

Acoustic Inspection Devices: Detecting the Undetectable

Unique Characteristics of Acoustic Technologies allow them to:

- **DETECT** anomalies, contraband and hidden compartments in liquid-filled containers and solid form commodities,
- **SORT/CLASSIFY** liquid types into groups of like and unlike,
- **DISCRIMINATE** liquids and bulk solids as a function of temperature,
- **DETERMINE** the fill-level in liquid-filled containers, and
- **RAPID** and easy-to-interpret measurement results.

Emerging homeland security threats and increasingly sophisticated adversaries have heightened the need for effective technologies that can classify, sort and discriminate the contents of small and large containers, from liquids to bulk solids, within a few seconds. Current technologies are limited by prolonged laboratory analysis, high false positive readings and extensive training required for operators.



But an advanced technology developed at Pacific Northwest National Laboratory addresses those challenges using acoustic measurement capabilities. PNNL's Acoustic Inspection Devices leverage decades of expertise in applied ultrasonic physics and a variety of diverse technical disciplines.

These systems can accurately inspect, classify, sort and discriminate the contents of sealed containers, while doing so in a way that is non-intrusive and non-destructive to the materials being studied. PNNL's acoustic technology platforms have evolved over the past 15 years to become a tool used by government agencies domestically and internationally in detecting and interdicting smuggled and dangerous materials at borders.

The latest version of this system is called the Container Screening Device (CSD). It is a portable benchtop system used for real-time, sealed-container inspection and content classification. The CSD was designed to inspect and classify/discriminate the liquid contents in smaller containers such as shampoo bottles, soda cans, glass containers and other containers as large as a 55-gallon drum from those pre-characterized acoustic signatures in the active database.

The Science Behind the Solution

The patented CSD (US Pat #: 7,246,522) works by launching ultrasonic pulses into a container and analyzing the return echoes. Then, those echoes are used to accurately measure the temperature-corrected acoustic velocity (speed of sound) and relative acoustic attenuation for characterization and classification purposes. These echoes are also used to determine if there are hidden compartments, contraband or other anomalous items hidden inside a container or bulk solid item. Additional acoustic properties may also be obtained and are currently under study at the Laboratory.



This method is based upon years of fundamental scientific research in correlating two acoustic



Key Areas of Acoustic Technology Applicability:

- Law enforcement and contraband detection
- Customs and border security
- Fuel compliance operations
- Government and military applications
- Transportation compliance
- Quality control
- Inventory management
- Public events security, and
- First-response operations.

physical property measurements – as a fingerprint for classification/ discrimination of liquids and solids – using nondestructive and non-invasive means for acquiring information through a solid material or liquid-filled sealed container.

PNNL has developed, tested and employed an automated technology platform for generating these profiles for use with the CSD. The measurement process provides results in three to four seconds for a single container.

Flexible Platform for Multiple Uses

The CSD technology can be readily engineered into many different forms depending on the specific application or environment. The capabilities and functionality that the CSD provides reach far beyond the security and law-enforcement realms, and can provide distinct advantages to industry as well.

For example, the CSD could be employed in inventory receiving and management to ensure acceptable levels of liquid product are being delivered to warehouses and to verify shipping manifests immediately upon receipt without opening containers.



Years of Advancement

The initial application of acoustic sciences was for use in the early 1990s. This technology was deployed for use in chemical weapons detection and treaty verification. Over the past 15 years, PNNL scientists evolved the technology to become more portable, more effective and more accurate – shrinking the platform from the size of a laptop to that of a cordless drill.

This technology was subsequently tailored and licensed to a software development company through a technology-transfer commercialization process, resulting in the patented Product Acoustic Signature System™ (PASS).

The CSD has been further enhanced beyond its commercial predecessor to include advances in sensor excitation, signal processing, capabilities and functionality. These improvements have resulted in better measurement sensitivity, accuracy and reliability.

A Class All Its Own

For its purpose, ease of use, functionality and capabilities, the CSD has secured a significant niche in detection and screening of hazardous and dangerous liquid materials. The measurement data are precise and reliable, and its database design is flexible and allows for the addition of new signatures to the database without the need to upgrade.

Most importantly, the CSD technology allows determinations to be made without opening a sealed container, which would reduce environmental, safety and human health risks associated with more commonly intrusive inspections.

About Pacific Northwest National Laboratory

Pacific Northwest National Laboratory is a Department of Energy (DOE) Office of Science research facility that delivers breakthroughs in the areas of environment, energy, health, fundamental science and national security. Battelle, based in Columbus, Ohio, has operated PNNL since 1965. A unique agreement with the DOE enables us to work with industrial clients and leverage DOE's vast resources. We have a long history of working with industry. PNNL is located in Richland, Washington, and in 2005 had an annual business volume of more than \$725 million and more than 4,200 employees. Addition web resources are at: <http://www.pnl.gov>

General inquiries:

Steve Martin
Manager, Integrated Systems Solutions
Pacific Northwest National Laboratory
P.O. Box 999 / K8-21
Richland, WA 99352
(509) 372-4086
Steve.Martin@pnl.gov

Technical inquiries:

Aaron Diaz
Scientist, Applied Physics and Materials Characterization Sciences
Pacific Northwest National Laboratory
P.O. Box 999 / K5-26
Richland, WA 99352
(509) 375-2606
Aaron.Diaz@pnl.gov