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Guidelines for Routine User Maintenance of Gas Chromatographs

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# Purpose

The purpose of this document is to provide the end-users in the Quality Control Laboratory at Vertellus (2110 West Gate City Boulevard, Greensboro, NC 27403) with a general guideline for maintaining their AutosystemXL, Clarus 500/580 and Clarus 590/690 gas chromatographs in-house, following the routine maintenance steps laid out in the instrument customer hardware and user guides. This document also contains recommendations for tools and consumables to have on hand as well as any industry standard best practices that are not expressly documented within the official manuals for the above instrument models. This document can be used stand-alone or as a guide for developing an in-house protocol by the customer.

# A. Gas Management

## A.1. Traps and Filters

Gas traps and filters should be installed in-line between your ultra-high purity (UHP 5.0 grade or 99.999% purity) compressed gas cylinders and your instrument. A minimum purity of UHP Hydrogen, UHP Helium and Zero grade air should be used on GC systems. Traps should have high capacity and efficiency levels for oxygen, hydrocarbons and water such that the gas output of these traps is 99.9999% pure for chemical analysis. It is recommended for UHP 5.0 grade Helium (carrier flow) and UHP 5.0 grade Hydrogen to have traps for Oxygen, moisture and hydrocarbons. Zero grade Air requires traps for moisture and hydrocarbons only.

These traps need to be replaced by whichever occurs first of the following conditions:

1. The trap is saturated as indicated by performance or a physical indicator in the trap such as color changing particles.
2. The trap is clogged, leaking or otherwise malfunctioning or defective
3. You have had 12 tank changes since installing the trap or trap cartridge
4. The expiration date has passed or the maximum lifetime as indicated by the trap manufacturer has been exceeded.

Generally, traps should be replaced every year and purged with gas for 15 minutes at low flow before reconnecting the outlet of the gas cylinder to the GC. Part numbers for traps, cartridges, fittings etc. can be found in the attached consumables catalog.

## A.2. Regulators

Gas tank regulators have an average wear life on their gaskets of no more than (NMT) 5 years. Regulators should be replaced or rebuilt and leak tested every 5 years with the appropriate style, purity and pressure ratings for the gas used. Leak test the regulator on every tank change and every time a new regulator is installed.

## A.3. Tubing and fittings

Copper tubing oxidizes and leaks over time and also becomes brittle at the joints or in spots that experience changes in humidity or temperature (such as behind a GC oven). It is recommended that you use an electronic leak detector or a mixture of 50/50 isopropanol and water to check all fittings from the gas source to the back of the instrument on a monthly basis or if anything has disrupted the position of the tubing or connected instruments.

# B. Syringes

## B.1. Per-use or Daily Maintenance

The syringe plungers should be cleaned regularly upon each sample injection, with an appropriate number of solvent rinses for the sample matrix injected.

## B.2. Routine Periodic Maintenance (every 500 injections)

After approximately 500 injections, since insolubles can build up and cause friction, the syringe should be inspected and cleaned per the below procedure. Additionally, syringes that are not used for several hours could "freeze," i.e., the syringe plunger will not move (this can also be caused by some solvents or sample matrices) which would require the below maintenance steps.

**Note:** It is typically advised to replace the syringe instead of performing the below maintenance steps, as removing and replacing the plunger can sometimes scratch the inner surface of the syringe barrel and create active sites or decrease the accuracy and precision of the syringe.

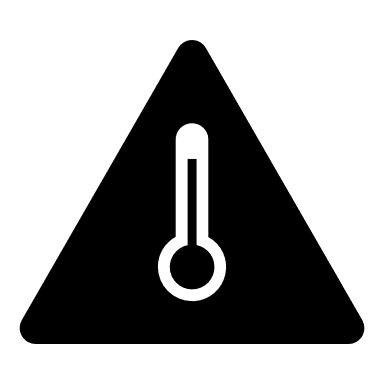
To clean the syringe plunger:

1. Remove the plunger from the syringe barrel. If there are any signs of rust or plunger wear, replace the syringe.
2. Wipe the plunger with a tissue soaked in an appropriate solvent.
3. Replace the plunger.
4. Pull and expel the same solvent through the barrel several times.

# C. Injection Ports (injectors)

The injection ports tend to require the most frequent maintenance as they are the point of entry for your sample into the system. Injector maintenance consists of:

1. Replacing septa (every 200 injections).
2. Replacing and repacking CAP and PSS injector liners
3. Removing a broken liner from the injector body
4. Replacing the charcoal trap or replacing charcoal on the split/splitless CAP and PSS injectors.

****CAUTION: The injection ports (injectors) on the GC are heated zones, as that is where sample volatilization occurs. Cool the injectors to below 100°C before performing maintenance to avoid burns and damage to the injector.

## C.1. Septa

Septa should be replaced on a regular basis. How often depends on the type of septa used, the temperature of the injection port, and the number of injections made. The septum that shipped with your instrument is a Thermogreen LB-2 Septa (Part Number N6621028, package of 50). This septum can handle about **200** injections at moderate temperatures and is one of the more robust types of septum as far as thermal stability and wear. Your septa may need to be replaced more frequently, but typically every 200 injections is the general guideline.

*NOTE: To minimize the possibility of contamination, avoid unnecessary handling of septa.*

To change a septum:

1. Turn off the injector heater and allow the injector to cool.
2. Remove the septum cap.
3. Pry the old septum from the septum cap with a screwdriver.
4. Insert a new septum in the septum cap.
5. Replace the septum cap.

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## C.2. Injection port Liners

### C.2.a. Packed Column Injectors

Typically use with packed injectors is to perform on-column injections, i.e. the packed columns you use extend up to the septum, and you do not have an injection port liner on your packed injectors. As this is the case, the only maintenance on these is changing the septum as outlined above. In the event you use injection port liners on packed columns (the packed column only extends to the bottom of the injection port as it does in capillary injections) see the 09936591E Clarus 500-580GC Service and Hardware Guide p336 for instructions to replace the liners.

### C.2.b. Replacing Capillary Split/Splitless (CAP) and Programmable Split/Splitless (PSS) Injectors

The liner-removal procedure is similar for CAP and PSS wide-bore and narrow-bore liners. To remove the liners, you need a CAP liner-removal tool (Part Number 02506534) or a PSS liner-removal tool (Part Number 02506247) as shown below.



To remove a capillary injector liner:

1. Turn off the injector heater.

Note: Allow the injector to cool until it is slightly warm to the touch. Cooling the injector to a temperature that is too low (<80 °C) will make it difficult to remove the injector liner.

1. Remove the septum cap.
2. Remove the injector cover.

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1. Loosen the threaded collar using the spanner (Part Number N6101359) provided, then remove the threaded collar.

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1. Replace the septum cap on the injector.
2. Pull the septum cap upwards to remove the septum purge assembly. The carrier gas inlet line is coiled. This allows you to pull the septum purge assembly over to the side and gain access to the injector liner.

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NOTE: The inlet line used in PPC capillary injectors (CAP and PSS) is coiled but the septum purge assembly does not terminate in a snubber as shown. Instead it is connected to a PPC module. The coil of the inlet line is long enough so that you can pull the septum purge assembly out of the opening in the top cover and gain access to the injector liner.

1. Insert the CAP liner-removal tool (Part Number 02506534) over the end of the CAP liner and lift the liner out of the injector.

**or**

Insert the PSS liner-removal tool (Part Number 02506247) over the end of the PSS liner and lift liner out of the injector.

* CAUTION: The liner must be cool (no hotter than 100 °C) or the liner-removal tool will melt! The end of the liner-removal tool may flare out with use. If this happens, cut off about ¼” of the worn end of the tube.

A close up of a map

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NOTE: If the quartz liner breaks inside the CAP injector, it can be removed by first removing the column, then removing with a 9/16-inch wrench the 1/4-inch injector fitting that is inside the oven. The liner should fall out of the injector with the fitting. If the liner is stuck, you can push it out from the top or bottom of the injector.

CAUTION: The PSS injector liner does not have a 1/4-inch fitting like the CAP injector. Be very careful when removing this liner to prevent breaking it. Do not cool the injector below 80 °C. This will make it easier to remove the liner and O-ring. As the injector cools, the O-ring adheres to the metal base.

NOTE: Each capillary liner has an O-ring installed on the frosted portion of the CAP liner and on the part furthest away from the dimple on the PSS injector. If the O-ring has adhered to the injector, you may not be able to easily remove the liner (step 7 above). If this is the case, use a small screwdriver to dislodge the O-ring before removing the liner and O-ring.

1. Install a new liner O-ring near the ground portion of the liner.

NOTE: If your results produce background contamination when a new O-ring is first installed, condition the injector at the maximum temperature of the O-ring (listed below). Depending on the type of column used, you may first want to remove the column before baking it out at a high temperature.

1. Insert the liner in the injector body.
2. Place the septum purge assembly over the liner.
3. Press the septum purge assembly down to correctly position the liner in the injector.
4. Make sure that you secure the septum purge assembly tightly to the injector base with the 1/4-inch spanner.

## C.3. Removing a Broken Liner from the Injector Body

### C.3.a. CAP Injectors

If the quartz liner breaks inside the CAP injector, it can be removed by first removing the column, then removing with a 9/16-inch wrench the 1/4-inch injector fitting that is inside the oven. The liner should fall out of the injector with the fitting. If the liner is stuck, you can push it out from the top or bottom of the injector. At this time, you should clean the injector fitting inside the oven with a swab and appropriate solvent and inspect the ferrule. If the ferrule is worn, replace it too.

NOTE: Clarus 590 and Clarus 690 GC’s also have a gold-plated inlet seal that should be replaced whenever the injector fitting is removed, whenever the inlet seal becomes dirty or contaminated, or every 6-12 months depending on wear.

### C.3.b. PSS Injectors

If a liner breaks in the PSS injector body, the best way to remove all pieces of quartz is to remove the injector from the Clarus GC.

To remove a broken PSS liner from the injector:

1. Turn off the Clarus GC. Allow the injector to cool until it is slightly warm to the touch.
2. Disconnect and remove the column from the injector.
3. Loosen the two screws the secure the GC top cover and raise the top cover until it locks in the raised position.
4. Remove the top cover from the PSS injector. Mark the position of the injector on the metal deck with a pencil.
5. Remove the screw that secures the fan assembly to the PSS injector, then remove the fan assembly (see the following figure).
6. Remove the two screws that secure the PSS injector to the metal deck.
7. Remove the cable clamps that hold the heater and sensor wires and the gas tubing (see the following figure).
8. Carefully lift the PSS injector out of the Clarus 500/580 GC. Invert the PSS injector and remove all the broken quartz liner from it.
9. Reinstall the PSS injector to the Clarus 500/580 GC and reinstall the fan assembly.
10. Lower the Clarus 500/580 GC top cover and properly align the PSS injector with the top cover before you completely tighten the PSS injector mounting screws.

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## C.4. Replacing Charcoal traps on CAP and PSS Injectors

The charcoal trap will eventually become saturated. When this occurs, ghost peaks and changes in split ratio will be observed.

### C.4.a. Replacing a Charcoal Trap (applies to all PSS and CAP injectors on AutosystemXL, Clarus 500 and Clarus 580 GC’s only)

1. Turn off the GC. Allow the injectors/detectors to become cool to the touch.
2. Loosen the two hold-down screws on the top cover of the GC (see following figure) and raise the top cover until the cover locks in the raised position.
3. Remove the septum cap, then remove the top cover from the injector.
4. Loosen the threaded collar using the 1/4-inch spanner (Part Number N6101359), and then remove the threaded collar.
5. Replace the septum cap on the injector.
6. Pull the septum cap upwards to remove the septum purge assembly.
7. Using a 1/8-inch wrench, loosen the fittings that are connected to the charcoal trap and remove the charcoal trap (see the following figure). If you have a PPC charcoal trap, use a 1/4-inch wrench to loosen the fitting that connects the trap to the transducer.
8. Install a new PPC version charcoal trap (Part Number N6100331) or the manual pneumatics version charcoal trap (Part Number N6100275).

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### C.4.b. Replacing Charcoal Traps on Clarus 590 and 690 GC CAP Injectors

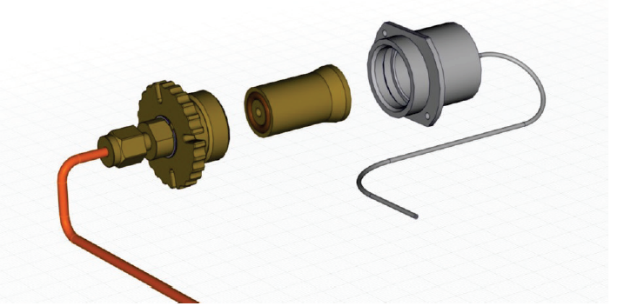
The charcoal trap will eventually become saturated. When this occurs, ghost peaks and changes in split ratio will be observed.

1. Turn off all heated zones (e.g. oven, injectors, and detector) and allow them to become cool to the touch.
2. Turn off the GC.
3. Turn off the carrier gas to the injector.
4. Loosen the two hold-down screws on the top cover of the GC (see following figure) and raise the top cover until the cover locks in the raised position.
5. Locate the charcoal trap in the left rear corner of the GC.

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1. Unscrew the large nut then pull it away from the trap. Carefully move the tubing just enough to remove the cartridge.



1. Insert a new cartridge into the body.
2. Align the large nut with the body and turn it clockwise until tight.
3. Start the carrier gas flow.
4. Lower the Clarus GC top cover and tighten the two hold-down screws.

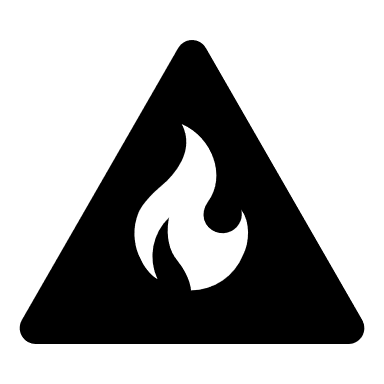
# D. Flame Ionization Detector (FID) Maintenance

FID maintenance consists of replacing the FID jet, cleaning the FID jet, replacing an o-ring in the collector, and cleaning the FID collector and cap.

## D.1. Replacing a FID Jet

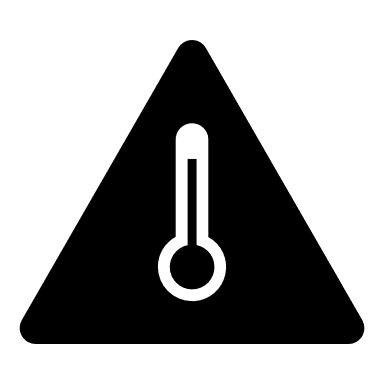
NOTE: The FID jet rarely becomes plugged. However, if plugging occurs, it is usually sample dependent. It is recommended that you replace a plugged jet rather than clean it.

To replace the FID jet:

** WARNING! Before you begin, extinguish the flame via the keyboard by setting the

hydrogen flow to “0” or if you have manual pneumatics (AutosystemXL), turn the outer knob on the hydrogen needle valve completely clockwise to off.

1. Turn off the Clarus 500/580 GC power.

WARNING! The FID is hot and can cause serious burns! To prevent injury, allow the detector to become cool to the touch.

2. Open the detector cover (see Figure 9-26).

3. Remove the polarizing cable from the pin on the polarizing filter assembly.A close up of a mans face

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1. Loosen the knurled ring, then lift the FID collector off of the FID base and put it out of the way.
2. Insert the nozzle removal tool (Part Number N6103188) into the FID base and lift the nozzle out of the FID base. Do not unscrew it.

A close up of a map

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1. Insert a 1/4-inch nutdriver into the FID base to engage the 1/4-inch nut on the FID jet assembly.
2. Loosen the FID jet assembly (turn the 1/4-inch nut counterclockwise) and pull it out of the FID. You should be able to pull out the FID jet assembly with the nutdriver. If not, then pull out the FID jet assembly with a pair of forceps or needle nose pliers.

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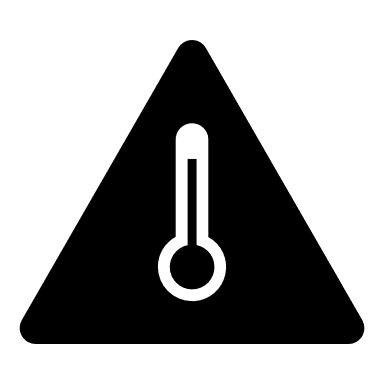
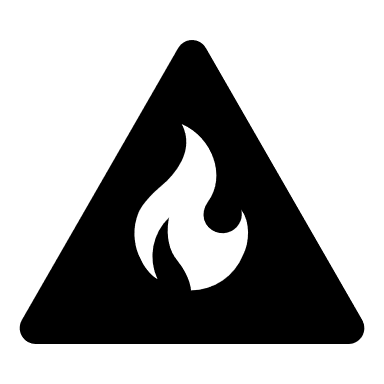
1. Insert a new FID jet assembly (P/N N6550080 for Clarus 590 and 690 GC, all previous model GC’s use P/N N6100361) and secure it in place with the 1/4-inch nut driver.

NOTE: Inspect the metal ring within the FID nozzle since it may become bent or deformed after repeated removal.

1. Insert the nozzle assembly into the FID base until you feel it bottom.
2. Insert the FID collector back on the FID base and tighten the knurled ring.
3. Reconnect the polarizing wire to the polarizing pin on the FID collector.
4. Turn on the FID heater and allow it to return to the temperature setting.
5. Re-ignite the flame.

## D.2. Replacing the O-Ring in the FID Collector

Since the O-ring in the FID collector is in contact with the heated surface of the FID base, you will notice over time that it has become brittle or broken and must be replaced.

 CAUTION: The FID is hot and can cause serious burns! To prevent injury, extinguish the FID flame, turn off the FID heater, and allow the detector to become cool to the touch.

To replace the O-ring in the FID collector:

1. Remove the polarizing voltage wire from the polarizing pin (as shown in the Replacing a Jet steps above).

2. Loosen the knurled ring, then lift the FID collector off the FID base.

3. Remove the old O-ring (see the following figure) from the FID collector and insert a new O-ring (P/N 09902143).

4. Insert the FID collector back on the FID base and tighten the knurled ring.

5. Connect the polarizing wire to the polarizing pin on the FID collector.

6. Turn on the FID heater and allow it to return to the temperature setting.

7. Re-ignite the flame.



# E. Tools

The tools to have on hand:

|  |  |  |
| --- | --- | --- |
| **Tool** | **Use** | **Part Number** |
| ¼” Crescent wrench | Column fittings at injector end | These can be purchased individually from a hardware store or come as part of the basic GC toolkit part number N9301327 |
| 7/16” Crescent wrench | Brass swagelock fittings on gas plumbing, and column fittings on FID |
| ½” Crescent wrench | Injector fitting |
| 9/16” Crescent wrench | Injector fitting |
| Flat Screwdriver | Opening top lid of GC |
| Electronic Gas Leak Detector | Check for helium and hydrogen leaks | N9306089 |
| Electronic Gas Flowmeter | Verify your flowrates | N9307086 |
| FID flow measuring adaptor tube (autolite fid) | To measure gas flow rates from the detector output (with the flame off) | N6103119 |
| Polarizing filter Nozzle assembly extraction tool | Replacing the FID Jet | N6103188 |
| Modified 1/4-inch nutdriver narrow OD | Replacing the FID Jet | N6101297 |
| Ceramic wafer scribe (pack of 10) | Cutting capillary columns | N9301376 |
| CAP liner-removal tool | Replacing liners | 02506534 |
| PSS liner-removal tool | Replacing liners | 02506247 |
| ¼” Spanner | Replacing liners | N61001359 |

# F. Consumable Parts and Frequency List

Table of part numbers with frequencies

|  |  |  |
| --- | --- | --- |
| **Part Description** | **Part Number** | **Frequency** |
| **Gas Management** | | |
| Traps  (for UHP Helium and UHP Hydrogen) | Moisture, Hydrocarbons, Oxygen  (see catalog) | Every 12 months or 12 tanks |
| Traps  (for zero grade air) | Moisture and Hydrocarbons  (see catalog) | Every 12 months or 12 tanks |
| **Syringes** | | |
| 5 μL Syringe, Metal Plunger PTFE-tipped Seal 0.63 mm OD Needle BLUE Barrel (Pkg. 10 syringes) | N6103241 (pack of 10) | Every 500 injections or once a month based on your usage |
| **Injectors-All** | | |
| Septa, thermogreen (package of 50)—or whatever septa you choose | N6621028  (for the thermogreen pack of 50) | Every 200 injections (roughly once every 3 weeks) |
| **Injectors-AutosystemXL, Clarus 500 & Clarus 580 GC’s** | | |
| PE Autosystem Focus Liner, 4mm w/ wool, #092092 for CAP injectors | SGE Part number 092092 (pack of 5)  ***OR***  PerkinElmer equivalent (I think) Part number N6121020  (pack of 5) | Every 200-600 injections |
| Quartz Split liner with Silanized Glass Wool for PSS injectors (pack of 5) | SGE Part number 726522 \*\*incorrect part number, 0726522 is for graphite o-rings for 4mm liners (pack of 5)  ***OR***  PerkinElmer Part number N6121009 | Every 200-600 injections |
| Liner O-ring (CAP) Silicone  (Max temp 250C) | N6101374 (pack of 10) | Every liner replacement or removal |
| Liner O-ring (CAP) Graphite  (Max temp 450C) | N6101378 (pack of 5) | Every liner replacement or removal |
| Liner O-ring (PSS) Viton  (Max temp 250C) | N6101747 (pack of 10) | Every liner replacement or removal |
| Liner O-ring (PSS) Graphite  (Max temp 450C) | N6101751 (pack of 5) | Every liner replacement or removal |
| Charcoal Trap Manual Pneumatics CAP and PSS injectors  (Autosystem and AutosystemXL) | N6100275 | When saturated or every 24 months |
| Charcoal Trap PPC Pneumatics  CAP and PSS injectors  (Clarus 500 and 580) | N6100331 | When saturated or every 24 months |
| Capillary Column nut-Injector | 09903392 (pack of 5) | When worn or plugged |
| Capillary Column ferrule-injector  (for columns with id of 530µm) | 09920107 (pack of 10) | When leaking or worn, or when installing a column |
| Capillary Column ferrule-injector  (for columns with id of 180µm—320 µm) | 09920105 (pack of 10) | When leaking or worn, or when installing a column |
| **Injectors-Clarus 590 & Clarus 690 GC’s** | | |
| Quartz Split Liner with Silanized Glass Wool for **CAP** injectors (pack of 5) | N6121009 | Every 200-600 injections |
| Quartz Split liner with Silanized Glass Wool for **PSS** injectors (pack of 5) | N9306232 | Every 200-600 injections |
| Charcoal Trap CAP injectors | N6550142 | When saturated or every 12 months |
| Gold seal and washer | N6551043 | When dirty, worn, leaking, or every 12 months |
| Capillary Column nut-injector | N6552084 | When worn or plugged |
| 1/16 in. Short Graphite/Vespel Ferrule (Pkg. 10)  For column ID 180 – 320 µm | 09200685 (pack of 10) | When leaking or worn, or when installing a column |
| 1/16 in. Short Graphite/Vespel Ferrule (Pkg. 10)  For column ID 530 µm | 09200687 (pack of 10) | When leaking or worn, or when installing a column |
| **FID Detector-** **AutosystemXL, Clarus 500, Clarus 580 GC’s** | | |
| FID Jet | N6100361 | When clogged or every 12 months |
| FID Nozzle Assembly | N6100430 | When -0.97 mV or every 24 months |
| FID Collector O-ring | 09902143 | When brittle |
| FID Collector assembly autoignite | N6100357 | Have one on-hand |
| Capillary Column nut-FID  (also used on both ends of Packed columns) |  | When worn or plugged |
| 1/8 in. Graphite/Vespel Ferrule (Pkg. 10)  For column ID 180 – 530 µm | 09903394 | When leaking or worn, or when installing a column |
| **FID Detector-Clarus 590 and Clarus 690 GC’s** | | |
| FID Jet | N6550080 | When clogged or every 12 months |
| FID Nozzle Assembly | N6550072 | When -0.97 mV or every 24 months |
| FID Collector O-ring | 09902143 | When brittle |
| FID Collector Assembly | N6550077 | Have one on-hand |
| Capillary Column ferrule-injector  (for columns with id of 180µm—320 µm) | 09920105 (pack of 10) | When leaking or worn, or when installing a column |
| Capillary Column ferrule-injector  (for columns with id of 530 µm) | 09920107 (pack of 10) | When leaking or worn, or when installing a column |
| 1/8 in. Graphite/Vespel Ferrule (Pkg. 10)  For column ID 180 – 530 µm | 09903394 (pack of 10) | When leaking or worn, or when installing a column |