

# Mass Spectrometer General Maintenance Protocol

## 1 Scope

The purpose of this protocol is to provide general guidelines for maintenance of mass spectrometry instruments. This document applies to personnel using the associated instrument(s)/equipment in the following discipline/category of testing: Explosives (chemistry) examinations performed at the Huntsville facility. Refer to the “General Instrument Maintenance Protocol” for overall instrument maintenance guidelines and definitions.

## 2 Principle

These instruments are obtained from several different manufacturers. All instruments eventually require maintenance, troubleshooting, and repair. Although the user interface and hardware fittings may differ, the overall instrument principles and maintenance are similar. The mass spectrometers are typically used in tandem with either a gas chromatograph (GC) or a liquid chromatograph (LC). Refer to the “Gas Chromatograph General Maintenance Protocol” and the “Liquid Chromatograph General Maintenance Protocol” for chromatographic system maintenance.

## 3 Equipment/Materials/Reagents

Any materials (such as pump oil and solvents) and all replacement parts will meet manufacturer’s specifications and recommendations. Manufacturer’s instrument manuals and specific performance monitoring protocols are generally the best source for this information.

## 4 Standards and Controls

All standards, solutions, and gases required are specified in the appropriate SOP.

## 5 Calibration

Any procedures used to calibrate and/or verify the integrity of the instrument will be specified in the appropriate SOP.

## **5.1 Tuning**

As defined in the “General Instrument Maintenance Protocol,” tuning refers to the adjusting of parameters (e.g., lens voltages) to maximize instrument performance. All mass spectrometers provide a general automatic tune function. Individual instrument performance monitoring protocols have specific information on use of this function. Mass spectrometers also provide the ability to manually tune the same parameters. Manual tuning can be used as needed, provided that the required documentation is provided, and the decision criteria specified in the performance monitoring protocol is achieved.

## **6 Sampling or Sample Selection**

Not applicable.

## **7 Procedures**

### **7.1 Preventative Maintenance**

Each type and model of an instrument may have different, specialized components requiring specific preventative maintenance. Suggested step-by-step directions for specific maintenance procedures may be found in the manufacturer’s instrument manuals. The following procedures are generic in nature and are included for reference.

#### **7.1.1 Ion Volume Cleaning**

Systems equipped with a removable ion volume should have the volume cleaned regularly. Lint-free gloves should be worn during the disassembly and reassembly of the mass spectrometer. Volume performance can be monitored by use of the performance monitoring standard criteria outlined in the instrument performance monitoring protocol.

- a. Remove the inner ion volume (with the filament and column inlet holes) from the outer housing.
- b. Prepare an appropriate cleaning solution (e.g. a slurry of aluminum oxide and methanol or Barkeepers Friend and water).
- c. Thoroughly clean the inner and outer surfaces of both pieces of the volume with the slurry. Using a cotton-tipped applicator, clean all dark or discolored areas, particularly around holes.
- d. If necessary, place the parts in a beaker with deionized water and sonicate for one minute.

- e. Thoroughly rinse the parts with deionized water followed by methanol.
- f. Place the ion volume parts in a beaker with methanol and sonicate for ten minutes.
- g. Thoroughly dry the ion volume parts.
- h. Re-assemble the volume.

### **7.1.2 Vacuum Pumps**

All MS systems have one or more rough/mechanical pumps. It is suggested that the pump oil level and clarity be checked weekly, and changed if needed. Some systems also have one or more turbo pumps as well. Turbo pumps are very sensitive and vary greatly, even within the same instrument. It is suggested that the oil not be replaced in turbo pumps. For changing the oil in the rough/mechanical pumps:

- a. Drain the mist filters and vent the MS.
- b. Allow the pump to cool for at least 10 minutes before continuing.
- c. Open the pump vent/fill hole.
- d. Place a sturdy plastic container under the oil drain.
- e. Open the oil drain and allow the old oil to empty.
- f. Add 10-20 mL of fresh oil to the pump with the drain open in order to flush the system.
- g. Replace the cover on the oil drain.
- h. Fill the pump with fresh oil until the proper fill level is noted in the level indicator.
- i. Replace the cover on the pump vent/fill hole.
- j. Seal, label, and dispose of the used oil as outlined in the *FBI Laboratory Safety Manual*.
- k. Repeat for each vacuum pump on the system.

### **7.2 Corrective Maintenance**

Each type and model of an instrument may have different, specialized components requiring

specific corrective maintenance. Suggested step-by-step directions for specific procedures may be found in the corresponding manufacturer's instrument manuals. When performed, relevant corrective maintenance will be entered into the appropriate log. The following procedures are generic in nature and are included for reference.

### **7.2.1 Source Bake-Out**

It should be noted that an occasional overnight baking-out of the detector may be useful when elevated baselines and other interferences are observed. The source temperature can be temporarily raised to 300°C. The transfer line should not be set to a temperature above the limit of the GC column. Please refer to specific column documentation for more information.

- a. Note the current source temperature.
- b. Select the bake out option and set the source temperature to 300°C.
- c. Allow the source to bake-out for several hours.
- d. When necessary, return the source temperature to the original setting.
- e. Allow the source to cool to the original temperature before operating the instrument.
- f. This procedure can be repeated keeping the source temperature elevated overnight. However, if the problems persist, it is likely that the source and/or analyzer need to be cleaned.

### **7.2.2 Source Cleaning**

The source will be cleaned on MS systems as needed, based on system performance. All systems require the removal of the entire source.

- a. When necessary, vent the MS system. Turn off the main power.
- b. Allow the source to cool before continuing.
- c. Open the vacuum manifold.
- d. Disconnect any gas lines or electrical connections to the source.
- e. Loosen and/or remove source retaining bolts and clips.
- f. Remove the source.

- g. Disassemble the source in order to separate the lenses and any surfaces that come in contact with the ionization chamber.
- h. Prepare an appropriate cleaning solution (e.g. a slurry of aluminum oxide and methanol or Barkeepers Friend and water).
- i. Thoroughly clean the pieces of the source with the slurry. Using a cotton-tipped applicator, clean all dark or discolored areas, particularly around holes. Warning: Only clean metal surfaces.
- j. If necessary, place the parts in a beaker with deionized water and sonicate for one minute.
- k. Thoroughly rinse the parts with deionized water followed by methanol.
- l. Place the parts in a beaker with methanol and sonicate for 10 minutes.
- m. Thoroughly dry all parts.
- n. Re-assemble the source.
- o. Place the source in the manifold and secure.
- p. Reconnect all gas lines and electrical connections.
- q. Seal the manifold.
- r. Turn on the main power and pump down the system, observing for vacuum leaks.

### **7.2.3 Analyzer Cleaning**

MS systems used in Huntsville employ three types of analyzers: ion trap, OrbiTrap, and quadrupole. In general, these analyzers do not need regular cleaning. However, an ion trap can be cleaned when venting the system for source cleaning. A quadrupole and OrbiTrap are more sensitive and should only be cleaned by certified service engineers when warranted by poor performance.

#### **7.2.3.1 Cleaning an Ion Trap**

- a. Vent the MS system by turning off the main power.
- b. Allow the analyzer to cool before continuing.
- c. Open the vacuum manifold.

- d. Disconnect any gas lines or electrical connections to the analyzer assembly.
- e. Remove the analyzer assembly from the manifold.
- f. Disassemble the ion trap and separate the ring and center electrodes.
- g. Prepare an appropriate cleaning solution (e.g. a slurry of aluminum oxide and methanol or Barkeepers Friend and water).
- h. Thoroughly clean the surfaces of the electrodes using the slurry. Using a cotton-tipped applicator, clean all dark or discolored areas. **Warning: Only clean metal surfaces.**
- i. If necessary, place the parts in a beaker with deionized water and sonicate for one minute.
- j. Thoroughly rinse the parts with deionized water followed by methanol.
- k. Place the parts in a beaker with methanol and sonicate for 10 minutes.
- l. Thoroughly dry the parts.
- m. Reassemble the ion trap and analyzer assembly.
- n. Place the analyzer assembly in the manifold and reconnect any gas lines and electrical connections.
- o. Seal the manifold.
- p. Turn on the main power and pump down the system, observing for vacuum leaks.

#### **7.2.4 Filament Replacement**

Generally, a broken filament results in a total loss of ions rather than degraded system performance. To replace a filament:

- a. When necessary, vent the MS system. Turn off the main power.
- b. Allow the source to cool before continuing.
- c. Open the vacuum manifold.
- d. Disconnect any gas lines or electrical connections to the source.

- e. Loosen and/or remove source retaining bolts and clips.
- f. Remove the source.
- g. Disassemble the source in order to expose the filament.
- h. Unplug the old filament and replace it with a new one.
- i. Re-assemble the source.
- j. Place the source in the manifold and secure.
- k. Reconnect all gas lines and electrical connections.
- l. Seal the manifold.
- m. Turn on the main power and pump down the system, observing for vacuum leaks.

## **8 Instrumental Conditions**

Refer to the appropriate procedures outlined in section 7, manufacturer's instrument manuals, or the instrument's performance monitoring protocol for specific instrumental conditions to be used during maintenance procedures.

## **9 Decision Criteria**

Every performance monitoring protocol will have specific decision criteria to determine if the instrument is operating properly. If these should fail, the operator should refer to the 'Decision Criteria' section of the specific performance monitoring protocol. Additional information is provided in the 'Corrective Maintenance' section of the "General Instrument Maintenance Protocol".

## **10 Calculations**

Not applicable.

## **11 Measurement Uncertainty**

Not applicable.

## 12 Limitations

Only properly trained personnel will perform duties involved in the operation, maintenance, or troubleshooting of any instrument. Instrument-specific limitations will be specified in the appropriate SOP.

## 13 Safety

Take standard precautions for the handling of all chemicals, reagents, and standards. Refer to the *FBI Laboratory Safety Manual* for the proper handling and disposal of all chemicals. Personal protective equipment should be used when handling any chemical and when performing any type of analysis. Many instrument components are held at temperatures of 250°C and higher. Precautions should be taken to prevent the contact of skin with heated surfaces and areas.

## 14 References

*Instrument Operations Group SOP Manual.*

Manufacturer's Instrument Manuals for the specific models and accessories used.

“General Instrument Maintenance Protocol” (IOG 001) *Instrument Operations Group SOP Manual.*

“Gas Chromatograph General Maintenance Protocol” (IOG 002) *Instrument Operations Group SOP Manual.*

“Liquid Chromatograph General Maintenance Protocol” (IOG 003) *Instrument Operations Group SOP Manual.*

*FBI Laboratory Safety Manual.*

*FBI Laboratory Quality Assurance Manual.*



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| 0      | 10/04/18   | New document which specifies instrument protocol for the Huntsville facility. |

**Approval**

Redacted - Signatures on File

Scientific Analysis  
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**TL Approval**

Explosives (Chemistry)  
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**QA Approval**

Quality Manager

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