NUSTL
NATIONAL URBAN SECURITY TECHNOLOGY LABORATORY

SAVER TechNote

October 2019

# FIELD PORTABLE GAS CHROMATOGRAPH/ MASS SPECTROMETER INSTRUMENTS

## AEL Number: 07CD-01-DPGC

*Portable gas chromatograph/mass spectrometers (GC/MS) are used by first responders during field operations to chemically analyze substances suspected to be narcotics, explosives, toxic industrial chemicals/materials, chemical warfare agents and other hazardous substances. Instruments range from 30–40 pounds and typically cost over $100,000. These instruments are capable of measuring gases, volatile and semi-volatile liquids, and the vapors from some solids. GC/MS can detect trace amounts of chemical compounds at the parts-per-billion to parts-per-trillion level or the microgram to nanogram level for certain solids. GC/MS is a powerful analytical technique because it enables separation of components of complex samples via a chromatographic column before sequential analysis of the separated components using a mass analyzer.*

## Overview

GC/MS is considered the gold standard of chemical identification for mixtures. At a high level, a sample is introduced onto the inlet of a GC column in a volatized form. The volatized mixture is separated into distinct chemical compounds as it passes through the column. Sample compounds that are more volatile (boil at a lower temperature) pass through the column more quickly than less volatile compounds. As individual compounds elute off the GC column, they enter the mass spectrometer and are ionized, creating charged fragment ions that travel through the mass analyzer and to create a unique spectral "fingerprint" for each sample compound.

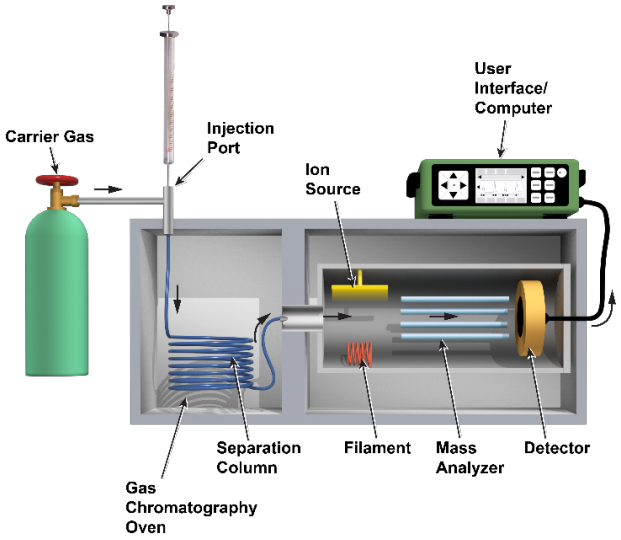


**Figure 1. Schematic of a Gas Chromatography/ Mass Spectrometry System**

*Figure courtesy of Pacific Northwest National Laboratory*

The GC/MS instrument records the retention times and relative amounts of each compound passing through column and their mass spectra. This data is plotted for the end user to view and the instrument's software matches this data against a library of known compounds to identify each compound in the sample.

The U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) established the System Assessment and Validation for Emergency Responders (SAVER) program to assist emergency responders making procurement decisions.

DHS S&T's National Urban Security Technology Laboratory (NUSTL) manages the SAVER program and conducts objective assessments and validations on commercial equipment and systems. These results, along with other relevant equipment information, is provided to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List.

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

For more information on this and other technologies, contact NUSTL by e-mail at NUSTL@hq.dhs.gov or visit the SAVER website: www.dhs.gov/science-and-technology/SAVER.

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## GC/MS Equipment Selection Considerations

Purchasing GC/MS systems should be carefully considered, as they represent a considerable investment of resource and time. Leadership must determine what gap this unique capability fills in the chemical detection and identification space. First responders should carefully consider their concept of operations and needs related to portability, start-up time, ease-of-use, sample collection, preparation, analysis options, data interpretation, maintenance and storage.

## Examples of Field Portable GC/MS Instruments

Currently there are four commercial field-portable GC/MS systems that can be operated from battery or ac power line. The mass spectrometer typically acquires data from ~40 to 300-500 atomic mass units (amu), depending on the manufacturer. Standard analysis times for a GC/MS range from 5-15 minutes, which is method and sample dependent. The Inficon Hapsite and Griffin 510 can be operated in MS-only mode (i.e., survey mode) in which an air sample is directly introduced into the mass spectrometer without GC separation for near real-time chemical analysis. The Perkin Elmer/Smiths Detection system does not have a direct MS analysis interface, as it is primarily built around the scenario that multiple samples will be collected at a site of interest, instead of taking the instrument to the site. End-users may prefer one of these options, depending on their concept of operations.

All of the systems are capable of analyzing gas, liquid, and solid samples, but each GC/MS system performs these analyses in different ways and require special attachments and different degrees of sample preparation. As such, the type of sample and sample preparation required (e.g. dilution or dissolving a solid) needs to be considered for a field scenario, where quick decisions may be needed.

When target chemicals are present at trace levels, a larger sample amount or longer collection/pre-concentration time may be needed. Conversely, if a sample concentration is too high it can saturate the system, which will cause down-time as the system will need to be purged.

**Figure 2. Inficon Hapsite ER**

*Image courtesy of Inficon*


**Figure 3. FLIR Detection Griffin G-510**

*Image courtesy of FLIR*

**Figure 4. Perkin Elmer Torion T-9**

*Image courtesy of Perkin Elmer*

**Figure 5. Smiths Detection GUARDION**

*Image Courtesy of Smiths Detection*