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Forensic Technology Testing & Evaluation Report Form

Project Information

Title: Torion GUARDION[®]-7 Gas Chromatograph Toroidal Ion Trap Mass Spectrometer (GC-TMS)

Evaluation Type: Instrumentation

Stakeholder: SOCOM, Torion Technologies Inc., NFSTC Mobile Lab Project

Start Date: 01/22/09 End Date: 02/10/2009

Serial # Information: Unable to Locate

Manufacturer Information

Manufacturer: Torion Technologies Inc.

Address: 796 East Utah Valley Drive, Suite 200

American Fork, UT 84003

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Stakeholder Information

Contact Person(s): Maj. Aaron K. Cowan, 910-432-2062 (Office), e-mail: Cowana@soc.mil

Evaluation Team

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Evaluation Overview

The National Forensic Science Technology Center (NFSTC) was asked to conduct a brief assessment on the Torion GUARDION-7 Gas Chromatograph Toroidal Ion Trap Mass Spectrometer (GC-TMS) instrument manufactured by Torion Technologies Inc. This twenty-five-pound portable GC-TMS instrument is currently utilized by civilian first responders, environmental monitoring personnel, and military recruits for the rapid identification of unknown gas, solid and liquid chemical substances. The purpose of this performance evaluation was to establish the suitability of this innovative technology for use in the analysis and identification of some forensically relevant substances. The samples used during this assessment were selected to be a small representative subset from each of the following groups: controlled substances and common cutting agents.

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Product Specifications

Photos:



Product Uses:

According to the manufacturer, the Torion GUARDION-7 GC-TMS can be used to identify chemical warfare agents (CWA), explosives, drugs, industrial chemicals, and other organic compounds.

Dimensions:

Approximately 12in x 18in x 7in

Weight:

Approximately 25 Pounds

Storage Conditions:

Not applicable

Operational Conditions:

Not known

Power Requirements:

100-120 volts AC or batteries DC

Cost:

>\$100K

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Sample Data

Figure 1: NFSTC Test Mix (1.0 mg/mL conc.)
in MeOH using 100 µm PDMS SPME

- Methamphetamine
- Benzocaine
- Caffeine
- Cocaine
- Diazepam
- Codeine
- Testosterone Propionate

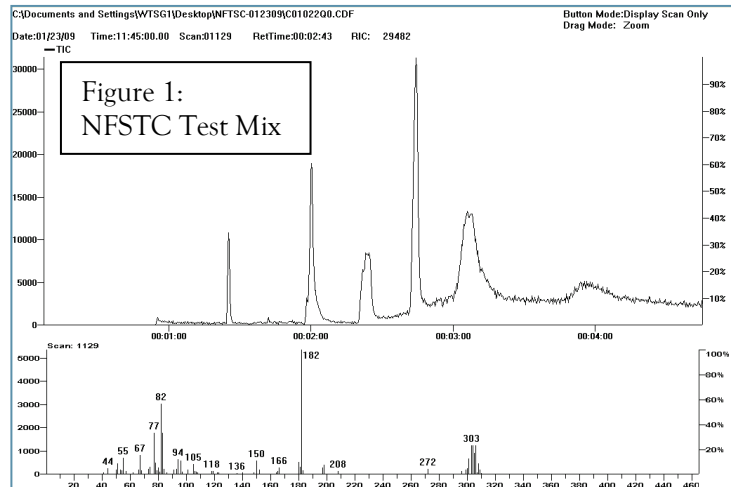
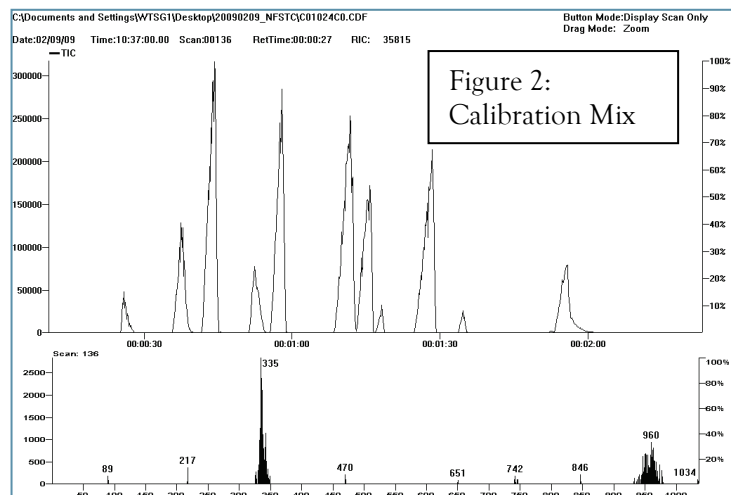


Figure 2: Torion 12-analyte mass calibration mix

- Benzene
- Bromoform
- N-Butylbenzene
- 4-Bromofluorobenzene
- 2-Chloroacetophenone
- 1,2-Dibromoethane
- Diethyl phthalate
- Di-n-butyl sulfide
- Naphthalene
- Nitrobenzene
- Tetrachloroethene
- Toluene



Findings

Strengths:

- The Torion GUARDION-7 GC-TMS is designed to perform in field environments that even most competitors of portable GC/MS instruments would be unable to handle.
- The GC-TMS instrument weighs approximately 25 pounds and is engineered to be housed completely encased within a 12in x 18in x 7in ruggedized pelican case, which protects the unit from shock, vibration, and harsh environmental conditions during transport.
- This unit is truly portable and does not require any external carrier gas supply or external power source, but it is capable if needed.
- Unit power-up to sample injection time was noted to be 3 to 4 minutes. Most other portable GC/MS instruments take at least 25 to 30 minutes to reach operational vacuum and temperature conditions.
- After sample injection occurs, results can be obtained within 2 to 4 minutes, depending on the GC parameters set in the uploaded method.
- This portable device can be used to analyze gas, liquid or solid (dissolved powder) samples containing single or multiple component mixtures.
- The Solid Phase Micro Extraction (SPME) syringe serves as a single mechanism by which both sample preparation (extraction) and sample injection can occur in one efficient, easy-to-use device. Most other portable and laboratory-based GC/MS systems require a somewhat lengthy sample extraction technique – solid phase extraction, liquid-liquid, or other process – followed by the loading of a manual or autosampler syringe for injection.

Areas for Improvement:

- Although the SPME technique is quite straightforward to execute, extreme care must be taken to prevent SPME fiber breakage during extraction and sample injection. It was noted that after extended re-use, the SPME fibers became very fragile and easily broke off. During this evaluation, there were several occasions in which the fiber had broken off while the syringe was in the injection port, which resulted in instrument maintenance and lengthy downtime.
- This instrument does not possess an internal mass calibration standard for the tuning of the mass spectrometer. Currently, the GUARDION-7 utilizes a 12-analyte external mass calibration standard to ensure proper mass assignments, which can be a cumbersome and time-consuming process. Mass calibration on the GUARDION-7 requires the operator to do some data manipulation using the CHROMION-1 software following the injection and analysis of the mass cal standard. Most other portable GC/MS systems utilize an internal perfluorotributylamine (PFTBA) calibrant for tuning and require very little to no operator assistance. Also, the Torion external mass calibration standard must be stored from 4 to 6°C after its initial preparation to maintain stability for future use.
- Most of the analyte peaks displayed in many of the total ion current (TIC) chromatographs appeared to be irregularly shaped and lacked classic peak characteristics.

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- The G7 uses a common CF card for method and data storage. Unfortunately, this device has limited speed and storage capacity, which resulted in several “Buffer Full – cannot save more data” errors. These errors were eliminated when data was transferred to the laptop and then subsequently removed from the CF card.
- Only one instrument method and library can be stored on the GUARDION-7 at a time. This creates a problem if the compounds of interest are of different volatilities. For example, controlled substances require much higher injector temperatures than explosives do; therefore, to ensure optimal conditions for detection and identification of compounds, multiple methods and libraries need to be quickly available to the user for selection and execution.
- The instrument GC method is restricted to only a one-step programmable temperature ramp and hold time. Most gas chromatographs on the market today have the capability of executing multiple programmable temperature ramps and hold times. Having a multi-step programmable GC method would allow for better separation of individual compounds from complex mixtures. During the evaluation, co-elution occurred with the drugs diazepam and codeine, which are usually easily resolved using a multi-step GC programmable method.
- A semi-integrated, powerful, large-storage-capacity tablet PC or mini-laptop should be utilized to eliminate the current GC-TMS internal computer, three-button menu-driven display, and required external laptop. The CHROMION-I software or GC-TMS graphical user interface (GUI) should also be modified in such a way as to provide a quick means to select method and library settings, perform instrument diagnostics, execute easy-to-use real-time mass spectrometer tunes, and perform live data acquisition with immediate review and library search capabilities.

Limitations:

- The Torion GUARDION-7 has a limited mass scan range of 50 to 500 m/z for small organic molecule identification. For some forensic applications, the instrument should be able to reach upper mass ranges of at least 650 m/z.
- High concentrations can easily overload the Toroidal Ion Trap, producing a space charge effect (spectral distortion) that results in values being recorded for mass-to-charge ratios where there are no ions. *This is a limitation common to all ion trap technology.*
- SPME fibers are sold in varying chemical compositions to target specific analytes or compounds for extraction. Therefore, the right type of SPME fiber must be chosen for optimal extraction of the analyte(s) of interest from the complex matrix being sampled.
- Replacement Supelco SPME fibers can range from \$300 to \$400 dollars per package of three.
- The carrier gas cylinders, columns, and other proprietary replacement parts have to be purchased directly from Torion.

The opinions, findings and conclusions or recommendations expressed in this publication/program/exhibition are those of the author(s) and do not necessarily reflect those of the National Institute of Justice.