AHURA

First**Defender**™

Application Note – Rapid Identification of Hazardous Waste

THE FIRST TOOL OF THE FIRST RESPONDER

Disposing of chemical waste safely and properly is of growing concern to communities around the globe. With increasingly complex industrial processes new materials are being developed that need proper disposal. Waste treatment facilities need to identify the products that they are receiving and remediation firms need to understand the contents of illegally dumped drums.

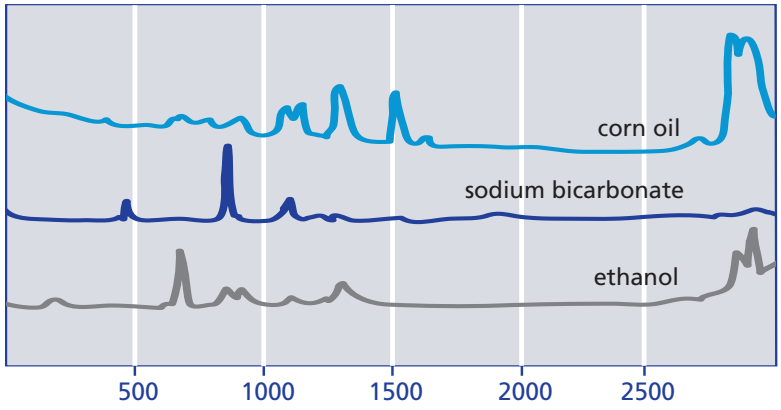
Ahura's ***First*** **Defender** is the ideal instrument for this job. It is rugged and decon-able. It uses Raman spectroscopy to identify materials without contacting them, even through glass and plastic. It can identify up to 5 concurrent substances, increasing the effective library to more than a billion possible combinations. This application note will demonstrate how the ***First*** **Defender** is used to safely and rapidly sample the entire contents of a barrel.

When a laser beam is focused on a sample, inelastic Raman scattering is produced due to the photon-molecule interaction between the material and the incident laser light. The frequencies and intensities of the Raman scattered photons relate to the conformation and electronic states of the probed molecule. Thus, the Raman spectrum of a material can be used as a unique chemical signature of the material *Figure 1.*

The ***First*** **Defender** is the only light-weight and rugged handheld instrument for in-the-field identification of unknown solids and liquids. It sets a new standard for accuracy, applicability, durability, ruggedness, and usability over the demanding environmental requirements of the real world. It is capable of rapidly identifying the chemical composition of a material in less than 30 seconds. During the operation, the Raman spectrum of the sample is collected first and then is matched against the stored Raman spectrum library of over one thousand chemicals. Spectral libraries can be added in minutes by the user for additional compounds of interest. The system is able to analyze samples though various transparent glass and plastic containers and thus completely avoid sample contamination and minimize potential personnel exposure to toxic chemicals. The immediate identification of the material enables rapid waste material grouping, treatment, storage, and disposal. It drastically reduces the time and cost for waste analysis, storage, transportation, and decontamination.

Hazardous waste analysis often involves collecting and analyzing solid or liquid samples from various containment vessels [1],[2],[3]. Composite liquid waste samplers (COLIWASA), open tube (Thief) samplers, and Bacon bomb samplers are commonly used for liquid contained in drums and tanks. Scoops, trowels, waster pile samplers, and triers are used for solid waste sampling. Onsite preliminary assessment usually is done by visual inspection. The waste is inspected and separated based on physical status (liquid or solid) or color of the sediment. Further tests are then often done offsite or in a nearby field/mobile laboratory to determine such things as water reactivity, peroxide identification, cyanide identification, sulfide identification, and halogen identification. Robust and handheld analytical techniques are needed in the field to supplement laboratory testing and provide a method for rapid triage of hazardous waste.

Figure 1: **The Raman spectra of ethanol, sodium bicarbonate, and corn oil.**



INNOVATIVE HAND-HELD SOLUTIONS FOR HOMELAND SECURITY AND PUBLIC SAFETY

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In this article, we illustrate the rapid chemical identification of samples contained in a composite liquid waste sampler (COLIWASA). The COLIWASA is widely used to collect non-homogenous samples from tanks, drums, and other large containers or vessels. They are designed to preserve the "stratification" of these samples as shown in *Figure 2.* COLIWASAs are generally available in a variety of materials: such as glass, Teflon, HDPE, and PVC. The material is selected for the application and the chemical resistance required. The COLIWASA studied in this article was made from PVC (Lab Safety Supply, item # 53533). PVC offers excellent chemical resistance while providing excellent optical throughput.

The ***First*** **Defender** unit is used to scan each of the stratified layers to chemically identify the sample in each layer which was sectioned by the COLIWASA. The nose cone of the ***First*** **Defender** was removed from the unit to allow measurements through the thick walled plastic COLIWASA. The unit was positioned at angle to the COLIWASA to allow penetration of the wall of the COLIWASA while keeping the focused laser spot away from the valve control rod in the center. The laser light passes through the PVC plastic wall of the COLIWASA and the Raman light scattered by the material in the tube is then collected back into the instrument where it is dispersed by the spectrometer and detected. The on-board chemometric algorithms subsequently identify the chemical composition of the material based on matching the Raman spectra acquired, shown in *Figure 1* with those stored in the instruments material library. In this example, the tube contains sodium bicarbonate (bottom white layer), corn oil (middle yellow layer), and ethanol (top transparent layer). Each of these chemicals is positively identified in about one minute time. While the spectrum and analysis results are displayed immediately, the digital data are stored for further analysis and record. The tube was never opened and the sample was not perturbed during testing. Further analysis of the sample is thus readily possible using standard laboratory testing procedures if justified following the initial triage by the ***First*** **Defender**.

The ***First*** **Defender** can be used similarly for other sampling procedures. For open tube sampler, the Raman spectrum can be acquired through the sample bottle. For solids, the sample collected using scoop, trowel, sampling trier, grain sampler, waste pile sampler, and Veihmeyer sampler can be analyzed open-air or in a translucent bottle or tube.

The versatility of the ***First*** **Defender** through its accurate non-contact line-of-sight measurements make it ideal for onsite hazardous waste identification in real world environmental conditions.

Figure 2: **COLIWASAs are used to sample stratified wastes in a container.**

Figure 3: **Each layer of the stratified waste contained in a COLIWASA is rapidly identified by Ahura's *First* Defender unit.**

REFERENCES:

1. *U. S. Army Corps of Engineers, Department of the Army, 1 February 2001; Engineering and Design: Requirements for the Preparation of Sampling and Analysis Plans.*
2. *U. S. Environmental Protection Agency, 16 November 1994; Tank Sampling SOP# 2010*
3. *U. S. Environmental Protection Agency, Office of Solid Waste, Test Methods for the Evaluation of Solid Waste, Physical/ Chemical Methods.*

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