Form	Deviation Request Form
Title	DRF - Tech Procedure for Drug Chemistry Gas Chromatograph/Mass Spectrometry
Laboratory Location	Lab-wide
Discipline/Section	Drug Chemistry
A. Requested deviation applies to:	Technical Procedure Gas Chromatograph/Mass Spectrometry, Version 18
B. Requested deviation:	See attached.
C. Necessity for the deviation:	1. Merlin Microseals are an alternative to septa that do not contain silicone and therefore have different manufacture's requirements for replacement. These microseals will reduce coring that occurs with septa and allow the instruments to run longer without as much needed maintenance. 2. Update numbering to reference the correct line. 3. All other methods are 40-600 amu. This method was inadvertantly missed during the update and needs updated as well. 4. Add new Coelution method for for cases where current methods are unable to separate certain compounds.
D: Technical Review and Authorization	
Technical Authorization	Yes - Authorized
Technical Authorizer	☐ Galassie, Allison
Duration	1 year / next procedure revision
E: Quality Assurance Authorization	
Acceptable within general QA guidelines and good laboratory practice?	Yes
Significant negative impact to Crime Laboratory Quality System?	No
QA Authorization	Yes - Authorized
QA Authorizer	☐ Schell, Kathleen
Effective Date:	5/31/2024
Attachments	GCMS DRF.docx

Version: 7.0
Created at 4/19/2024 4:46 PM by ☐ Bandy, Lauren
Last modified at 5/24/2024 7:35 AM by ☐ Schell, Kathleen

Close

Technical Procedure Gas Chromatograph/Mass Spectrometry, Version 18

1. Add:

5.2.3.9 **Merlin Microseal**

- Replace annually, if applicable
- Post-maintenance check: Successful system verification or tune (see **5.4**) followed by a successful blank as outlined in **5.3.4.3**.

2. Update **5.1.2.2.2** to be: The difference of the highest and lowest retention times of each component shall satisfy the criteria set forth in **5.3.2.2**

3. In Appendix C: **500LOW Methods** – Update Scan range to be 40-600 amu.

4. In Appendix C add:

Coelution METHODS – These methods are used to improve resolution between structurally similar compounds including but not limited to opiates and synthetic cannabinoids. Method run time is approximately 24 minutes and the sample injection is 1uL. Scan range is 40-600amu. The following are the specific methods used:

Coelution100 – 100 split, 0 minute initial time, 210° C initial temperature, 2° C /minute ramp, 250° C final temperature, 4.00 minute final time, 24.00 minute total run time

Coelution20 – 20 split, 0 minute initial time, 210° C initial temperature, 2° C /minute ramp, 250° C final temperature, 4.00 minute final time, 24.00 minute total run time

Coelution5 – 5 split, 0 minute initial time, 210° C initial temperature, 2° C /minute ramp, 250° C final temperature, 4.00 minute final time, 24.00 minute total run time

CoelutionSL – No split, 0 minute initial time, 210° C initial temperature, 2° C /minute ramp, 250° C final temperature, 4.00 minute final time, 24.00 minute total run time

Technical Procedure for Drug Chemistry Gas Chromatograph/Mass Spectrometry (GC-MS)

1.0 Purpose - This procedure specifies the required elements for the calibration and use of the Agilent 6890 GC (or equivalent) interfaced to the Agilent 5973 Series MSD (or equivalent) for Drug Chemistry analyses.

2.0 Scope - This procedure applies to all GC-MS instruments used for drug chemistry analyses in the Drug Chemistry Sections of the State Crime Laboratory.

3.0 Definitions

- **Performance verification -** The initial confirmation of the reliability of a previously or externally validated method or instrument.
- **Probability Based Matching** – An algorithm designed to compare an unknown mass spectrum against a reference collection of mass spectra for the purpose of identification.
- **Quality control (QC) check -** Periodic confirmation of the reliability of equipment, instrumentation, and/or reagents.
- **Primary reference material –** Any reference material obtained from a source other than the State Crime Laboratory and which has documentation issued by the provider authenticating its chemical composition.
- **Secondary reference material –** Any reference material used in the course of casework that has its chemical composition verified by a primary reference material.
- **Signal-to-noise ratio** – The height of a peak compared to the baseline level immediately before or after the peak.

4.0 Equipment, Materials and Reagents

4.1 Equipment

- Agilent Gas Chromatograph 6890 Series (GC), or equivalent
- Agilent 5973 Series Mass Selective Detector (MSD), or equivalent
- Agilent Automatic Liquid Sampler
- PC with Agilent Analytical MSD Productivity ChemStation Software or equivalent
- Computer Printer or other data output device

4.2 Materials

- Sample vials, inserts, and caps
- 10 µL syringe
- A non-polar capillary column with a (5 %-Phenyl)-methylpolysiloxane stationary phase, such as a DB-5MS or RTx-5MS, or other column as needed
- Septum
- Liners
- Pump Oil
- Gold Seal

4.3 Commercial Reagents

- Methanol
- Hexane

- Chloroform
- Acetonitrile
- Ethyl acetate
- Helium gas, Grade 5.0
- Perfluorotributylamine [PFTBA], neat
- Acetone
- Methylene chloride
- Isopropyl alcohol

***Solvents listed above shall be ACS grade or higher**

4.4 Reference Materials

- Multi-component drug solutions
- Primary or Secondary reference material

5.0 Procedure

5.1 Instrument Performance Verification for New Instrumentation

5.1.1 New GC-MS instruments shall be installed by a manufacturer representative and shown to meet any manufacturer's requirements.

5.1.2 The GC-MS Coordinator or designee shall conduct a performance verification on new GC-MS instruments prior to use for casework.

5.1.2.1 The performance verification shall include successful tunes (see **5.4**) on three separate days.

5.1.2.2 The performance verification shall include the successful analysis of multi-component reference material standard solutions from **5.3.2** run on three separate days.

5.1.2.2.1 The mass spectra of each component shall be successfully compared to reference material as set forth in **5.7.3.**

5.1.2.2.2 The difference of the highest and lowest retention times of each component shall satisfy the criteria set forth in **5.3.2.3.**

5.1.2.3 The data shall be filed in the FA Resource Manager object repository ("Manage Files") by the GC-MS Coordinator or designee to document set up of the new instrument.

5.1.2.4 A new entry for the instrument shall be made in the Resource Manager section of FA prior to use in casework. The new entry will include:

5.1.2.4.1 The manufacturer's serial number.

5.1.2.4.2 The unique section identifier for the new instrument.

5.1.2.4.3 A notation under "Verification Date" to reflect the date the performance verification was completed.

5.1.2.4.4 A "Performance Verification" Action History, stating the instrument has been released for casework.

5.1.3 Each GC-MS instrument shall have a GC-MS Logbook, which shall be maintained electronically. The GC-MS Logbook shall consist of the Activity Log, the Maintenance Log, and Retention Time Log.

5.1.3.1 The Activity Log shall include the date, sample identifier, initials of operator, and comments for each sample analyzed, where applicable. The Activity Log shall also include substances observed in the sample.

5.1.3.2 Any unusual error messages shall be recorded in the Activity Log.

5.1.3.3 If samples are rerun for any reason, a new entry shall be recorded in the Activity Log. (Blank solvent runs do not need to be recorded.)

5.1.3.4 The Activity Log shall contain the appropriate file name(s) for monthly performance check data. Other retention time reference material data may also be stored in the logbook (see **5.3.2.2**).

5.1.3.5 The Maintenance Log shall include the date, description of work performed, length of any column trimmed, parts replaced, and the initials of the person performing or documenting the maintenance.

5.1.3.6 Tunes shall be documented in the Activity Log, as described in **5.4.4** and retained according to **5.4.5**. Tunes performed to check instrument performance during maintenance or troubleshooting need not be retained.

5.1.3.7 All information stored in the GC-MS Logbook shall be archived at least annually into the FA object repository ("Manage Files") associated with each instrument.

5.2 Maintenance

5.2.1 Record maintenance at the time it is performed. The GC-MS Coordinator or designee shall file all maintenance records in the object repository ("Manage Files") for the specific instrument in the Resource Manager section of FA.

5.2.1.1 Document completion of maintenance in the Maintenance Log of the GC-MS Logbook associated with the specific GC-MS instrument.

5.2.1.1.1 If maintenance is performed over the course of several days, only one event encompassing all work done needs to be recorded.

5.2.1.2 The GC-MS Coordinator or designee shall update the GC-MS Logbook when the instrument is placed in or out of service.

5.2.2 Record lengths of column trimmed in the Maintenance Log. A highlighted entry shall also be made in the Activity Log, documenting the column trimming. If the column is

trimmed, the instrument shall be out of service until a monthly performance check is successfully completed (see **5.3.2**).

5.2.2.1 Standards run prior to the column maintenance shall not be used for retention time comparison after the column maintenance.

5.2.3 **Routine maintenance** – The routine maintenance schedule is a suggested minimum guideline. The maintenance schedule will be determined by the GC-MS Coordinator or designee based upon instrument use and performance.

5.2.3.1 Wash Vials

- Rinse and/or fill with the appropriate wash solvent as needed when in use.
- Post-maintenance check: None.

5.2.3.2 Septum

- Replace at least monthly.
- Post-maintenance check: Successful system verification or tune (see **5.4**) followed by a successful blank as outlined in **5.3.4.3**.

5.2.3.3 Syringe

- Inspect monthly for cleanliness and ease of movement. Replace as needed.
- Post-maintenance check, if syringe is removed and/or replaced: Successful blank as outlined in **5.3.4.3,** as well as either a monthly performance check (see **5.3.2**) or a post-maintenance performance check (see **5.3.3)**.

5.2.3.4 Liner

- Replace as needed, or every six months.
- Post-maintenance check: Successful system verification or tune (see **5.4**) followed by a successful blank as outlined in **5.3.4.3,** as well as either a monthly performance check (see **5.3.2**) or a post-maintenance performance check (see **5.3.3)**.

5.2.3.5 Pump Oil

- Change at least twice a year, if applicable.
- Post-maintenance check: Successful tune (see **5.4**) followed by a successful blank as outlined in **5.3.4.3**.

5.2.3.6 Clean Source

- Clean at least annually.
- Post-maintenance check: Successful tune (see **5.4**) followed by a successful blank as outlined in **5.3.4.3,** as well as a monthly performance check (see **5.3.2**).

5.2.3.7 Gold Seal

- Replace annually.
- Post-maintenance check: Successful tune (see **5.4**) followed by a successful blank as outlined in **5.3.4.3,** as well as a monthly performance check (see **5.3.2**).

5.2.3.8 Helium Tank

- Replace as needed to ensure a supply of helium.
- Post-maintenance check: Successful tune (see **5.4**).
- NOTE: Instruments on an air handling system need not be documented in the GC-MS Logbook and are exempt from the post-maintenance check.

5.2.4 Non-routine Maintenance

5.2.4.1 When non-routine maintenance is performed, the instrument shall be out of service until the non-routine maintenance is evaluated by the GC-MS Coordinator or designee to determine the need for additional instrument checks prior to analyzing samples.

5.2.4.1.1 If maintenance is performed that may affect retention times, a monthly performance check (see **5.3.2**) shall be performed before the instrument is placed back in service. This includes, but is not limited to, column changes.

5.2.5 Shutdown

5.2.5.1 A successful tune (see **5.4**) shall be performed following any GC or MS shutdown.

5.2.5.2 The shutdown shall be noted in the Activity Log.

5.3 Standards and Controls

5.3.1 Naming and Saving of Instrument Files *(".D" folders and all files contained therein)*

5.3.1.1 All instrument files created during performance checks, and all blanks and data files associated with case samples shall be saved on the instrument computer hard drive according to the year/month in which it was collected.

5.3.1.2 All instrument files listed above shall be placed into a compressed (.zip) file. The compressed file shall be named with the instrument identifier, year, and month in which it was collected.

5.3.1.3 The compressed (.zip) file shall be archived monthly in the FA object repository ("Manage Files") associated with the GC-MS instrument on which it was collected.

5.3.2 Monthly Performance Check

5.3.2.1 Two multi-component standard solutions, made up of a variety of drugs commonly encountered in the laboratory shall be injected on a monthly basis when the instrument is in use to verify instrument performance. The solutions shall be run during the first seven calendar days of each month. Any instrument on which the standard solutions are not run during the first seven days of the month shall be out of service until the standard solutions are successfully run.

5.3.2.2 The retention time of each required component of the standard solutions shall be compared to previous runs. Any shift greater than 1.0% that cannot be attributed to maintenance shall be documented in the GC-MS Log and the instrument evaluated by the GC-MS Coordinator or designee. The instrument shall be taken out of service and steps shall be taken, such as column maintenance or other preventative maintenance, until the shift is no longer greater than 1.0%.

5.3.2.3 The mass spectrum of each required component in the standard solution shall be substantially the same as a reference material spectrum (see **5.7.3**). Any appreciable differences shall be noted in the GC-MS Logbook and the instrument evaluated by the GC-MS Coordinator or designee.

5.3.2.4 The total ion chromatograms for each standard solution shall be visually inspected for resolution between the required components. Any deficiencies shall be documented in the GC-MS Logbook and the instrument shall be evaluated by the GC-MS Coordinator or designee.

5.3.2.5 The Forensic Scientist reviewing the monthly standard solution injections shall document the retention times for each standard solution in the GC-MS Retention Time log. The reviewing Forensic Scientist shall mark the activity log to indicate the successful run of each standard solution.

5.3.3 Post-Maintenance Performance Check

5.3.3.1 Any standard solution may be run to verify instrument performance following certain maintenance tasks as designated above (see **5.2.3**).

5.3.3.2 If a multicomponent standard solution is used, the total ion chromatograms for the standard solution shall be visually inspected for resolution between the required components and their peak shape. If a single component standard solution is used, the total ion chromatography shall be visually inspected for the presence of peaks and their shape. Any deficiencies shall be documented in the GC-MS Logbook and the instrument shall be evaluated by the GC-MS Coordinator or designee.

5.3.3.3 The mass spectrum of each required component in the standard solution shall be substantially the same as the reference material spectrum (see **5.7.3**). Any appreciable differences shall be noted in the GC-MS Logbook and the instrument evaluated by the GC-MS Coordinator or designee.

5.3.3.4 The Forensic Scientist reviewing the post-maintenance performance solution injection shall mark the activity log to indicate the successful run of the solution.

5.3.4 Blank injections

5.3.4.1 Prior to the injection of a sample, a blank solvent injection shall be made using the same method and split ratio as the sample.

5.3.4.2 The solvent shall be prepared by the individual Forensic Scientist at the time of sample preparation and be the same solvent from the same bottle used in the sample preparation.

5.3.4.3 The blank solvent injection shall be evaluated to ensure that the instrument and solvent are free of the following:

5.3.4.3.1 Any identifiable controlled substance.

5.3.4.3.2 Any substance that may interfere with the identification of sample component(s).

NOTE: The presence of large amounts of common gas chromatography peaks (e.g., siloxanes) shall be noted in the GC-MS Logbook and reported to the GC-MS Coordinator or designee, however their presence does not prohibit the use of the blank for the sample.

5.3.5 Syringe flush

5.3.5.1 The syringe shall be flushed at least 10 times with solvent between injections to ensure the sample integrity between injections and to ensure that no sample transfer is made between sample vials.

5.3.5.2 Methanol shall be used in the first wash vial.

5.3.5.3 Hexane or chloroform shall be used in the second wash vial.

5.4 Calibrations (Tune) – MSD

5.4.1 Calibration (tuning) shall, at minimum, be successfully completed on a weekly basis, as well as prior to the monthly performance check utilizing the Standard Spectra Tune.

5.4.1.1 A Standard Spectra Tune shall be performed using Perfluorotributylamine (PFTBA) as the tuning standard.

5.4.1.2 Compare the tune report to specifications as outlined in Appendix B.

5.4.1.2.1 The tune specifications can also be found on the “GC-MS Tune Parameters” form.

5.4.1.3 Notify the GC-MS Coordinator or designee of any major variations.

5.4.2 In lieu of a tune, a System Verification shall be completed daily (if applicable) prior to instrument use on days when a Standard Spectra Tune is not performed.

5.4.2.1 The system verification report shall be considered successful if the report states "passes."

5.4.2.2 The system verification report shall be considered unsuccessful if the report states "one or more specifications was out of range." Notify the GC-MS Coordinator or designee. Steps shall be taken to address the parameters out of specification. A successful Standard Spectra Tune is required after a failed system verification report, and prior to the instrument being used for casework.

5.4.3 Neither a tune nor a system verification is required to be completed on days when instruments are not in use. Sample sequences that continue overnight may be allowed to complete without performing a new tune or system verification (as applicable) provided that they do not extend more than twenty-four hours beyond the time of the last tune or system verification, or noon, whichever is later.

5.4.4 Record each tune or system verification in the Activity Log along with initials, date, and any parameters that are out of specification.

5.4.4.1 Tunes may be performed by any qualified personnel in the section however, a qualified forensic scientist shall review the pass/fail status of all tunes. The initials of both individuals shall be documented in the Activity Log.

5.4.5 Tune reports or system verification reports shall be maintained electronically. Tune reports or system verification reports shall be placed in a folder named with the month and year. All months within the year shall be placed in a compressed (.zip) file, named with the instrument name and year in which they were collected, and uploaded annually into the FA Resource Manager object repository ("Manage Files") for the instrument on which they correspond.

5.5 Sampling – Refer to the Drug Chemistry Section Administrative Procedure for Drug Chemistry Analysis.

5.6 Instrument Procedure

5.6.1 If an instrument problem or error message occurs, the individual who discovers the problem shall notify the GC-MS Coordinator or designee. If the problem cannot be immediately corrected, the Activity Log shall be marked to show that the instrument is out of service.

5.6.2 Sample Preparation

5.6.2.1 Refer to the Drug Chemistry Section Technical Procedure for Extractions and Separations and the Technical Procedure for the Identification of Plant Material and Plant Material Extracts

5.6.2.1.1 Unless otherwise specified in the aforementioned procedures, approximately no more than 20 milligrams of material shall be

utilized for GC-MS sample preparation. Special circumstances may require more or less material.

5.6.2.2 Evaluate and prepare samples prior to injection to avoid overloading and the introduction of extreme pH, oil, sugar, and compounds known to be retained in the instrument.

5.6.2.3 Solid samples shall be filtered with solvent to prevent particulate matter and undesired compounds from being introduced into the instrument (e.g., sugars). Particulate matter shall not be visible in an auto-sampler vial.

5.6.3 GC-MS Methods

5.6.3.1 When the standard methods are not appropriate to analyze a compound, a modified method may be used in accordance with the Laboratory Procedure for Authorizing Deviations.

5.6.3.1.1 In the event a new GC-MS method needs to be developed refer to the Laboratory Procedure for Validation of Technical Procedures and section **5.1.2** above.

5.6.3.2 Descriptions of specific method parameters are located in Appendix C.

5.6.3.2.1 When GC-MS is being used as a screening technique, the GC method chosen shall screen for a wide variety of controlled substances, from phenethylamines to high molecular weight compounds such as synthetic cannabinoids and steroids.

5.6.3.3 Splitless injections are generally not utilized but may be used for sample solutions that did not provide successful identification of a compound using a 5:1 or higher split ratio.

5.6.4 Sequences

5.6.4.1 The current date shall be used when naming a sequence log file. Sequences need not be archived.

5.6.5 Instrument Files

5.6.5.1 Instrument file names shall include the year designation and the case file number to ensure that files from different years with the same file number are distinguishable.

5.6.5.2 Instrument files associated with casework and performance checks shall not be deleted or overwritten.

5.6.5.3 Instrument files shall be archived as outlined in **5.3.1**.

5.7 Evaluation and Identification

5.7.1 The GC-MS provides retention time data and mass spectral data.

5.7.2 Evaluate the total ion chromatogram (TIC) for peaks of interest.

5.7.2.1 The data generated from an unknown substance shall be evaluated to ensure that it is suitable prior to comparison to known reference material or published spectral data.

5.7.2.2 Initial evaluation shall include:

5.7.2.2.1 The assessment of peaks in the TIC that have a signal to noise ratio of at least 3 when compared to the baseline.

5.7.2.2.2 Peaks shall have acceptable shape (e. g., Gaussian), but slight asymmetry and tailing may occur and shall be mitigated as necessary.

5.7.2.3 Peaks fitting the criteria of **5.7.2.2** shall be further evaluated for mass fragmentation patterns and ion distributions.

5.7.2.3.1 If the sample produces peaks not fitting the criteria of **5.7.2.2**, the mass fragmentation pattern may still be assessed to determine if additional steps need be taken to obtain peaks fitting **5.7.2.2**, including but not limited to changing the split ratio, concentrating the sample, or preparing a new sample.

5.7.2.3.2 In a multicomponent sample, if peaks fitting the criteria in **5.7.2.2** can be confirmed, preliminary data supports the identification, and the substance(s) is/are controlled substances, no additional analysis will be performed to confirm additional component(s) that may be present providing the highest charge in the case has been satisfied with the confirmed component, without management or designee, approval.

5.7.2.4 For derivatized samples and/or reference materials with two or more derivatization sites, the presence of a single GC peak, or any combination of peaks, related to the derivatized compound of interest is acceptable.

5.7.3 Mass Spectral Identification

5.7.3.1 The sample mass spectrum shall be searched and compared to an electronic reference collection of reference material mass spectra. Probability Based Matching (PBM) shall be used to aid the Forensic Scientist in the identification but shall not be used as the sole basis of identification.

5.7.3.1.1 Approved libraries for comparison include but are not limited to all versions of the NCSCL GCMS library, NIST GCMS library, SWGDRUG GCMS library, Cayman Spectral GCMS library, and NPS Discovery GCMS library. However, only the current NCSCL GCMS library shall be used to identify controlled substances. See Technical Procedure for Drug Chemistry Analysis for exceptions.

5.7.3.2 The sample mass spectrum shall have the same base peak as the reference standard mass spectrum unless variations in abundance have been previously documented and deemed acceptable by the laboratory (e.g., due to spectral tilting).

5.7.3.3 The sample mass spectrum shall have the same molecular ion as the reference standard, when observed.

5.7.3.3.1 Certain chemical compounds do not produce an observable molecular ion under electron impact (EI) mass spectral conditions. In such cases, comparison can still be conducted based on the fragment ions present in the spectra.

5.7.3.4 All ions with a relative intensity greater than 5% of the base peak in the reference standard spectrum shall be present in the sample mass spectrum at a comparable intensity. The relative abundance for the majority of ions in the sample mass spectrum shall be consistent with the reference standard spectrum.

5.7.3.4.1 For compounds whose mass spectrum consists of no ions greater than 5% of the base peak (e.g., phenethylamines, nitazenes), magnify the y-axis of the reference standard spectrum and the sample mass spectrum (to 5%) to aid in comparison.

5.7.3.4.1.1 Evaluate the general distribution of ions across the spectra to ensure the majority of ions in the reference standard spectrum are present in the sample mass spectrum at comparable intensity. The relative abundance for the majority of ions shall be consistent between the reference standard spectrum and the sample mass spectrum.

5.7.3.4.1.2 This magnified spectrum from **5.7.3.4.1** shall be included in the casefile.

5.7.3.4.2 The absence of low abundance ions (ions with a relative intensity less than 5%) does not preclude an identification.

5.7.3.5 For compounds included in the following table, which are confirmed utilizing GC-MS in conjunction with preliminary testing, the retention time of a single sample shall be compared to the retention time of the respective reference material according to **5.7.4.3**.

Methamphetamine	Phentermine
Psilocin	Bufotenine
LSD	LAMPA
Fentanyl	Beta-methyl Fentanyl

5.7.3.6 The presence of ions in the mass spectrum that are not present in all scans of the chromatographic peak may be indicative of background noise or co-eluting substances. Isolate the source of the additional ions and subtract

prior to searching the reference collection of reference material mass spectra.

5.7.3.6.1 For spectra where the additional ions are unable to be isolated and/or subtracted but are of a known source, then the analyst shall make a note of the co-elution or background noise in the casefile. Instances such as these do not prevent the analyst from making an identification.

5.7.3.6.2 For spectra where the additional ions are unable to be isolated and/or subtracted and are of an unknown source, then further separation methods may be required, such as performing an extraction to isolate the target analyte or using a different instrumental method.

5.7.3.7 A confirmation is made when an unknown mass spectrum satisfies the requirements of **5.7.3**. If a confirmation cannot be made, additional resources may be consulted.

5.7.4 Retention Time (RT) Identification

5.7.4.1 Retention time data shall be required for the following:

5.7.4.1.1 No preliminary tests are available for the substance identified by GC-MS.

5.7.4.1.2 Sample size does not allow for additional testing, other than GC-MS.

5.7.4.2 When sample size allows, two separate samplings shall be utilized. Either sample may be used for retention time comparison; however, both analyzed samples shall meet mass spectral identification criteria. When separate samples are analyzed, the sample used for retention time comparison shall be noted in the Drug Workbook.

5.7.4.3 The requirement for retention time identification shall be retention time which, when compared to a reference material standard, has a difference of less than or equal to 0.05 minute. The retention time may be determined by using an integrator in the data analysis software or may be determined as the elution time at which the mass spectrum was collected.

5.7.4.4 The reference material standard shall be run within ninety days before or after the case sample and shall be run on the same method as the case sample (split ratio is excluded). The interval between a sample and a standard injection shall not contain column maintenance.

5.7.5 For sample runs, the case record shall contain:

- Total Ion Chromatogram (TIC) for the corresponding blank.
- Total Ion Chromatogram (TIC) for the sample.
- Mass spectra of peaks of interest, such as common diluents, artifacts, or peaks comparable in size to any controlled substances present.

- For items utilizing the hypergeometric sampling plan, mass spectra of the identified substance(s) are required for each unit analyzed; however, mass spectra of peaks of interest that are consistent between all units analyzed are only required to be included for the first unit.

- Expanded mass spectra of compounds as defined in **5.7.3.4.1.**
- Mass spectra of any reference material standards used for identification and its unique identifier, and the corresponding library search.
- When retention time is required for identification of a compound, the blank and standard TIC as well as the mass spectrum of the reference material shall be included. Retention times shall be indicated for comparison purposes.

5.7.6 As an exception to **5.7.5,** sample runs not used due to blanks not meeting the requirements set forth in **5.3.4.3**, the case record shall contain at least the following:

- Total Ion Chromatogram (TIC) for the corresponding blank.
- Total Ion Chromatogram (TIC) for the sample.

5.8 Reporting - Refer to the Drug Chemistry Section Technical Procedure for Drug Chemistry Analysis.

5.9 Calculations - N/A

5.10 Uncertainty of Measurement - N/A

6.0 Limitations

6.1 The GC-MS methods described in this procedure cannot be used to distinguish between optical isomers or some positional isomers.

6.2 Introduction of improperly prepared samples may lead to poor sensitivity and carryover, and as such controlled substances should be confirmed within reason; sufficient abundance of the total ion chromatogram peaks needs to be achieved in order to produce acceptable spectra, without overloading the chromatographic system.

6.3 The 500LOW Methods cannot eliminate the co-elution of ethylone and alpha-Pyrrolidinopentiophenone (alpha-PVP), as well as some other co-eluting compounds. If these substances are encountered in combination in casework, other methods of isolation may need to be considered.

6.4 Some compounds, such as THCA, GHB, and NBOH compounds, exhibit thermal degradation. Other methods of analysis may need to be considered.

7.0 Safety

7.1 Refer to the Laboratory Safety Manual: Chemical Hygiene Plan and Hazardous Communication Program.

7.2 Handle syringes with care to avoid punctures.

7.3 Use extreme caution dismantling/installing/transporting compressed gas cylinders. Cylinders shall not be moved without the cylinder cap securely in place.

7.4 Gas Chromatograph and Mass Spectrometer may be extremely hot. Avoid touching hot areas and wear protective gloves while performing maintenance.

7.5 Refer to Appendix A for chemical hygiene and safety precautions for extremely hazardous and particularly hazardous substances.

8.0 References

Agilent GC Instrument Manuals (for each series used in the section)

Agilent MS Instrument Manuals (for each series used in the section)

Moffat, A.C., et al., eds. *Clarke's Isolation and Identification of Drugs*. 2nd Edition. London: Pharmaceutical Press, 1986.

Skoog, Douglas A., F. James Holler and Timothy A. Nieman. *Principles of Instrumental Analysis*. 5th *Edition*. Garcourt Brace & Company, 1998.

Agilent GC-MSD ChemStation and Instrument Operation Student Manual Course Number H4043A Volume 1, Revision E.02.xx. Agilent Technologies: printed February 2008.

Murray, K.K, R.K. Boyd, M.N. Eberlin, G.J. Langley, L. Li and Y. Naito. IUPAC Recommendations 2013. *Pure Appl. Chem.*, 2013, **85**, 1515-1609.

Laboratory Safety Manual: Chemical Hygiene Plan and Hazardous Communication Program.

9.0 Records

- GC-MS Log Book
- Case Record
- GC-MS Tune Parameters form

10.0 Attachments

- **Appendix A** – Chemical Hygiene and Safety Precautions for Extremely Hazardous and Particularly Hazardous Substances
- **Appendix B**
- **Appendix C**

Revision History		
Effective Date	Version Number	Reason
05/03/2024	18	Added **Signal-to-Noise** definition Removed **Diagnostic Ion** definition **5.2.3.3 –** Removed SV or tune; added "or a post-maintenance performance check"; updated reference to other paragraph 5.2.3.4 – Added "or a post-maintenance performance check."; updated reference to other paragraph **5.2.3.2, 5.2.3.5, 5.2.3.6, 5.2.3.7** – Updated reference to other paragraph **5.2.3.8 –** Removed SV; updated grammar **5.3.2.2** – Removed **5.3.3, 5.3.3.1, 5.3.3.2, 5.3.3.3, 5.3.3.4 –** Added new Post-Maintenance Performance Check **5.3.4 and 5.3.5 –** Old **5.3.3** and **5.3.4** **5.4.1.1 –** Removed "according to specification listed in Appendix B" **5.4.1.2** – Removed "previous tunes and" **5.4.2.1 –** Removed **5.4.4.1 –** Clarified who can perform and approve Tunes **5.6.4.1 –** Added "log file." **5.7.2.2.1 –** Indented part of **5.7.2.2** **5.7.2.2.2 –** Added peak shape criteria **5.7.2.3 –** Old **5.7.2.2.1** **5.7.2.3.1 -** Old **5.7.2.2.2** **5.7.2.3.2 –** Old **5.7.2.2.3;** Replaced "are able to" with "can" and "needs to" with "will"; Added "without management or designee, approval" **5.7.2.4 –** Added requirements for derivatized compounds **5.7.3.1.1 –** Added approved libraries for comparison Old **5.7.3.2 –** Removed New **5.7.3.2 –** Old **5.7.3.3;** Reworded to add requirement for base peak to be present; Removed "diagnostic ions" **5.7.3.3 –** Old **5.7.3.3.1**; Reworded **5.7.3.3.1 –** Clarified when molecular ion may not be present **5.7.3.4 –** Old **5.7.3.3.2;** Replaced 10% with 5%; Add wording regarding abundance of ions **5.7.3.4.1 –** Old **5.7.3.3.2.1;** Updated 10% to 5%; Added examples of compounds that fall in this category; Removed reference to "general distribution of ions" Old **5.7.3.3.2.1.1 -** Removed **5.7.3.4.1.1 –** Added criteria for ion distribution in compounds with low fragmentation **5.7.3.4.1.2 –** Old **5.7.3.3.2.2;** Updated paragraph reference **5.7.3.4.2-** Updated 10% to 5% **5.7.3.6 –** Old **5.7.3.5;** Removed "major" **5.7.4.2 –** Added criteria to document sample used for RT in workbook **5.7.5** and **5.7.6 –** Updated reference to previous paragraphs **6.3** - Changed "separate" to "eliminate"; Removed "such as derivatization" Old **6.4**- Removed New **6.4 –** Added limitation of thermally unstable compounds **Appendix C MAINT METHOD -** Added

Appendix A – Chemical Hygiene and Safety Precautions for Extremely Hazardous and Particularly Hazardous Substances

Methylene Chloride/Dichloromethane **DANGER: PARTICULARLY HAZARDOUS SUBSTANCE** *	
	**HEALTH 2** **FLAMMABILITY 1** **REACTIVITY 1**
Detection of Release	Clear colorless liquid. Ether like odor
Signs/Symptoms of Exposure	Serious eye irritation; skin irritation; may cause drowsiness or dizziness.
PEL	ACGIH (TLV) – 50 ppm; OSHA Specifically Regulated Chemicals/Carcinogens – (PEL) 25 ppm
Associated Hazards	Serious eye and skin irritation; suspected of causing cancer
Controls	Use under fume hood. Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product. Use eye protection. Handle with gloves. Wear lab coat. Gloves: Fluorinated rubber (break through time = 148 minutes)
Safe handling, storage, disposal	Avoid contact with skin and eyes. Avoid inhalation of vapor or mist. Keep in a tightly closed container. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Dispose of in Hazardous Chemical Waste.
Emergency Procedures (2.2)(4.1)(6)	**Eye Contact:** Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. **Inhalation Exposure:** If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician. **Ingestion:** Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician. **Skin Contact:** Wash off with soap and plenty of water. Consult a physician. **Spills:** Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Small contained spill: wearing appropriate PPE, collect with absorbent material, and place in container. Dispose in Hazardous Chemical Waste. Large spills: Evacuate area and call 911 (Haz Mat).

*__GHS Ratings (2.1)__:
Skin irritation (Category 2)
Eye irritation (Category 2A)
Carcinogenicity (Category 2)
Specific target organ toxicity - single exposure (Category 3), Central nervous system

__IARC:__
Group 2A: Probably carcinogenic to humans

Appendix B

Standard Spectrum Tune Parameters

1. The mass assignments of the three tuning masses shall be within +/- 0.2 amu of 69.00, 219.00, and 502.00. If the deviation is larger than +/- 0.2 amu, document the deviation on the tune and/or in the activity log. Perform another standard spectra tune. If the problem persists, document the deviation on the tune and/or in the activity log and notify the GC-MS Coordinator or designee. The instrument shall remain out of service until the problem is corrected.

2. The peak widths of the three tuning masses shall be 0.55 +/- 0.10 amu and the peaks shall generally be smooth and symmetrical. If the deviation is greater than 0.10 amu, document the deviation on the tune and/or in the activity log. Perform another standard spectra tune. If the problem persists, document the deviation on the tune and/or in the activity log and notify the GC-MS Coordinator or designee. The instrument shall remain out of service until the problem is corrected.

3. The base peak shall be identified as mass 69. The relative abundance ratio of mass 219 to mass 69 shall be within 40 – 85 % and the relative abundance ratio of mass 502 to mass 69 shall be within 2 – 5 %. If these requirements are not met, document the deviation on the tune and/or in the activity log. Perform another standard spectra tune. If the problem persists, document the deviation on the tune and/or in the activity log and notify the GC-MS Coordinator or designee. The instrument shall remain out of service until the problem is corrected.

4. The 70/69 isotopic ratio shall be from 0.5 – 1.6, the 220/219 ratio shall be from 3.2 – 5.4, and the 503/502 the ratio shall be from 7.9 – 12.3. If these requirements are not met, document the deviation on the tune and/or in the activity log. Perform another standard spectra tune. If the problem persists, document the deviation on the tune and/or in the activity log and notify the GC-MS Coordinator or designee. The instrument shall remain out of service until the problem is corrected.

5. The abundance of any peaks less than 69 amu shall not be greater than 10 % of the abundance of the base peak.

- **a.** Peaks at 18, 28, 32, or 44 amu are indicative of water, nitrogen, oxygen, and carbon dioxide respectively, and may indicate an air leak.

- **b.** If an air leak is detected, the air leak shall be isolated and corrected and the tune repeated. Record the tunes and maintenance activity in the GC-MS logbook. If the problem persists, document the deviation on the tune and/or in the activity log and notify the GC-MS Coordinator or designee. The instrument shall remain out of service until the problem is corrected.

Appendix C

GC Method Parameters

Column dimensions: 30 m X 0.25 mm X 0.25 µm

HIGH METHODS – These methods are used for compounds that elute after 16 min. in the screen method, such as some steroids and some synthetic cannabinoids. Method run time is 25 min. and the sample injection is 1 µL. Scan range is 40-600 amu. The following are the specific methods used:

HIGH100 – 100 split, 1.00 minute initial time, 280 ºC initial temperature, 10 ºC/minute ramp, 300 ºC final temperature, 22.00 minute final time, 25.00 minute total run time

HIGH20 – 20 split, 1.00 minute initial time, 280 ºC initial temperature, 10 ºC/minute ramp, 300 ºC final temperature, 22.00 minute final time, 25.00 minute total run time

HIGH5 – 5 split, 1.00 minute initial time, 280 ºC initial temperature, 10 ºC/minute ramp, 300 ºC final temperature, 22.00 minute final time, 25.00 minute total run time

HIGHSL – No split, 1.00 minute initial time, 280 ºC initial temperature, 10 ºC/minute ramp, 300 ºC final temperature, 22.00 minute final time, 25.00 minute total run time

LOW METHODS – These methods are used for the majority of drug samples. It is used for compounds that elute before 20 min. in the screen method. Method run time is 20 min. and the sample injection is 1 µL. Scan range is 40-600 amu. The following are the specific methods used:

LOW100 - 100 split, 1.50 minute initial time, 100 ºC initial temperature, 30 ºC/minute ramp, 300 ºC final temperature, 11.83 minute final time, 20.00 minute total run time

LOW20 – 20 split, 1.50 minute initial time, 100 ºC initial temperature, 30 ºC/minute ramp, 300 ºC final temperature, 11.83 minute final time, 20.00 minute total run time

LOW5 – 5 split, 1.50 minute initial time, 100 ºC initial temperature, 30 ºC/minute ramp, 300 ºC final temperature, 11.83 minute final time, 20.00 minute total run time

LOWSL – No split, 1.50 minute initial time, 100 ºC initial temperature, 30 ºC/minute ramp, 300 ºC final temperature, 11.83 minute final time, 20.00 minute total run time

SCREEN METHODS – These methods shall be used to screen samples when a controlled substance is NOT previously indicated. Method run time is 35 min. and the sample injection is 1 µL. Scan range is 40-600 amu. The following are the specific methods used:

SCRN100 - 100 split, 1.50 minute initial time, 100 ºC initial temperature, 30 ºC/minute ramp, 300 ºC final temperature, 26.83 minute final time, 35.00 minute total run time

SCRN20 – 20 split, 1.50 minute initial time, 100 ºC initial temperature, 30 ºC/minute ramp, 300 ºC final temperature, 26.83 minute final time, 35.00 minute total run time

SCRN5 – 5 split, 1.50 minute initial time, 100 ºC initial temperature, 30 ºC/minute ramp, 300 ºC final temperature, 26.83 minute final time, 35.00 minute total run time

500LOW METHODS (To be used on an as needed basis) - These methods are used to improve resolution between structurally similar compounds, including but not limited to synthetic cannabinoids and

phenethylamines. Method run time is approximately 31 minutes and the sample injection is 1 uL. Scan range is 40-500amu. The following are the specific methods used:

500LOW100 – 100 split, 2.00 minute initial time, 70 °C initial temperature, 15 °C / minute ramp, 275 °C final temperature, 15.00 minute final time, 30.67 minute total run time.

500LOW20 – 20 split, 2.00 minute initial time, 70 °C initial temperature, 15 °C / minute ramp, 275 °C final temperature, 15.00 minute final time, 30.67 minute total run time.

500LOW5 – 5 split, 2.00 minute initial time, 70 °C initial temperature, 15 °C / minute ramp, 275 °C final temperature, 15.00 minute final time, 30.67 minute total run time.

500LOWSL – No split, 2.00 minute initial time, 70 °C initial temperature, 15 °C / minute ramp, 275 °C final temperature, 15.00 minute final time, 30.67 minute total run time.

MAINT METHOD – This method may only be used after minor maintenance such as syringe replacement, septum, and liner changes. Method run time is approximately 4.50 minutes and the sample injection is 1 uL. Scan range is 40-600amu.

MAINT – 20 split, 1.50 minute initial time, 100 °C initial temperature, 30 °C / minute ramp, 190 °C final temperature, 4.50 minute total run time.