results shows all releases in samples close to the SC level and both release and no-release results as the liquid loading approaches the PC level. The tests for the Vermiculite/calcium sulfate combination span a wide range of liquid loadings. Two samples with liquid loading at 150 (1.5 g liquid per g solid) both gave releases as did all samples tested with liquid loading above 200. Results from nine samples with liquid loadings ranging from 110 to 130 included both releases and no-releases.

3.5 RESULTS OF PAINT FILTER LIQUIDS TEST

All hazardous materials to be disposed in landfills are required to pass the Paint Filter Liquids Test (PFLT), known as SW-846 Method 9095 (U.S. EPA, 1986). The complete method for the PFLT is given in Appendix E.

The PFLT was performed on several sorbent/sorbate combinations to see how results compared with those of the LRT. The PFLT differs from the LRT in that a smaller sample (100 g) is used, and there is no compression of the sample other than gravity. The test duration is also shorter (5 minutes compared to 10 minutes for the LRT).

Samples of Floor Dry/water and Safe-Step/oil were tested at several different liquid loadings. The results are shown in Figures 8 and 9, respectively, along with the LRT results. For the Floor Dry/water samples, Method 9095 showed releases at liquid loadings as low as 125 (i.e., 1.25 g water per 1.00 g dry sorbent), while the lowest LRT releases occurred at 135 (1.35 g liquid per g dry sorbent). This suggests that Method 9095 is, at least for some sorbates, a more stringent test than the LRT. For oily liquids, however, the LRT appears to be more stringent. This is demonstrated by the test results for the Safe-Step/motor oil combination. No releases of motor oil were observed, even in samples with liquid loading of 50 (i.e., 0.50 g oil per 1.00 g dry sorbent) in the Method 9095 whereas the LRT showed releases at oil loadings as low as 25 (0.25 g oil per 1.00 g dry sorbent). These results suggest

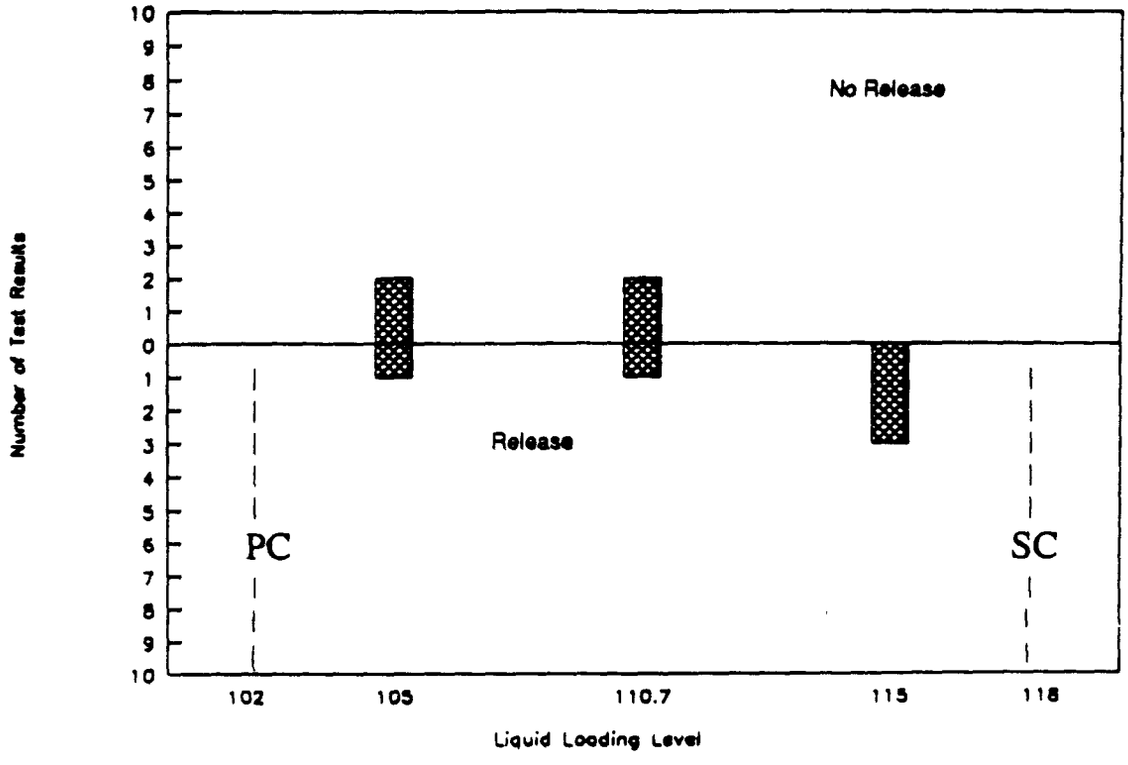


Figure 6. LRT results: SND-M/acetone in water (5% solution).

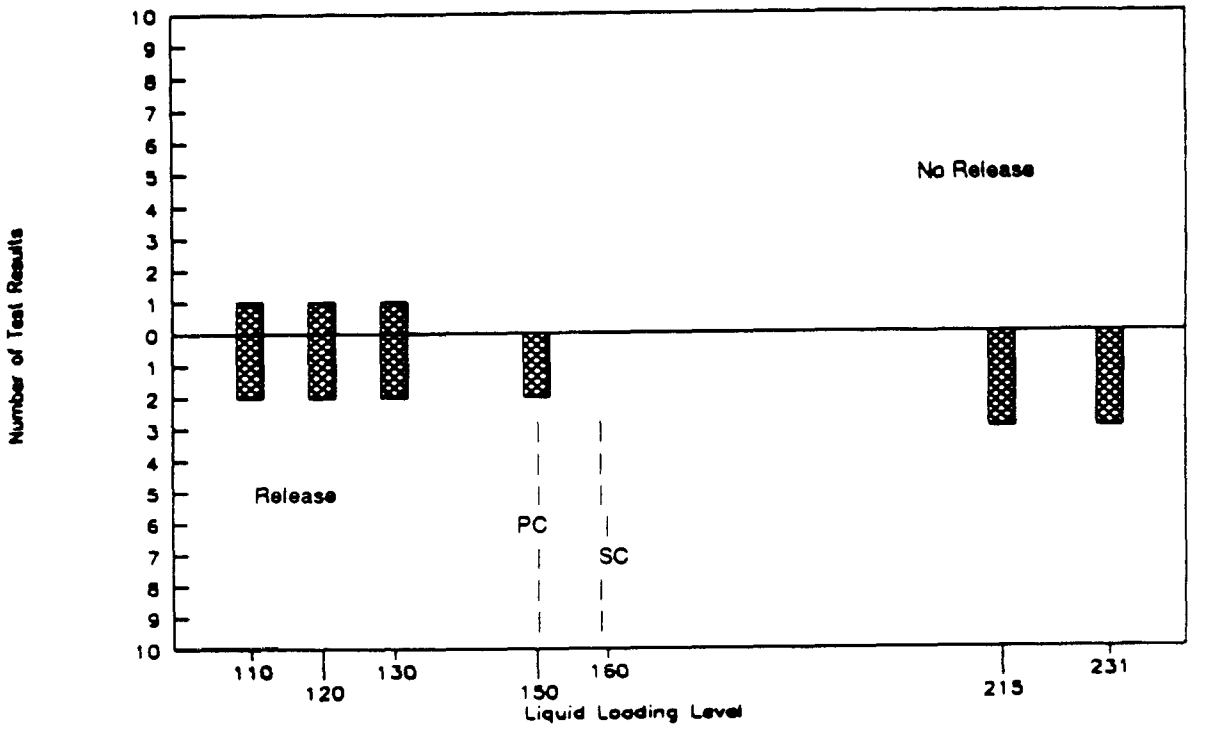


Figure 7. LRT results: Vermiculite/calcium sulfate.

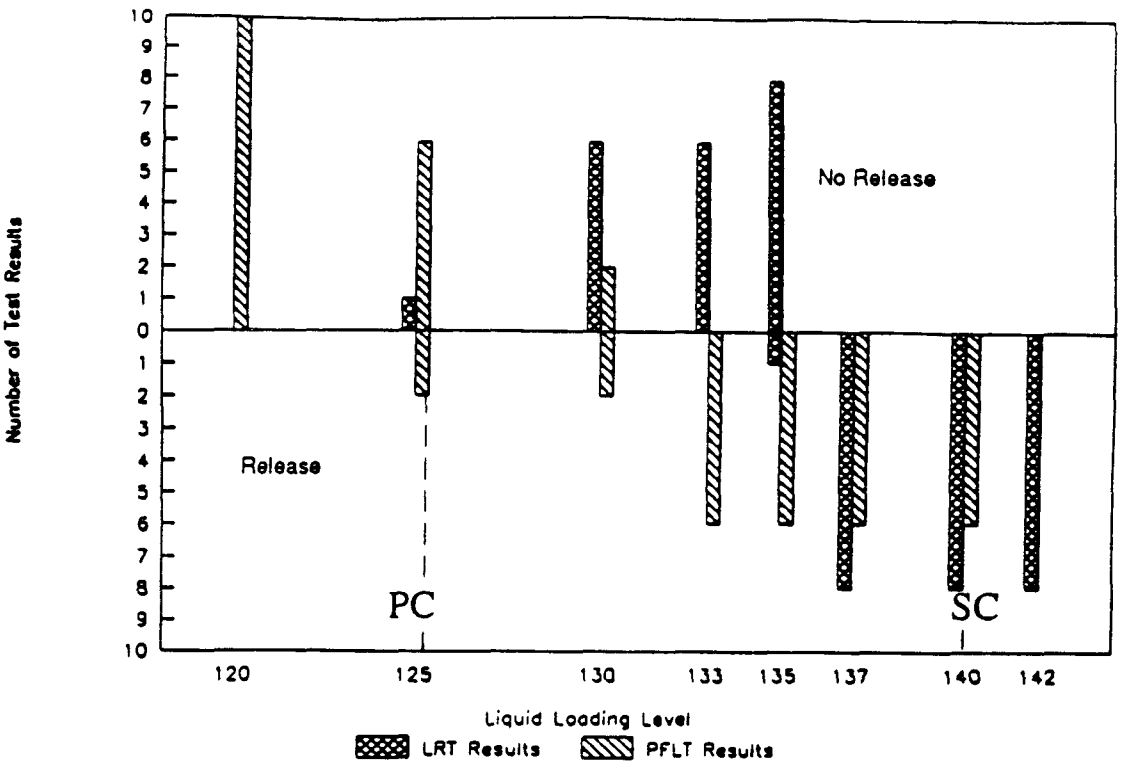


Figure 8. LRT and PFLT results: Floor Dry/water.

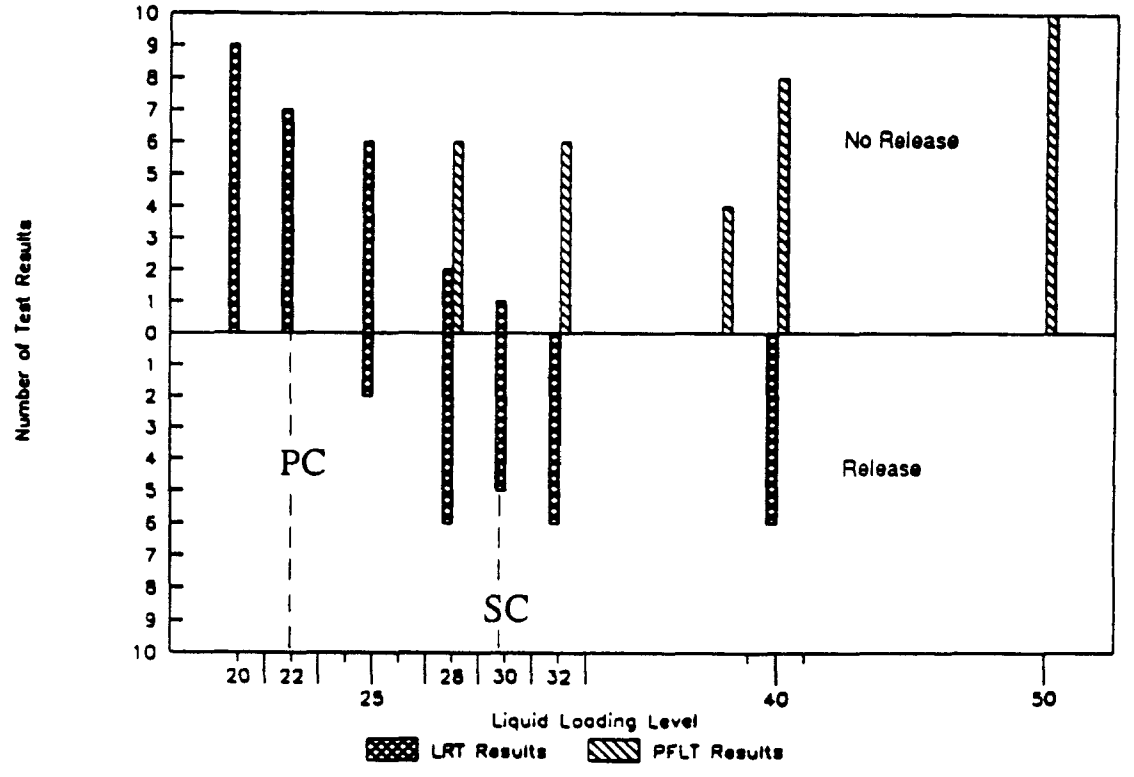


Figure 9. LRT and PFLT results: Safe-Step/motor oil.

that the two methods should be used in combination to determine whether an unknown sample contains releasable liquid. The PFLT should be performed first since it is a simpler test. If a sample gives releases in the PFLT, there is no need to perform the LRT.

3.6 RESULTS WHEN SAMPLE HEIGHT IS ALTERED

The ADM test cell holder is designed to be filled to a height of 10 cm. To test the effect of sample size, 5-cm samples of Floor Dry/water and Safe-Step/oil, with four different liquid loadings, were tested. The results of these tests along with the results from similar 10-cm test samples are shown in Figures 10 and 11. These results indicate that the smaller samples give less consistent results, evidence that the LRT is sensitive to sample size.

3.7 RESULTS WHEN TEMPERATURE IS ALTERED

The viscosity of most liquids decreases as temperature increases; thus, it is likely that the temperature of sorbent/sorbate test samples will affect LRT results. To test the effects of temperature on the LRT, samples of SND-M with diesel fuel were prepared with liquid loadings ranging from 70 to 90 (0.7 to 0.9 g liquid per g dry sorbent). Samples at each loading were tested at 4°C and 40°C. Results of these tests, along with test results for samples at 23°C, are presented in Figure 12. As expected, releases occurred in the heated samples at liquid loadings below the lowest liquid level giving releases in the colder samples. At a liquid loading of 85 (0.85 g liquid per g sorbent), all samples tested at 23°C and 40°C gave releases whereas three releases and three no-releases were seen for the samples tested at 4°C.

In some instances, materials that have been exposed to extreme outdoor temperatures during transport will need to be tested. For example, sorbed waste in drums transported by truck during hot weather may reach temperatures above 40°C. In cold weather, the temperature may be well below 0°C. If samples are taken from drums on the truck and brought directly to the laboratory, for consistent results, the samples should be brought to room temperature before testing.

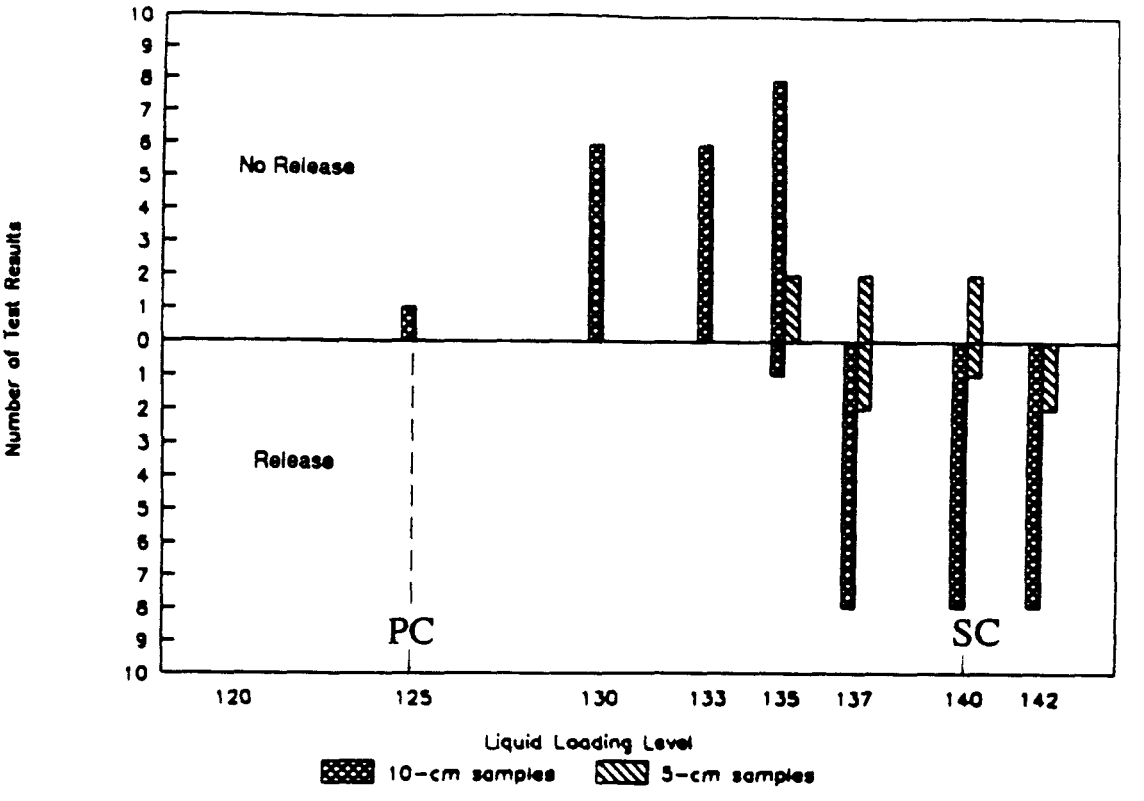


Figure 10. LRT results for 5-cm and 10-cm samples of Floor Dry/water.

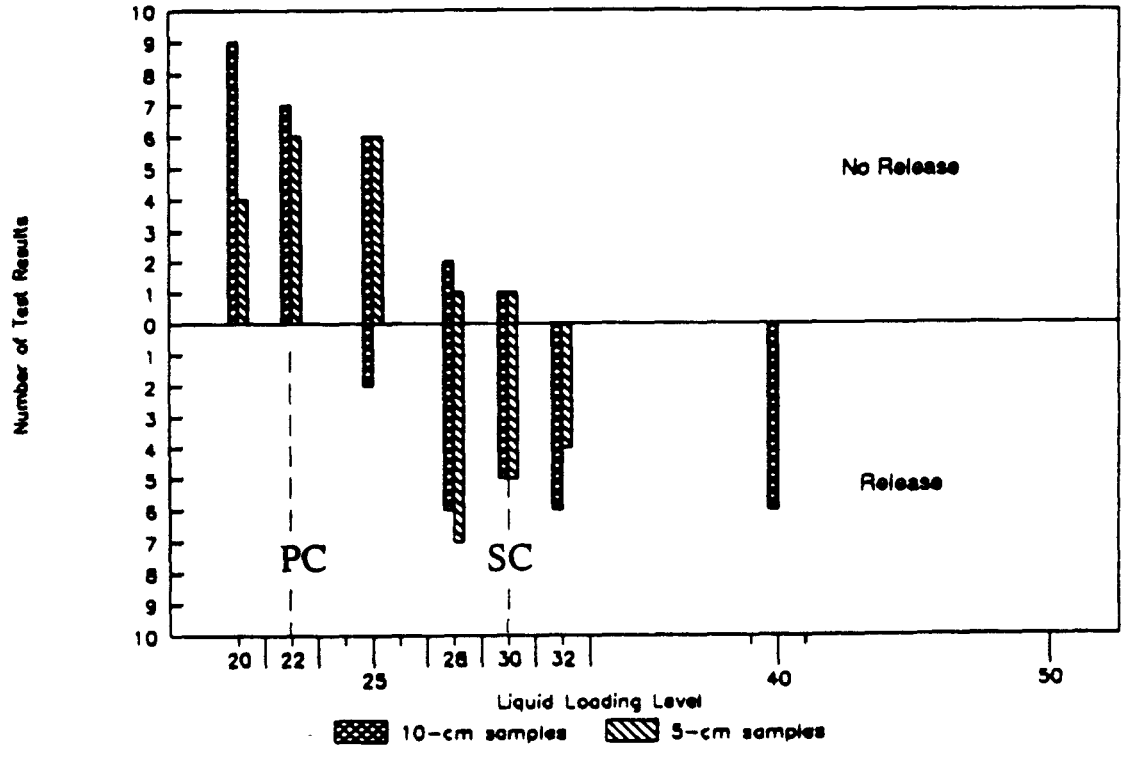


Figure 11. LRT results for 5-cm samples and 10-cm samples of Safe-Step/motor oil.

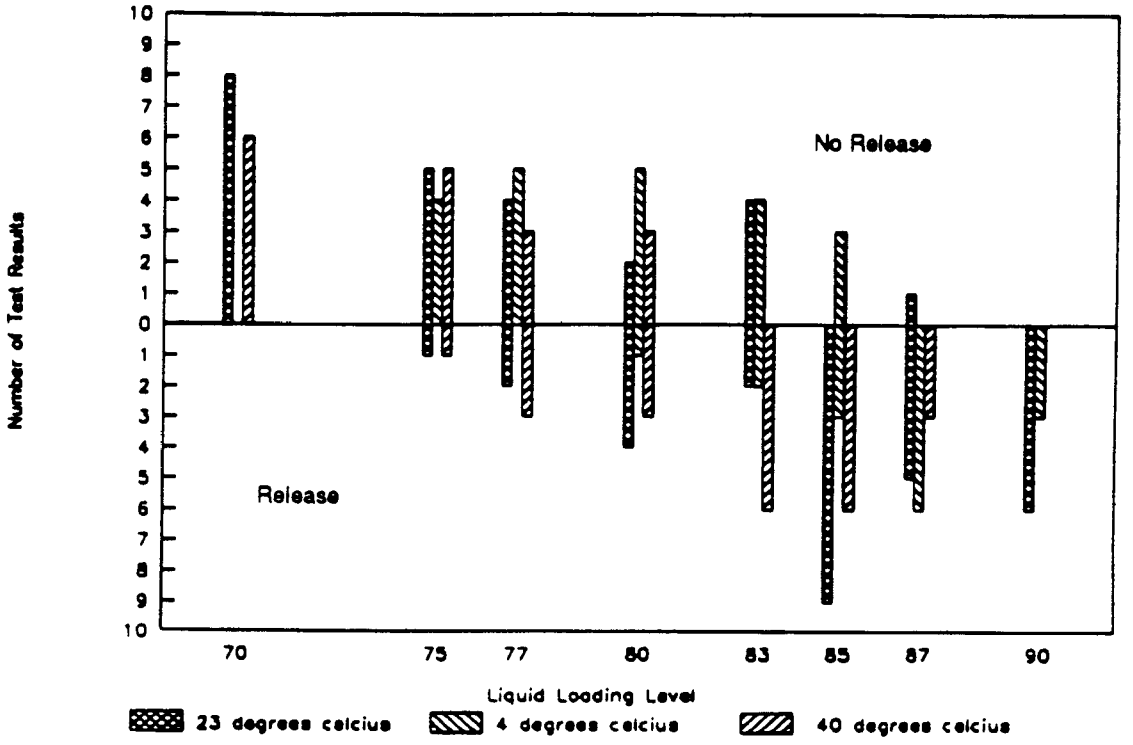


Figure 12. LRT results: SND-M/diesel fuel at 4° C, 23° C, and 40° C.

3.8 DISCUSSION OF IMBIBER BEADS®

The sampling and testing of organic polymer sorbents pose problems that could not be resolved in the LRT development and validation studies. RTI attempted to test a mixture consisting of the sorbent Imbiber Beads® (IB) and diesel fuel in the ADM LRT device with the following results.

At low liquid loading levels (0.1 to 0.2 g liquid per g sorbent), IB could be transferred easily to the LRT sample holder. After compression at 50 psi for 10 minutes, however, the sample was a solid mass. To remove the sample from the cell was extremely difficult (eventually it had to be hammered out). At low liquid loading levels, no release of liquid was observed.

At higher liquid loading levels (above 0.4 g liquid per g sorbent), the beads appeared to polymerize, forming a solid rubber-like mass. The material appears to be altered irreversibly. In this form, the material had to be cut into small pieces in order to transfer it to the sample holder. The irreversible behavior of this material suggests that use of IB constitutes a solidification technique rather than sorption.

4.0 THE COLLABORATIVE STUDY DESIGN

The purpose of the collaborative study was to assess the interlaboratory variability of the method and to demonstrate consistency of test results. In addition to evaluating the method protocol developed for use with the ADM test device, the collaborative study also provided an opportunity for other manufacturers to demonstrate equivalency of their devices to detect liquid release.

Five laboratories that had participated in the previous study (in the fall of 1987) agreed to assist again by testing samples using the 1988 Draft Protocol and the ADM test device. One additional laboratory also agreed to participate. Thus, the collaborative study included six participating laboratories plus RTI. Ultimately, a total of 36 tests were performed by each of the six participating laboratories: six samples at each of three different liquid loadings for two different sorbent/sorbate combinations. A total of 42 tests were performed for Floor Dry/water at each of three different liquid loadings. For Safe-Step/oil, 42 tests were performed at two liquid loadings, and 37 tests were performed at one liquid loading.

4.1 PARTICIPATING LABORATORIES

The laboratories listed below participated in the 1988 collaborative study:

- Chemical Waste Management, Inc., Riverdale, IL
- GSX Services, Pinewood, SC
- Industrial and Environmental Analysts, Inc., RTP, NC
- Microbac Laboratories, Inc., Erie, PA
- Western Research Institute, Laramie, WY
- Wilson Laboratories, Salina, KS (WL)
- Research Triangle Institute, RTP, NC (RTI)

Using the ADM LRT device, these laboratories tested the samples prepared by RTI.

4.2 OPPORTUNITY TO DEMONSTRATE EQUIVALENCY

The collaborative study also provided an opportunity for companies to demonstrate equivalency of other test devices. Three participating laboratories received sets of samples so that they could perform tests in an alternate device. The laboratories and the devices they tested are Chemical Waste Management, Inc., (their own device); Analytical Testing and Consulting (their own device); and Western Research Institute (WRI) (Millipore device). Prior to the study, drawings of these devices and the test protocol to be used were sent to RTI for review.

Two of the alternate test devices use sample cells similar in size to the ADM cell. The Millipore device requires a somewhat larger sample.

4.3 DEVICE CALIBRATION

All of the ADM test devices used in the collaborative study were previously calibrated for the 1987 collaborative study to ensure that the pressure application by each device was correct and consistent between devices. Immediately prior to the 1988 collaborative study, each device was recalibrated to be certain that there would be a minimum variation in the vertical pressure imposed on the samples tested in different devices at different laboratories. The recalibrations also served to indicate how frequently recalibration of the ADM device is needed to maintain consistency in the pressure readings. The device calibrations were performed by Dr. Roy Borden, Department of Civil Engineering, North Carolina State University. The calibration method is presented in Appendix C.

4.4 SORBENT/SORBATE COMBINATIONS

The sorbent/sorbate combinations selected for the collaborative study were Floor Dry/water and Safe-Step/motor oil. These same sorbents/sorbate combinations were used in the 1987 study. Using these same combinations again allowed verification that the problems identified in 1987 had been effectively corrected. (See RTI, 1988a, for discussion of the 1987 study.) These two sorbent/sorbate combinations presented different types of problems from the standpoint of handling and testing.

Properties of Floor Dry and Safe-Step are given in Table 1, and the properties of deionized water and Valvoline SAE 50 weight motor oil are listed in Table 2 (see section 3.0).

The PC levels for water in Floor Dry and for oil in Safe-Step were determined in long-term tests as explained in section 3.3. The liquid loadings for samples to be tested in the collaborative study were selected based on the experimentally determined PC level for each combination.

In the method validation study, the Floor Dry/water combination showed a PC of 125%. For samples with known liquid loadings above the PC level, the LRT results showed a very narrow range of liquid loadings, going from zero releases to all releases (i.e., six samples tested at a liquid loading of 133 gave zero releases while eight samples tested at a liquid loading of 137 all gave releases; see Figure 3). The Safe-Step/oil combination showed a PC of 22%. LRT results for Safe-Step/oil showed a broad range of liquid loadings in the transition region between zero releases to all release results (see Figure 4).

Each participating laboratory initially received two groups of Floor Dry/water samples and two groups of Safe-Step/oil samples. Six separate replicate samples comprised each group. The liquid loadings in the test samples and the relationship to the PC are given in Table 4.

4.5 SAMPLE PREPARATION

As in the LRT development and validation testing, it is important that all collaborative study samples prepared from a given sorbent be as uniform as possible. To minimize the effects of sorbent variability on the replicate tests, samples of dry sorbent for the study were prepared from a very large single batch of sorbent. Since the total quantity of sorbent needed exceeded the amount in a single shipment or lot, separate lots of sorbent were combined (as illustrated in Figure 2, section 3.0) to make an acceptably large batch. This large batch was split repeatedly into two equivalent portions (using a riffle sample splitter) until samples were obtained of approximately the quantity necessary for a single test.

TABLE 4. LIQUID LOADING IN COLLABORATIVE STUDY SAMPLES

SORBENT/SORBATE COMBINATION	LIQUID LOADING* AT PC	LIQUID LOADING* IN TEST SAMPLES (SIX REPLICATES)	RELATIONSHIP TO PC
Floor Dry/Water			
(group 1)	121.3	110	0.9 PC
		135	1.1 PC
(group 2)	125.4**	138	1.1 PC
Safe-Step/Oil	22		
(group 1)		19.8	0.9 PC
		33	1.5 PC
(group 2)		28	1.27 PC

* Liquid loading, expressed as percentage, is defined as g liquid per g dry sorbent times 100.

** Recalculated based on revised data.

4.5.1 Floor Dry

Because the test development and validation studies required such a large number of samples, there was insufficient material from the initial sorbent batch to supply samples for the 1988 collaborative study. A separate large batch of Floor Dry had to be obtained and split. About 250 200-g samples were needed. The same splitting scheme described in section 3.1.1 was again used to prepare the samples. Each 200-g split was placed in a 1-L wide-mouth glass bottle, capped, and sealed with parafilm. These sorbent samples were labeled sequentially (Z1, Z2,...Z250) and stored until time for use.The average moisture content in the new batch of samples was needed to prepare test samples to a prespecified liquid loading for the collaborative study. To estimate the average moisture content of the new Floor Dry samples, moisture determinations were performed (as described in section 3.1.2) on four of the sealed 200-g samples, selected at random. The results of the four moisture determinations ranged from 0.90% to 1.15% and averaged 1.06%.

4.5.2 Safe-Step

A sufficient quantity of material was processed and split at the beginning of the method validation study to supply samples for the collaborative study. Thus, no new processing steps were needed.

4.6 DISCUSSION OF COLLABORATIVE STUDY DESIGN

The collaborative study was designed to evaluate the method's capability to reproduce results obtained previously by RTI for specific sorbent/sorbate combinations. In particular, the study objectives were to:

- evaluate the probability of passing a wet sample (i.e., a sample with liquid loading above 1.1 PC for Floor Dry/water and above 1.5 PC for Safe-Step/motor oil);
- evaluate the probability of failing a dry sample (i.e., a sample with liquid loading below 0.9 PC); and
- assess interlaboratory precision.

Since the result from an individual test is either a release or a non-release, the results of a large number of tests are expected to have a binomial probability distribution. Based on this distribution, Figure 13 shows that a design having 36 analyses of any one mix will have a somewhat limited power to correctly find that the test is unacceptable if, in fact, the error rate for the test is too high.

The figure shows that having 0 wrong results out of 36 samples implies that the true probability of getting a wrong result for that mixture is less than 8% based on the 90% upper confidence level (UCL). If the study shows that 8 out of 36 results are wrong, then the true probability of a wrong result is somewhere between 12% (90% lower confidence limit [LCL]) and 37% (90% upper confidence limit [UCL]).

Six samples at each liquid loading for each sorbent/sorbate combination were provided to each laboratory. This gives a total of 42 samples for each liquid loading, providing a design of slightly higher power than the sample size of 36 evaluated in Figure 13. Figure 14 shows the power of the experimental design used for the collaborative study. The design is for a sample size of 42 (n = 42) (i.e., 7 laboratories X 6 replicates for each sample type).

The collaborative study was designed to test the null hypothesis (H_0) that the true probability of passing a wet sample or of failing a dry sample is p = 0.1 versus the alternative (Ha) that the probability exceeds 0.1. With the 42 test design, the null hypothesis is rejected if more than 8 wrong results are observed. In Figure 14, the box entitled "Tail Area Probabilities" shows that the probability (area) of accepting the null hypothesis when it is true is greater than 95%. This information is presented graphically with the tail area probabilities as the ordinate and the numbers of failures as the abscissa.

Another item of concern is the power of the design to reject the null hypothesis if it is false. The power is given by (1 - beta). As seen in the box in Figure 14, if the true probability of passing a wet sample or of failing a dry sample is p = 0.2, then the probability of rejecting the null hypothesis (power) is approximately 1 - 0.19 = 0.81.

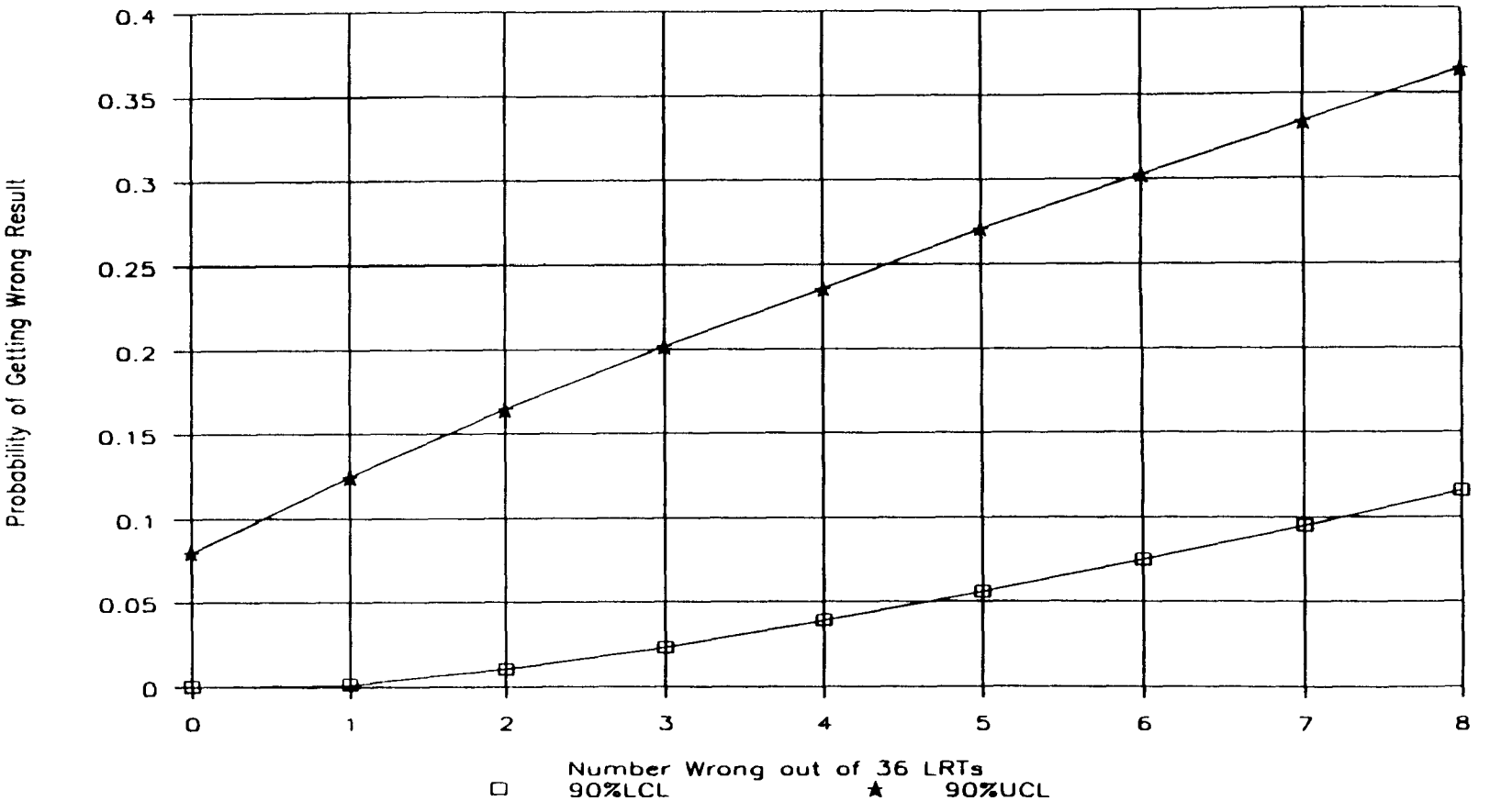


Figure 13. Confidence intervals for probability of getting a wrong result as a function of number of failures

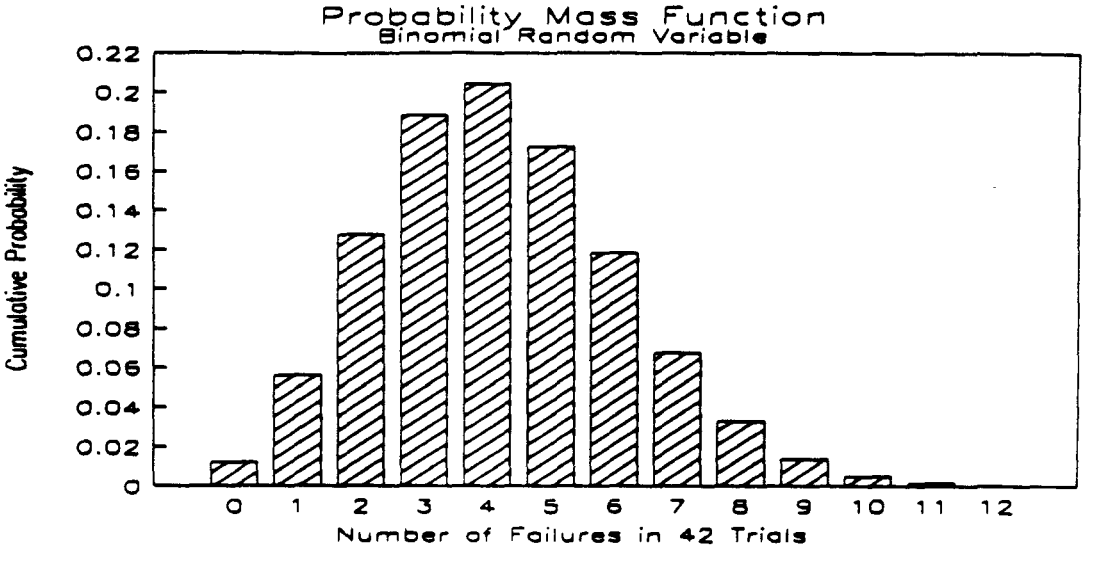
Sample Size: n = 42

Ho :	p = 0.1	Alpha = 0.1
Ha1 :	p = 0.2	Beta 1 = 0.19
Ha2 :	p = 0.3	Beta 2 = 0.0012
		Critical Value = 6.69

Tail Area Probabilities

X	Area
6	0.88
7	0.95
8	0.98
9	0.99

(Area = probability of X or fewer failures in 42 trials)



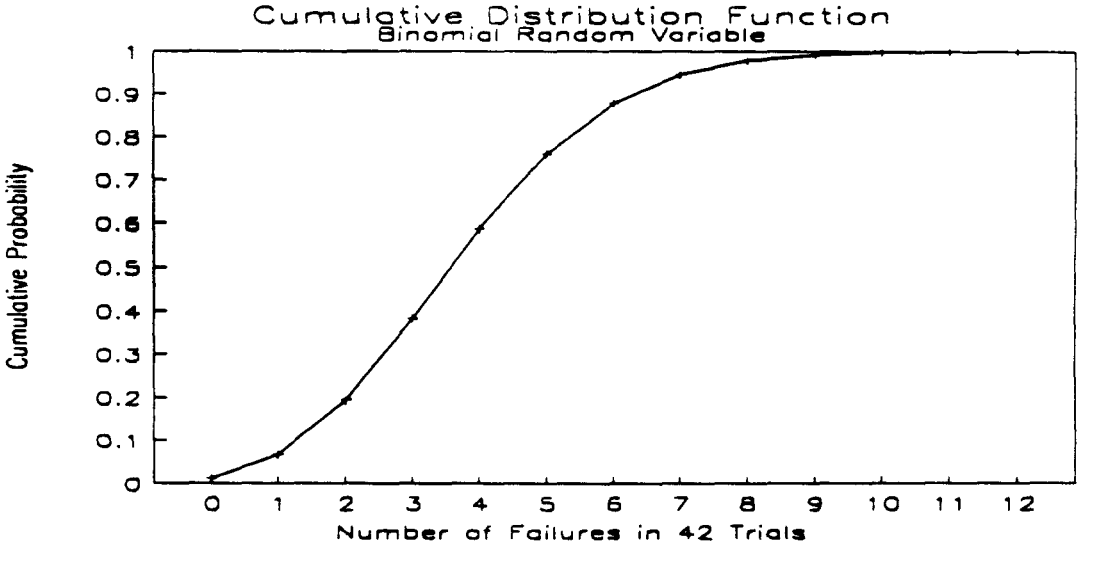


Figure 14. Experimental design parameters.

5.0 DISCUSSION OF THE COLLABORATIVE STUDY RESULTS

5.1 RESULTS USING THE ADM DEVICE

The collaborative study results from all tests conducted using the ADM device are shown in Table 5 (see Appendix F for a complete data set). The Floor Dry/water and Safe-Step/oil results both show four releases for samples with liquid loading at 0.9 PC. Since this is below the critical number of wrong results allowed by the design (see Figure 14), there is no reason to reject the H_0 that the true probability is 0.1 of failing a sample with a liquid loading of 0.9 PC.

The Floor Dry/water results showed 24 releases (out of 42 tests) for the samples with a liquid loading of 135 (1.1 PC). After the results were reported, a third group of Floor Dry/water samples was tested at a slightly higher liquid loading (138). From these 42 tests, 26 releases were reported. This is not significantly different from the results for the samples loaded at 135. Both groups of wet samples give sufficient evidence to reject the H_0 that the true probability is 0.1 of passing a sample with a liquid loading at 135 to 138.

These Floor Dry/water results indicate that a liquid loading of 138 is still within the transition region where both releases and non-releases are observed. The transition region may, in fact, extend beyond 1.1 times the PC for the Floor Dry/water combination. Another explanation is that the error associated with the PC determination is such that the samples with liquid loading at 138 are very close (say, within 5%) to the true PC. There is insufficient information on the particular batch of sorbent used in the collaborative study to draw a meaningful conclusion on this issue.

The Safe-Step/motor oil samples with a liquid loading of 33 (1.5 PC) all gave releases. After these results were reported, a third group of Safe-Step/motor oil samples with a liquid loading of 28 (1.27 PC) was tested. Out of 37 tests, all but two gave releases. Thus, the null hypothesis is not rejected for either of the two wet samples. The results indicate that a liquid loading of 1.5 PC is above the edge of the transition zone that gives both releases and non-releases.

TABLE 5. RESULTS FROM THE 1988 COLLABORATIVE STUDY USING ADM DEVICES

LIQUID LOADING LEVEL* (relationship to PC)	Lab #1	Lab #2	Lab #3	Lab #4	Lab #5	Lab #6	RTI	TOTAL NUMBER OF RELEASES	TOTAL % RELEASE
NUMBER OF RELEASES FOR FLOOR DRY AND WATER**									
110 (0.9 PC)	0	1	0	1	0	2	0	4	9.5
135 (1.1 PC)	4	3	4	2	3	2	6	24	57.1
138 (1.1 PC)+	3	1	3	3	5	5	6	26	61.9
NUMBER OF RELEASES FOR SAFE-STEP AND OIL**									
19.8 (0.9 PC)	1	0	0	0	1	2	0	4	9.5
28 (1.27 PC)	6	6	6	5	6	5	1±	35	94.6ƒ
33 (1.5 PC)	6	6	6	6	6	6	6	42	100.0

* Liquid loading is expressed as (g of liquid per g dry sorbent) x (100).

** Each laboratory tested six samples of each sample type, except as noted.

+ Based on a recalculation of the PC

± Only one sample was tested.

ƒ 35 releases out of 37 samples tested

5.2 RESULTS USING OTHER DEVICES

Table 6 summarizes the data from three participating laboratories using devices other than the ADM device. These tests were conducted to demonstrate equivalency to the ADM device. Equivalency test results for Floor Dry/water samples showed 0 releases for samples with liquid loadings of 110 (0.9 PC). For wet samples with a liquid loading at 135, half of the 18 samples gave releases. All of the wet samples with a liquid loading at 138 gave releases. These results indicate that the devices tested performed at least as well as the ADM device for the Floor Dry/water samples.

In the tests of the Safe-Step/oil samples, the CWM device showed three releases out of five tests for the samples with a liquid loading at 19.8 (0.9 PC); no releases were reported from six tests conducted in each of the other devices. All samples with a liquid loading at 33 (1.5 PC) gave releases. The performance of these devices appears to be at least as consistent as the ADM device. The Millipore device and the device by Analytical Testing and Consulting performed particularly well. The results obtained using the CWM device for the dry sample suggest that it gives a more stringent test.

TABLE 6. RESULTS FROM 1988 LRT COLLABORATIVE STUDY EQUIVALENCY TESTS

LIQUID LOADING LEVEL*	NUMBER OF RELEASES			TOTAL NUMBER OF TESTS	TOTAL NUMBER OF RELEASES	TOTAL % RELEASE
	CWM DEVICE	MILLIPORE DEVICE	ANALYTICAL TESTING DEVICE			
FLOOR DRY AND WATER						
110 (0.9 PC)	0	0	0	18	0	0.0
135 (1.1 PC)	0	5	4	18	9	50.0
138 (1.1 PC)	6	6	6	18	18	100.0
SAFE-STEP AND OIL						
19 (0.9 PC)	3**	0	0	17	3	17.6
33 (1.5 PC)	6	6	6	18	18	100.0

* Liquid loading is expressed as (g of liquid per g dry sorbent) x (100).

** Only 5 samples were analyzed in the CWM device.

6.0 QUALITY ASSURANCE

A Quality Assurance Project Plan (RTI, 1988b) for the LRT method development and evaluation effort is provided as a companion document to this report.

7.0 CONCLUSIONS/RECOMMENDATIONS

Based on the results of the method validation testing and the 1988 collaborative study, the following conclusions were drawn:

- Overall, the LRT method, as tested, showed improvement over the Draft Protocol evaluated previously.

- The LRT is, for some sorbent/sorbate combinations, a more stringent test than the PFLT (Method 9095), and for some combinations, the PFLT is more stringent. Based on this finding, use of the two tests in combination should be considered. The PFLT should be performed first, since it requires only minimal equipment, a 5-minute test time, and minimal cleanup time.

- The LRT is sensitive to sample size. Therefore it is important to use a consistent sample volume to determine liquid release. If devices other than the ADM device are used in equivalency demonstrations, sample volume should be considered in determining equivalency to results from the ADM device.

- The LRT results are affected by temperature. For consistent results, samples should be brought to a reasonable room temperature (e.g., 23°C) prior to testing.

- The LRT method has not been demonstrated for sorbents that polymerize in the presence of certain sorbates (e.g., Imbiber Beads® with petroleum products).

- Comparing the single-laboratory results to the collaborative study results (i.e., comparing Figures 3 and 4 to Table 5) shows the multilaboratory results to be slightly more aberrant. In the collaborative study, the LRT method passed dry samples more than 90% of the time for the two sorbent/sorbate mixtures; this is acceptable. The method performed well on the Safe-Step/oil sorbate wet samples at both 127% and 150% PC.

- The collaborative study did not demonstrate acceptable performance of the LRT method for the Floor Dry/water samples with liquid loadings at 135 and 138.

- In general, interlaboratory differences do not appear to be unreasonable. The failure of certain wet samples to show releases is probably due to the close proximity of the liquid loading to the PC level. When liquid loading is close to the PC level, multiple tests show releases and no-releases.

- The equivalency results indicate that other devices perform as well as the ADM device, albeit with less test data.

8.0 REFERENCES

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2. Melvold, Robert W. and Steven C. Gibson. 1987. Guidance Manual for Selection and Use of Sorbents for Liquid Hazardous Substance Releases. Prepared for U.S. EPA - Cincinnati, OH, by Environmental Monitoring and Services, Inc. Newbury Park, CA. EPA/600/2-87/047. July 1987.

3. U.S. EPA. 1986. Test Methods for Evaluating Solid Waste, Physical Chemical Methods (SW-846).

4. RTI. 1988a. Fall 1987 Liquid Release Test Collaborative Study Report (Draft). Prepared by Paula Hoffman, Research Triangle Institute, RTP, NC, under EPA Contract 68-01-7075, WA 76. Submitted to Project Manager Barry Lesnick, U.S. EPA, OSW. January 1988.

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APPENDIX A

LIQUID RELEASE TEST (LRT)
1988 DRAFT PROTOCOL

LIQUID RELEASE TEST (LRT) PROCEDURE

1.0 Scope and Application

1.1 The Liquid Release Test (LRT) is a laboratory test designed to determine whether or not liquids will be released from sorbents when they are subjected to overburden pressures in a landfill.

1.2 Any liquid-loaded sorbent that fails the EPA Paint Filter Free Liquids Test (PFT) (SW-846 Method 9095), may be assumed to release liquids in this test. Analysts should ensure that the material in question will pass the PFT before performing the LRT.

2.0 Summary of Method

2.1 A representative sample of the liquid-loaded sorbent, standing 10 cm high in the device, is placed between twin stainless steel screens and two stainless-steel grids, in a device capable of simulating landfill overburden pressures. An absorptive filter paper is placed on the side of each stainless-steel grid opposite the sample (i.e., the stainless-steel screen separates the sample and the filter paper, while the stainless-steel grid provides a small air gap to prevent wicking of liquid from the sample onto the filter paper). A compressive force of 50 psi is applied to the top of the sample. Release of liquid is indicated when a visible wet spot is observed on either filter paper.

3.0 Interferences

3.1 When testing sorbents loaded with volatile liquids (e.g., solvents), any released liquid migrating to the filter paper may rapidly evaporate. For this reason, filter papers should be examined immediately after the test has been conducted.

3.2 It is necessary to thoroughly clean and dry the stainless-steel screens prior to testing to prevent false positive or false negative results. Material caught in screen holes may impede liquid transmission through the screen causing false negative results. A stiff bristled brush, like those used to clean testing sieves, may be used to dislodge material from holes in the screens. The screens should be ultrasonically cleaned with a laboratory detergent, rinsed with Deionized water, rinsed with acetone, and thoroughly dried.

When sorbents containing oily substances are tested, it may be necessary to use solvents (e.g., methanol or methylene chloride) to remove any oily residue from the screens and from the sample holder surfaces.

3.3 When placing the 76 mm screen on top of the loaded sample it is important to ensure that no sorbent is present on top of the screen to contact the filter paper and cause false positive results. In addition, some sorbent residue may adhere to container sidewalls and contact the filter as the sample compresses under load, causing wet spots on the edges of the filter. This type of false positive may be avoided by carefully centering the 76 mm filter paper in the device prior to initiating the test.

3.4 Visual examination of the sample may indicate that a release is certain (e.g., free standing liquid or a sample that flows like a liquid), raising concern over unnecessary clean-up of the LRT device. An optional 5 minute Pre-Test, described in Appendix A of this procedure, may be used to determine whether or not an LRT must be performed.

4.0 Apparatus and Materials

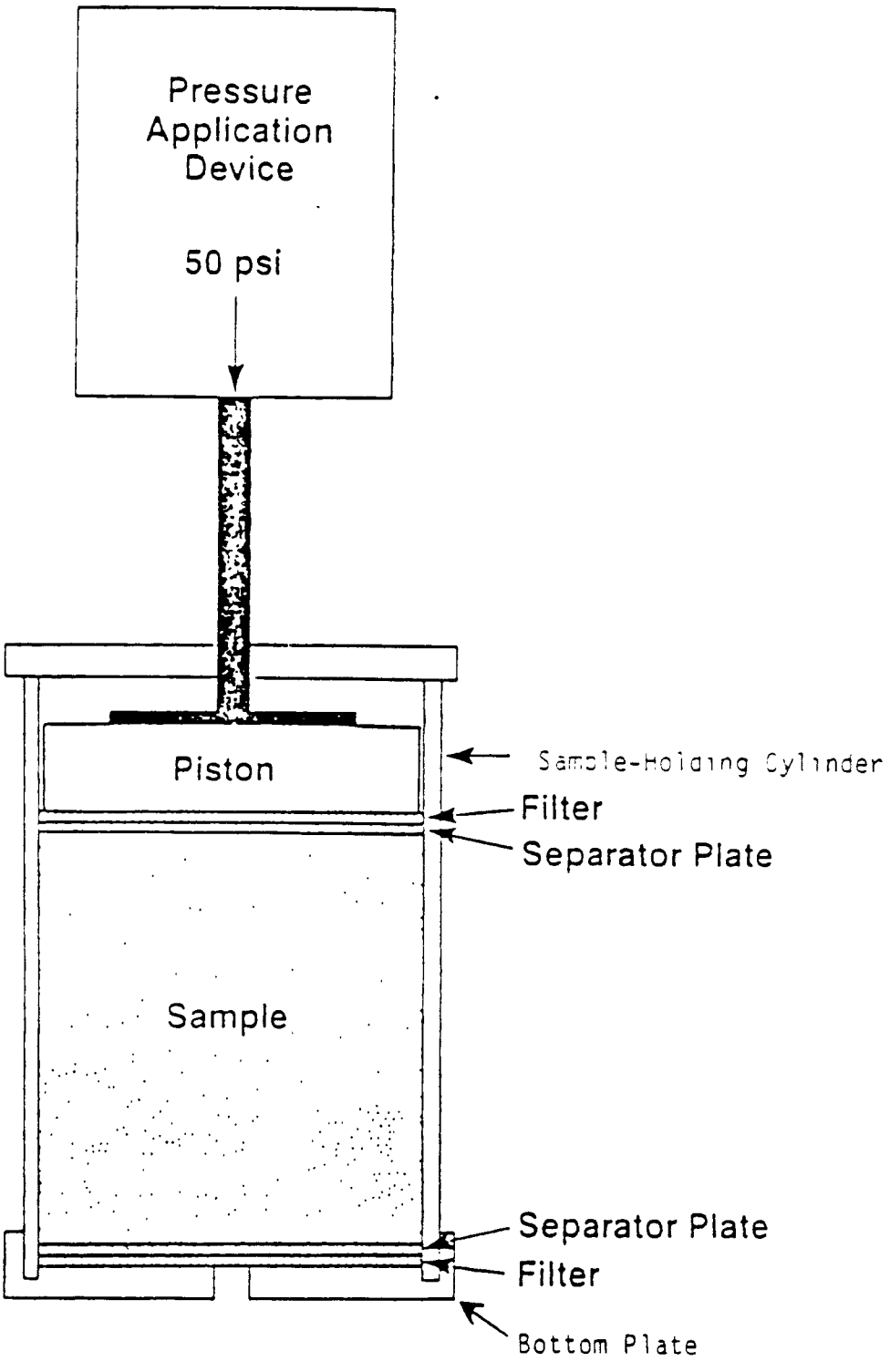
4.1 LRT Device (LRTD): A device capable of applying 50 psi of pressure continuously to the top of a confined, cylindrical sample (see Figure 1). The pressure is applied by a piston on the top of the sample. All device components contacting the sample (i.e., sample-holder, screens, and piston) should be resistant to attack by substances being tested. The LRTD consists of two basic components , described below.

4.1.1 Sample holder: A rigid-wall cylinder, with a bottom plate, capable of holding a 10 cm high by 76 mm diameter sample.

4.1.2 Pressure Application Device: In the LRTD (Figure 1), pressure is applied to the sample by a pressure rod pushing against a piston that lies directly over the sample. The rod may be pushed against the piston at a set pressure using pneumatic, mechanical, or hydraulic pressure. Pneumatic pressure application devices should be equipped with a pressure gauge accurate to within $\pm$ 1 psi, to indicate when the desired pressure has been attained and whether or not it is adequately maintained during the test. Other types of pressure application

FIGURE 1.

LRT Device



devices (e.g., mechanical or hydraulic) may be used if they can apply the specified pressure continuously over the ten minute testing time. The pressure application device must be calibrated by the manufacturer, using a load cell or similar device placed under the piston, to ensure that 50 $\pm$ 1 psi is applied to the top of the sample. The pressure application device should be sufficiently rugged to deliver consistent pressure to the sample with repeated use.

4.2 Stainless-Steel Screens: To separate the sample from the filter, thereby preventing false positive results from particles falling on the filter paper. The screens are made of stainless steel and have hole diameters of 0.012 inches with 2025 holes per square inch. Two diameters of screens are used: a larger (90 mm) screen beneath the sample and a smaller (76 mm) screen that is placed on top of the sample in the sample-holding cylinder.

4.3 Stainless-Steel Grids: To provide an air gap between the stainless-steel screen and filter paper, preventing false positive results from capillary action. The grids are made of 1/32" diameter, woven, stainless-steel wire cut to two diameters, 90 mm and 76 mm.

4.4 Filter Papers: To detect released liquid. Two sizes, one 90 mm and one 76 mm, are placed on the side of the screen opposite the sample. The 76 mm diameter filter paper has the outer 6 mm cut away except 3 conical points used for centering the paper (see Figure 2). Blue, seed-germination filter paper manufactured by Schleicher and Schuell (Catalog Number 33900) is suitable. Other colored, absorptive papers may be used as long as they provide sufficient wet/dry contrast for the operator to clearly see a wet spot.

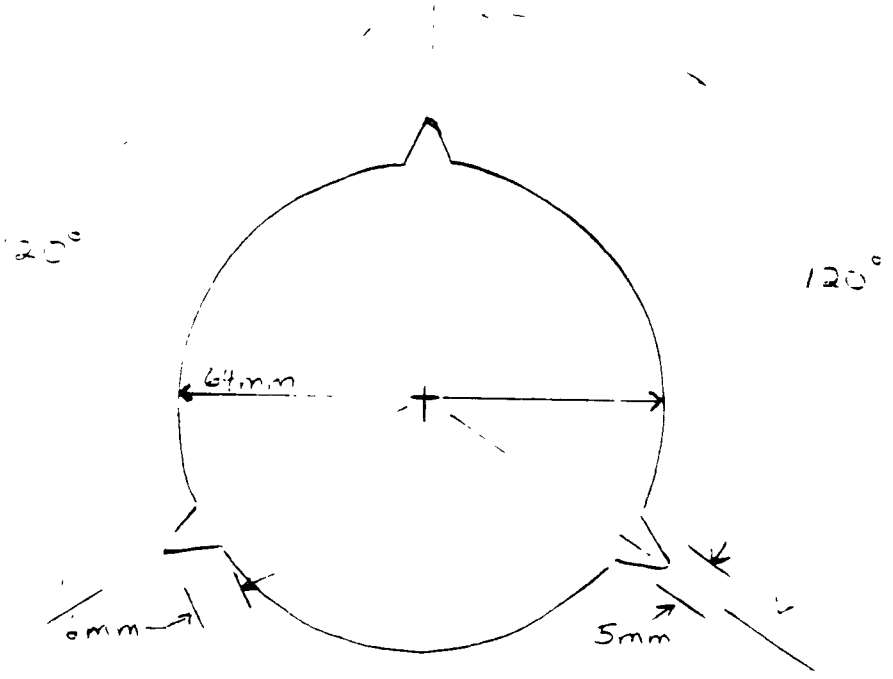


FIGURE 2. 76 mm diameter filter paper.

4.5 Spatula: To assist in loading and removing the sample.

4.6 Rubber or wooden mallet: To tap the sides of the device to settle and level the sample.

5.0 Reagents

5.1 Acetone.

6.0 Sample Collection, Preservation and Handling

6.1 All samples should be collected using a sampling plan that addresses the considerations discussed in "Test Methods for Evaluating Solid Wastes (SW-846)." The sampling plan should be designed to detect and sample any pockets of liquids that may be present in a container (i.e., in the bottom or top of the container).

6.2 Preservatives should not be added to samples.

6.3 Samples should be tested as soon as possible after collection, but in no case after more than three days after collection. If samples must be stored, they can be stored in sealed containers and maintained under dark, cool conditions (temperature ranging between 35^{o} and 72^{o} F). Samples should not be frozen.

7.0 Test Procedure

The procedure below was developed for the original LRTD, manufactured by Associated Design and Manufacturing Company (ADM). Procedures for other LRTDs, along with evidence for equivalency to the ADM device, should be supplied by the manufacturer.

7.1 Disassemble the LRTD and make sure that all parts are clean and dry.

7.2 Invert the sample-holding cylinder and place the large stainless-steel screen, the large stainless-steel grid, then a 90 mm filter paper on the cylinder base (bottom-plate side).

7.3 Secure the bottom plate (plate with a hole in the center and four holes located on the outer circumference) to the flange on the bottom of the sample-holding cylinder using four knob screws.

7.4 Turn the sample holder assembly to the right-side-up position (bottom-plate-side down). Fill the sample holder with a representative sample until the sample height measures 10 cm (up to the etched line in the cylinder).

7.5 Tap the sides of the sample holder with a rubber or wooden mallet to remove air pockets and to settle and level the sample.

7.6 Repeat filling, and tapping until a sample height of 10 cm is maintained after tapping.

7.7 Smooth the top of the sample with a spatula to create a horizontal surface.

7.8 Place the small stainless-steel screen, then the small stainless-steel grid on top of the sample.

NOTE: Prior to placing the stainless-steel grid on top of the screen, make sure that no sorbent material is on the grid side of the stainless-steel screen.

7.9 Place the 76 mm filter paper on top of the small stainless-steel grid, making sure the filter paper is centered in the device.

7.10 Using the piston handle (screwed into the top of the piston) lower the piston into the sample holder until it sits on top of the filter paper. Unscrew and remove the handle.

7.11 Place the loaded sample holder into position on the baseplate and lock into place with two toggle clamps.

7.12 Place the pressure application device on top of the sample-holder. Rotate the device to lock it into place and insert the safety key.

7.13 Connect air lines.

7.14 Initiate rod movement and pressure application by pulling the air-valve lever towards the operator and note time on data sheet. The pressure gauge at the top of the pressure application device should read as specified in the factory calibration record for the particular device. If not, adjust regulator to attain the specified pressure.

NOTE: After pressure application the air lines can be disconnected, the toggle clamps can be released, and the LRTD can be set aside for 10 minutes while other LRTDs are pressurized. LRTD pressures should be checked every 3 minutes to ensure that the specified pressure is being maintained. If the specified pressure is not being maintained to within $\pm$ 1 psi, the LRTD must be reconnected to the air lines and pressure applied throughout the 10 minute test.

7.15 After 10 minutes place the LRTD on the baseplate, reconnect air lines and toggle clamps, and turn off pressure (retract the rod) by pushing the air-valve lever away from the operator. Note time on data sheet.

7.16 When the air gauge reaches 0 psi, disconnect the air lines and remove the pressure-application device by removing the safety key, rotating the device, and lifting it away from the sample holder.

7.17 Screw the piston handle into the top of the piston.

7.18 Lift out the piston.

7.19 Remove the filter paper and immediately examine it for wet spots (wet area on the filter paper). The presence of a wet spot(s) indicates a positive test (i.e., liquid release). Note results on data sheet.

7.20 Release toggle clamps and remove sample holder from baseplate. Invert sample holder onto suitable surface and remove the knob screws holding the bottom plate.

7.21 Remove the bottom plate and immediately examine the filter paper for wet spots as described in step 7.19. Note results on data sheet. Wet spot(s) on either filter indicates a positive test.

APPENDIX A

1.0 Scope and Application

1.1 The LRT Pre-Test is an optional, 5 minute, laboratory test designed to determine whether or not liquids will be definitely released from sorbents before applying the LRT. This test is performed to prevent unnecessary clean-up and possible damage to the LRT device.

1.2 This test is purely optional and totally up to the discretion of the operator as to when it should be used.

2.0 Summary of Method

A representative sample will be loaded into a glass grid that is placed on a glass plate already stained with 2 dyes (one water soluble and one oil soluble). A second glass plate will be placed on top and a 2 lb. weight placed on top for 5 minutes. At the end of 5 minutes the base of the glass grid is examined for any dye running along the edges, this would indicate a liquid release.

3.0 Interferences

A liquid release can be detected at lower Liquid Loading Levels with extremely clean glassware. The glass plates and glass grid should be cleaned with a laboratory detergent, rinsed with Deionized water, rinsed with acetone, and thoroughly dried.

4.0 Apparatus and Materials

4.1 Glass Plate: 2 glass plates measuring 7.5 cm x 7.5 cm.

4.2 Glass Grid: See Figure 3.

4.3 Paint Brush: Two small paint brushes for applying dyes.

4.4 Spatula: To assist in loading the sample.

4.5 Weight: 2.7 Kg weight to apply pressure to the sample.

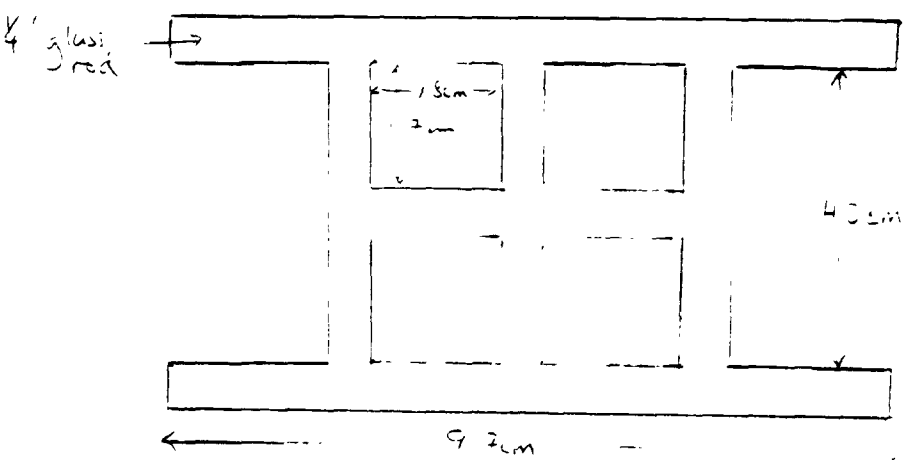


FIGURE 3. Glass grid specifications.

5.0 Reagents

5.1 Methylene Blue dye in methanol.

5.2 Anthraquinone dye in toluene.

6.0 Sample Collection, Preservation and Handling

See LRT Procedure.

7.0 Test Procedure

7.1 Paint one strip, approximately 1 cm wide, of methylene blue dye across the center of a clean and dry glass plate (see Figure 4). The dye is allowed to dry.

7.2 Paint one strip, approximately 1 cm wide, of anthraquinone dye across the center of the same glass plate (see Figure 4). This strip should be adjacent to and parallel with the methylene blue strip. The dye is allowed to dry.

7.3 Place the glass grid in the center of the dye-painted glass plate.

7.4 Place a small amount of sample into the glass-grid holes, pressing down gently until the holes are filled to slightly above the grid top.

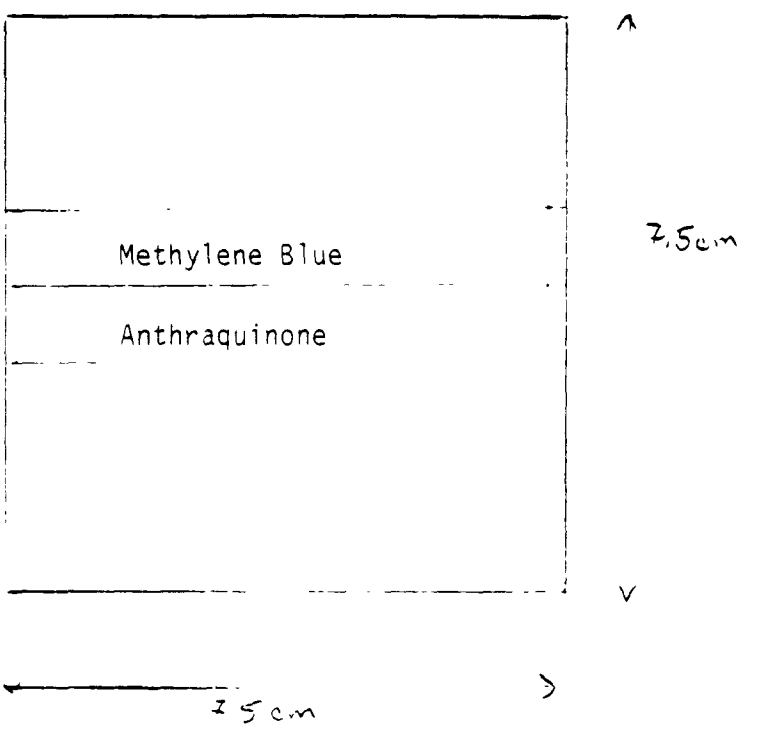


FIGURE 4. Positioning of dye on glass plate.

7.5 Place a second, clean and dry, glass plate on top of the sample and grid.

7.6 Placed a 2.7 Kg weight on top of the glass for 5 minutes.

7.7 After 5 minutes remove the weight and examine the base of the grid extending beyond the sample holes for any indication of dyed liquid. The entire assembly may be turned upside down for observation. Any indication of liquid constitutes a release and the LRT does not need to be performed.

APPENDIX B

SATURATED CONCENTRATION (SC) AND PRESSURIZED CONCENTRATION (PC) PROCEDURES AND RESULTS

B.1 Saturated Concentration Procedure

B.2 Pressurized Concentration Procudure

B.3 Experimental Data

B.1 SATURATED CONCENTRATION PROCEDURE

Definition and General Description

The Saturated Concentration (SC) is defined as the Liquid-Loading Level (LLL) that results when a sorbent is flooded with sorbate and excess liquid allowed to drain away. LLL is the ratio of liquid weight to dry solid weight multiplied by 100. The SC for a specific sorbent/sorbate combination is determined as part of the Pressurized Concentration (PC) determination and provides an upper boundary for testing LLLs. The SC represents the LLL that should just start to fail the Paint Filters Test.

A pre-weighed, dry sorbent (e.g., 200 g Floor Dry, 450 g Safe-Step) is saturated for 24 hours in the sorbate. The sorbent is then allowed to drain using only gravitational forces until the flow becomes negligible (less than a drop per minute). The wet sorbent is weighed and the SC value determined by the ratio of the weight of the liquid to the weight of the dry sorbent.

Procedure

1. Weigh empty jar, and note weight to nearest tenth of gram.

2. Pour into empty jar an adequate dry, representative sample to fill 90-mm diameter, 10-cm-high sample holder (e.g., 200 g Floor Dry, 450 g Safe-Step). Note weight to nearest tenth of gram.

3. Determine dry sample weight by subtracting empty jar weight.

4. Saturate the one-sample aliquot of sorbent for 24 hours by covering the sorbent in a jar with the sorbate, such that all sorbent is wet and not exposed to the atmosphere.

5. Seal the jar with parafilm and shake the sample vigorously until the sorbent/sorbate are homogenized. (NOTE: Safe-Step samples will have to be stirred rather than shaken.)

6. After 24 hours, shake the sample vigorously (NOTE: Do not re-stir Safe-Step; the sorbate will have to be decanted due to the fine-grain size). Open the jar, place a single thickness of ladies pantyhose over the mouth of the jar containing the saturated sorbent, turn the jar upside down, and let the sorbate drain until the flow becomes negligible (less than one drop per minute).

7. Weigh wet sorbent in jar, and calculate wet sorbent weight:

   wet sorbent wt = wet sorbent in jar - empty jar wt

8. Calculate SC using the following equation:

$$SC = \frac{(\text{wet sorbent wt} - \text{dry sorbent wt})}{\text{dry sorbent wt}} \times 100$$

B.2 PRESSURIZED CONCENTRATION PROCEDURE

Definition and General Description

The Pressurized Concentration (PC) is defined as the maximum Liquid-Loading Level (LLL) which will not release liquids when subjected to 50 psi pressure over the life of the landfill. LLL is the ratio of liquid weight to dry solid weight multiplied by 100.

Saturated sorbent is placed in a pre-weighed ADM-LRT-device sample holder. The saturated sample is left to drain for 15 minutes and the device sample holder re-weighed. The sample holder is placed in the device, and a pressure of 50 psi applied. After 1 hour, the pressure on the sample holder is released and the cell is re-weighed to determine the liquid weight loss. Two dry blue blotter papers (76-mm and 90-mm) are put into place. The pressure is immediately reapplied and held constant (except for weighings) for hourly intervals until no visible release is noted on the blotter papers, which are replaced at each weighing. The sample holder is then re-weighed every 24 hours until, again, no visible release is noted on the blotter papers, which are replaced at each weighing. The rate of liquid loss is calculated. When the rate of liquid loss reaches 0.01 g/hr or less for three consecutive weighings, the PC LLL is calculated.

Procedure

1. Pre-weigh dry, empty ADM-LRT-device sample holder (consisting of sample holder cylinder, flange, flange screws, piston, 2 stainless-steel screens, and 2 stainless-steel grids). Note weight to nearest tenth of gram.

2. Attach sample holder flange to cylinder with the flange screws and with the 90-mm stainless-steel screen and grid in place.

3. Place saturated sorbent in sample holder to the specified sample height (10 cm).

4. Place 76-mm stainless-steel screen and grid, then set the piston on top of the sample.

5. Weigh entire sample holder assembly with sorbent and piston inside. Note weight to nearest tenth of gram.

6. Place a small pan under the drain-hole on the device to catch any sorbate that is squeezed out.

7. Attach pressure-application device to sample holder and apply 50 psi pressure. Note time to nearest minute.

8. After 1 hour, release the pressure, note the time to the nearest minute, remove the pressure application device, and immediately weigh the entire sample holder assembly. Note weight to nearest tenth of gram.

9. Put in place one 76-mm and one 90-mm diameter blotter paper.

10. Immediately re-attach the pressure-application device to sample holder and apply 50 psi pressure.

11. At the end of 1 hour, replace the blotter papers with dry blotter papers and weigh the entire sample holder assembly, noting the weight to nearest tenth of gram. Immediately re-attach the pressure-application device to sample holder and apply 50 psi pressure.

12. Repeat Step 11 at hourly intervals until no visible release is detected on the blotter papers.

13. Repeat Step 11 at 24-hour intervals until no visible release is detected on the blotter papers.

14. Calculate the Rate of Sorbate Lost (RSL) for each 1-hour and each 24-hour period:

$$\text{RSL (g/hr)} = \frac{[\text{sample holder assembly wt - previous sample holder assembly wt}]\ (g)}{[\text{time difference}]\ (\text{hours})}$$

[Note: (g) weighed to nearest tenth of gram and hours measured to nearest tenth of an hour.]

If this rate reaches a consistent value for three consecutive times, no further weighings are necessary. If this rate does not reach a consistent value for two consecutive times, then weighings should be continued until this criterion is met.

15. Calculate the SC:

$$\text{SC} = \frac{(\text{wet sorbent wt at the first of the two consistent RSL criteria}) - (\text{dry sorbent wt put in sample holder})}{\text{dry sorbent wt put in sample holder}} \times 100$$

B.3 Experimental Data

PC DETERMINATIONS. FLOOR DRY & WATER
RTI-000 DEVICE DRY & CLEAN WT.: 3878 8 g
RTI-000 DRY SAMPLE WT 167.7 g.
PRESSURE. 50 psi

DATE	TIME (HRS)	delta TIME (HRS)	RTI-OOO WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
05/18/88	0.0	0	4289.8	0	0	0	0	
05/18/88	1.0	1	4281.0	8.8	0.0	8.8	0.0	
05/18/88	2.0	1	4276.4	4.6	4.2	4.8	4.3	BF:SATURATED TF:1 SPOT ON EDGE
05/18/88	3.0	1	4272.0	4.4	0.2	4.4	0.2	BF:SATURATED TF:1 SPOT ON EDGE
05/18/88	4.1	1	4267.9	4.1	0.3	3.7	0.3	BF:SATURATED TF:1 SPOT ON EDGE
05/18/88	5.1	1	4264 0	3.9	0.2	3.9	0.2	BF:SATURATED TF:DRY
05/18/88	6 1	1	4263.2	0.8	3.1	0.8	3.1	BF:1 SPOT ON EDGE & 2 CENTER TF:DAMP
05/19/88	22.0	16	4261.4	1.8	-1.0	0.1	-0.1	BF:UNIFORM WETNESS TF:DAMP
05/19/88	23 1	1	4261.0	0.4	1.4	0.4	1.4	BF:3 SPOTS TF:DAMP
05/19/88	24 0	1	4260.3	0.7	-0.3	0.8	-0.3	BF:2 SPOTS NEAR EDGE TF:1 SPOT ON EDGE
05/19/88	25 5	2	4259.5	0.8	-0.1	0.5	-0.1	BF:DAMP TF:1 SPOT ON EDGE
05/19/88	26 6	1	4258.9	0.6	0.2	0.5	0.2	BF & TF:NO SPOTS
05/20/88	50 4	24	4256.2	2.7	-2.1	0.1	-0.1	BF:UNIFORM WETNESS TF:VERY WET
05/21/88	75.0	25	4252.5	3.7	-1.0	0.2	0.0	BF:UNIFORM WETNESS TF:WET
05/22/88	102.8	28	4252.9	-0.4	4.1	0.0	0.1	BF:UNIFORM WETNESS TF:NO SPOTS
05/23/88	126.0	23	4250.8	2.1	-2.5	0.1	-0.1	BF:UNIFORM WETNESS TF:WET
05/24/88	147.2	21	4249.3	1.5	0.6	0.1	0.0	TF & BF: WET FROM EVAP
05/25/88	147.3	0	4247.3	2.0	-0.5	12.0	-3.0	TF: VERY WET BF:SLIGHTLY WET
05/26/88	169.4	22	4245.4	1.9	0.1	0.1	0.0	TF & BF: WET FROM EVAP
05/27/88	185.3	16	4243.8	1.6	0.3	0.1	0.0	TF:LG SPOT NEAR EDGE BF:DAMP
06/01/88	212.3	27	4239.8	4.0	-2.4	0.1	-0.1	TF & BF: WET FROM EVAP

B.3 Experimental Data

PC DETERMINATIONS: FLOOR DRY & WATER (5-18-88)
RTI-G DEVICE DRY & CLEAN WT.: 3856.5 g.
RTI-G DRY SAMPLE WT: 170.1 g.
PRESSURE: 50 psi

DATE	TIME (HRS)	delta TIME (HRS)	RTI-G WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
05/18/88	0.0	0	4269.4	0	0	0	0	
05/18/88	1.0	1	4256.9	12.5	0.0	12.5	0.0	
05/18/88	2.0	1	4252.6	4.3	8.2	4.5	8.6	BF:SATURATED TF:DRY
05/18/88	3.0	1	4251.7	0 9	3.4	0.9	3.4	BF:1 LG SPOT TF:1 SPOT ON EDGE
05/18/88	4.1	1	4251.3	0.4	0.5	0.4	0.5	BF:1 LG SPOT TF:1 SPOT ON EDGE
05/18/88	5.1	1	4244.8	6.5	-6.1	6.5	-6.1	BF:SATURATED TF:MISSING
05/18/88	6.1	1	4244.1	0.7	5.8	0.6	5.4	BF:SEVERAL SPOTS TF:VISIBLE WETNESS ON EDGE
05/19/88	22.0	16	4242.6	1.5	-0.8	0.1	-0.1	BF:UNIFORM WETNESS TF:DAMP
05/19/88	23.0	1	4241.8	0.8	0.7	0.8	0.7	TF:1 SPOTS BF:DAMP
05/19/88	23.9	1	4241.3	0.5	0.3	0.6	0.3	BF:1 SPOT TF:DAMP TO TOUCH
05/19/88	25.5	2	4240.6	0.7	-0.2	0.5	-0.1	BF & TF:DAMP TO TOUCH
05/20/88	50.7	25	4238.7	1.9	-1.2	0.1	0.0	BF & TF: VERY WET
05/21/88	74.6	24	4236.7	2.0	-0.1	0.1	0.0	BF:UNIFORM WETNESS TF: WET
05/22/88	102.7	28	4234.6	2.1	-0.1	0.1	0.0	BF:UNIFORM WETNESS TF: WET
05/23/88	125.8	23	4232.6	2.0	0.1	0.1	0.0	BF:SLIGHTLY WET TF:VERY WET
05/24/88	147.2	21	4231.0	1.6	0.4	0.1	0.0	TF: WET FROM EVAP. BF: MOIST & PARTICLES ON FILTER
05/25/88	147.3	0	4229.3	1.7	-0.1	10.2	-0.6	TF:WET BF:SLIGHTLY WET
05/26/88	169.5	22	4227.1	2.2	-0.5	0.1	0.0	TF: LG SPOT ON EDGE BF: MOIST FROM EVAP
05/27/88	185.4	16	4225.7	1.4	0.8	0.1	0.1	TF:MOIST TO TOUCH BF:SLIGHTLY WET
06/01/88	212.4	27	4221.9	3.8	-2.4	0.1	-0.1	TF & BF: WET FROM EVAP

B.3 Experimental Data

SC AND PC DETERMINATIONS: SND-M & 5% ACETONE SOLUTIONS
DEVICE: WRI-1 (CELL, GRIDS, SCREENS, AND PISTON) WT: 3783.8 g
DRY SAMPLE WT: 217.4 g WET SAMPLE WT: 748.7 g
WATER REMOVED AFTER SATURATION CONCENTRATION: 254.6 g
WATER REMOVED AFTER 50 MINUTES OF PRESSURE: 30.6 g
PRESSURE: 50 PSI

DATE	TIME (HRS)	delta TIME (HRS)	WRI-1 WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
06/27/88	0.0	0.0	4251.1	0	0	0	0	
06/27/88	1.0	1.0	4245.9	5.2	0.0	5.2	0.0	TF WET ON EDGE; BF SATURATED
06/27/88	1.2	0.2	4241.2	4.7	0.0	28.2	0.0	BF SATURATED; TF WET ON EDGE
06/27/88	2.2	1.0	4236.7	4.5	0.0	4.5	0.0	BF SATURATED; TF WET ON EDGE
06/27/88	2.3	0.2	4233.1	3.6	0.0	21.6	0.0	BF SATURATED; TF DRY
06/27/88	3.3	0.9	4230.2	2.9	0.0	3.1	0.0	BF WET; TF DRY
06/27/88	3.4	0.2	4230.0	0.2	0.0	1.2	0.0	TF DRY; BF DRY
06/27/88	4.4	1.0	4227.5	2.5	0.0	2.5	0.0	TF EDGE WET; BF UNIFORM WETNESS
06/27/88	4.6	0.2	4225.6	1.9	0.0	11.4	0.0	BF 3/4 WET ; TF DRY
06/28/88	23.4	18.8	4223.4	2.2	0.0	0.1	0.0	TF WET; BF DAMP FROM ENVIRONMENT
06/28/88	24.6	1.3	4223.2	0.2	0.0	0.2	0.0	TF & BF NO RELEASE
06/28/88	49.5	24.8	4222.7	0.5	0.0	0.0	0.0	TF WET AROUND EDGE
06/29/88	49.6	0.2	4220.6	2.1	0.0	12.6	0.0	TF SPOTS ON EDGE
06/29/88	73.6	24.0	4220.4	0.2	0.0	0.0	0.0	TF WET AROUND EDGE
06/30/88	73.8	0.2	4218.3	2.1	0.0	12.6	0.0	TF&BF MOIST FROM ENVIRONMENT
06/30/88	97.8	24.0	4218.1	0.2	0.0	0.0	0.0	TF&BF NO RELEASE
07/01/88	98.0	0.2	4216.1	2.0	0.0	12.0	0.0	TF&BF MOIST FROM ENVIRONMENT
07/01/88	193.9	95.9	4215.8	0.3	0.0	0.0	0.0	TF&BF NO RELEASE
07/05/88	194.1	0.2	4211.8	4.0	0.0	24.0	0.0	TF&BF MOIST FROM ENVIRONMENT
07/05/88		-194.1	4211.5	0.3	0.0	0.0	0.0	TF&BF NO RELEASE

PC DETERMINATIONS. SAFE STEP & OIL (38 percent liquid loading)
DEVICE: RTI-G (CELL, GRIDS, SCREENS, AND PISTON) WT: 3858.7 g
DRY SAMPLE WT: 444.4 g WET SAMPLE WT: 613.3 g
PRESSURE: 50 PSI

DATE	TIME (HRS)	delta TIME (HRS)	RTI-G WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
06/27/88	0.0	0.0	4422.9	0	0	0	0	
06/27/88	1.0	1.0	4415.2	7.7	0.0	7.7	0.0	TF & BF SATURATED
06/27/88	2.0	1.0	4411.6	3.6	0.0	3.6	0.0	TF & BF WET
06/27/88	2.2	0.2	4410.1	1.5	0.0	9.0	0.0	TF & BF 1/2 WET
06/27/88	3.2	1.0	4407.6	2.5	0.0	2.5	0.0	TF: HALF WET BF: EDGE WET & FEW SPOTS IN CENTER
06/27/88	3.3	0.2	4406.9	0.7	0.0	4.2	0.0	
06/27/88	4.3	1.0	4405.4	1.5	0.0	1.5	0.0	TF HALF WET & BF LESS WET THAN TF
06/27/88	4.5	0.2	4404.7	0.7	0.0	4.2	0.0	TF 3/4 WET ; BF VERY WET
06/28/88	23.2	18.7	4402.0	2.7	0.0	0.1	0.0	BF WET ON EDGE; TF DRY
06/28/88	23.4	0.2	4401.7	0.3	0.0	1.8	0.0	BF: SPOTS ON EDGE AND 1 IN CENTER TF: WET ON EDGE
06/28/88	24.5	1.1	4401.5	0.2	0.0	0.2	0.0	TF 1 SPOT ON EDGE; BF 5 SPOTS
06/28/88	24.6	0.2	4401.2	0.3	0.0	1.8	0.0	TF WET ON EDGE; BF EDGE & CENTER SPOTS
06/28/88	25.7	1.0	4400.6	0.6	0.0	0.6	0.0	TF 2 SPOTS CENTER; BF SPOTS
06/28/88	25.8	0.2	4400.4	0.2	0.0	1.2	0.0	TF & BF SPOTS OF WETNESS
06/28/88	26.8	1.0	4399.7	0.7	0.0	0.7	0.0	
06/28/88	27.0	0.2	4399.2	0.5	0.0	2.5	0.0	TF & BF FEW SPOTS CENTER AND EDGE
06/28/88	28.0	1.0	4398.6	0.6	0.0	0.6	0.0	TF & BF FEW SPOTS CENTER AND EDGE
06/28/88	28.2	0.2	4398.3	0.3	0.0	1.8	0.0	TF WET ON EDGE; BF WET EXCEPT CENTER
06/29/88	44.1	15.9	4397.0	1.3	0.0	0.1	0.0	TF NR; BF 5 SPOTS ON EDGE
06/29/88	44.2	0.2	4396.8	0.2	0.0	1.2	0.0	TF & BF SLIGHT WETNESS ON EDGE
06/29/88	45.2	1.0	4396.5	0.3	0.0	0.3	0.0	TF & BF NR
06/29/88	45.4	0.2	4396.4	0.1	0.0	0.6	0.0	TF NR; BF 3 SPOTS NEAR EDGE
06/29/88	46.4	1.0	4396.1	0.3	0.0	0.3	0.0	TF NR; BF SLIGHTLY WET AROUND EDGE
06/29/88	46.6	0.2	4395.9	0.2	0.0	1.2	0.0	TF 1 SPOT; BF SMALL AERA ON EDGE
06/29/88	47.9	1.4	4395.5	0.4	0.0	0.3	0.0	TF NR; BF SPOT ON EDGE

PC DETERMINATIONS. SAFE STEP & OIL (38 percent liquid loading)

PC DETERMINATIONS: SAFE STEP & OIL (38 percent liquid loading)
(continued)

DATE	TIME (HRS)	delta TIME (HRS)	RTI-G WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
06/29/88	48.1	0.2	4395.4	0.1	0.0	0.6	0.0	
06/29/88	49.1	1.0	4395.0	0.4	0.0	0.4	0.0	TF 1 SPOT NEAR CENTER; BF SPOT
06/29/88	49.3	0.2	4394.7	0.3	0.0	1.8	0.0	TF STRIPS IN CENTER & EDGE SPOTS; BF SPOT ON EDGE
06/29/88	50.1	0.9	4394.4	0.3	0.0	0.3	0.0	TF SPOTS ON GRID MARKS; BF SPOTS ON ED
06/29/88	50.3	0.2	4394.1	0.3	0.0	1.8	0.0	TF EDGE & SPOT ON GRIDS & BF EDGE WET
06/30/88	67.2	16.9	4393.1	1.0	0.0	0.1	0.0	TF THREE SPOTS ON GRID; BF EDGE & SPOTS ON GRIDS
06/30/88	67.3	0.2	4393.0	0.1	0.0	0.6	0.0	TF NR; BF EDGES
06/30/88	68.7	1.4	4392.8	0.2	0.0	0.1	0.0	TF NR; BF EDGES
06/30/88	68.8	0.2	4392.7	0.1	0.0	0.6	0.0	TF NR; BF EDGES
06/30/88	69.8	1.0	4392.3	0.4	0.0	0.4	0.0	BF 1 SPOT ON EDGE
06/30/88	70.0	0.2	4392.2	0.1	0.0	0.6	0.0	BF 4 SPOTS ON EDGE
06/30/88	71.3	1.3	4392.0	0.2	0.0	0.2	0.0	BF FEW SPOTS ON GRID NEAR EDGE
06/30/88	72.9	1.7	4391.8	0.2	0.0	0.1	0.0	BF FEW SPOTS ON EDGE
06/30/88	73.1	0.2	4391.6	0.2	0.0	1.2	0.0	BF 1 SMALL SPOT ON EDGE
06/30/88	89.9	16.8	4391.6	0.0	0.0	0.0	0.0	TF FEW SMALL SPECS; BF 1/8 WET FROM EDG
06/30/88	90.1	0.2	4391.0	0.6	0.0	3.6	0.0	BF SPOTS ON EDGE
07/01/88	91.1	1.0	4390.8	0.2	0.0	0.2	0.0	BF 1 SMALL SPOT
07/01/88	91.3	0.2	4390.7	0.1	0.0	0.6	0.0	TF & BF NR
07/01/88	92.3	1.0	4390.6	0.1	0.0	0.1	0.0	BF 1 SPOT NEAR EDGE
07/01/88	92.4	0.2	4390.6	0.0	0.0	0.0	0.0	
07/01/88	93.9	1.4	4390.6	0.0	0.0	0.0	0.0	TF & BF NR
07/01/88	94.0	0.2	4390.4	0.2	0.0	1.2	0.0	TF & BF NR
07/01/88	190.4	96.4	4390.4	0.0	0.0	0.0	0.0	TF NR; BF DAMP ON EDGE
07/05/88	190.6	0.2	4388.9	1.5	0.0	9.0	0.0	TF & BF NR

PC DETERMINATIONS: SND-M & 5% ACETONE SOLUTION
DEVICE: WRI-E (CELL, GRIDS, SCREENS, AND PISTON) WT: 3842.7 g
DRY SAMPLE WT: 228.6 g WET SAMPLE WT: 700.8 g
PRESSURE: 50 PSI

DATE	TIME (HRS)	delta TIME (HRS)	WRI-E WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
07/18/88	0.0	0.0	4340.5	0	0	0	0	
07/18/88	1.0	1.0	4334.8	5.7	0.0	5.7	0.0	TF 1/4 WET; BF SATURATED
07/18/88	1.2	0.2	4330.0	4.8	0.0	28.8	0.0	TF 1/4 WET; BF SATURATED
07/18/88	2.2	1.0	4325.1	4.9	0.0	4.7	0.0	TF 1/4 WET; BF SATURATED
07/18/88	2.4	0.2	4321.7	3.4	0.0	20.4	0.0	TF 1/8 WET; BF SATURATED
07/18/88	3.8	1.5	4317.8	3.9	0.0	2.7	0.0	TF NR; BF SATURATED
07/18/88	4.0	0.2	4315.3	2.5	0.0	15.0	0.0	BF 3/4 WET
07/18/88	5.2	1.2	4313.2	2.1	0.0	1.7	0.0	BF 3/4 WET
07/18/88	5.4	0.2	4313.1	0.1	0.0	0.6	0.0	TF & BF NR
07/19/88	21.2	15.8	4310.1	3.0	0.0	0.2	0.0	TF MOIST FROM ENVIRONMENT; BF WET
07/19/88	21.4	0.2	4310.0	0.1	0.0	0.6	0.0	TF & BF NR
07/19/88	22.4	1.0	4309.4	0.6	0.0	0.6	0.0	TF & BF NR
07/19/88	22.5	0.2	4309.2	0.2	0.0	1.2	0.0	TF & BF NR
07/20/88	46.3	23.8	4306.1	3.1	0.0	0.1	0.0	TF & BF WET FROM ENVIRONMENT
07/20/88	46.5	0.2	4305.8	0.3	0.0	1.8	0.0	TF & BF NR
07/21/88	71.2	24.7	4303.2	2.6	0.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT
07/21/88	71.4	0.2	4302.9	0.3	0.0	1.8	0.0	TF & BF NR
07/22/88	94.1	22.7	4300.8	2.1	0.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT
07/22/88	94.2	0.2	4300.6	0.2	0.0	1.2	0.0	TF & BF NR
07/25/88	164.4	70.2	4296.0	4.6	0.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT
07/25/88	164.6	0.2	4295.8	0.2	0.0	1.2	0.0	TF & BF NR
07/26/88	189.0	24.4	4293.3	2.5	0.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT

B.3 Experimental Data

PC DETERMINATIONS: SAFE STEP & OIL (32 percent liquid loading)
DEVICE: RTI-000 (CELL, GRIDS, SCREENS, AND PISTON) WT: 3882.2 g
DRY SAMPLE WT: 439.2 g WET SAMPLE WT: 579.8 g
PRESSURE: 50 PSI

DATE	TIME (HRS)	delta TIME (HRS)	RTI-000 WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
07/25/88	0.0	0.0	4459.5	0	0	0	0	
07/25/88	0.2	0.2	4452.0	7.5	0.0	45.0	0.0	TF & BF SATURATED
07/25/88	1.2	1.1	4448.2	3.8	0.0	3.6	0.0	TF & BF SATURATED
07/25/88	1.4	0.2	4442.4	5.8	0.0	34.8	0.0	TF & BF WET
07/25/88	2.3	0.9	4438.8	3.6	0.0	4.0	0.0	TF & BF WET
07/26/88	2.5	0.2	4436.5	2.3	0.0	13.8	0.0	TF & BF WET
07/26/88	18.2	15.7	4432.6	3.9	0.0	0.2	0.0	TF & BF WET
07/26/88	18.3	0.2	4432.3	0.3	0.0	1.8	0.0	TF & BF WET ON GRIDS
07/26/88	19.4	1.0	4431.0	1.3	0.0	1.3	0.0	TF & BF WET ON GRIDS & EDGES
07/26/88	19.5	0.2	4430.5	0.5	0.0	3.0	0.0	TF & BF WET ON GRIDS
07/26/88	20.6	1.1	4429.3	1.2	0.0	1.1	0.0	TF & BF WET ON GRIDS
07/26/88	20.7	0.2	4428.7	0.6	0.0	3.6	0.0	TF & BF WET ON GRIDS
07/26/88	22.4	1.6	4427.0	1.7	0.0	1.0	0.0	TF & BF WET ON GRIDS
07/26/88	23.4	1.0	4426.4	0.6	0.0	0.6	0.0	TF & BF WET ON GRIDS
07/26/88	23.6	0.2	4426.1	0.3	0.0	1.8	0.0	TF & BF WET ON EDGES AND GRIDS
07/26/88	24.5	1.0	4425.3	0.8	0.0	0.8	0.0	TF & BF WET ON EDGES AND GRIDS
07/27/88	24.7	0.2	4425.2	0.1	0.0	0.5	0.0	TF & BF WET ON EDGES AND GRIDS
07/27/88	41.7	17.0	4423.6	1.6	0.0	0.1	0.0	TF & BF 1/2 WET
07/27/88	41.9	0.2	4423.3	0.3	0.0	1.8	0.0	
07/27/88	43.0	1.1	4423.4	-0.1	0.0	-0.1	0.0	TF SPOTS; BF SPOTS AND EDGES WET
07/27/88	43.1	0.2	4423.3	0.1	0.0	0.6	0.0	BF & TF FEW SPOTS
07/27/88	44.6	1.5	4423.1	0.2	0.0	0.1	0.0	TF SPOT ; BF WET ON EDGE
07/27/88	44.8	0.2	4422.9	0.2	0.0	1.2	0.0	TF NR; BF EDGE WET AND SPOTS ON GRIDS
07/27/88	45.8	1.0	4422.6	0.3	0.0	0.3	0.0	
07/27/88	45.9	0.2	4422.3	0.3	0.0	1.8	0.0	TF & BF SPOTS
07/27/88	47.0	1.1	4421.9	0.4	0.0	0.4	0.0	BF & TF EDGES WET
07/27/88	47.2	0.2	4421.8	0.1	0.0	0.6	0.0	BF SPOTS ON EDGE

PC DETERMINATIONS: SAFE STEP & OIL (32 percent liquid loading)
(continued)

DATE	TIME (HRS)	delta TIME (HRS)	RTI-000 WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
07/28/88	48.2	1.0	4421.4	0.4	0.0	0.4	0.0	BF SPOTS ON EDGE
07/28/88	63.7	15.5	4420.4	1.0	0.0	0.1	0.0	TF & BF WET ON EDGE AND GRIDS
07/28/88	63.9	0.2	4420.2	0.2	0.0	1.2	0.0	
07/28/88	65.8	1.9	4420.0	0.2	0.0	0.1	0.0	TF & BF 1-2 SPOTS
07/28/88	66.0	0.2	4420.0	0.0	0.0	0.0	0.0	
07/28/88	68.0	2.0	4419.7	0.3	0.0	0.1	0.0	BF WET ON EDGE (1 SPOT)
07/28/88	68.2	0.2	4419.6	0.1	0.0	0.6	0.0	BF WET ON EDGE (1 SPOT)
07/28/88	69.6	1.4	4419.2	0.4	0.0	0.3	0.0	
07/28/88	69.8	0.2	4419.1	0.1	0.0	0.6	0.0	BF WET AROUND EDGE
07/29/88	70.7	0.9	4419.0	0.1	0.0	0.1	0.0	BF WET AROUND EDGE
07/29/88	86.6	15.9	4418.3	0.7	0.0	0.0	0.0	BF WET AROUND EDGE
07/29/88	86.8	0.2	4418.1	0.2	0.0	1.2	0.0	TF & BF NR
07/29/88	88.2	1.5	4418.0	0.1	0.0	0.1	0.0	TF & BF NR
07/29/88	88.4	0.2	4418.0	0.0	0.0	0.0	0.0	TF & BF NR
08/01/88	112.1	23.6	4416.4	1.6	0.0	0.1	0.0	TF & BF WET FROM ENVIRONMENT
08/01/88	112.2	0.2	4416.4	0.0	0.0	0.0	0.0	TF & BF NR

PC DETERMINATIONS: VERMICULITE & CaSO4 SOLUTIONS (160 percent liquid loading)
DEVICE: WRI-1 (CELL, GRIDS, SCREENS, AND PISTON) WT: 3780.6 g
DRY SAMPLE WT: 64.3g WET SAMPLE WT: 167.3 g
PRESSURE: 50 PSI

DATE	TIME (HRS)	delta TIME (HRS)	WRI-1 WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
07/26/88	0.0	0.0	3947.4	0	0	0	0	
07/26/88	1.1	1.1	3944.0	3.4	0.0	3.1	0.0	TF & BF SATURATED
07/26/88	1.3	0.2	3943.6	0.4	0.0	2.4	0.0	TF WET AROUND EDGE; BF NR
07/26/88	2.3	1.0	3942.8	0.8	0.0	0.8	0.0	TF SPOTS ON EDGE
07/27/88	26.4	24.2	3941.1	1.7	0.0	0.1	0.0	TF & BF WET FROM ENVIRONMENT
07/27/88	26.6	0.2	3941.0	0.1	0.0	0.6	0.0	TF & BF NR
07/28/88	52.2	25.6	3939.5	1.5	0.0	0.1	0.0	TF & BF WET FROM ENVIRONMENT
07/28/88	52.4	0.2	3938.7	0.8	0.0	4.8	0.0	TF & BF NR
07/29/88	77.0	24.6	3937.6	1.1	0.0	0.0	0.0	TF & BF WET FROM ENVIRONMENT
07/29/88	77.1	0.2	3937.3	0.3	0.0	1.8	0.0	TF & BF NR

PC DETERMINATIONS: VERMICULITE & CaSO4 SOLUTION (160 percent liquid loading)
DEVICE: WRI-E (CELL, GRIDS, SCREENS, AND PISTON) WT: 3842.7 g
DRY SAMPLE WT: 67.8 g WET SAMPLE WT: 176.4 g
PRESSURE: 50 PSI

DATE	TIME (HRS)	delta TIME (HRS)	WRI-E WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
08/01/88	0.0	0.0	4020.1	0	0	0	0	
08/01/88	1.0	1.0	4018.4	1.7	0.0	1.7	0.0	TF WET; BF DRY
08/01/88	1.2	0.2	4018.2	0.2	0.0	1.2	0.0	BF & TF NR
08/01/88	2.7	1.5	4017.3	0.9	0.0	0.6	0.0	BF & TF NR
08/01/88	3.7	1.1	4016.7	0.6	0.0	0.6	0.0	
08/01/88	3.9	0.2	4016.3	0.4	0.0	2.4	0.0	TF & BF NR
08/02/88	27.9	24.0	4014.8	1.5	0.0	0.1	0.0	TF & BF NR
08/03/88	51.9	24.0	4013.3	1.5	0.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT
08/04/88	77.0	25.1	4010.9	2.4	0.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT
08/05/88	100.7	23.7	4009.1	1.8	0.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT
08/06/88	113.5	12.8	4007.2	1.9	0.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT

B.3 Experimental Data

PC DETERMINATIONS: SAFE STEP & OIL (32 percent liquid loading)
DEVICE: RTI-G (CELL, GRIDS, SCREENS, AND PISTON) WT: 3861.2 g
DRY SAMPLE WT: 439.5 g WET SAMPLE WT: 580.1 g
PRESSURE: 50 psi

DATE	TIME (HRS)	delta TIME (HRS)	RTI-G WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
07/26/88	0.0	0.0	4428.5	0	0	0	0	
07/26/88	0.2	0.2	4423.2	5.3	0.0	31.8	0.0	TF & BF SATURATED
07/26/88	1.2	1.0	4418.0	5.2	0.0	5.2	0.0	TF & BF SATURATED
07/26/88	1.3	0.2	4415.4	2.6	0.0	15.6	0.0	TF & BF WET
07/26/88	2.1	0.8	4412.7	2.7	0.0	3.4	0.0	TF & BF WET
07/26/88	2.3	0.2	4411.7	1.0	0.0	6.0	0.0	TF & BF WET
07/27/88	18.1	15.8	4408.4	3.3	0.0	0.2	0.0	TF & BF WET
07/27/88	18.3	0.2	4408.3	0.1	0.0	0.6	0.0	TF & BF WET ON GRIDS
07/27/88	19.3	1.0	4407.9	0.4	0.0	0.4	0.0	TF & BF SPOTS ON GRIDS & EDGES
07/27/88	19.5	0.2	4407.6	0.3	0.0	1.8	0.0	TF & BF WET ON GRIDS
07/27/88	20.5	1.1	4406.6	1.0	0.0	1.0	0.0	TF & BF WET ON GRIDS
07/27/88	20.7	0.2	4406.4	0.2	0.0	1.2	0.0	TF & BF WET ON GRIDS
07/27/88	22.4	1.7	4405.1	1.3	0.0	0.8	0.0	TF & BF WET ON GRIDS
07/27/88	23.4	1.0	4404.3	0.8	0.0	0.8	0.0	TF & BF WET ON GRIDS
07/27/88	23.5	0.2	4404.1	0.2	0.0	1.2	0.0	TF & BF WET ON EDGES AND GRIDS
07/27/88	24.9	1.4	4403.3	0.8	0.0	0.6	0.0	TF & BF WET ON EDGES AND GRIDS
07/27/88	25.1	0.2	4403.2	0.1	0.0	0.6	0.0	TF & BF WET ON EDGES AND GRIDS
07/28/88	42.1	17.0	4401.5	1.7	0.0	0.1	0.0	TF & BF 1/2 WET
07/28/88	42.3	0.2	4401.3	0.2	0.0	1.2	0.0	TF & BF FEW SPOTS
07/28/88	43.3	1.0	4401.3	0.0	0.0	0.0	0.0	TF NR; BF FEW SPOTS
07/28/88	43.4	0.2	4401.2	0.1	0.0	0.6	0.0	BF FEW SPOTS
07/28/88	44.9	1.5	4400.7	0.5	0.0	0.3	0.0	TF SPOT ; BF FEW SPOTS
07/28/88	45.0	0.2	4400.7	0.0	0.0	0.0	0.0	TF NR; BF EDGE WET AND SPOTS ON GRIDS
07/28/88	46.0	1.0	4400.4	0.3	0.0	0.3	0.0	BF WET ON EDGE
07/28/88	46.2	0.2	4400.3	0.1	0 0	0.6	0.0	TF & BF SPOTS
07/28/88	47.2	1.0	4399.8	0.5	0.0	0.5	0.0	BF & TF EDGES WET
07/28/88	47.4	0.2	4399.5	0.3	0.0	1.8	0.0	BF SPOTS ON EDGE

PC DETERMINATIONS: SAFE STEP & OIL (32 percent liquid loading)
(continued)

DATE	TIME (HRS)	delta TIME (HRS)	RTI-G WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
07/28/88	48.4	1.0	4399.1	0.4	0.0	0.4	0.0	BF SPOTS ON EDGE
07/29/88	63.9	15.5	4398.4	0.7	0.0	0.0	0.0	TF & BF WET ON EDGE AND GRIDS
07/29/88	64.1	0.2	4398.3	0.1	0.0	0.6	0.0	TF & BF NR
07/29/88	66.0	1.9	4398.3	0.0	0.0	0.0	0.0	TF & BF NR
07/29/88	66.1	0.2	4398.1	0.2	0.0	1.2	0.0	TF & BF NR
07/29/88	90.1	24.0	4396.8	1.3	0.0	0.1	0.0	BF WET AROUND EDGE
08/01/88	113.8	23.7	4395.4	1.4	0.0	0.1	0.0	TF AND BF WET FROM ENVIRONMENT
08/01/88	114.0	0.2	4395.5	-0.1	0.0	-0.6	0.0	TF & BF NR

B.3 Experimental Data

PC DETERMINATIONS: FLOOR DRY & WATER
RTI-000 DEVICE DRY & CLEAN WT.: 3884.8 g.
RTI-000 DRY SAMPLE WT: 174.8 g.
PRESSURE : 50 psi

DATE	TIME (HRS)	delta TIME (HRS)	RTI-OOO WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
09/08/88	0.0	0	4305.9	0	0	0	0	
09/08/88	1.0	1	4296.3	9.6	0.0	9.6	0.0	BF:SATURATED TF:1SPOT ON EDGE
09/08/88	2.0	1	4291.6	4.7	4.9	4.7	4.9	BF:SATURATED TF: NR
09/08/88	2.2	0	4290.3	1.3	3.4	7.8	20.4	
09/08/88	3.2	1	4287.0	3.3	-2.0	3.3	-2.0	BF:NR TF:NR
09/08/88	3.3	0	4286.7	0.3	3.0	1.8	18.0	BF 1 SPOT
09/08/88	4.7	1	4286.0	0.7	-0.4	0.5	-0.3	
09/08/88	4.8	0	4285.7	0.3	0.4	1.8	2.4	BF&TF:VERY WET
09/09/88	21.4	17	4279.9	5.8	-5.5	0.4	-0.3	TF & BF NR
09/09/88	22.8	1	4278.9	1.0	4.8	0.7	3.3	TF & BF NR
09/09/88	23.0	0	4278.5	0.4	0.6	2.4	3.6	WET FROM ENVIRONMENT
09/10/88	52.2	29	4276.1	2.4	-2.0	0.1	-0.1	
09/11/88	76.7	25	4274.0	2.1	0.3	0.1	0.0	DAMP FROM ENVIRON.
09/12/88	99.6	23	4271.3	2.7	-0.6	0.1	0.0	SLIGHTLY DAMP FROM ENVIRON.
09/13/88	123.4	24	4269.7	1.6	1.1	0.1	0.0	DAMP FROM ENVIRON.
09/14/88	143.0	20	4267.7	2.0	-0.4	0.1	0.0	DAMP FROM ENVIRON.
09/15/88	169.9	27	4264.6	3.1	-1.1	0.1	0.0	DAMP FROM ENVIRON.

PC DETERMINATIONS: FLOOR DRY AND WATER
RTI-G DEVICE DRY & CLEAN WT.: 3859.4 g.
RTI-G DRY SAMPLE WT: 182.7 g.
PRESSURE : 50 psi

DATE	TIME (HRS)	delta TIME (HRS)	RTI-G WEIGHT (g)	WEIGHT CHANGE (g)	delta WEIGHT CHANGE (g)	WT CHANGE/ TIME CHANGE	delta WT CHANGE/ delta TIME CHANGE	COMMENTS
09/08/88	0.0	0	4303.6	0	0	0	0	
09/08/88	1.0	1	4286.6	17.0	0.0	17.0	0.0	TF:NR BF:SATURAATED
09/08/88	2.0	1	4281.5	5.1	11.9	5.1	11.9	BF:3/4 WET, TF:SPOTS ON EDGE
09/08/88	2.2	0	4279.8	1.7	3.4	10.2	20.4	BF: 1/2 WET
09/08/88	3.2	1	4277.2	2.6	-0.9	2.6	-0.9	BF : WET ON EDGE
09/08/88	3.3	0	4276.9	0.3	2.3	1.8	13.8	BF:WET ON EDGE
09/08/88	4.7	1	4276.2	0.7	-0.4	0.5	-0.3	
09/08/88	4.9	0	4275.4	0.8	-0.1	4.8	-0.6	TF & BF VERY WET
09/09/88	21.0	16	4269.0	6.4	-5.6	0.4	-0.3	BF WET AROUND EDGE, 1 SPOT
09/09/88	22.6	2	4268.3	0.7	5.7	0.4	3.6	TF & BF NR
09/09/88	22.8	0	4268.0	0.3	0.4	1.8	2.4	BF 1 SPOT
09/09/88	23.8	1	4267.5	0.5	-0.2	0.5	-0.2	TF & BF NR
09/09/88	24.0	0	4267.3	0.2	0.3	1.2	1.8	TF & BF NR
09/09/88	25.0	1	4266.8	0.5	-0.3	0.5	-0.3	TF & BF WET FROM ENVIRONMENT
09/10/88	53.8	29	4263.7	3.1	-2.6	0.1	-0.1	
09/11/88	78.4	25	4259.0	4.7	-1.6	0.2	-0.1	TF & BF DAMP FROM ENVIRONMENT
09/12/88	101.2	23	4256.2	2.8	1.9	0.1	0.1	TF & BF DAMP FROM ENVIRONMENT
09/13/88	124.8	24	4254.4	1.8	1.0	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT
09/14/88	144.8	20	4252.7	1.7	0.1	0.1	0.0	TF & BF DAMP FROM ENVIRONMENT
09/15/88	171.6	27	4249.9	2.8	-1.1	0.1	0.0	

APPENDIX C

LIQUID RELEASE TEST DEVICE CALIBRATION

C.1 Procedure Used To Calibrate LRT Devices

C.2 Calibration Results For ADM LRT Devices

C.1 Procedure Used To Calibrate LRT Devices

Note: This procedure was developed by Dr. Roy Borden, North Carolina State University, Department of Civil Engineering, who served as a consultant to RTI on this project. The procedure was used to calibrate the devices built by Associated Design and Manufacturing Company (ADM), Alexandria, VA.

General Description

Each LRT device should be calibrated to apply 50 ▲ 1 psi to the top of a sample. The calibration should be performed using all of the individual pieces of the device (i.e., pressure application device, sample cell body, baseplate, and piston), spacers set at the location where the top of the sample would be, and a load cell placed directly under the spacers. Placement of the load cell requires a test frame to hold the LRT device, providing a hole underneath such that the spacers can be set inside the sample cell at the appropriate height and the load cell placed directly below the spacers (See Figure).

Procedure

1. Connect the LRT sample cell to the test frame as shown in Figure 3.

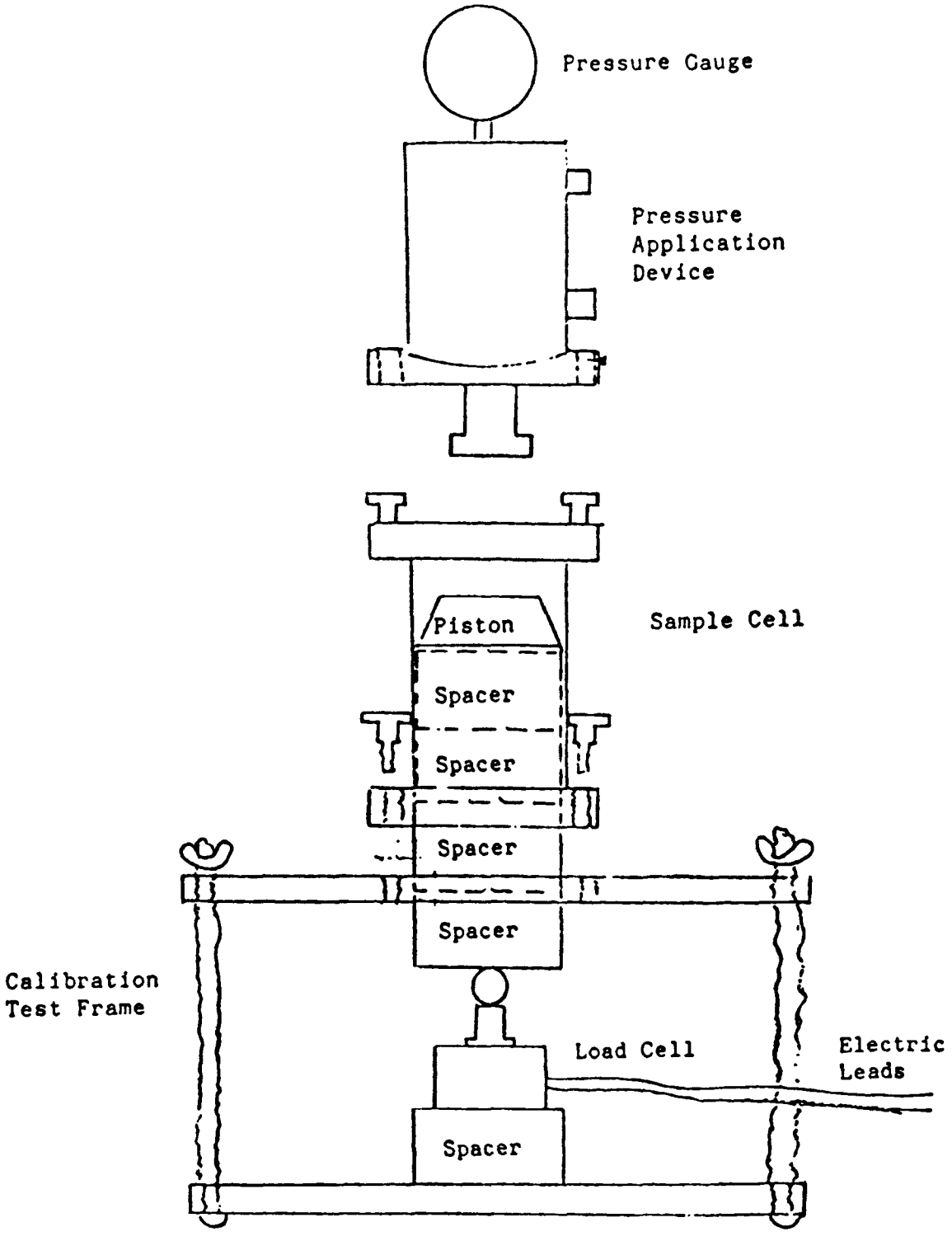
2. Place a calibrated load cell directly beneath the spacers which are set at the appropriate height within the sample cell, representative of the sample thickness (e.g., 10 cm).

3. Place a 76 mm stainless-steel screen, then a 76 mm filter paper on top of the spacers

4. Place the piston on top of the spacers, stainless-steel screen, and filter paper in the LRT sample cell.

5. Attach the pressure application device to the sample cell and apply 50 psi pressure to the piston via the baseplate regulator and monitor the load cell. The load cell calibration is used to determine the load per unit area actually being applied by the system. The pressure is then released, the baseplate regulator adjusted, and the pressure again applied to the piston. This procedure should be repeated until the desire pressure of 50 ▲ 1 psi is obtained.

6. After the desired setting is obtained, release the pressure and reapply the pressure three times to ensure consistent results. Record the pressure gauge (located on top of the pressure application device and denoted by 'A' in Figure 3) and load cell readings for each trial.



Equipment Set-up for LRT Device Calibration

C.2 Calibration Results For ADM LRT Devices

Device	Piston Gauge Settings (psi)		
	September 1987	April/August 1988	March 1991
A	56	51	42.5
B	53	---	---
C	53	56.5	---
D	49	---	49.3
E	58	53.2	48.7
F	51	---	---
G	---	51	---
RTI-000	43	46	42.4

APPENDIX D

LIQUID RELEASE TEST (LRT) RESULTS

D.1 Results for Floor Dry/Water

D.2 Results for Safe-Step/Motor Oil

D.3 Results for Vermiculite/0.01 N Calcium Sulfate Solution

D.4 Results for SND-M/5% Acetone Solution

D.5 Results for SND-M/Diesel Fuel

D.1 Results For Floor Dry/Water

LRT TESTS :FLOOR DRY & WATER
PRESSURE: 50 PSI

DATE	SAMPLE NUMBER	SORBENT/ SORBATE	% LLL	TIME (MIN)	HEIGHT (CM)	DEVICE	TOP FILTER	BOTTOM FILTER	COMMENTS
05/25/88	U2	FD/H2O	125	10	10	WRI-E	NR	NR	
06/10/88	U249	FD/H2O	130	10	10	WRI-E	NR	NR	
06/10/88	U237	FD/H2O	130	10	10	WRI-E	NR	NR	
06/10/88	U252	FD/H2O	130	10	10	WRI-1	NR	NR	
06/10/88	U219	FD/H2O	130	10	10	WRI-E	NR	NR	
06/10/88	U250	FD/H2O	130	10	10	WRI-1	NR	NR	
06/10/88	U248	FD/H2O	130	10	10	WRI-1	NR	NR	
06/10/88	U14	FD/H2O	133	10	10	WRI-E	NR	NR	
06/10/88	U27	FD/H2O	133	10	10	WRI-E	NR	NR	
06/10/88	U26	FD/H2O	133	10	10	WRI-1	NR	NR	
06/10/88	U28	FD/H2O	133	10	10	WRI-1	NR	NR	
06/10/88	U10	FD/H2O	133	10	10	WRI-E	NR	NR	
06/10/88	U15	FD/H2O	133	10	10	WRI-1	NR	NR	
05/31/88	U100	FD/H2O	135	10	10	WRI-E	NR	NR	
06/02/88	U163	FD/H2O	135	10	10	WRI-1	NR	NR	
05/31/88	U104	FD/H2O	135	10	10	WRI-1	NR	NR	
05/25/88	U1	FD/H2O	135	10	10	WRI-1	NR	NR	TF: RELEASE ON EDGE
06/02/88	U178	FD/H2O	135	10	10	WRI-E	NR	NR	
06/02/88	U176	FD/H2O	135	10	10	WRI-1	NR	NR	
06/02/88	U164	FD/H2O	135	10	10	WRI-1	NR	NR	
06/02/88	U168	FD/H2O	135	10	10	WRI-1	NR	R	BF: 1 DOT ON GRID MARK
05/31/88	U95	FD/H2O	135	10	10	WRI-E	NR	NR	
06/02/88	U179	FD/H2O	137	10	10	WRI-E	NR	R	
05/31/88	U103	FD/H2O	137	10	10	WRI-1	NR	R	BF: 2 DOTS
06/03/88	U152	FD/H2O	137	10	10	WRI-1	NR	R	
06/02/88	U165	FD/H2O	137	10	10	WRI-1	NR	R	
05/31/88	U241	FD/H2O	137	10	10	WRI-1	NR	R	BF: SATURATED
06/03/88	U161	FD/H2O	137	10	10	WRI-E	NR	R	
06/03/88	U158	FD/H2O	137	10	10	WRI-1	NR	R	
05/31/88	U36	FD/H2O	137	10	10	WRI-E	NR	R	BF: 1/2 SATURATED
06/03/88	U159	FD/H2O	140	10	10	WRI-E	NR	R	
05/31/88	U240	FD/H2O	140	10	10	WRI-1	NR	R	
06/03/88	U154	FD/H2O	140	10	10	WRI-1	NR	R	
06/03/88	U155	FD/H2O	140	10	10	WRI-E	NR	R	
06/03/88	U162	FD/H2O	140	10	10	WRI-1	NR	R	
06/03/88	U239	FD/H2O	140	10	10	WRI-E	NR	R	
05/31/88	U245	FD/H2O	140	10	10	WRI-E	NR	R	
05/31/88	U251	FD/H2O	140	10	10	WRI-E	NR	R	
06/03/88	U147	FD/H2O	142	10	10	WRI-E	NR	R	
06/03/88	U151	FD/H2O	142	10	10	WRI-1	NR	R	
05/31/88	U243	FD/H2O	142	10	10	WRI-1	NR	R	
06/03/88	U149	FD/H2O	142	10	10	WRI-E	NR	R	
05/31/88	U99	FD/H2O	142	10	10	WRI-E	NR	R	
06/03/88	U148	FD/H2O	142	10	10	WRI-1	NR	R	
05/31/88	U244	FD/H2O	142	10	10	WRI-1	NR	R	
06/03/88	U146	FD/H2O	142	10	10	WRI-1	NR	R	

D.1 Results For Floor Dry/Water

LRT TESTS: FLOOR DRY & WATER (continued)
PRESSURE: 50 PSI

DATE	SAMPLE NUMBER	SORBENT/ SORBATE	% LLL	TIME (MIN)	HEIGHT (CM)	DEVICE	TOP FILTER	BOTTOM FILTER	COMMENTS
05/26/88	U3	FD/H2O	145	10	10	WRI-1	NR	R	STANDING WATER IN BOTTOM OF JAR
05/12/88	* U23	FD/H2O	105	10	5	RTI-000	NR	NR	
05/12/88	* U24	FD/H2O	105	10	5	RTI-G	NR	NR	
06/08/88	* U236	FD/H2O	135	10	5	WRI-1	NR	NR	
06/03/88	* U174	FD/H2O	135	10	5	WRI-E	NR	R	RELEASE ON GRID MARK
06/08/88	* U236	FD/H2O	135	10	5	WRI-E	NR	NR	
06/03/88	* U174	FD/H2O	135	10	5	WRI-1	NR	R	RELEASE ON GRID MARK; FILLED FIRST
06/03/88	* U157	FD/H2O	137	10	5	WRI-1	NR	R	RELEASE ON GRID MARK
06/03/88	* U180	FD/H2O	137	10	5	WRI-1	NR	NR	FILLED FIRST
06/03/88	* U157	FD/H2O	137	10	5	WRI-E	NR	R	RELEASE ON GRID MARK; FILLED FIRST
06/03/88	* U180	FD/H2O	137	10	5	WRI-E	NR	NR	
06/03/88	* U156	FD/H2O	140	10	5	WRI-1	NR	NR	FILLED FIRST
06/03/88	* U160	FD/H2O	140	10	5	WRI-E	NR	NR	
06/03/88	* U160	FD/H2O	140	10	5	WRI-1	NR	NR	FILLED FIRST
06/03/88	* U156	FD/H2O	140	10	5	WRI-E	NR	R	
06/08/88	* U150	FD/H2O	142	10	5	WRI-E	NR	R	
06/08/88	* U150	FD/H2O	142	10	5	WRI-1	NR	R	

* LOADED IN ONE BOTTLE AND SPLIT INTO TWO SAMPLES

D.2 Results For Safe-Step/Motor Oil

LRT TESTS: SAFE STEP & OIL
PRESSURE: 50 PSI

DATE	SAMPLE NUMBER	SORBENT/ SORBATE	% LLL	TIME (MIN)	HEIGHT (CM)	DEVICE	TOP FILTER	BOTTOM FILTER	COMMENTS
05/31/88	V147	SS/OIL	20	10	10	WRI-E	NR	NR	TF:RELEASE DUE CONTACT WITH EDGE
05/16/88	V10	SS/OIL	20	10	10	RTI-000	NR	NR	MAINTAINENCE WORKING ON ROOM TEMP
05/31/88	V198	SS/OIL	20	10	10	WRI-1	NR	NR	TF:RELEASE DUE CONTACT WITH EDGE
06/03/88	V193	SS/OIL	20	10	10	WRI-1	NR	NR	
06/03/88	V199	SS/OIL	20	10	10	WRI-E	NR	NR	
06/03/88	V115	SS/OIL	20	10	10	WRI-E	NR	NR	
06/03/88	V111	SS/OIL	20	10	10	WRI-1	NR	NR	
05/31/88	V141	SS/OIL	20	10	10	WRI-1	NR	NR	TF:RELEASE DUE CONTACT WITH EDGE
06/03/88	V114	SS/OIL	20	10	10	WRI-1	NR	NR	
06/03/88	V195	SS/OIL	22	10	10	WRI-E	NR	NR	
05/31/88	V139	SS/OIL	22	10	10	WRI-E	NR	NR	TF:RELEASE DUE CONTACT WITH EDGE
05/31/88	V134	SS/OIL	22	10	10	WRI-1	NR	NR	TF:RELEASE DUE CONTACT WITH EDGE
06/03/88	V194	SS/OIL	22	10	10	WRI-E	NR	NR	
06/03/88	V110	SS/OIL	22	10	10	WRI-1	NR	NR	
06/03/88	V200	SS/OIL	22	10	10	WRI-E	NR	NR	
06/03/88	V112	SS/OIL	22	10	10	WRI-1	NR	NR	
06/06/88	V203	SS/OIL	25	10	10	WRI-E	NR	NR	
06/06/88	V113	SS/OIL	25	10	10	WRI-1	NR	NR	
06/06/88	V109	SS/OIL	25	10	10	WRI-1	NR	NR	
05/31/88	V146	SS/OIL	25	10	10	WRI-E	R	NR	TF: CONTACT WITH EDGE; RELEASE ON GRID MARK
06/06/88	V119	SS/OIL	25	10	10	WRI-E	NR	NR	
05/31/88	V140	SS/OIL	25	10	10	WRI-1	NR	NR	TF:RELEASE DUE CONTACT WITH EDGE
06/06/88	V201	SS/OIL	25	10	10	WRI-1	NR	NR	
05/31/88	V133	SS/OIL	25	10	10	WRI-1	R	NR	TF: CONTACT WITH EDGE; RELEASE ON GRID MARK
05/31/88	V197	SS/OIL	28	10	10	WRI-E	NR	R	TF:RELEASE DUE CONTACT WITH EDGE BF:2 DOTS
06/06/88	V160	SS/OIL	28	10	10	WRI-1	NR	NR	
06/06/88	V157	SS/OIL	28	10	10	WRI-E	R	NR	TF: WET SPOT ON GRID MARK
06/06/88	V162	SS/OIL	28	10	10	WRI-E	R	NR	TF: SLIGHTLY WET ON GRID MARK
05/31/88	V196	SS/OIL	28	10	10	WRI-E	R	NR	TF: CONTACT WITH EDGE; RELEASE ON GRID MARK
06/06/88	V161	SS/OIL	28	10	10	WRI-1	NR	NR	
06/06/88	V116	SS/OIL	28	10	10	WRI-E	R	NR	TF: WET SPOT ON GRID MARK
05/31/88	V135	SS/OIL	28	10	10	WRI-1	R	NR	TF: CONTACT WITH EDGE; RELEASE ON GRID MARK
05/26/88	V191	SS/OIL	30	10	10	WRI-E	R	NR	
05/26/88	V14	SS/OIL	30	10	10	WRI-1	R	NR	
05/26/88	V189	SS/OIL	30	10	10	WRI-1	R	NR	
05/17/88	V13	SS/OIL	30	10	10	RTI-G	NR	NR	SAMPLE ONLY SAT FOR 24 HRS (NOT 72 HRS)
05/26/88	V126	SS/OIL	30	10	10	WRI-E	R	R	
05/26/88	V15	SS/OIL	30	10	10	WRI-E	R	NR	
06/13/88	V132	SS/OIL	32	10	10	WRI-E	R	R	OOZES AROUND PISTON
06/13/88	V129	SS/OIL	32	10	10	WRI-1	R	R	OOZES AROUND PISTON
05/25/88	V55	SS/OIL	32	10	10	WRI-E	R	R	
06/13/88	V187	SS/OIL	32	10	10	WRI-1	R	R	OOZES AROUND PISTON
06/13/88	V155	SS/OIL	32	10	10	WRI-1	R	R	OOZES AROUND PISTON
06/13/88	V10	SS/OIL	32	10	10	WRI-E	R	R	OOZES AROUND PISTON

D.2 Results For Safe-Step/Motor Oil

LRT TESTS: SAFE STEP & OIL (continued)
PRESSURE: 50 PSI

DATE	SAMPLE NUMBER	SORBENT/ SORBATE	% LLL	TIME (MIN)	HEIGHT (CM)	DEVICE	TOP FILTER	BOTTOM FILTER	COMMENTS
06/13/88	V4	SS/OIL	40	10	10	WRI-1	R	R	OOZES AROUND PISTON; LIQUID OUT BOTTOM
05/25/88	V182	SS/OIL	40	10	10	WRI-E	R	R	
06/13/88	V185	SS/OIL	40	10	10	WRI-E	R	R	OOZES AROUND PISTON; LIQUID OUT BOTTOM
06/13/88	V183	SS/OIL	40	10	10	WRI-E	R	R	OOZES AROUND PISTON; LIQUID OUT BOTTOM
05/16/88	V11	SS/OIL	40	10	10	RTI-G	R	R	MAINTAINENCE WORKING ON ROOM TEMP
06/13/88	V124	SS/OIL	40	10	10	WRI-1	R	R	OOZES AROUND PISTON; LIQUID OUT BOTTOM
06/07/88	V118	SS/OIL	20	10	5	WRI-E	NR	NR	
06/07/88	V120	SS/OIL	20	10	5	WRI-1	NR	NR	
06/07/88	V120	SS/OIL	20	10	5	WRI-E	NR	NR	
06/07/88	V118	SS/OIL	20	10	5	WRI-1	NR	NR	
06/13/88	V177	SS/OIL	22	10	5	WRI-E	NR	NR	
06/13/88	V177	SS/OIL	22	10	5	WRI-1	NR	NR	
06/08/88	V117	SS/OIL	22	10	5	WRI-1	NR	NR	
06/08/88	V117	SS/OIL	22	10	5	WRI-E	NR	NR	
06/08/88	V138	SS/OIL	22	10	5	WRI-1	NR	NR	
06/08/88	V138	SS/OIL	22	10	5	WRI-E	NR	NR	
06/13/88	V180	SS/OIL	25	10	5	WRI-E	NR	NR	
06/06/88	V204	SS/OIL	25	10	5	WRI-E	NR	NR	
06/13/88	V180	SS/OIL	25	10	5	WRI-1	NR	NR	
06/06/88	V202	SS/OIL	25	10	5	WRI-1	NR	NR	
06/06/88	V202	SS/OIL	25	10	5	WRI-E	NR	NR	
06/06/88	V204	SS/OIL	25	10	5	WRI-1	NR	NR	
06/09/88	V154	SS/OIL	28	10	5	WRI-1	R	R	SLIGHT POOLING ON BOTTOM
06/10/88	V153	SS/OIL	28	10	5	WRI-E	R	R	SLIGHT POOLING ON TOP
06/09/88	V154	SS/OIL	28	10	5	WRI-E	R	NR	SLIGHT POOLING ON TOP
06/09/88	V152	SS/OIL	28	10	5	WRI-1	R	R	SLIGHT POOLING
06/10/88	V153	SS/OIL	28	10	5	WRI-1	R	R	SLIGHT POOLING ON TOP
06/09/88	V143	SS/OIL	28	10	5	WRI-E	NR	NR	NO POOLING;1 SPOT ON EDGE
06/09/88	V152	SS/OIL	28	10	5	WRI-E	R	R	SLIGHT POOLING
06/09/88	V143	SS/OIL	28	10	5	WRI-1	R	R	POOLING ON TOP AND BOTTOM OF SAMPLE
05/26/88	V125	SS/OIL	30	10	5	WRI-E	NR	NR	
05/26/88	V125	SS/OIL	30	10	5	WRI-1	R	R	
05/26/88	V53	SS/OIL	30	10	5	WRI-1	R	R	
05/27/88	V52	SS/OIL	30	10	5	WRI-E	R	R	
05/26/88	V53	SS/OIL	30	10	5	WRI-E	R	R	
05/27/88	V52	SS/OIL	30	10	5	WRI-1	R	R	
06/13/88	V156	SS/OIL	32	10	5	WRI-1	R	R	OOZES AROUND PISTON
06/13/88	V176	SS/OIL	32	10	5	WRI-E	R	R	OOZES AROUND PISTON
06/13/88	V156	SS/OIL	32	10	5	WRI-E	R	R	OOZES AROUND PISTON
06/13/88	V176	SS/OIL	32	10	5	WRI-1	R	R	OOZES AROUND PISTON

D.3 Results For Vermiculite/0.01 N Calcium Sulfate Solution

LRT TESTS: VERMICULITE & CaSO4 SOLUTION
PRESSURE: 50 PSI

DATE	SAMPLE NUMBER	SORBENT/ SORBATE	% LLL	TIME (MIN)	HEIGHT (CM)	DEVICE	TOP FILTER	BOTTOM FILTER	COMMENTS
07/29/88	W19	VER/CaSO4	110	10	10	WRI-E	NR	NR	
08/01/88	W20	VER/CaSO4	110	10	10	WRI-1	NR	R	BF SATURATED
08/01/88	W36	VER/CaSO4	110	10	10	WRI-1	NR	R	BF SATURATED
07/21/88	W25	VER/CaSO4	120	10	10	RTI-G	NR	NR	
07/21/88	W24	VER/CaSO4	120	10	10	RTI-G	NR	R	BF SMALL SPOTS ON EDGE
07/21/88	W32	VER/CaSO4	120	10	10	WRI-1	R	R	BF & TF 1/2 WET
07/20/88	W27	VER/CaSO4	130	10	10	RTI-G	NR	NR	
07/20/88	W26	VER/CaSO4	130	10	10	WRI-1	R	R	TF & BF 1/2 WET
07/20/88	W31	VER/CaSO4	130	10	10	WRI-1	R	R	TF & BF 1/2 WET
07/19/88	W30	VER/CaSO4	150	10	10	WRI-1	R	R	TF 3/4 SATURATED; BF SATURATED
07/19/88	W29	VER/CaSO4	150	10	10	WRI-1	R	R	TF & BF SATURATED
07/18/88	W74	VER/CaSO4	215	10	10	RTI-G	R	R	TF & BF SATURATED; H2O ON PISTON
07/18/88	W28	VER/CaSO4	215	10	10	RTI-G	R	R	TF & BF SATURATED; H2O ON PISTON
07/20/88	W73	VER/CaSO4	215	10	10	RTI-G	R	R	TF & BF SATURATED
07/15/88	EXTRA-10	VER/CaSO4	231	10	10	WRI-1	R	R	TF & BF SATURATED
07/15/88	EXTRA-12	VER/CaSO4	231	10	10	WRI-1	R	R	TF & BF SATURATED
07/15/88	EXTRA-11	VER/CaSO4	231	10	10	WRI-E	R	R	TF & BF SATURATED

D.4 Results For SND-M/5% Acetone Solution

LRT TESTS: SND-M/ACETONE SOLUTION
PRESSURE: 50 PSI

DATE	SAMPLE NUMBER	SORBENT/ SORBATE	% LLL	TIME (MIN)	HEIGHT (CM)	DEVICE	TOP FILTER	BOTTOM FILTER	COMMENTS
08/01/88	Y17	OD/ACE	105	10	10	WRI-1	NR	R	BF 1/8 WET
08/01/88	Y18	OD/ACE	105	10	10	WRI-1	NR	NR	
08/01/88	Y14	OD/ACE	105	10	10	WRI-1	NR	NR	
07/18/88	Y6	OD/ACE	110.7	10	10	RTI-G	NR	R	
07/18/88	Y7	OD/ACE	110.7	10	10	RTI-G	NR	NR	
07/18/88	Y8	OD/ACE	110.7	10	10	RTI-G	NR	NR	
07/25/88	Y13	OD/ACE	115	10	10	WRI-1	NR	R	BF SATURATED
07/25/88	Y12	OD/ACE	115	10	10	WRI-1	NR	R	
07/25/88	Y5	OD/ACE	115	10	10	WRI-1	NR	R	

D.5 Results For SND-M/Diesel Fuel

TEMPERATURE RUGGEDNESS TEST

S/S = SND-M/DIESEL FUEL
TEMPERATURE = 23 degrees celcius
TEST DURATION = 10 minutes
PRESSURE= 50 psig
SAMPLE HEIGHT= 10 cm

SAMPLE	DATE	DEVICE	%LLL	TF	BF
Y67	11/4/88	RTI-000	70	NR	NR
Y64	11/4/88	RTI-G	70	NR	NR
Y69	11/4/88	RTI-G	70	NR	NR
Y65	11/4/88	RTI-000	70	NR	NR
Y132	10/25/88	RTI-000	70	NR	NR
Y133	10/25/88	RTIG	70	NR	NR
Y62	11/4/88	RTI-000	70	NR	NR
Y61	11/4/88	RTI-G	70	NR	NR
Y126	10/28/88	RTI-000	75	NR	NR
Y121	10/28/88	RTI-G	75	NR	R
Y119	10/28/88	RTI-000	75	NR	NR
Y131	10/25/88	RTI-G	75	NR	NR
Y138	10/27/88	RTI-000	75	NR	NR
Y130	10/25/88	RTI-000	75	NR	NR
Y118	10/31/88	RTI-000	77	NR	R
Y122	10/31/88	RTI-000	77	NR	NR
Y120	10/28/88	RTI-G	77	NR	R
Y137	10/27/88	RTI-000	77	NR	NR
Y136	10/27/88	RTI-G	77	NR	NR
Y140	10/27/88	RTI-G	77	NR	NR
Y135	10/25/88	RTI-G	80	NR	NR
Y142	10/27/88	RTI-000	80	NR	NR
Y134	10/25/88	RTI-000	80	NR	R
Y123	10/31/88	RTI-G	80	NR	R
Y124	10/28/88	RTI-G	80	NR	R
Y125	10/28/88	RTI-000	80	NR	R
Y129	10/28/88	RT-G	83	NR	NR
Y147	10/27/88	RTI-000	83	NR	R
Y127	10/28/88	RTI-G	83	NR	NR
Y144	10/27/88	RTI-G	83	NR	R
Y9	10/28/88	RTI-000	83	NR	NR
Y141	10/27/88	RTI-G	83	NR	NR

D.5 Results For SND-M/Diesel Fuel

TEMPERATURE RUGGEDNESS TEST

S/S = SND-M/DIESEL FUEL
TEMPERATURE = 23 degrees celcius (continued)

SAMPLE	DATE	DEVICE	%LLL	TF	BF
Y145	10/27/88	RTI-G	85	NR	R
Y16	10/28/88	RTI-000	85	NR	R
Y146	10/27/88	RTI-000	85	NR	R
Y143	10/27/88	RTI-000	85	NR	R
Y10	10/28/88	RTI-G	85	NR	R
Y88	11/8/88	RTI-000	85	NR	R
Y93	11/8/88	RTI-G	85	NR	R
Y92	11/8/88	RTI-000	85	NR	R
Y128	10/28/88	RTI-000	85	NR	R
Y15	10/31/88	RTI-G	87	NR	R
Y11	10/31/88	RTI-000	87	NR	NR
Y3	10/31/88	RTI-000	87	NR	R
Y4	10/31/88	RTI-000	87	NR	R
Y2	10/31/88	RTI-G	87	NR	R
Y1	10/31/88	RTI-G	87	NR	R
Y150	10/24/88	RTI-000	90		R
Y83	11/7/88	RTI-000	90	NR	R
Y84	11/7/88	RTI-000	90	NR	R
Y79	11/7/88	RTI-G	90	NR	R
Y80	11/7/88	RTI-G	90	NR	R
Y38	10/24/88	RTI-G	90		R

D.5 Results For SND-M/Diesel Fuel

TEMPERATURE RUGGEDNESS TEST

S/S = SND-M/DIESEL FUEL
TEMPERATURE = 4 degrees celcius (COLD)
TEST DURATION = 10 minutes
PRESSURE= 50 psig
SAMPLE HEIGHT= 10 cm

SAMPLE	DATE	DEVICE	%LLL	TF	BF
Y36	10/31/88	RTI-G	75	NR	NR
Y108	11/7/88	RTI-000	75	NR	NR
Y34	10/31/88	RTI-000	75	NR	NR
Y35	10/31/88	RTI-G	75	NR	NR
Y107	11/7/88	RTI-000	77	NR	NR
Y29	10/31/88	RTI-G	77	NR	NR
Y106	11/7/88	RTI-000	77	NR	NR
Y25	10/31/88	RTI-G	77	NR	NR
Y30	10/31/88	RTI-000	77	NR	NR
Y23	10/31/88	RTI-000	80	NR	NR
Y24	10/31/88	RTI-G	80	NR	NR
Y105	11/7/88	RTI-G	80	NR	NR
Y101	11/7/88	RTI-G	80	NR	NR
Y100	11/7/88	RTI-000	80	NR	R
Y33	10/31/88	RTI-000	80	NR	NR
Y52	10/31/88	RTI-000	83	NR	NR
Y98	11/7/88	RTI-000	83	NR	NR
Y53	10/31/88	RTI-G	83	NR	R
Y99	11/7/88	RTI-G	83	NR	NR
Y54	10/31/88	RTI-000	83	NR	R
Y94	11/7/88	RTI-G	83	NR	NR
Y45	10/31/88	RTI-000	85	NR	NR
Y46	10/31/88	RTI-000	85	NR	NR
Y113	10/27/88	RTI-G	85	NR	R
Y117	10/31/88	RTI-000	85	NR	R
Y112	10/31/88	RTI-G	85	NR	NR
Y48	10/31/88	RTI-G	85	NR	R
Y42	10/31/88	RTI-G	87	NR	R
Y90	11/7/88	RTI-G	87	NR	R
Y89	11/7/88	RTI-OOO	87	NR	R
Y47	10/31/88	RTI-G	87	NR	R
Y85	11/7/88	RTI-000	87	NR	R
Y41	10/31/88	RTI-000	87	NR	R
Y115	11/7/88	RTI-G	90	NR	R
Y114	11/7/88	RTI-000	90	NR	R
Y116	10/27/88	RTI-000	90	NR	R

D-5 Results For SND-M/Diesel Fuel

TEMPERATURE RUGGEDNESS TEST

S/S = SND-M/DIESEL FUEL
TEMPERATURE = 40 degrees celcius (HOT)
TEST DURATION = 10 minutes
PRESSURE= 50 psig
SAMPLE HEIGHT= 10 cm

SAMPLE	DATE	DEVICE	%LLL	TF	BF
Y55	11/4/88	RTI-G	70	NR	NR
Y59	11/4/88	RTI-G	70	NR	NR
Y56	11/4/88	RTI-000	70	NR	NR
Y63	11/4/88	RTI-000	70	NR	NR
Y58	11/4/88	RTI-000	70	NR	NR
Y60	11/4/88	RTI-G	70	NR	NR
Y28	11/1/88	RTI-G	75	NR	NR
Y72	11/4/88	RTI-G	75	NR	NR
Y68	11/4/88	RTI-G	75	NR	NR
Y71	11/4/88	RTI-000	75	NR	NR
Y31	11/1/88	RTI-000	75	NR	NR
Y32	11/1/88	RTI-000	75	NR	R
Y111	11/4/88	RTI-000	77	NR	NR
Y27	11/1/88	RTI-G	77	NR	R
Y22	11/1/88	RTI-G	77	NR	NR
Y109	11/4/88	RTI-G	77	NR	R
Y57	11/4/88	RTI-000	77	NR	NR
Y26	11/1/88	RTI-000	77	NR	R
Y19	11/1/88	RTI-000	80	NR	R
Y103	11/4/88	RTI-000	80	NR	NR
Y110	11/7/88	RTI-000	80	NR	R
Y21	11/1/88	RTI-000	80	NR	NR
Y104	11/7/88	RTI-G	80	NR	R
Y20	11/1/88	RTI-G	80	NR	NR
Y51	11/1/88	RTI-G	83	NR	R
Y50	11/2/88	RTI-000	83	NR	R
Y97	11/7/88	RTI-000	83	NR	R
Y102	11/7/88	RTI-000	83	NR	R
Y66	11/7/88	RTI-G	83	NR	R
Y49	11/2/88	RTI-000	83	NR	R
Y40	11/2/88	RTI-G	85	NR	R
Y44	11/2/88	RTI-G	85	NR	R
Y91	11/7/88	RTI-G	85	NR	R

D.5 Results For SND-M/Diesel Fuel

TEMPERATURE RUGGEDNESS TEST

S/S = SND-M/DIESEL FUEL
TEMPERATURE = 40 degrees celcius (continued)

SAMPLE	DATE	DEVICE	%LLL	TF	BF
Y96	11/7/88	RTI-G	85	NR	R
Y43	11/2/88	RTI-G	85	NR	R
Y95	11/7/88	RTI-000	85	NR	R
Y37	11/2/88	RTI-G	87	NR	R
Y70	11/2/88	RTI-000	87	NR	R
Y39	11/2/88	RTI-000	87	NR	R

METHOD 9095

PAINT FILTER LIQUIDS TEST

1.0 SCOPE AND APPLICATION

1.1 This method is used to determine the presence of free liquids in a representative sample of waste.

1.2 The method is used to determine compliance with 40 CFR 264.314 and 265.314.

2.0 SUMMARY OF METHOD

2.1 A predetermined amount of material is placed in a paint filter. If any portion of the material passes through and drops from the filter within the 5-min test period, the material is deemed to contain free liquids.

3.0 INTERFERENCES

3.1 Filter media were observed to separate from the filter cone on exposure to alkaline materials. This development causes no problem if the sample is not disturbed.

4.0 APPARATUS AND MATERIALS

4.1 Conical paint filter: Mesh number 60 (fine meshed size). Available at local paint stores such as Sherwin-Williams and Glidden for an approximate cost of $0.07 each.

4.2 Glass funnel: If the paint filter, with the waste, cannot sustain its weight on the ring stand, then a fluted glass funnel or glass funnel with a mouth large enough to allow at least 1 in. of the filter mesh to protrude should be used to support the filter. The funnel is to be fluted or have a large open mouth in order to support the paint filter yet not interfere with the movement, to the graduated cylinder, of the liquid that passes through the filter mesh.

4.3 Ring stand and ring, or tripod.

4.4 Graduated cylinder or beaker: 100-mL.

5.0 REAGENTS

5.1 None.

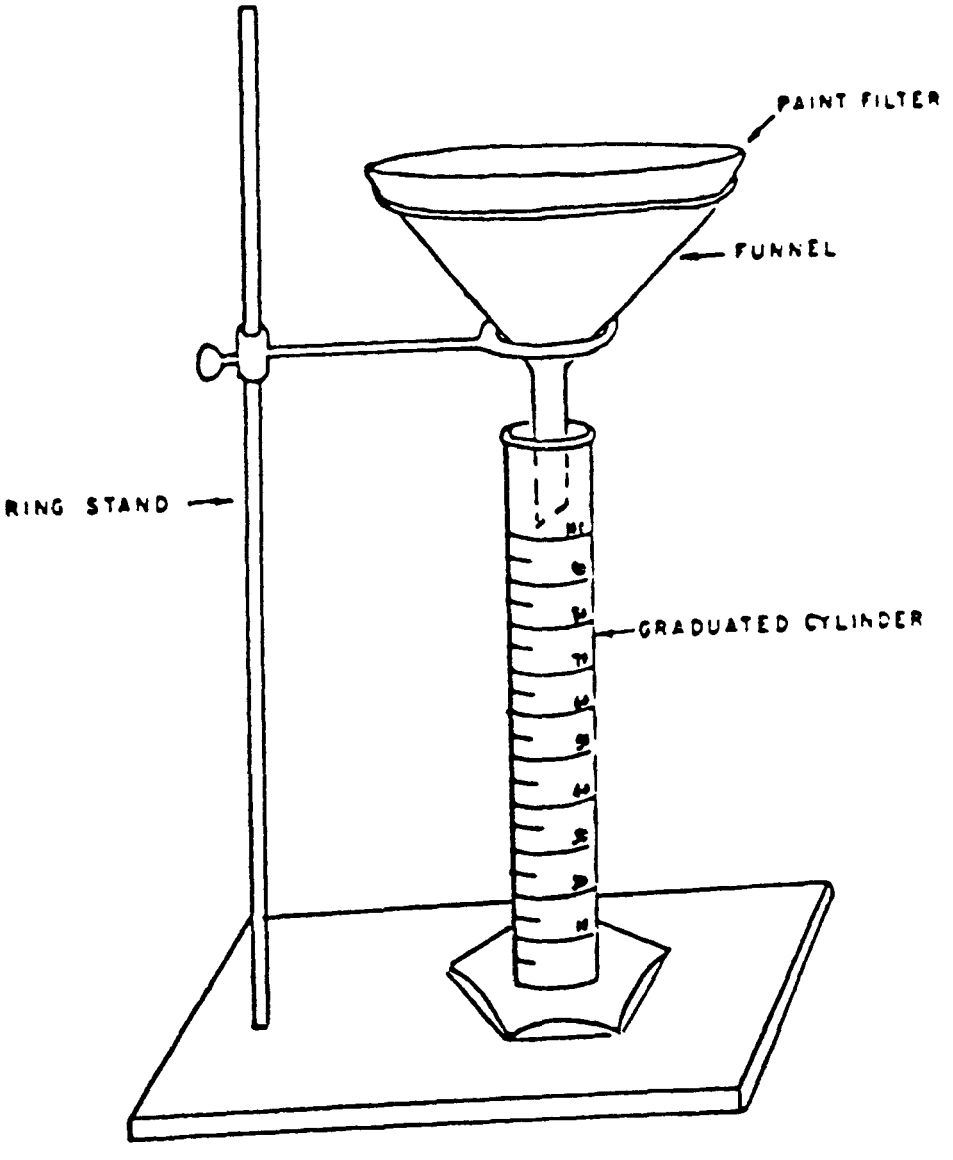
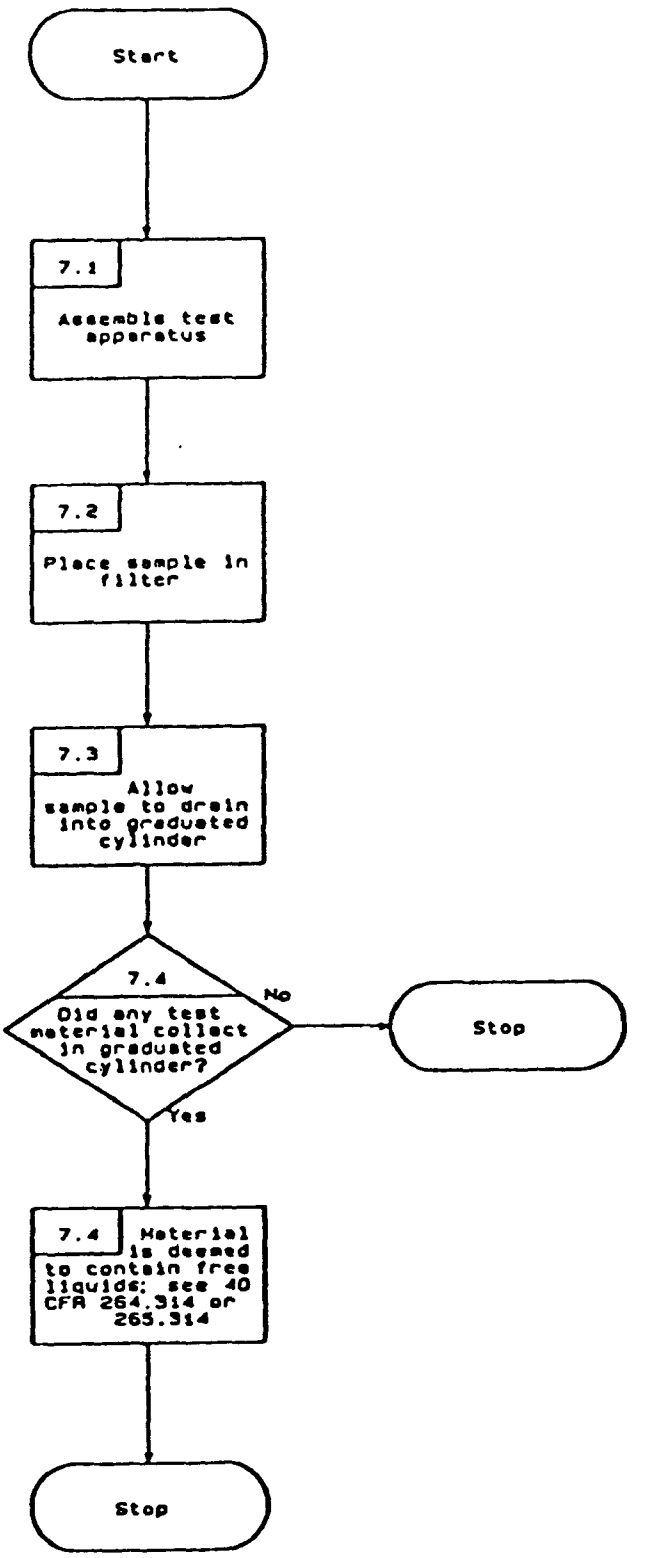


Figure 1. Paint filter test apparatus.

METHOD 9095

PAINT FILTER LIQUIDS TEST



Revision 0

Date September 1986

APPENDIX F

1988 LIQUID RELEASE TEST (LRT) COLLABORATIVE STUDY RESULTS

F.1 Results from Seven Laboratories Testing ADM Devices

F.2 Results from Three Laboratories Testing Other Devices

F.1 Results From Seven Laboratories Testing ADM Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: CWM
LRT DEVICE: ADM

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS	
					T	B
FD/H2O	Z115	200.0	215.4	110	NR	NR
FD/H2O	Z127	200.0	215.4	110	NR	NR
FD/H2O	Z138	200.0	215.4	110	NR	NR
FD/H2O	Z225	200.0	215.4	110	NR	NR
FD/H2O	Z233	200.0	215.4	110	NR	NR
FD/H2O	Z247	200.0	215.4	110	NR	NR
FD/H2O	Z38	200.0	264.8	135	NR	R
FD/H2O	Z44	200.0	264.8	135	NR	R
FD/H2O	Z50	200.0	264.8	135	NR	NR
FD/H2O	Z210	200.0	264.8	135	NR	R
FD/H2O	Z213	200.0	264.8	135	NR	NR
FD/H2O	Z223	200.0	264.8	135	NR	R
FD/H2O	Z163	200.0	270.8	138	NR	R
FD/H2O	Z169	200.0	270.8	138	NR	NR
FD/H2O	Z176	200.0	270.8	138	NR	NR
FD/H2O	Z77	200.0	270.8	138	NR	R
FD/H2O	Z83	200.0	270.8	138	NR	NR
FD/H2O	Z76	200.0	270.8	138	R	R
SS/OIL	V223	450.0	89.1	19.8	NR	NR
SS/OIL	V228	450.0	89.1	19.8	NR	NR
SS/OIL	V222	450.0	89.1	19.8	NR	NR
SS/OIL	V218	450.0	89.1	19.8	NR	R
SS/OIL	V221	450.0	89.1	19.8	NR	NR
SS/OIL	V219	450.0	89.1	19.8	NR	NR
SS/OIL	V3	450.0	126.0	28	R	R
SS/OIL	V287	450.0	126.0	28	R	R
SS/OIL	V288	450.0	126.0	28	R	R
SS/OIL	V237	450.0	126.0	28	R	R
SS/OIL	V286	450.0	126.0	28	R	R
SS/OIL	V240	450.0	126.0	28	R	R
SS/OIL	V40	450.0	148.5	33	R	R
SS/OIL	V46	450.0	148.5	33	R	R
SS/OIL	V44	450.0	148.5	33	R	R
SS/OIL	V42	450.0	148.5	33	R	R
SS/OIL	V45	450.0	148.5	33	R	R
SS/OIL	V48	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.1 Results From Seven Laboratories Testing ADM Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: GSX
LRT DEVICE: ADM

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS T	B
FD/H2O	Z135	200.0	215.4	110	R	NR
FD/H2O	Z129	200.0	215.4	110	NR	NR
FD/H2O	Z246	200.0	215.4	110	NR	NR
FD/H2O	Z130	200.0	215.4	110	NR	NR
FD/H2O	Z229	200.0	215.4	110	NR	NR
FD/H2O	Z140	200.0	215.4	110	R	NR
FD/H2O	Z202	200.0	264.8	135	NR	NR
FD/H2O	Z212	200.0	264.8	135	NR	NR
FD/H2O	Z45	200.0	264.8	135	NR	R
FD/H2O	Z48	200.0	264.8	135	NR	NR
FD/H2O	Z46	200.0	264.8	135	R	NR
FD/H2O	Z41	200.0	264.8	135	NR	NR
FD/H2O	Z152	200.0	270.8	138	NR	R
FD/H2O	Z146	200.0	270.8	138	NR	R
FD/H2O	Z157	200.0	270.8	138	NR	NR
FD/H2O	Z145	200.0	270.8	138	NR	R
FD/H2O	Z180	200.0	270.8	138	NR	R
FD/H2O	Z174	200.0	270.8	138	NR	R
SS/OIL	V69	450.0	89.1	19.8	R	NR
SS/OIL	V254	450.0	89.1	19.8	R	NR
SS/OIL	V261	450.0	89.1	19.8	NR	NR
SS/OIL	V255	450.0	89.1	19.8	NR	NR
SS/OIL	V238	450.0	89.1	19.8	NR	NR
SS/OIL	V236	450.0	89.1	19.8	NR	NR
SS/OIL	V104	450.0	126.0	28	R	NR
SS/OIL	V215	450.0	126.0	28	R	NR
SS/OIL	V209	450.0	126.0	28	NR	NR
SS/OIL	V242	450.0	126.0	28	R	R
SS/OIL	V106	450.0	126.0	28	R	R
SS/OIL	V97	450.0	126.0	28	R	NR
SS/OIL	V22	450.0	148.5	33	R	R
SS/OIL	V24	450.0	148.5	33	R	R
SS/OIL	V267	450.0	148.5	33	R	R
SS/OIL	V19	450.0	148.5	33	R	R
SS/OIL	V274	450.0	148.5	33	R	R
SS/OIL	V270	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.1 Results From Seven Laboratories Testing ADM Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: IEA
LRT DEVICE: ADM

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS T	B
FD/H2O	Z133	200.0	215.4	110	NR	NR
FD/H2O	Z122	200.0	215.4	110	NR	NR
FD/H2O	Z110	200.0	215.4	110	NR	NR
FD/H2O	Z116	200.0	215.4	110	NR	NR
FD/H2O	Z224	200.0	215.4	110	NR	NR
FD/H2O	Z120	200.0	215.4	110	NR	NR
FD/H2O	Z131	200.0	264.8	135	NR	NR
FD/H2O	Z124	200.0	264.8	135	NR	R
FD/H2O	Z119	200.0	264.8	135	NR	NR
FD/H2O	Z183	200.0	264.8	135	NR	R
FD/H2O	Z193	200.0	264.8	135	NR	R
FD/H2O	Z197	200.0	264.8	135	NR	R
FD/H2O	U288	200.0	270.8	138	NR	NR
FD/H2O	U289	200.0	270.8	138	NR	R
FD/H2O	U285	200.0	270.8	138	NR	NR
FD/H2O	U286	200.0	270.8	138	NR	R
FD/H2O	U278	200.0	270.8	138	NR	NR
FD/H2O	U282	200.0	270.8	138	NR	R
SS/OIL	V28	450.0	89.1	19.8	NR	NR
SS/OIL	V37	450.0	89.1	19.8	NR	NR
SS/OIL	V256	450.0	89.1	19.8	NR	NR
SS/OIL	V63	450.0	89.1	19.8	NR	NR
SS/OIL	V39	450.0	89.1	19.8	NR	NR
SS/OIL	V67	450.0	89.1	19.8	NR	NR
SS/OIL	V169	450.0	126.0	28	R	NR
SS/OIL	V175	450.0	126.0	28	R	R
SS/OIL	V60	450.0	126.0	28	R	NR
SS/OIL	V216	450.0	126.0	28	R	NR
SS/OIL	V179	450.0	126.0	28	R	NR
SS/OIL	V170	450.0	126.0	28	R	NR
SS/OIL	V248	450.0	148.5	33	R	R
SS/OIL	V25	450.0	148.5	33	R	R
SS/OIL	V244	450.0	148.5	33	R	R
SS/OIL	V247	450.0	148.5	33	R	R
SS/OIL	V271	450.0	148.5	33	R	R
SS/OIL	V245	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.1 Results From Seven Laboratories Testing ADM Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: MICROBAC
LRT DEVICE: ADM

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS T	B
FD/H2O	Z121	200.0	215.4	110	R	NR
FD/H2O	Z144	200.0	215.4	110	NR	NR
FD/H2O	Z243	200.0	215.4	110	NR	NR
FD/H2O	Z237	200.0	215.4	110	NR	NR
FD/H2O	Z123	200.0	215.4	110	NR	NR
FD/H2O	Z125	200.0	215.4	110	NR	NR
FD/H2O	Z209	200.0	264.8	135	NR	R
FD/H2O	Z204	200.0	264.8	135	NR	NR
FD/H2O	Z40	200.0	264.8	135	R	R
FD/H2O	Z42	200.0	264.8	135	NR	NR
FD/H2O	Z47	200.0	264.8	135	NR	NR
FD/H2O	Z198	200.0	264.8	135	NR	NR
FD/H2O	Z154	200.0	270.8	138	NR	R
FD/H2O	Z148	200.0	270.8	138	NR	NR
FD/H2O	Z159	200.0	270.8	138	NR	R
FD/H2O	Z153	200.0	270.8	138	NR	NR
FD/H2O	Z147	200.0	270.8	138	NR	NR
FD/H2O	Z158	200.0	270.8	138	NR	R
SS/OIL	V62	450.0	89.1	19.8	NR	NR
SS/OIL	V29	450.0	89.1	19.8	NR	NR
SS/OIL	V72	450.0	89.1	19.8	NR	NR
SS/OIL	V262	450.0	89.1	19.8	NR	NR
SS/OIL	V253	450.0	89.1	19.8	NR	NR
SS/OIL	V258	450.0	89.1	19.8	NR	NR
SS/OIL	V284	450.0	126.0	28	NR	R
SS/OIL	V108	450.0	126.0	28	R	R
SS/OIL	V282	450.0	126.0	28	R	R
SS/OIL	V207	450.0	126.0	28	NR	R
SS/OIL	V213	450.0	126.0	28	NR	NR
SS/OIL	V241	450.0	126.0	28	R	R
SS/OIL	V100	450.0	148.5	33	R	R
SS/OIL	V250	450.0	148.5	33	R	R
SS/OIL	V99	450.0	148.5	33	R	R
SS/OIL	V243	450.0	148.5	33	R	R
SS/OIL	V25	450.0	148.5	33	R	R
SS/OIL	V27	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.1 Results From Seven Laboratories Testing ADM Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: WILSON
LRT DEVICE: ADM

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS T	B
FD/H2O	Z128	200.0	215.4	110	NR	NR
FD/H2O	Z111	200.0	215.4	110	NR	NR
FD/H2O	Z238	200.0	215.4	110	R	R
FD/H2O	Z118	200.0	215.4	110	NR	NR
FD/H2O	Z230	200.0	215.4	110	NR	NR
FD/H2O	Z231	200.0	215.4	110	NR	NR
FD/H2O	Z203	200.0	264.8	135	NR	NR
FD/H2O	Z208	200.0	264.8	135	NR	R
FD/H2O	Z200	200.0	264.8	135	NR	R
FD/H2O	Z196	200.0	264.8	135	NR	NR
FD/H2O	Z51	200.0	264.8	135	NR	NR
FD/H2O	Z54	200.0	264.8	135	NR	R
FD/H2O	Z156	200.0	270.8	138	NR	NR
FD/H2O	Z150	200.0	270.8	138	NR	NR
FD/H2O	Z161	200.0	270.8	138	NR	R
FD/H2O	Z155	200.0	270.8	138	NR	NR
FD/H2O	Z149	200.0	270.8	138	NR	NR
FD/H2O	Z160	200.0	270.8	138	NR	NR
SS/OIL	V34	450.0	89.1	19.8	NR	NR
SS/OIL	V264	450.0	89.1	19.8	NR	NR
SS/OIL	V35	450.0	89.1	19.8	NR	NR
SS/OIL	V66	450.0	89.1	19.8	NR	NR
SS/OIL	V259	450.0	89.1	19.8	NR	NR
SS/OIL	V64	450.0	89.1	19.8	NR	NR
SS/OIL	V214	450.0	126.0	28	R	NR
SS/OIL	V211	450.0	126.0	28	R	NR
SS/OIL	V281	450.0	126.0	28	R	NR
SS/OIL	V103	450.0	126.0	28	R	NR
SS/OIL	V206	450.0	126.0	28	R	NR
SS/OIL	V210	450.0	126.0	28	R	NR
SS/OIL	V17	450.0	148.5	33	R	R
SS/OIL	V21	450.0	148.5	33	R	R
SS/OIL	V23	450.0	148.5	33	R	R
SS/OIL	V275	450.0	148.5	33	R	R
SS/OIL	V265	450.0	148.5	33	R	R
SS/OIL	V272	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.1 Results From Seven Laboratories Testing ADM Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: WRI
LRT DEVICE: ADM

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS	
					T	B
FD/H2O	Z219	200.0	215.4	110	NR	NR
FD/H2O	Z218	200.0	215.4	110	NR	NR
FD/H2O	Z227	200.0	215.4	110	NR	NR
FD/H2O	Z234	200.0	215.4	110	NR	NR
FD/H2O	Z248	200.0	215.4	110	NR	NR
FD/H2O	Z242	200.0	215.4	110	NR	NR
FD/H2O	Z244	200.0	264.8	135	NR	R
FD/H2O	Z105	200.0	264.8	135	NR	NR
FD/H2O	Z102	200.0	264.8	135	NR	NR
FD/H2O	Z108	200.0	264.8	135	NR	NR
FD/H2O	Z101	200.0	264.8	135	NR	R
FD/H2O	Z194	200.0	264.8	135	NR	R
FD/H2O	Z85	200.0	270.8	138	NR	R
FD/H2O	Z86	200.0	270.8	138	NR	R
FD/H2O	Z79	200.0	270.8	138	NR	R
FD/H2O	Z73	200.0	270.8	138	NR	NR
FD/H2O	Z88	200.0	270.8	138	NR	R
FD/H2O	Z186	200.0	270.8	138	NR	R
SS/OIL	V75	450.0	89.1	19.8	R	NR
SS/OIL	V81	450.0	89.1	19.8	NR	NR
SS/OIL	V74	450.0	89.1	19.8	NR	NR
SS/OIL	V79	450.0	89.1	19.8	NR	NR
SS/OIL	V77	450.0	89.1	19.8	NR	NR
SS/OIL	V83	450.0	89.1	19.8	NR	NR
SS/OIL	V59	450.0	126.0	28	R	NR
SS/OIL	V172	450.0	126.0	28	R	NR
SS/OIL	V58	450.0	126.0	28	R	NR
SS/OIL	V178	450.0	126.0	28	R	NR
SS/OIL	V174	450.0	126.0	28	R	NR
SS/OIL	V171	450.0	126.0	28	R	NR
SS/OIL	V85	450.0	148.5	33	R	R
SS/OIL	V86	450.0	148.5	33	R	R
SS/OIL	V88	450.0	148.5	33	R	R
SS/OIL	V92	450.0	148.5	33	R	R
SS/OIL	V93	450.0	148.5	33	R	R
SS/OIL	V95	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.1 Results From Seven Laboratories Testing ADM Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: RTI
LRT DEVICE: ADM

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS T	B
FD/H2O	Z136	200.0	215.4	110	NR	NR
FD/H2O	Z250	200.0	215.4	110	NR	NR
FD/H2O	Z249	200.0	215.4	110	NR	NR
FD/H2O	Z236	200.0	215.4	110	NR	NR
FD/H2O	Z235	200.0	215.4	110	NR	NR
FD/H2O	Z232	200.0	215.4	110	NR	NR
FD/H2O	Z109	200.0	264.8	135	NR	R
FD/H2O	Z259	200.0	264.8	135	NR	R
FD/H2O	Z188	200.0	264.8	135	NR	R
FD/H2O	Z43	200.0	264.8	135	NR	R
FD/H2O	Z192	200.0	264.8	135	NR	R
FD/H2O	Z53	200.0	264.8	135	NR	R
FD/H2O	U268	200.0	270.8	138	NR	R
FD/H2O	U279	200.0	270.8	138	NR	R
FD/H2O	U274	200.0	270.8	138	NR	R
FD/H2O	U275	200.0	270.8	138	NR	R
FD/H2O	U265	200.0	270.8	138	NR	R
FD/H2O	U270	200.0	270.8	138	NR	R
SS/OIL	V38	450.0	89.1	19.8	NR	NR
SS/OIL	V33	450.0	89.1	19.8	NR	NR
SS/OIL	V36	450.0	89.1	19.8	NR	NR
SS/OIL	V30	450.0	89.1	19.8	NR	NR
SS/OIL	V32	450.0	89.1	19.8	NR	NR
SS/OIL	V31	450.0	89.1	19.8	NR	NR
SS/OIL	V173	450.0	126.0	28.0	R	NR
SS/OIL	V					
SS/OIL	V					
SS/OIL	V					
SS/OIL	V					
SS/OIL	V					
SS/OIL	V251	450.0	148.5	33.0	R	R
SS/OIL	V269	450.0	148.5	33.0	R	R
SS/OIL	V18	450.0	148.5	33.0	R	R
SS/OIL	V249	450.0	148.5	33.0	R	R
SS/OIL	V252	450.0	148.5	33.0	R	R
SS/OIL	V246	450.0	148.5	33.0	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.2 Results From Three Laboratories Testing Other Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: CWM
LRT DEVICE: THEIR OWN DEVICE

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS T	B
FD/H2O	Z142	200.0	215.4	110	NR	NR
FD/H2O	Z143	200.0	215.4	110	NR	NR
FD/H2O	Z226	200.0	215.4	110	NR	NR
FD/H2O	Z228	200.0	215.4	110	NR	NR
FD/H2O	Z239	200.0	215.4	110	NR	NR
FD/H2O	Z240	200.0	215.4	110	NR	NR
FD/H2O	Z217	200.0	264.8	135	NR	NR
FD/H2O	Z221	200.0	264.8	135	NR	NR
FD/H2O	Z199	200.0	264.8	135	NR	NR
FD/H2O	Z95	200.0	264.8	135	NR	NR
FD/H2O	Z96	200.0	264.8	135	NR	NR
FD/H2O	Z107	200.0	264.8	135	NR	NR
FD/H2O	Z166	200.0	270.8	138	R	R
FD/H2O	Z177	200.0	270.8	138	R	R
FD/H2O	Z171	200.0	270.8	138	R	R
FD/H2O	Z165	200.0	270.8	138	R	R
FD/H2O	Z175	200.0	270.8	138	R	R
FD/H2O	Z164	200.0	270.8	138	R	R
SS/OIL	V220	450.0	89.1	19.8	R	R
SS/OIL	V224	450.0	89.1	19.8	R	R
SS/OIL	V217	450.0	89.1	19.8		
SS/OIL	V226	450.0	89.1	19.8	R	R
SS/OIL	V227	450.0	89.1	19.8	NR	NR
SS/OIL	V225	450.0	89.1	19.8	NR	NR
SS/OIL	V43	450.0	148.5	33	NR	R
SS/OIL	V41	450.0	148.5	33	R	R
SS/OIL	V47	450.0	148.5	33	R	R
SS/OIL	V49	450.0	148.5	33	R	R
SS/OIL	V50	450.0	148.5	33	R	R
SS/OIL	V51	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.2 Results From Three Laboratories Testing Other Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: WRI
LRT DEVICE: MILLIPORE

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL (%)	LIQUID RELEASE RESULTS T	B
FD/H2O	Z134	200.0	215.4	110	NR	NR
FD/H2O	Z141	200.0	215.4	110	NR	NR
FD/H2O	Z132	200.0	215.4	110	NR	NR
FD/H2O	Z137	200.0	215.4	110	NR	NR
FD/H2O	Z223	200.0	215.4	110	NR	NR
FD/H2O	Z126	200.0	215.4	110	NR	NR
FD/H2O	Z205	200.0	264.8	135	NR	R
FD/H2O	Z89	200.0	264.8	135	NR	R
FD/H2O	Z78	200.0	264.8	135	NR	R
FD/H2O	Z84	200.0	264.8	135	NR	R
FD/H2O	Z37	200.0	264.8	135	NR	NR
FD/H2O	Z190	200.0	264.8	135	NR	R
FD/H2O	Z82	200.0	270.8	138	NR	R
FD/H2O	Z75	200.0	270.8	138	NR	R
FD/H2O	Z81	200.0	270.8	138	NR	R
FD/H2O	Z87	200.0	270.8	138	NR	R
FD/H2O	Z74	200.0	270.8	138	NR	R
FD/H2O	Z80	200.0	270.8	138	NR	R
SS/OIL	V73	450.0	89.1	19.8	NR	NR
SS/OIL	V78	450.0	89.1	19.8	NR	NR
SS/OIL	V76	450.0	89.1	19.8	NR	NR
SS/OIL	V82	450.0	89.1	19.8	NR	NR
SS/OIL	V84	450.0	89.1	19.8	NR	NR
SS/OIL	V80	450.0	89.1	19.8	NR	NR
SS/OIL	V71	450.0	148.5	33	R	R
SS/OIL	V87	450.0	148.5	33	R	R
SS/OIL	V90	450.0	148.5	33	R	R
SS/OIL	V91	450.0	148.5	33	R	R
SS/OIL	V94	450.0	148.5	33	R	R
SS/OIL	V96	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP

F.2 Results From Three Laboratories Testing Other Devices

LIQUID RELEASE TEST RESULTS
1988 COLLABORATIVE STUDY

LAB: ANALYTICAL TESTING & CONSULTING
LRT DEVICE: THEIR OWN DEVICE

SORBENT/LIQUID	SAMPLE NUMBER	DRY SAMPLE WEIGHT	WEIGHT LIQUID ADDED (grams)	LIQUID LOADING LEVEL	LIQUID RELEASE RESULTS	
FD/H2O	Z139	200.0	215.4	110	NR	NR
FD/H2O	Z117	200.0	215.4	110	NR	NR
FD/H2O	Z241	200.0	215.4	110	NR	NR
FD/H2O	Z245	200.0	215.4	110	NR	NR
FD/H2O	Z112	200.0	215.4	110	NR	NR
FD/H2O	Z114	200.0	215.4	110	NR	NR
FD/H2O	Z220	200.0	264.8	135	R	R
FD/H2O	Z112	200.0	264.8	135	R	R
FD/H2O	Z216	200.0	264.8	135	LEAKED	
FD/H2O	Z52	200.0	264.8	135	CRACKED	
FD/H2O	Z185	200.0	264.8	135	R	R
FD/H2O	Z191	200.0	264.8	135	NR	NR
FD/H2O	Z103	200.0	215.4	110	NR	NR
FD/H2O	Z93	200.0	215.4	110	NR	NR
FD/H2O	Z97	200.0	215.4	110	NR	NR
FD/H2O	Z90	200.0	215.4	110	NR	NR
FD/H2O	Z91	200.0	215.4	110	NR	NR
FD/H2O	Z104	200.0	215.4	110	NR	NR
FD/H2O	Z98	200.0	215.4	135	NR	NR
FD/H2O	Z92	200.0	264.8	135	NR	NR
FD/H2O	Z106	200.0	264.8	135	NR	R
FD/H2O	Z99	200.0	264.8	135	NR	R
FD/H2O	Z100	200.0	264.8	135	NR	R
FD/H2O	Z94	200.0	264.8	135	NR	R
FD/H2O	Z168	200.0	270.8	138	R	R
FD/H2O	Z179	200.0	270.8	138	NR	R
FD/H2O	Z173	200.0	270.8	138	R	R
FD/H2O	Z167	200.0	270.8	138	NR	R
FD/H2O	Z178	200.0	270.8	138	NR	R
FD/H2O	Z172	200.0	270.8	138	R	R
SS/OIL	V263	450.0	89.1	19.8	NR	NR
SS/OIL	V257	450.0	89.1	19.8	NR	NR
SS/OIL	V260	450.0	89.1	19.8	NR	NR
SS/OIL	V68	450.0	89.1	19.8	NR	NR
SS/OIL	V61	450.0	89.1	19.8	NR	NR
SS/OIL	V65	450.0	89.1	19.8	NR	NR
SS/OIL	V268	450.0	89.1	33	R	R
SS/OIL	V266	450.0	148.5	33	R	R
SS/OIL	V276	450.0	148.5	33	R	R
SS/OIL	V16	450.0	148.5	33	R	R
SS/OIL	V20	450.0	148.5	33	R	R
SS/OIL	V273	450.0	148.5	33	R	R

* FD: FLOOR DRY
H20: WATER
SS: SAFE-STEP