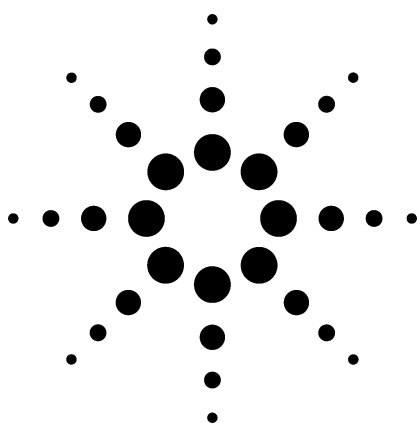


The Agilent Mobile Laboratory for Chemical and Biological Defense

Technical Overview

A guide to facilities, instrumentation, and capabilities of the Agilent Mobile Laboratory



Abstract

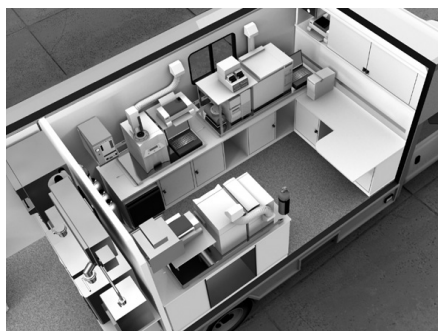
The Agilent Mobile Laboratory takes the full power of the analytical laboratory to the incident site to detect chemical warfare agents, biological warfare agents, and toxic industrial compounds. This description of the laboratory's facilities, instrumentation, and capabilities is a supplement to the referenced video presentation [1].

Introduction

The Agilent Mobile Laboratory is an integrated analytical platform equipped with state-of-the-art measurement systems. It is configured to detect and confirm the presence of chemical and biological agents in air, water, soil, or food supplies. This mobile platform allows for near real-time, onsite measurements, resulting in more rapid access to information and therefore enabling faster decision-making. The unit also offers the benefit of avoiding the transportation of hazardous materials over long distances, thus reducing the potential for accidental exposure or contamination.

The key to the success of the mobile lab is its safety-oriented design. Some of the safety features of the unit include: a pressurized air system, Class III glovebox, biological safety cabinet, and two airlocks [2].

As a mobile vehicle with a fully functional lab, the Agilent Mobile Laboratory offers near real-time results that, in an emergency, may be critical in saving lives and protecting public health.



Interior view of the Agilent Mobile Laboratory.

Overview of the Mobile Platform

The mobile platform is based on a specially-modified, Ford heavy-duty truck, equipped with a V-10 gasoline engine, automatic transmission, power steering, 4-wheel power disc brakes, and heavy-duty springs. The platform includes both side and rear-entry doors with dual-pane windows. The rear door leads into the sample preparation compartment, and the side door leads into the analysis compartment.



Located in each corner underneath the platform, four electro-hydraulically controlled jacks stabilize the entire platform. The control compartment for the stabilizer jacks is conveniently located at the side of the platform. Adjustments can be made to each jack, if necessary.

The mobile platform is equipped with two generators, one on each side. These are controlled directly from the outside or from a control panel located inside the laboratory compartment.

All components of the mobile platform are clearly labeled to facilitate efficient laboratory setup and use.

Additionally, there are filtered fresh air intakes and exhaust vents with HEPA filtration units for each of the two laboratory compartments. This filtration system ensures that the air coming into and being exhausted out of each of the lab compartments is free of contaminants. This air handling system also ensures that the sample analysis compartment is kept at positive pressure relative to the sample preparation compartment.

Constructed to Meet Biological Safety Level-3 (BSL-3) Requirements

Effective biological containment and the associated BSL rating requires a combination of specially designed and constructed facilities, the availability and appropriate use of personal protection equipment, and documented compliance with good laboratory practices (GLP) and techniques. Although there are currently no formal requirements for a mobile BSL-3 facility, the Agilent Mobile Laboratory was designed and fabricated for BSL-3 containment based upon extrapolation of the requirements for a fixed BSL-3 laboratory. Some of these design features include:

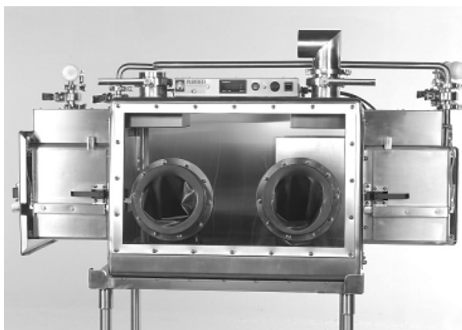
- Walls, ceilings, and counters are designed to be easy to clean and decontaminate
- Walls, ceilings and floors are sealed to prevent air leaks
- Laboratory access is restricted; windows are sealed shut
- Laboratory air is directly exhausted to the outside through HEPA filters
- A biological safety cabinet and Class III glovebox is available for handling of infectious agents

As the mobile laboratory has already been designed and constructed for BSL-3 containment, true BSL-3 certification would further require comprehensive documentation of operating procedures, as well as equipping the laboratory with the required personal protection equipment.

The Sample Preparation Compartment

This compartment is a fully functional sample preparation facility that can safely handle potentially hazardous chemical and biological materials and convert them into forms appropriate for analysis. It was designed in conjunction with the US Army and Agilent channel partners, who are leaders in their fields, to ensure the safety of the analysts.

The compartment is maintained at negative pressure versus the sample analysis compartment. Raw samples are introduced directly into the Class III glovebox from the outside through an airlock. The glovebox and HEPA filtration system are self-contained, allowing the laboratory technicians to safely receive and handle unknown materials of a possible toxic or harmful nature.



View of a Class III glovebox incorporated into the Agilent Mobile Laboratory. Photo courtesy of Purified-Germfree, Ormond Beach, FL.

This compartment is also equipped with a Class II biological safety cabinet. This allows for sample preparation to be done in a clean, safe, laminar air-flow environment. The biological safety cabinet can accommodate an optional incubator.

Prepared samples are passed into the analysis compartment through another airlock.

The Sample Analysis Compartment

This compartment is a fully functional, well-equipped laboratory that, in its standard configuration, contains three Agilent analytical measurement systems. These instruments are used for the detection and confirmation of toxic industrial compounds (TIC), chemical warfare agents (CWA), and biological warfare agents (BWA). An optional fourth instrument, such as a liquid chromatograph/mass spectrometer (LC/MS), inductively coupled plasma-mass spectrometer (ICP/MS) or BioAnalyzer, can be added to further expand the analytical capabilities of this laboratory. Each instrument in this compartment has its own independently filtered exhaust vent.

The laboratory can be equipped with an optional heated transfer line for remote air sampling. The heated transfer line is installed directly to an intake pumping system, which is attached to analytical instrumentation located inside the sample analysis compartment. The other end of the heated transfer line can be inserted into buildings, vehicles, shipping containers, or any other area where direct air sampling is needed.

The sample analysis compartment is designed with ample storage space, wide door cabinets, several storage drawers, and shelves. The work areas are well lit with ceiling lights. There is refrigerated storage for samples or chemicals. Additional roof mounted air conditioners are included in both compartments of the mobile platform.

The CWA Detection and Confirmation System

Developed in cooperation with the U.S. Army, this system is configured to analyze samples from air, liquid, solid, and soil for CWAs. This technology is used extensively in support of the Army's weapons defense, monitoring and demilitarizing programs. The system has been demonstrated effective in the detection and confirmation of nerve agents such as sarin gas and VX, as well as for blister agents, such as mustard gas.



The CWA detection and confirmation system.

The CWA detection and confirmation system is comprised of an Agilent Technologies 6890N Gas Chromatograph, 5973N Mass Spectrometer, and a Dynatherm Model IACEM 980 Thermal Desorber. The Agilent Technologies 6890N Gas Chromatograph comes equipped with a split/splitless capillary injector, automatic flow control, and a dual-wavelength Flame Photometric Detector (FPD).

The Agilent 5973N Mass Spectrometer detector (MSD) provides a mass range from 1.6-800 atomic mass units. The mass axis stability of the detector is 0.15 atomic mass units over a 12-hour period. The superior stability specification of this detector permits its use in this mobile platform. In addition, the 5973N comes equipped with an electron-impact ionization source and turbo-molecular pump. This instrument configuration allows testing of air (in a direct or remotely collected mode), liquid, soil, and solid samples. Typical airborne sample test sensitivities are on the order of nanograms per cubic meter for the nerve agents GA, GB, GD, GF, VX, and for the blister agents HD and HN_x. An example of a chromatogram showing detected CWAs is given in Figure 1.

A review of the latest techniques and methods for the analysis of CWAs is now available. See Reference 3.

Femtogram levels of toxic industrial chemicals such as acrolein, methyl isocyanate, parathion, phosgene, and toluene 2,4-diisocyanate are attainable with this and the second combined 6850/5973 GC/MS installed in this compartment.

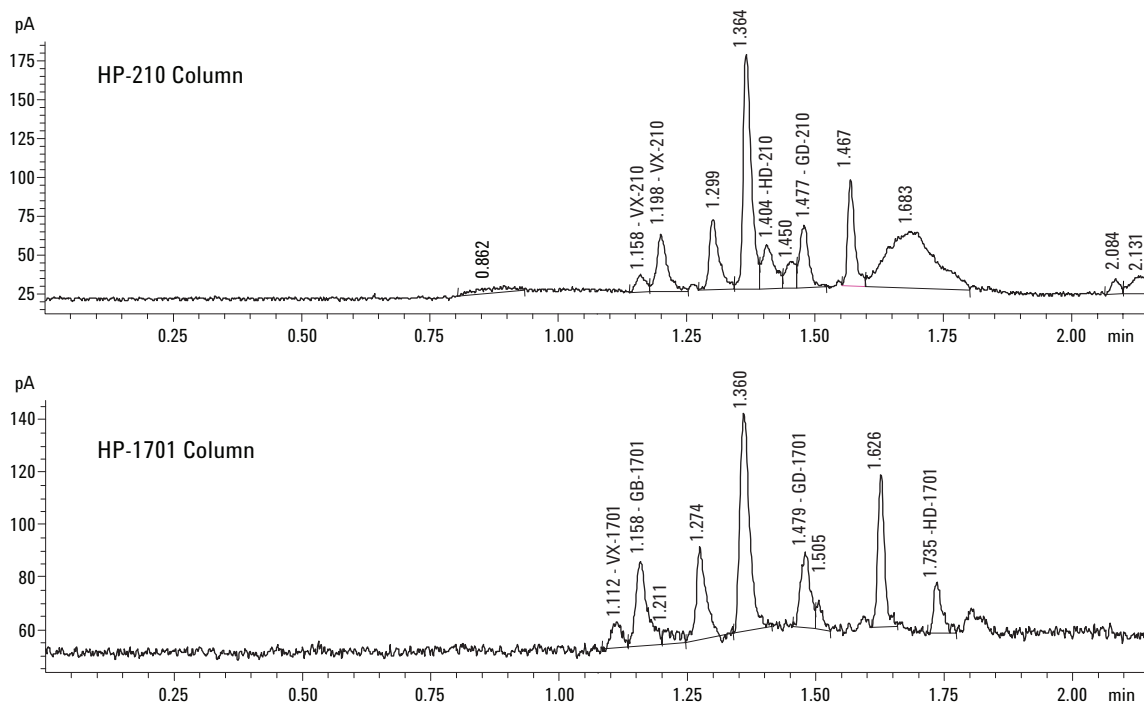


Figure 1. A chromatogram of selected CWA.

TIC Detection and Confirmation System

One of the most challenging aspects of planning the analytical response to the release of a TIC is the vast number of potential target chemicals. The U.S. EPA Chemical Emergency Preparedness and Prevention Office maintains a list of 356 “extremely hazardous substances.” Although no single measurement technique would be able to analyze for all of the compounds listed, Agilent Technologies offers several different complementary techniques which could be used in tandem to provide near-comprehensive analytical capability.

The TIC Detection and Confirmation System: which consists of an Agilent 6850 or 6890 Gas Chromatograph and a 5973N MSD, offers the widest applicability for the analysis of hazardous chemicals. This system is configured for the detection and confirmation of unknown chemical compounds in samples from water and food supplies. It is also suitable for detection of nonweapon chemical spills, explosives, and environmental contaminants. The system includes a sophisticated

spectral search and deconvolution algorithm along with the National Institute of Standards and Technology (NIST) chemical library, which contains over 143,000 compounds to assist with the identification of uncharacterized releases [2].

Agilent Technologies also offers LC/MS and ICP/MS for the analysis of nonvolatile or thermally labile materials and metal-containing compounds, respectively.



The TIC detection and confirmation system.

The BWA Detection and Confirmation System

Agilent offers two complimentary technologies to detect and confirm biological agents. The first, which is based upon an organism's unique chemical profile, was developed by MIDI, an Agilent Technologies Channel Partner, in collaboration with the US Army Medical Research Institute for Infectious Diseases (USAMRIID). A complementary approach is to make DNA-based measurements following polymerase chain reaction (PCR) amplification using the unique lab-on-a-chip technology incorporated into the Agilent 2100 BioAnalyzer.

The MIDI Sherlock system is comprised of an Agilent Technologies 6850 Gas Chromatograph equipped with an Agilent 7683 and the MIDI Sherlock Microbial Identification System (MIS) software. The Sherlock libraries consist of more than 25,000 analyses of strains obtained from experts and from culture collections. The cultures were

collected worldwide to avoid potential geographic bias. The Sherlock MIS system, which is completely automated from sample introduction to final reporting, has been used to positively identify the presence of anthrax, plague, brucellosis, glanders, melioidosis and tularmia bacteria and its strains. An example of a flame ionization detector (FID) cellular fatty-acid chromatogram indicating the presence of *Bacillus anthracis* is shown in Figure 2.



The BWA detection and confirmation system.

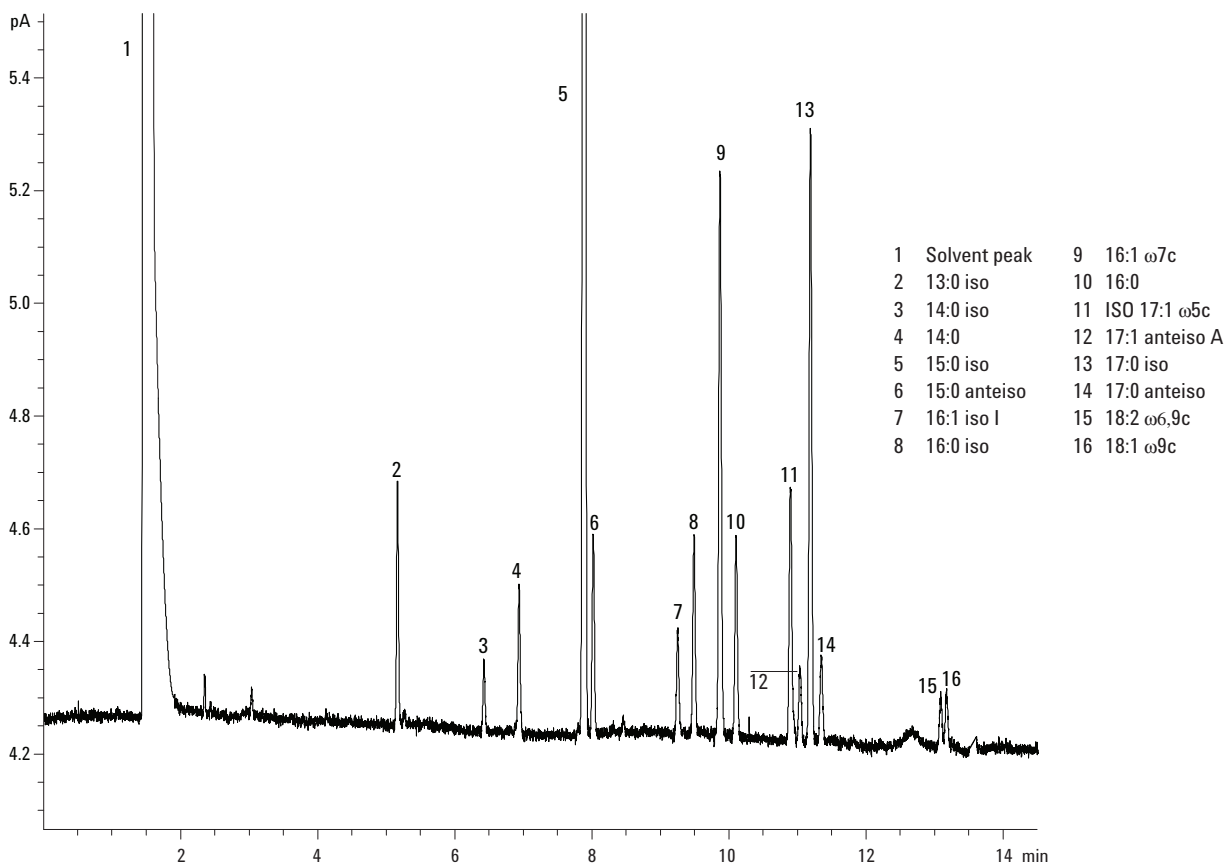


Figure 2. An example of a methylated cellular fatty-acid chromatogram for *Bacillus anthracis*.

For laboratories requiring DNA-based measurements as a complement to analyses based upon an organism's unique fatty acid profile, Agilent Technologies offers the Agilent 2100 BioAnalyzer. The 2100 BioAnalyzer uses microfluidic lab-on-a-chip technology to provide qualitative and quantitative information on DNA, RNA, and proteins in biological samples.



Agilent 2100 Bioanalyzer and DNA LabChip.

Biological pathogens can be detected and identified using the 2100 BioAnalyzer after specific DNA sequences from the chosen pathogens are amplified by PCR using selective primers.

The primary advantage of the 2100 BioAnalyzer relative to other PCR based detection methods, such as real time PCR, is that the 2100 BioAnalyzer allows researchers to develop multiplex detection assays that can simultaneously interrogate collected samples for many different types of bacteria and viruses. A multiplex assay enables a laboratory to run a single test (rather than six or more different tests), resulting in a dramatic reduction of operating costs and a more efficient workflow.

Support Systems

The CWA, BWA, and TIC detection and confirmation systems require gases for operation.

One section of the analysis compartment conveniently and securely stores up to three cylinders of compressed gas. The Packard Model 9200 Hydrogen Generator is included for applications requiring hydrogen. Its use ensures that only the necessary amount of hydrogen is present in this compartment. This also eliminates any restrictions associated with the transport of hydrogen cylinders.

Numerous power outlets are distributed through both compartments. The entire mobile platform is wired for a local area network (LAN), with connection points available in all areas. The electrical systems, including generator control and fuel consumption monitoring, are administered from an interior control panel. The panel is clearly labeled and easy to use. Warning signals are generated for critical functions.

All the instruments in the mobile laboratory are controlled by Agilent Technologies ChemStation software. The software is loaded in docked portable PCs. Dedicated printers are used for report printing, and PCs and printers are interfaced via an industry standard LAN.

Data files and methods are provided for validating the calculations and algorithms that are used by the software in producing results. Certificate of validation, password protection, runtime logbook, and revision log history are included to provide GLP compliance. Operational qualification, performance validation, and instrument qualification services are available worldwide.

The mobile platform was designed to use industry standard components so that all systems can be readily serviced throughout the world regardless of location. All of the Agilent instruments and software were designed and manufactured under a quality system that has been registered to ISO 9001.

Conclusion

For the past 30 years, Agilent's Life Sciences and Chemical Analysis Group has established a core competency in detecting, identifying, and confirming the presence of a wide array of chemical and biological compounds. With a singular focus on technological innovation and world class engineering to provide robust, reliable, high performance products and solutions, Agilent Technologies has distinguished itself by fulfilling the measurement needs of its customers be it environmental contaminants, microbial pathogens, food adulterants, or CWAs and BWAs.

In addition to providing reliable measurement products for use in the fixed laboratory environment, Agilent Technologies, in cooperation with the military and a select group of channel partners, has deployed transportable systems since the early 1990s. The singular advantage of a mobile laboratory is that it brings the full power of the traditional analytical laboratory to an incident site, enabling more rapid access to information that may be critical in making faster decisions in order to help save lives and protect the public health.

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Printed in the USA
April 30, 2003
5988-9152EN