Performance Verification Testing of Monitoring and Measurement Technologies for Dioxin and Dioxin-like Compounds in Soil and Sediment

Superfund Innovative Technology Evaluation Program

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Overview of Dioxin Demonstration

- Five technologies analyzed 209 soil, sediment, and extract samples for dioxin and dioxin-like compounds.
- An identical sample set was analyzed by standard laboratory methods (1613B and 1668A).
- Study design included a mixture of performance evaluation and environmental samples.
- Technologies operated by developers (experts); observers monitored adherence to the demonstration plan.
- The field demonstration was held on April 26 through May 5, 2004 in Saginaw, MI, in collaboration with the Michigan Department of Environmental Quality (MDEQ) and the U.S. Fish and Wildlife Service (FWS).
- During the period of the demonstration, most of the test samples were analyzed in the field. Any remaining samples were analyzed in the developer's laboratory so that a complete data set was obtained.
- All technologies report toxicity equivalents (TEQ) and not individual congener concentrations.

Purpose of the Demonstration

- Evaluate the performance characteristics of each technology relative to standard methods
- Challenge the technologies with a variety of samples with distinguishing characteristics, interferents, and matrix compositions
- Assess the cost and time to use these technologies, relative to standard methods
- Understand the ease of use and operational characteristics of each technology

Collection Sites for the Environmental Samples

Primary Study Objectives

- **Accuracy:** Comparison to performance evaluation samples (certified or spiked concentrations)
- **Precision:** Reproducibility on replicate samples
- **Comparability:** Relative to the reference laboratory results
- **Method Detection Limits:** Results for three low-level samples (seven replicates each)
- **False Positive/False Negative Results:** Relative to reference laboratory detects/non-detects
- **Matrix Effects:** Results compared to determine performance in multiple ways (e.g., environmental sites; soils vs. sediments; samples with high concentrations of other contaminants such as PCBs or PAHs)
- **Technology Costs:** Cost to operate the field technology; includes comparison to laboratory-based methods

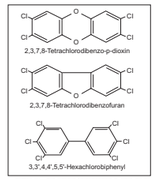

Figure 1. Structures of a representative dioxin, furan, and polychlorinated biphenyl

Secondary Study Objectives

- Skill and training required to operate the technology
- Health and safety aspects associated with the operation of the technology
- Portability
- Sample throughput

Participating Developers/Technologies

Developer	Technology Name	Technology Type
Abraxis LLC	Coplanar PCB ELISA Kit	Immunoassay
CAPE Technologies	DF1 Dioxin/Furan Immunoassay Kit	Immunoassay
Hybrizyme Corporation	AhR-PCR™ Kit	Ah Receptor and polymerase chain reaction
Wako Pure Chemical Industries, Ltd.	Dioxin ELISA Kit	Immunoassay
Xenobiotic Detection Systems	CALUX®	Ah Receptor

Reference Laboratory - AXYS Analytical Services (Sidney, B.C.)
EPA Method 1613B (7 dioxins/10 furans) and Method 1668A (12 dioxin-like PCBs)

Reporting and Comparison of Results

Developer	Reporting Units	Developer Stated LOD	Comparison to HRMS
Abraxis LLC	Total TEQ_{PCB}	6.25	Total TEQ_{PCB} PCB 126 TEQ
CAPE Technologies	Total TEQ_{DF}	1	Total TEQ_{DF}
Hybrizyme Corporation	AhR units	10	Total TEQ_{DF} Total TEQ
Wako Pure Chemical Industries. Ltd.	2,3,7,8-TCDD EQ pg/g	20	Total TEQ_{DF} 2,3,7,8-TCDD TEQ
Xenobiotic Detection Systems	Total TEQ_{DF} Total TEQ_{PCB}	0.3	Total TEQ_{DF} Total TEQ_{PCB}

Why are Alternatives to Laboratory-based Methods Needed?

- High resolution mass spectrometric (HRMS) methods are highly accurate and sensitive, but costly and time-consuming
- Cost per sample range: $500 - $1,600, depending upon data reporting, level of QA/QC, and sample complexity
- More affordable and quicker analytical techniques will **not** replace HRMS, but will provide the user with data that will benefit many environmental characterization or sampling projects

Outcomes

- Data generated from each technology will be statistically evaluated and compared to results from a standard reference laboratory
- Performance of each technology will not be compared to each other
- Performance evaluation will be summarized and published in a publicly available report as well as at (www.epa.gov/ORD/SITE)

Conclusions

- Program is intended to accelerate the acceptance and use of innovative technologies, with the ultimate goal of improved environmental protection.
- Demonstration of dioxin monitoring and measurement technologies will provide valuable performance and cost information for developers and users.
- Publication of the final reports is scheduled for March 2005.

Acknowledgement

Technical support for this project was provided by the Battelle Columbus Laboratory. The Michigan Department of Environmental Quality and U.S. EPA Region 5 were the hosts for the demonstration.