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Innovative Technology Verification Report

Field Analytical Screening Program: PCP Method

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Executive Summary

This innovative technology evaluation report (ITER) presents information on the demonstration of the U. s . Environmental Protection Agency (EPA) Region 7 Superftmd Field Analytical Screening Program (FASP) method for determining pentachlorophenol (PCP) contamination in soil and water. This method was demonstrated in Morrisville, North Carolina, in August 1993. The demonstration was conducted by PRC Environmental Management, Inc. (PRC), under contract to the EPA Environmental Monitoring Systems Laboratory-Las Vegas (EMSL-LV). The demonstration was developed under the Monitoring and Measurement Technologies Program (MMTP) of the Superfund innovative Technologies Evaluation (SITE) Program.

The FASP PCP Method was demonstrated in conjunction with the demonstrations of four other field screening technologies: (1) the HNU-Hanby Test Kit developed by HNU Systems, (2) the Penta RISc Test Systems developed by EnSys Incorporated, (3) the EnviroGard PCP Test Kit developed by Millipore Corporation, and (4) the Penta RaPID Assays developed by Ohmicron Corporation. The results of these demonstrations are presented in separate reports similar to this one.

The first objective of this demonstration was to evaluate the FASP PCP Method for accuracy and precision in detecting high and low levels of PCP by comparing its results to those from a confirmatory laboratory that used standard EPA-approved analytical methods. These EPA-approved methods are used to provide legally defensible analytical data to monitor or enforce environmental regulations. Because these EPAapproved methods are used by the regulatory community, this demonstration also used these methods. While these methods may include inherent tendencies that may bias data or may include procedures that developers disagree with, they are the best methods for providing legally defensible data as defined by the regulatory community. To remove as much of these inherent tendencies as possible, PRC used post hoc residual analysis to remove data outliers. The FASP PCP technology was also qualitatively evaluated for the length of time required for analysis, ease of use, portability, and operating cost.

The second objective of the demonstration was to evaluate the specificity of the technology. The specificity was evaluated by examining the effects of naturally-occurring matrix effects, site-specific matrix effects, and chemical cross-reactivity. Information on the technology's specificity was gathered from literature, the analysis of demonstration samples, and through a specificity study.

The site selected for demonstrating the technology was the former Koppers Company (Koppers) site in Morrisville, North Carolina. This site was selected because a National Risk Management Research Laboratory (NRMRL) SITE demonstration was planned for this site, allowing a conjunction of logistical and support efforts between NRMRL and EMSL-LV. Another reason for selecting the former Koppers site was that historical documentation indicated that PCP contamination ranged from none detected to 3,200 parts per million @pm) in soil and from none detected to 1,490 parts per billion (ppb) in groundwater. The PCP carrier used at this site was a mixture of isopropyl ether and butane. Soil and water samples also were collected from the Winona Post site in Winona, Missouri. Samples from the Winona Post site were shipped to the former Koppers site for inclusion as demonstration samples. Winona Post samples were included to broaden the scope of the demonstration by introducing a different sample matrix and a different PCP carrier, diesel fuel.

The FASP PCP Method is designed to provide quick, accurate results for PCP concentrations in soil and water samples. This method also can detect and quantify other phenols. PCP concentrations are reported in either parts

per billion or parts per million for soils and parts per billion for waters. This method was developed by the EPA Superfund Branch for use at Superfund sites.

The FASP PCP Method uses a gas chromatograph (GC) equipped with a megabore capillary column and either a flame ionization detector (FID) or an electron capture detector (ECD) to identify and quantify PCP. Gas chromatography is an EPA-approved method for determining PCP concentrations in soil, water, and waste samples. The FASP PCP Method is an abbreviated, modified version of these methods.

Soil and water samples require extraction before GC analysis. To remove interferences caused by petroleum hydrocarbons, including PCP carriers such as mineral spirits, kerosene, diesel fuel, and fuel oil, an acid-base partition cleanup step. In this step, the method includes petroleum hydrocarbons are removed from the reagent water, while potassium phenates remain in the reagent water. Sample extracts are injected onto a GC, separated with a DB-5 megabore capillary column, and the PCP is identified and quantified using an FID. The sample extracts are then compared to standards to determine whether PCP is present in the sample and, if so, at what concentration. The FASP PCP Method will only provide high parts per billion detection levels of PCP in water when an FID is used. To achieve a lower detection limit, the sample extracts are reanalyzed using an ECD.

The FASP PCP method is field-portable only in a mobile laboratory. It should be used indoors in a temperature-controlled environment. Reagents required for soil and water sample analysis require refrigeration and the GC and extraction fume hood require electricity. The FASP PCP Method requires experienced GC operators to produce reliable results. The average number of demonstration samples extracted, concentrated, and analyzed in one lo-hour day during the demonstration was 14. The detection limit reported by this method for soil samples is 0.8 ppm and 1 .O ppb for water samples.

The FASP PCP Method can be affected by naturally occurring matrix effects such as humic acids, pH, or salinity. Other matrix effects include PCP carriers such as petroleum hydrocarbons or solvents. Due to the nature of chromatography, this method is not greatly influenced by chemical cross-reactivity. The FASP PCP Method was found to be most affected by the diesel fuel used as a PCP carrier solvent. A specificity study performed during the demonstration showed that diesel fuel would provide a positive response when present at a concentration of 10 ppm. Petroleum hydrocarbon interferences were found to affect results for the Winona Post samples.

PRC used linear regression and inferential statistics to compare the technology's data to that from the confirmatory laboratory. When the data sets were evaluated as a whole, a less accurate performance on the Winona Post samples was observed due to the diesel fuel PCP carrier solvent. Both the entire data set and the Winona Post data alone showed that the method produced Level 1 data. However, the method performed well when the samples from the former Koppers site were examined separately. Within this data grouping, the technology produced Level 2 data, which was statistically similar to that from the confirmatory laboratory or that could be mathematically corrected to become similar to that from the confirmatory laboratory. Generally, if 10 to 20 percent of the soil samples (not contaminated with petroleum) are sent to a confirmatory laboratory, then the results from the other 80 to 90 percent can be corrected. This could result in a significant savings in analytical costs. The water analysis portion of this demonstration produced similar results. The FASP PCP Method produced Level 2 data for the samples collected from the former Koppers site. The regression analysis and the Wilcoxon Signed Ranks Test indicated that the technology's data is strongly correlated to the confirmatory data, but is statistically different. This means that the FASP PCP Method's data must be mathematically corrected by having 10 to 20 percent of its samples slated for confirmatory analysis. The Winona Post data showed that even when using sample cleanup, the method produces Level 1 data that is both dissimilar to the confirmatory data and that cannot be mathematically corrected.

PRC evaluated field duplicate samples to determine the technology's precision relative to the confirmatory laboratory's. PRC found no significant difference between the precision of the FASP PCP Method and that of the confirmatory laboratory's for soil and water analysis. In addition, no PCP carrier effect on precision was observed.