VOC Ozone Precursor Analyzer

User’s Manual
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NOTE: TotalChrom is the updated version of the software previously marketed as Turbochrom. This product is compatible with TotalChrom and Turbochrom version 6.1.x. The term TotalChrom has been used throughout this document to denote either system.

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Preface

About This Manual

This manual describes how to install and use the VOC Ozone Precursor Analyzer, consisting of:

- A Clarus 500 gas chromatograph (GC) with DOTLINK interface,
- TurboMatrix Thermal Desorber (fitted with the Air Sampler Accessory),
- columns (BP1 and PLOT),
- TotalChrom Software and computer system,
- All of the necessary parts to set up a complete system.

Before using this system, you should be familiar with the techniques of gas chromatography and thermal desorption. You should also have some familiarity with the Clarus 500 GC, TurboMatrix Thermal Desorber, and TotalChrom. For complete instructional information on these products, refer to their manuals.
Summary of Contents

In addition to this summary of contents, the first page of each chapter of the manual contains a more detailed description of the contents of that chapter.

**Chapter 1:** **About the VOC Ozone Precursor Analyzer.** Describes the VOC Ozone Precursor Analyzer. It begins with a brief description of the system, followed by a description of each major component, and ends with a brief description of the sequence of events in a typical run.

**Chapter 2:** **Installation.** Describes how to install the VOC Ozone Precursor Analyzer system.

**Chapter 3:** **Running an Analysis.** Describes how to set up TotalChrom Methods, the Clarus 500 GC and TurboMatrix Thermal Desorber for an analysis to measure the atmospheric concentration of the volatile ozone precursors listed in Title 1 of the 1990 US Clean Air Act Amendment (CAAA).

**Chapter 4:** **Maintenance.** Describes maintenance procedures a typical user should perform on the VOC Ozone Precursor Analyzer.

**Appendix:** Contains a list of the volatile ozone precursors and annotated chromatograms that identify the components in a synthetic mixture that are separated using the VOC Ozone Precursor Analyzer.
Information and Warnings

The following information and warnings described in this manual apply to the use of the VOC Ozone Precursor Analyzer.

Compressed Gases

Cylinders (tanks) of compressed gases should be handled with caution. Avoid knocking the valves, and ensure that the correct valves and gauges are installed. It is recommended that gas cylinders be stored and sited outside the laboratory and connected to the instrument through copper lines. Take care not to kink or stress the gas lines. For safety, cylinders should be firmly clamped in position.

When hydrogen is used as the combustion gas for a flame ionization detector, special care must be taken to avoid buildup of explosive hydrogen/air mixtures. Ensure that all couplings used in the hydrogen lines are leak free, and do not allow hydrogen to vent within the oven.

---

**Important**

**Hydrogen must not** be used as a carrier gas because it reacts with and eliminates acetylene from the chromatogram.

---

About Gas Supplies for the Ozone Precursor Analyzer

Due to the continuous operating features of the Ozone Precursor Analyzer, there are some special requirements for the gas supplies of the chromatographic system. Table P-1 summarizes the gases and requirements.

**Table P-1. Gas use for the Ozone Precursor Analyzer System.**

<table>
<thead>
<tr>
<th>Gas</th>
<th>Manual Pneumatics Supply Pressure (PSI)</th>
<th>PPC Supply Pressure (PSI)</th>
<th>Use</th>
<th>Flow Rate (mL/min)</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helium</td>
<td>&gt;60</td>
<td>70-90</td>
<td>Carrier</td>
<td>5</td>
<td>Lasts 3 months</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>&gt;40</td>
<td>70-90</td>
<td>FID Fuel</td>
<td>~80</td>
<td>Lasts 5 weeks</td>
</tr>
<tr>
<td>Air</td>
<td>80-120</td>
<td>70-90</td>
<td>Nafion Dryer</td>
<td>250</td>
<td>An air cylinder lasts 5 days.</td>
</tr>
<tr>
<td></td>
<td><strong>NOTE:</strong> Dew point must be &lt; -50ºC</td>
<td><strong>NOTE:</strong> Dew point must be &lt; -50ºC</td>
<td>FID Fuel</td>
<td>900</td>
<td>(An air generator lasts indefinitely.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TurboMatrix Power</td>
<td>Negligible</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Peltier Purge</td>
<td>160</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**

Dew point must be < -50ºC
Each Ozone Precursor Analyzer system needs helium for carrier gas, hydrogen for FID fuel, and air for multiple purposes, including FID fuel, ATD power, and Nafion dryer operation. One tank of helium and one tank of hydrogen will last about one month. (Hydrogen must not be used as a carrier gas because it converts acetylene to ethane.) The helium gas should be the best chromatographic grade (99.999% purity) available, with an oxygen filter. This prevents oxidation of the methyl silicone phase and consequently keeps the column bleed to a minimum. Hydrogen gas should also be the best commercial grade available for normal chromatographic operation. A hydrogen generator may also be used for FID fuel gas, but not as the carrier gas.

Air is a major concern since one Ozone Precursor Analyzer system will use one five-foot cylinder in about six days. The Peltier cooled cold trap always has some surfaces that are at -50°C and to prevent ice formation the cold trap is purged with air continuously. The air must be as DRY and MUST HAVE A DEW POINT OF LESS THAN -50°C. It is not recommended that standard breathing air or air from a laboratory compressor is used. Compressor air contains high levels of moisture which will damage the peltier cooler and eventually lead to component failure. An air dryer accessory (P/Nxxxx-xxxx) is available to remove moisture from the air supply to both the peltier cooler and the Nafion dryer.

However a laboratory air compressor may be used in conjunction with a Zero Air Generator such as the Whatman Model 78-30 (M130) with Receiver tank Type 72-007 and may be purchased from PerkinElmer as part of the system. This is a self-drying generator, so no additional filters are required. With a Zero Air Generator installed, a system can run for almost one month or more without a visit or tank change. This means that the highest level of system reliability is achieved and, hence, more hourly samples are collected. The payback period is about one year based on normal supply costs, in addition to the savings on visits, replacement filter dryers, etc. It is very desirable to have a system that runs at least three weeks without a tank change. However, if AC power is lost, the air generator stops and the FID flames will be extinguished. If the GC has Programmable Pneumatic Control (PPC) the GC can be programmed to light the flames automatically. However GCs with manual pneumatics require some user intervention to light the flames so it is recommended that a backup air tank is connected as well so that air will be provided if the air generator (The Whatman air generator can be ordered through PerkinElmer as a special item.)

Ventilation

To ensure adequate cooling of the instrument electronics, do not obstruct the gap at the base of the instrument, and leave at least a 6-inch clearance between instruments.
Using Hydrogen

**Warning** Flame Ionization Detectors (FIDs) use hydrogen as fuel. If the hydrogen is turned on without a column attached to the injector and detector fittings inside the oven, hydrogen could diffuse into the oven creating the possibility of an explosion. To avoid possible injury, **DO NOT TURN ON THE HYDROGEN UNLESS A COLUMN IS ATTACHED AND ALL JOINTS HAVE BEEN LEAK TESTED.**

**BEFORE DISCONNECTING A COLUMN, MAKE CERTAIN THAT THE HYDROGEN HAS BEEN TURNED OFF.**

**IF TWO FIDs ARE INSTALLED AND ONLY ONE HAS A COLUMN ATTACHED TO IT, MAKE CERTAIN THAT YOU CAP OFF THE UNUSED DETECTOR INLET FITTING WITH A 1/8-INCH STAINLESS STEEL PLUG (P/N N930-0061).**

Electricity

Ensure that the power cord is correct for your location, and that the ground leads of all electrical units (for example, computers and integrators) are connected together via the circuit ground to earth. Use only three-prong outlets with common earth ground connections.

Servicing of electrical components within the Clarus 500 GC and TurboMatrix Thermal Desorber should be performed **only by a PerkinElmer Service Engineer.** Servicing of incoming AC line components should be performed only by a licensed electrician.

**Warning** To prevent electrical shock and injury, all instruments must be unplugged from the AC power before you remove any panels.

Under no circumstances should circuit boards be removed or inserted unless the instruments are disconnected from AC power.

Heated Zones

Heated zones should be treated with caution. The detector cover may get hot, especially if the flame ionization detectors are operated at high temperatures. As a general rule, allow heated zones to cool before attempting to work in the oven or detector areas. Allow the TurboMatrix sample tube to cool before handling.
Conventions

In this manual, the following special formats are used to set apart important information and warnings:

**Warning**
A warning indicates an operation that could cause *personal injury* if precautions are not followed.

**Caution**
A caution indicates an operation that could cause *instrument damage* if precautions are not followed.

**Important**
An important indicates an operation that could cause *failure* if precautions are not followed.

**Note**
Notes emphasize significant information in a procedure or description.
About the Ozone Precursor Analyzer

About the US CAAA

System Overview

TurboMatix Thermal Desorber

Air Sampler Accessory

Figure 1-4. The flow path TurboMatrix 650 with the Air Sampler in the sample collection state.

Figure 1-5. The Air Sampler and Nafion Dryer.

Clarus 500 GC

TotalChrom

Sequence of Events in a Run

Leak Testing

Sample Collection

Trap Heating and Chromatography

Data Collection

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This chapter describes the VOC Ozone Precursor Analyzer. It begins with a brief description of the system, followed by a description of each component, and ends with a brief description of the sequence of events in a typical run.

About the US CAAA

The US Clean Air Act Amendment (USCAA) requires the monitoring of ambient air for ozone and its precursors in those urban areas which fail the new air quality standards. Similar recommendations have also been made in Europe following the 1992 Ozone Directive and United Nations Economic Commission for Europe protocol on controlling Volatile Organic Compound (VOC) emissions.

Every hour the Ozone Precursor Analyzer measures the concentration of the components listed in Title 1 of the US Clean Air Act Amendment (USCAA) 1990 by collecting 600 mL of air into the TurboMatrix cold trap at 15 mL/min for 40 minutes. This volume ensures that there is no breakthrough of the most volatile compound – acetylene. The VOCs in the air are collected on the Peltier-cooled trap (at −30 °C) in the TurboMatrix TD system. This trap is packed with the adsorbents selected specifically for quantitative trapping of the C₂-C₁₂ components. The trap is then heated and the carrier gas flow is reversed to backflush the VOCs from the trap.
System Overview

The VOC Ozone Precursor Analyzer system (Figure 1-1) consists of a TurboMatrix Thermal Desorber fitted with an Air Sampler Accessory, a Clarus 500 Gas Chromatograph and, as an option, a computer with TotalChrom Data Processing. The TurboMatrix 100 and 150 Ozone Precursor Analyzers come with a Clarus 500GC with 2 FIDs and manual regulation of the combustion gases and auxiliary gas. The TurboMatrix 300, 350 and 650 Ozone Precursor Analyzers come with a Clarus 500GC with 2 FIDs and Programmable Pneumatic Control (PPC) of the combustion gases and auxiliary gas.

TurboMatrix Thermal Desorber

There are a number of versions of TurboMatrix Thermal Desorbers available with the Ozone Precursor System. All are supplied with the Air Sampling accessory and all may also be used for the analysis of volatile samples that have been adsorbed on ¼ inch sample tubes. The TurboMatrix 100 and TurboMatrix 150 use manual controlled pneumatics; the TurboMatrix 100 takes a single tube whereas the 150 may also be used to process up to 50 sample tubes. Likewise the TurboMatrix 300 and TurboMatrix 350 take a single sample tube and 50 sample tubes respectively but also have Programmable Pneumatic Control (PPC) where the pneumatics are controlled through the instrument software. Finally the TurboMatrix 650 takes 50 sample tubes and has PPC but also has the capability to monitor the impedance of the cold trap and, if it is used to analyze
sample tubes, the ability to re-trap the sample during sample processing. It also has the ability to dry purge the sample tube making it suitable for the analysis of toxic organic compounds as well. All versions of TurboMatrix Thermal Desorbers have a unique, Peltier-cooled trap (cold trap) capable of cooling to -30ºC without the need of any liquid cryogen.

Air Sampler Accessory

The Air Sampling accessory enables the TurboMatrix Thermal Desorber to draw air through the cold trap. The trap is prepacked with the correct adsorbents for quantitative trapping of the C2-C12 components listed in Title 1 of the US CAAA 1990 at a user selected flow rate and time. For the analysis of components listed in Title 1 the flow rate is usually set to 15ml/min and air is sampled for 40 minutes of each hour giving a sample volume of 600ml. The cold trap is then heated rapidly to pass any trapped compounds to the Clarus 500GC where separation of the VOCs occurs. This may be changed by the user but care should be taken if a larger volume is collected as acetylene will break through the cold trap at about 1000ml and ethylene and ethane may also be lost.

Even though the TurboMatrix TD system is equipped with an Online Sampler Accessory, it can still be used to analyze samples collected with tubes. Refer to Operation, in the TurboMatrix Instrument Manual (P/N M041-3331).

The Air Sampler Accessory for the TurboMatrix contains two valves (Valve RVB and Valve RVC), Nafion Dryer, built in flow controller, and an air pump. It uses a small air pump to draw samples of ambient air or calibration gas through the cold trap in the TurboMatrix. This system performs unattended analyses of air that is sampled at designated periods of time. The Flow path for the **TurboMatrix 100 and 150** is shown in figure 1-2, for the **TurboMatrix 300 and 350** in figure 1-3 and for the **TurboMatrix 650** in figure 1-4. These diagrams show the systems in the sample collection state. Rotary valve C (RVC) selects the sample stream between an air sample and a calibrant gas. The sample is pulled by the vacuum pump through the nafion dryer (see below) which removes moisture from the air stream through RVB which directs the sample to the cold trap via RVA and back through RVB through a mass flow controller which regulates the sample flow. When sample collection has finished RVB turns so that air is still drawn through the mass flow controller but does not pass into the cold trap. RVA will also turn so that the cold trap is connected to the transfer line and SV2 closes and ESV2 opens so that the cold trap is “backflushed” with the carrier gas. The cold trap is then heated rapidly to release the trapped volatiles through the transfer line to the Clarus 500 GC. A full description of the operating system is given in Appendix 3.
Figure 1-2. The flow path TurboMatrix 100 and 150 with the Air Sampler in the sample collection state.
Figure 1-3. The flow path TurboMatrix 300 and 350 with the Air Sampler in the sample collection state.

Figure 1-4. The flow path TurboMatrix 650 with the Air Sampler in the sample collection state.
**Vacuum Pump**

The air-sampling pump connects to the rear port on the side of the air sampler. It draws the sample or calibration standard through the system at the rate set on the flow controller.

**Nafion Dryer**

The Nafion Dryer uses a counterflow of dry air from the TurboMatrix to dry the air being sampled. The flow of dry air through the Nafion Dryer is switched on and off using the toggle valve, and adjusted using the needle valve. The dry air, which is derived internally from the compressed-air supply to the TurboMatrix, enters through the tee at the bottom of the dryer and exits through the tee at the top (air purge outlet). The Nafion Dryer is shown in figure 1-5.

> **Note** Although the Nafion Dryer is suitable for the volatile ozone precursors listed in this manual, it may adsorb some species, in particular alcohols and other polar species.

![Figure 1-5. The Air Sampler and Nafion Dryer.](image)

**Clarus 500 GC**

The Clarus 500 GC comes equipped with two FIDs, multi-dimensional capability (Deans' switch), and two columns (BP1 and PLOT) that separate the components listed in Title 1 of the US Clean Air Act Amendment 1990 (the list is in the Appendix). The Ozone Precursor System is available with a choice of 2 Clarus 500 GCs; either with
manual control of the pneumatics, when supplied with the TurboMatrix 100 or 150, or Programmable Pneumatic Control (PPC) when supplied with the TurboMatrix 300, 350 or 650. The Clarus 500 GC is controlled by the TotalChrom data handling system.

The two-column system enables the Clarus 500 GC to separate a sample ranging from C2 hydrocarbons to trimethyl benzenes and n-dodecane without requiring liquid cryogen. The Al2O3 PLOT is very efficient at separating low molecular weight hydrocarbon species including the C3 hydrocarbons but will retain the higher molecular weight hydrocarbons too strongly. Initially the two columns are connected in series with the sample being introduced into the BP1 column first. The low molecular weight compounds pass to the Al2O3 PLOT column where they are separated but before n-hexane elutes from the BP1 column the gas flow is directed away from the PLOT column to a second detector where the higher boiling compounds, eluting straight from the BP1 column, are measured.

TotalChrom

TotalChrom manages the running of the on line air system through a sequence file, which commands the analyzer to sample with ambient air or a calibration gas according to pre-set schedule. The resulting data files are typically exported to an external database, such as the EPA’s AIRS database. The operation of the system is enhanced through the use of 3rd party control software, such as PC anywhere, which allows remote access of the system.

Sequence of Events in a Run

The following section describes the sequence of events in a run.

1. Leak Testing of the Tube and Trap
2. Sample Collection
3. Trap Heating and Chromatography
4. Data Collection and Data Processing

Leak Testing

Any leak in the system prior to the column is equivalent to an uncontrolled split vent, and as such renders quantitation impossible. As with any GC installation it is imperative to eliminate all leaks in order to achieve optimum chromatography.

It is strongly recommended that you perform a leak check of the total system whenever the column or transfer line is changed, using a pressure leak-down procedure.
When the TurboMatrix Thermal Desorber is first started for air sampling it will load an empty tube to complete the sample path. When it does this it will perform a leak test, first on the tube seals, and then on the cold trap connections before any sampling takes place. Once the tube is in place and the system passes all leak tests the tube remains in place until the system is stopped and no further leak checks are performed.
Sample Collection

At the start of the sample collection, Valve RVB rotates so that the air-sampling pump draws air through the cold trap. At the end of the sample collection time, Valve RVB rotates and the desorb time (DSRB TIME) starts. (This is the time during which the oven is in contact with the sample tube and the air is purged from the cold trap through SV3.) During air sampling this purges the air from the cold trap with helium carrier gas and prevents the possibility of oxidation of any volatile components when the trap is heated.

Set the DSRB TIME on the TurboMatrix to the minimum value of one minute. This is an essential part of the functioning of the thermal desorber but it plays no active role in the analysis. Typically you should set the temperature of the tube desorb oven to a low value to preserve the seals, but high enough to prevent sample condensation. 75°C to 100°C is recommended.

Trap Heating and Chromatography

At the end of the desorb time, Valve RVA (in the TurboMatrix) rotates, SV1, SV2 and ESV2 switch and the cold trap is heated. During the trap heating stage, the sample that has been collected in the cold trap is backflushed from the trap and passed via the transfer line and into the GC columns for analysis.

Data Collection

By setting up a TotalChrom method as part of an automatic sequence, you can collect and analyze data from FID1 and FID2 that will run automatically over long periods of time. This is explained in detail in Chapter 3, "Running an Analysis." Since there are two columns and two FIDs, two channels of data are collected. The first file captures data for C2 to branched C6 and the second channel includes the data for C6 to C12. Data for the entire run is therefore a combination of the two. Two files are collected for each hour of operation.
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Only A PerkinElmer Service Engineer should install the Ozone Precursor System. These installation instructions are written for use by a PerkinElmer Service Engineer.

This chapter describes how to install the VOC Ozone Precursor Analyzer system. In addition to containing a list of items shipped, this chapter describes how to:

- Prepare your laboratory
- Unpacking the system
- Make the electrical connections between all of the instruments in the system
- Connecting to the TotalChrom data handling system
- Install the heated transfer line between the TurboMatrix and Clarus 500 GC
- Connect tubing between all of the instruments in the system
- Connect the components to the Air Sampler accessory
- Install the columns in the Clarus 500 GC oven
- Determine the midpoint pressure and correct restrictor length
- Install an outdoor sampling stream
Preparing Your Laboratory

Before installing your VOC Ozone Precursor Analyzer, prepare your laboratory according to the following guidelines:

Required Air Quality

To minimize contamination problems in your laboratory, provide a relatively dust-free environment. Make sure that the following gases or vapors are not present at levels exceeding federal, state, and local ordinances for continuous human exposure:

- Flammable
- Caustic
- Explosive
- Toxic
- Corrosive

Also, if an air compressor is used, ensure that there are no volatile organic vapours in the same environment as the air intake for the compressor. Air from the compressor will be used as the dry gas supply for the Nafion dryer and any contaminants in the air may cause contamination of the Nafion membrane.

Make sure that your laboratory environment is within the following limits of temperature and humidity:

- Ambient temperature between 15 °C and 32 °C.
- Constant relative humidity less than 75%, without condensation.

About Gas Supplies for the Ozone Precursor Analyzer

Due to the continuous operating features of the Ozone Precursor Analyzer, there are some special requirements for the gas supplies of the chromatographic system.

Table 2-1. Gas supplies and requirements.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Manual Pneumatics Supply Pressure (PSI)</th>
<th>PPC Supply Pressure (PSI)</th>
<th>Use</th>
<th>Flow Rate (mL/min)</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helium</td>
<td>&gt;60</td>
<td>70-90</td>
<td>Carrier</td>
<td>5</td>
<td>Lasts 3 months</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>&gt;40</td>
<td>70-90</td>
<td>FID Fuel</td>
<td>~80</td>
<td>Lasts 5 weeks</td>
</tr>
<tr>
<td>Air</td>
<td>80-120</td>
<td>70-90</td>
<td>Nafion Dryer</td>
<td>250</td>
<td>An air cylinder</td>
</tr>
<tr>
<td></td>
<td>NOTE: Dew point must be &lt; -50°C</td>
<td>NOTE: Dew point must be &lt; -50°C</td>
<td>FID Fuel</td>
<td>900</td>
<td>lasts 5 days.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TurboMatrix Power</td>
<td>Negligible</td>
<td>(An air generator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Peltier Purge</td>
<td>160</td>
<td>lasts indefinitely.)</td>
</tr>
</tbody>
</table>
Each Ozone Precursor Analyzer system needs helium for carrier gas, hydrogen for FID fuel and air for multiple purposes, including FID fuel, TurboMatrix power, and Nafion dryer operation. One tank of helium will last several months. One tank of hydrogen will last about one month. (Hydrogen must not be used as a carrier gas because it converts acetylene to ethane.) The helium gas should be the best chromatographic grade (99.999% purity) available with a high quality stainless steel regulator, with an oxygen filter. This prevents oxidation of the methyl silicone phase and consequently keeps the column bleed to a minimum. Hydrogen gas should also be the best commercial grade available for normal chromatographic operation.

**Caution**

- ALL GAS LINES must be copper or stainless steel. NO PLASTIC LINES may be used.

Air is a major concern since one Ozone Precursor Analyzer system will use one five-foot cylinder in about six days. The Peltier cooled cold trap always has some surfaces that are at -50ºC and to prevent ice formation the cold trap is purged with air continuously. The air must be as **DRY** and **MUST HAVE A DEW POINT OF LESS THAN -50ºC**. It is not recommended that standard breathing air or air from a laboratory compressor is used. Compressor air contains high levels of moisture which will damage the peltier cooler and eventually lead to component failure. An air dryer accessory (P/Nxxxx-xxxx) is available to remove moisture from the air supply to both the peltier cooler and the Nafion dryer.

However a laboratory air compressor may be used in conjunction with a Zero Air Generator such as the Whatman Model 78-30 (M130) with Receiver tank Type 72-007 and may be purchased from PerkinElmer as part of the system. This is a self-drying generator, so no additional filters are required. With a Zero Air Generator installed, a system can run for almost one month or more without a visit or tank change. This means that the highest level of system reliability is achieved and, hence, more hourly samples are collected. The payback period is about one year based on normal supply costs, in addition to the savings on visits, replacement filter dryers, etc. It is very desirable to have a system that runs at least three weeks without a tank change. However, if AC power is lost, the air generator stops and the FID flames will be extinguished. If the GC has Programmable Pneumatic Control (PPC) the GC can be programmed to light the flames automatically. However GCs with manual pneumatics require some user intervention to light the flames so it is recommended that a backup air tank is connected as well so that air will be provided if the air generator fails.

**Adequate Bench Space**

Provide bench or table space (typically 6 to 7 linear feet) to accommodate the dimensions of the TurboMatrix Thermal Desorber, Clarus 500 GC, and computer. The bench must also support the weight of the system. Provide space at the rear of the instruments for air circulation as well as access space on both sides of the instruments.
Sufficient Electrical Power

The VOC Ozone Precursor Analyzer System requires a grounded nominal 120-, 220-, or 240-VAC source. Data processing instruments and other accessories require separate outlets. (Refer to the appropriate instrument manual for power requirements.)

Unpacking Your VOC Ozone Precursor System

Carefully unpack the VOC Ozone Precursor Analyzer and check for obvious signs of damage that may have occurred during shipment. Immediately report damaged or missing items to the shipping carrier and PerkinElmer for replacements.

Place the Clarus 500GC and TurboMatrix Thermal Desorber on the bench with the TurboMatrix Thermal Desorber adjacent to and to the right of the Clarus 500GC.

VOC Analyzer Systems

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Pneumatic Control (Thermal Desorber and GC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N6510400</td>
<td>100TD Ozone Precursor non-PPC 120V</td>
<td>Manual</td>
</tr>
<tr>
<td>N6510401</td>
<td>100TD Ozone Precursor non-PPC 230V</td>
<td>Manual</td>
</tr>
<tr>
<td>N6510402</td>
<td>300TD Ozone Precursor w/PPC 120V</td>
<td>PPC</td>
</tr>
<tr>
<td>N6510403</td>
<td>300TD Ozone Precursor w/PPC 230V</td>
<td>PPC</td>
</tr>
<tr>
<td>N6510404</td>
<td>150ATD Ozone Precursor non-PPC 120V</td>
<td>Manual</td>
</tr>
<tr>
<td>N6510405</td>
<td>150ATD Ozone Precursor non-PPC 230V</td>
<td>Manual</td>
</tr>
<tr>
<td>N6510406</td>
<td>350ATD Ozone Precursor w/PPC 120V</td>
<td>PPC</td>
</tr>
<tr>
<td>N6510407</td>
<td>350ATD Ozone Precursor w/PPC 230V</td>
<td>PPC</td>
</tr>
<tr>
<td>N6510408</td>
<td>650ATD Ozone Precursor w/PPC 120V</td>
<td>PPC</td>
</tr>
<tr>
<td>N6510409</td>
<td>650ATD Ozone Precursor w/PPC 230V</td>
<td>PPC</td>
</tr>
</tbody>
</table>

Items Included with the VOC Ozone Precursor Analyzer System

A Shipping Kit is supplied with the VOC Ozone Precursor Analyzer System. Use the checklist on the following page to inventory the parts supplied. The part numbers should help you to identify items in the kit, but do not use these part numbers to order replacements. You can order replacement parts from PerkinElmer's catalog service.
## TurboMatrix Ozone Precursor (P/N N620-0113, N620-0114)

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Desorber, Entry Level Option</td>
<td>M041-3347</td>
<td>1</td>
</tr>
<tr>
<td>Manual Pneumatic Option, TD</td>
<td>M041-3360</td>
<td>1</td>
</tr>
<tr>
<td>Long Heated Transfer Line Option, TD</td>
<td>M041-3306</td>
<td>1</td>
</tr>
<tr>
<td>On Line Sampling Option</td>
<td>M041-3338</td>
<td>1</td>
</tr>
<tr>
<td>Sampler 50/60 Hz Operation</td>
<td>M041-4066, 120V</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>M041-4067, 240V</td>
<td></td>
</tr>
<tr>
<td>Air Sampling Pump</td>
<td>L427-1275, 120V</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>L427-1274, 240V</td>
<td></td>
</tr>
<tr>
<td>Linecord – 3C 14AWG 2M 125V 15A</td>
<td>0999-1420, 125V</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0999-1414, 250V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3C 18AWG 2.5M 250V 10A</td>
<td></td>
</tr>
</tbody>
</table>
## VOC Ozone Precursor Analyzer Shipping Kit (P/N N620-0102)

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAP-FLTR DRYER 1/8 FITTING</td>
<td>N930-1178</td>
<td>2</td>
</tr>
<tr>
<td>TRAP-M1000 OXYGEN 1/8 FITTING</td>
<td>N930-1179</td>
<td>1</td>
</tr>
<tr>
<td>TRAP-INDICATING OXYGEN 1/8 FTG</td>
<td>N930-1191</td>
<td>1</td>
</tr>
<tr>
<td>TRAP-MOISTURE 70ML 1/8 FTG</td>
<td>N930-1193</td>
<td>1</td>
</tr>
<tr>
<td>Turbomatrix Ozone Precursor Analyzer Manual</td>
<td>0993-6563</td>
<td>1</td>
</tr>
<tr>
<td>CONN FEMALE 1/8 BRASS</td>
<td>N930-1250</td>
<td>1</td>
</tr>
<tr>
<td>CONN MALE 1/8 X 1/8 NPT BRASS</td>
<td>N930-1253</td>
<td>5</td>
</tr>
<tr>
<td>CONN MALE 1/8 X 1/4 NPT BRASS</td>
<td>N930-1254</td>
<td>3</td>
</tr>
<tr>
<td>UNION CROSS 1/8 BRASS</td>
<td>N930-1259</td>
<td>1</td>
</tr>
<tr>
<td>NUT UNION 1/16</td>
<td>0990-3392</td>
<td>2 pack of 5</td>
</tr>
<tr>
<td>NUT 1/8 TUBE O.D.</td>
<td>0990-3453</td>
<td>2</td>
</tr>
<tr>
<td>FERRULES GRAPH/VESP 1/16 X 0.5MM</td>
<td>0992-0105</td>
<td>1 pack of 10</td>
</tr>
<tr>
<td>GRAPHITE FERRULE 1/8 X 0.5MM PK/10</td>
<td>0990-3981</td>
<td>1 pack of 10</td>
</tr>
<tr>
<td>CLIP-HAIRPIN 0.125 SFT SST</td>
<td>0990-8690</td>
<td>2</td>
</tr>
<tr>
<td>VALVE SHUT OFF TOGGLE</td>
<td>0990-3558</td>
<td>1</td>
</tr>
<tr>
<td>SWAGELOCK PORT CONN</td>
<td>0990-3917</td>
<td>2</td>
</tr>
<tr>
<td>FITTING 1/4 PIPE</td>
<td>0992-0220</td>
<td>1</td>
</tr>
<tr>
<td>AIR MONITORING TRAP PACKED</td>
<td>M041-3628</td>
<td>3</td>
</tr>
<tr>
<td>SUPPORT – 9000 CAPILLARY COLUMN</td>
<td>N610-1070</td>
<td>2</td>
</tr>
<tr>
<td>STAINLESS STEEL SAMPLE TUBE, EMPTY</td>
<td>L407-1030</td>
<td>2</td>
</tr>
<tr>
<td>TurboMatrix TD system PC Control Software</td>
<td>M041-3559</td>
<td>1</td>
</tr>
<tr>
<td>Cable Assy – AutoSystem Inline Relay</td>
<td>N620-0112</td>
<td>1</td>
</tr>
<tr>
<td>Column Set: A 50m x 0.32mm i.d. Al$_2$O$_3$/Na$_2$SO$_4$ PLOT column, and 50m x 0.22mm i.d. 1µm BP1 column</td>
<td>N630-0058</td>
<td>1</td>
</tr>
<tr>
<td>Cable Assy – HS40XL (start/read)</td>
<td>N101-1206</td>
<td>2</td>
</tr>
</tbody>
</table>
Making Electrical Connections

Each instrument in the system requires a grounded AC electrical outlet that provides voltage corresponding to the voltage marked on the instrument (120 VAC or 240 VAC).

Instrument grounding is required and it is accomplished by a third wire in your line voltage box. If your electrical outlet does not contain a ground, then contact your local electric company.

---

**Warning**

Do not remove or alter the ground pin on a three-prong line cord.

---

<table>
<thead>
<tr>
<th>13A, 250V Two-Pole with Earth Contact for use in Great Britain, Ireland, and Hong Kong</th>
<th>10/16A, 250V Two-Pole with Earth Contact for use in Austria, Germany, Italy, Netherlands, Norway, Portugal, Spain, and Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/16A, 250V Two-Pole with Dual Earth Contacts for use in Austria, Belgium, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, and Sweden</td>
<td>10A, 250V Two-Pole with Earth Contact for use in Switzerland</td>
</tr>
<tr>
<td>6/10A, 250V Two-Pole with Earth Contact for use in Denmark</td>
<td>200V Two Phase for use in Japan</td>
</tr>
<tr>
<td>10A, 250V Two-Pole with Earth Contact for use in Australia, New Zealand, and China</td>
<td>240V Single Phase for use in South Africa</td>
</tr>
<tr>
<td>20A, 115V for use in the United States</td>
<td></td>
</tr>
</tbody>
</table>

---

Figure 2-1. Typical AC outlet configurations.
Modifying the AC Line Cord

Ensure that the AC line cord plug is correct for your local electrical outlet. To modify an AC line cord:

1. Cut off the line cord plug.

2. Carefully trim the outer sleeve to expose three AC line signal wires (see Figure 2-2).

3. Carefully connect the three AC line signal wires to a plug suitable for the outlet in your location.

4. Connect a local plug to the three AC signal wires. Refer to Table 2-2.

<table>
<thead>
<tr>
<th>AC Line Signal</th>
<th>USA</th>
<th>International</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot (Live)</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Blue</td>
</tr>
<tr>
<td>Ground (Earth)</td>
<td>Green</td>
<td>Green/Yellow</td>
</tr>
</tbody>
</table>

Table 2-2. Wire color codes.

Figure 2-2. Line cord wires.
Making Electrical Connections

Setting up TotalChrom for GC Control and Data Processing requires the installation of several cables as described in the following paragraphs.

⚠️ Caution ⚠️

Installation of the special cable part number N620-0112 entails removal of the Clarus 500 GC cover and access to the main computer board. Improper installation or substitution of the cable will result in severe damage to the instrument.
Connecting the Stream Selector Cable N620-0112

The system selects either on-line ambient air or a calibration gas standard via the operation of rotary valve RVC in the diagram below. The operation of the Stream selection valve on the TurboMatrix, figure 2-3 is controlled from the Clarus 500 gas chromatograph by timed event of relay #1 using the special cable N620-0112. This cable includes an in-line relay, which converts the voltage output of the GC into a contact closure. The cable is attached to the TurboMatrix inputs marked STOP and GROUND. The TurboMatrix senses the contact closure and interprets this as a command to switch to the calibration gas port. Removing the contact closure causes the TurboMatrix to revert to the air sample stream. Figure 2-4 shows how the relay cable is installed.

The Sample/Calibration Gas stream selection is now controlled via a timed event entered into the Instrument Control Section within the TotalChrom Method. The very first run in a sequence needs to be handled in a slightly different way to subsequent runs and so four different TotalChrom methods will be required to select the appropriate vapor stream. Instructions for doing this are provided in the Running an Analysis Section 3.

Figure 2-3. Plumbing diagram showing the stream selector valve (RVC)
Connecting the TurboMatrix to the GC

Figure 2-4. Block diagram of the VOC Ozone Precursor System electrical connections.

Connecting the PC to the GC

1. Connect an Ethernet cable between the PC to the Ethernet port as shown in Figure 2-5 using the cable provided.
2. Power up the GC and PC.

5. Install the TotalChrom Workstation software on the PC and enter the user-license information according to the instructions provided with that product.
Installing the Heated Transfer Line

The heated transfer line connects the TurboMatrix Thermal Desorber to the Clarus 500 GC and consists of an insulated heater for the deactivated fused silica transfer line.

A silicone foam tube forms the exterior insulation and a braided heat-resistant sleeve is used to protect the silicone from extreme temperatures of the heater.

The transfer line may be heated to between 50°C and 300°C. A length of fused silica is sheathed in a stainless steel sleeve and transfers the volatile components from the cold trap to the GC column. The transfer line enters the GC through an opening in the rear panel.

Normally you will install the outer components of the transfer line at the GC and then at the TurboMatrix. Lastly, you will run the blank fused silica line, through the transfer line, from the GC oven to the TurboMatrix and make the required connections.
Installing the Heated Transfer Line in the Clarus 500 GC

To install the heated transfer line between the Clarus 500 GC and TurboMatrix Thermal Desorber:

Note: The long heated transfer line P/N M041-3306 is used to connect through the back of the Clarus 500 GC. The short heated transfer line (P/N M041-3332, not supplied) is used to enter the GC oven through an injector port.

6. Locate the heated transfer line assembly (P/N M041-3306) and remove it from the box.

7. Make two right-angle bends (with a radius of approximately 8-cm) in the heated transfer line assembly shown in Figure 2-6:

- At the GC end, make a bend that leaves a straight length of 50 cm. The GC end is the end without any electrical connections.
- The second bend is made after fitting to the GC. Bend the transfer line gently so that it comes forward and over towards the port on the TurboMatrix. Make a bend that leaves 9 cm of straight tube at the end with the electrical connections pointing to the right.

Figure 2-6. Bending the heated transfer line.
8. Position the TurboMatrix approximately 15 cm to the right of the GC.

9. Loosen and remove the four Phillips screws that secure the rear cover on the Clarus 500 GC. Remove the rear cover from the GC.

10. Locate the 1-inch access hole in the top right corner of the back of the oven.

11. Open the oven door and locate the PRT (temperature sensor). Loosen and remove the screw that secures the PRT.

![Diagram](image-url)

Figure 2-7. Removing the oven fan guard to install the heated transfer line.
12. Unscrew and remove the two screws that secure the oven fan guard. Remove the oven fan guard by bending it enough to clear the Deans' switch on the right side of the oven wall, see figure 2-7.

13. To clear a path for the transfer line, poke a hole through the oven insulation (with a rod or screwdriver) at the point where the transfer line will enter the oven.

14. Insert the GC end of the transfer line through the rear hole in the oven. If a TurboMatrix 300, 350 or 650 is used also insert the oven temperature sensor through the same hole and position it inside the GC oven.

15. Push the transfer line until the tube retainer is visible from inside the oven.

16. Remove the plastic plug from the Clarus 500 GC rear cover. Replace the rear cover on the GC and secure it in place. The foam rubber covering the transfer line is a tight fit with the pneumatic panel and will normally stay in position.

17. Using wire snips, cut a slot in the upper left corner fan guard for the transfer line. Cut the slot starting at the third square down from the upper left corner and cut four squares across, see figure 2-8.

18. Replace the fan guard in the oven. You will have to bend it to get it around the Deans' Switch and PRT. The PRT is very delicate and easily damaged.

19. Secure the fan guard with the two screws removed previously. Secure the PRT with the one screw removed previously.
Figure 2-8. Slot in the oven fan guard.
Installing the Heated Transfer Line in the TurboMatrix

To install the heated transfer line in the TurboMatrix:

1. Ensure that the TurboMatrix is not connected to the electrical or gas supplies.

2. Remove the top cover from the TurboMatrix by releasing 2 screws behind the transfer line entry, the top screw on the left hand front of the side cover and the nearest screw at the front of the top cover to the right of the transfer line. Pull the cover forwards.

3. Remove the front cover plate on the heated block by releasing the 4 screws holding it in place.

4. Pass the silicone foam rubber tube through the hole in the TurboMatrix top panel. The end of the foam-rubber will rest against the heated block. Reposition the TurboMatrix with respect to the GC if necessary. The electrical connector should be directed towards the right of the TurboMatrix (away from the GC).

5. Secure the end of the stainless steel sleeve to the TurboMatrix with the Transfer line clamp on the heated plate.

6. Cut the sealed end off the 0.32mm fused silica tubing (P/N xxxx-xxxx) and gently feed the cut end through the transfer line from the GC end. Push it through until it appears at the TurboMatrix end.

7. Place a sheet of paper below the transfer line connection to prevent any components that may be dropped from falling into the instrument.

8. Pull the end of the fused silica tubing forwards and away from the heated block to allow easier access. Position the 1/16-inch stainless steel nut (P/N 0497-2824) and a 0.5-mm i.d. graphite/Vespel ferrule (P/N 0497-2066; P/N 0992-0105, pkg of 10) over the end of the fused-silica tubing at the TurboMatrix end.
9. Withdraw the fused-silica tubing from the GC end of the heated transfer line until you can insert 3.5 cm of the free end of the fused-silica tubing into and through the outlet splitter block on the TurboMatrix. It may be easier to support the TurboMatrix end with some fine pointed tweezers to prevent the nut and ferrule from falling off whilst doing this.

10. Slide the nut and ferrule to the outlet splitter block and turn the nut until it is finger tight. Push the transfer line downwards until resistance is felt then withdraw the tubing by between 2 – 5 mm.

11. Make a leak-free connection by tightening the nut snug enough so that you cannot pull the fused-silica tubing out of the nut and ferrule. Usually ¼ turn beyond finger tight should be enough. **DO NOT OVERTIGHTEN THE NUT!**

---

**Note**

Do not touch the ferrules with your fingers. Use a tweezers or forceps to position the ferrules in the fitting or onto the fused silica line.

---

**Figure 2-9. Connect the Transfer Line to the Instrument Requires New Picture showing Temp Sensor Connections**
12. Connect the electrical connector to the receptacle located to the right of the cold trap. The connector is polarized so that it will only fit one way. Do not force the connection. If the TurboMatrix 300, 350 or 650 is used also connect the temperature sensor to the sensor connector.

13. Reconnect the electrical supply.
14. On the GC end, measure 20 cm of fused-silica tubing beyond the end of the transfer line. Cut off the excess fused silica tubing.

15. Insert the 0.5-mm union (P/N 0497-2073; P/N 0992-0144) in the square hole in the bracket. Secure the union to the bracket by inserting hairpin cotters (P/N 0992-3058) on the union above and below the bracket.

![Diagram of 0.5-mm Union and Hairpin Cotter](image)

**Figure 2-10. Connecting the 0.5-mm union to the bracket in the left side bottom hole of the oven wall.**

16. Put a nut and a graphite/Vespel ferrule (P/N 0497-2066; P/N 0992-0105, pkg of 10) over the end of the fused-silica tubing.

   **Note**

   Install the ferrule with the tapered end away from the body of the union.

17. Cut about 1 cm (3/8 inch) from the outlet end of the fused-silica tubing using a wafer scribe or other column cutting tool. Break off the tubing at the score mark making sure that the break is clean and square. Examine the cut with a magnifying glass and compare it to the following figure 2-11:
18. In the GC oven, make a single loop with the fused-silica tubing. Insert the end of the fused-silica tubing in the top of the 0.5-mm union on the left wall of the GC oven. Position the end of the fused silica tubing so that it is approximately halfway through the union.

19. Use a 1/4-inch wrench to tighten the nut only until you cannot pull the tubing from the nut. Usually ¼ turn beyond finger tight should be enough. DO NOT OVERTIGHTEN THE NUT!
Connecting the Tubing

The following figure 2-13 shows how to connect all tubing that is necessary to run the VOC Ozone Precursor Analyzer.

**Caution**

If you are using an air generator, make sure to connect (with a tee) an air cylinder into the air generator outlet line to use as a backup air supply if the AC power fails.

The air from the air generator or air cylinder should have a dew point of -50 °C or lower.

**Note**

The following diagram illustrates the tubing connection layout.

Figure 2-13. Tubing connection diagram.
Connecting the Vacuum Pump

To connect the vacuum pump to the air sampler:

- Connect the inlet port of the vacuum pump (P/N L427-1274 for 220/240V, L427-1275 for 120V) to the **Pump** port of the Air Sampler using the 1.9-mm i.d. Nylon tubing (P/N 0496-1164). See figure 2-14. Remove the protective cover over the pump outlet.

![Image of vacuum pump connection](image)

Figure 2-14a. Connecting vacuum pump to the air sampler.
Figure 2-14b Vacuum Pump Connections
Connecting the Nafion Air Dryer

The Nafion Dryer is easily damaged. Do not rotate the nuts that attach the Nafion tee fitting to the Nafion tube or you will rupture the membrane.

To connect the Nafion Air Dryer:

1. Connect the Nafion air dryer (P/N 0497-4414) to the **Dryer Return** and **Dryer Supply** tube stubs on the air sampler. Figure 2-15

2. Connect the plastic tube that exits the air sampler below the **Dryer Return** nut to the side arm on the **Dryer Return** tee using an 1/8-inch nut.

3. Connect a soap-bubble flow meter to the air purge outlet.

4. Using the needle valve on the air sampler, set the counter flow of dry air through the Nafion dryer to 240-250 mL/min.

![Diagram of Nafion Dryer Connection](image)

Figure 2-15. Connecting the Nafion Dryer.
Installing Columns

Install the transfer line from the TurboMatrix, PLOT column, BP-1 column and fused-silica restrictor in the Clarus 500 GC oven by referring to the following figure 2-16:

![Diagram of column connections]

Figure 2-16. Schematic of column connections.
Making Tubing Connections to the Deans’ Switch

When connecting fused-silica tubing or narrow bore fused silica columns to the Deans’ Switch, use the following procedure. This ensures that the end of the tubing or column is exactly aligned with the open end of the nut, ensuring a good connection.

1. Place the 1/16-inch extended nut (P/N 0990-3392, pkg of 5) on a flat surface with the closed end (the back of the nut with the small hole) facing up.

2. Insert the end of the fused-silica tubing through the small hole in the nut until the tubing reaches the flat surface.

3. Mark the tubing at the point at which it enters the small hole in the nut with a felt-tip pen, or a suitable alternative. Then remove the tubing.

4. Insert a graphite/Vespel ferrule (P/N 0497-2066; P/N 0992-0105, pkg of 10) into the nut as show in the above figure 2-17. Do not tighten.

5. Insert the tubing through the nut and ferrule until the mark aligns with the back of the nut.

6. Tighten the nut with a 1/4-inch AF spanner (P/N 0496-6624). For all connections to the Deans' Switch, brace the union with a second 1/4-inch AF spanner.

Note: The Deans’ Switch is fragile. YOU MUST use a second wrench when tightening to prevent rotation of the fitting.

Caution: Do not use graphite ferrules to connect tubing to the Deans' Switch. Always use graphite/Vespel ferrules. Pure graphite may extrude into the internal flow paths thereby causing blockages or adsorption of sample compounds.
Installing the PLOT Column

To install the PLOT column in the Clarus 500 GC oven:

1. Mount the 50m x 0.32mm Al₂O₃/Na₂SO₄ PLOT column (P/N N630-1107) on the column support in the rear of the oven.

2. Connect the inlet of the PLOT column to the top of the Deans’ Switch (Figure 2-19) using a 0.5-mm graphite/Vespel Ferrule (P/N 0497-2066; P/N 0992-0105) and nut. See “Making Tubing Connection to the Deans’ Switch” on page 2-26. USE TWO ¼ inch AF WRENCHES.

3. Cap the outlet end of the PLOT column with a septum.

Installing the BP1 Column

To install the BP1 column in the Clarus 500 GC oven:

1. Place the 50m x 0.22mm 1-µm BP-1 column (P/N N630-1108) on the front column support assembly, or tie the column onto the plot column using heat resistant string. (This method provides more room in the oven.)

2. Place a nut and a 0.5-mm graphite/Vespel Ferrule (P/N 0497-2066; P/N 0992-0105, pkg of 10) over one end of the BP-1 column tubing.

3. Cut about 1 cm (3/8 inch) from the end of the BP-1 column tubing using a wafer scribe or other column cutting tool. Break off the tubing at the score mark making sure that the break is clean and square. Examine the cut with a magnifying glass and compare it to the following figure 2-18:

![Figure 2-18. Example of a good tubing cut and bad cuts.](image-url)
4. Insert this end of the BP1 column into the glass-lined 0.5mm union on the left side of the oven wall.

5. Connect the nut to the union and tighten until it is finger tight. Make sure that the column butts up against the end of the TurboMatrix transfer line and then tighten with a pair of ¼ inch wrenches until the column cannot be pulled out. Usually ¼ turn beyond finger tight should be enough. DO NOT OVERTIGHTEN THE NUT!

6. Insert a nut and a 0.5mm graphite/Vespel Ferrule (P/N 0497-2066; P/N 0992-0105) over the other end of the BP1 column tubing.

7. Cut the end square and clean with a wafer scribe.

8. Insert this end of the BP1 column to the middle of the Deans’ Switch (Figure 2-19), so that the column just extends past the end of the nut. See “Making Tubing Connections to the Deans’ Switch” on page 2-26. USE TWO ¼ inch AF WRENCHES.

9. Install a length of 0.1mm i.d. fused silica restrictor tubing (about 40cm) to the lower side of the Deans’ Switch (Figure 2-19) so that the tubing just extends past the end of the nut. See ‘Making Tubing Connections to the Deans’ Switch” on page 2-26. USE TWO ¼ inch AF WRENCHES.

10. Plug the end of the restrictor with a septum to block it off temporarily.

![Connections to the Deans' Switch](image_url)

Figure 2-19. Connections to the Deans’ Switch
Leak Testing

To perform Leak testing.

1. Turn the TurboMatrix Thermal Desorber on, and select the STATUS/Pnu screen, where you can monitor the inlet actual pressure.

2. Ensure that the mid-point pressure regulator is wound fully out (depressurized) on a GC with manual pneumatics or that Valve 3 is set to OFF on a GC with PPC.

3. Set the TurboMatrix Thermal Desorber System Column Pressure to 47 psi by winding the pressure control knob located on the top left corner of the TurboMatrix 100 or 150 systems or by entering 47 psi on the screen for the TurboMatrix 300, 350 or 650. This pressurizes the entire TurboMatrix and columns set and the Deans’ Switch up to the septa.

4. Monitor the pressure reading for the AUX gas at the GC. If no leaks are present this will eventually reach 47 psi. It may take 10 or 15 minutes to stabilize as the gas has to pressurize both columns. If it does not reach 47 psi there is a leak somewhere between the transfer line connection on the TurboMatrix and the septa at the end of the PLOT column and the 0.1 mm restrictor. Use a 50:50 mixture of water: iso-propanol and “paint” each connection in turn to find the leak which will be shown by bubbles. Gently tighten the fitting until all trace of bubbles disappears.

4. A secondary leak test may be performed by depressurizing the TurboMatrix Thermal Desorber System inlet pressure regulator by winding the knob fully out (TurboMatrix 100 and 150) or by selecting <Tools>, <Maintenance>, <Column Leak Test> from the TurboMatrix 300, 350 or 650 touch screen and then observe the pressure reading on the TurboMatrix Thermal Desorber System display. The pressure should remain constant if there are no leaks.
5. If a leak is indicated (by falling pressure reading), find the leak and rectify it. Then pressurize the TurboMatrix Thermal Desorber System again by winding the regulator knob in to 47 psig, then repeat step 4.

6. Continue until there are no leaks.

7. You are now ready to continue the installation by measuring the carrier gas flow through the PLOT column.

**Measure the Plot column flow**

To measure the PLOT carrier gas flow rate:

1. Set the TurboMatrix carrier gas pressure once again to 47 psig using the pressure regulator on the 100 or 150 or by entering a column pressure of 47 psi using the touch screen on the 300, 350 or 650. Observe the actual pressure by selecting `<Show Actual>`.

2. Remove the septum from the end of the PLOT column and insert it through a 1/8 in Swagelok nut (P/N 0990-3453) and graphite ferrule (P/N 0990-3981). Cut about 1 cm off the end of the column using a wafer scribe.

3. Monitor the carrier gas pressure at the Aux Gas reading on the GC. It should eventually fall so that it is at 17.5 psi or lower. This may take 5 or 10 minutes as the gas has to escape through the PLOT column. If it does not drop to 17.5 psi or lower it suggests that there is a blockage in the PLOT column. Cut a bit more off the end of the column. If it still does not fall far enough there may be a blockage at the inlet to the column inside the Deans’ switch. Remove the column from the Deans’ switch, cut about 1 cm from the end, re-install to the Deans’ switch and repeat the Leak Test.

4. Once the Aux Gas pressure has fallen to 17.5 psi or lower, adjust it to 18 psi. If the GC has manual pneumatics this is done by turning the regulator (see Figure 2-20) clockwise whilst monitoring the Aux Gas pressure. Do this slowly and once at 18 psi observe it for several minutes to check that it is stable. For PPC controlled GCs set AUX gas 1 to 18 psi and set Valve 3 to “ON”.

5. Measure the flow using an electronic flow meter or soap bubble flow meter.

6. If using a soap bubble flow meter measure the flow until 3 readings in succession are identical. Record the flow rate, which should be between 1.9 and 2.3 mL/min.

7. Remove the septum from the fused silica restrictor and and insert it through a 1/8 in Swagelok nut (P/N 0990-3453) and graphite ferrule (P/N 0990-3981). Cut about 1 cm from the end with a wafer scribe. Measure the flow through the restrictor tubing. Cut off short lengths of the restrictor tubing until you achieve the same flow as through the PLOT column ±0.1 mL/min. Always wait some minutes to allow pressures to stabilize before measuring the flow. Hint: as the final flow is approached, cut off shorter and shorter pieces, each fresh piece being half of the previous piece. In this way you are less likely to cut off too much.
8. Repeat until the flow through the restrictor is the same as the column flow ±0.1 ml/min.

9. You are now ready to install the PLOT column and Restrictor to the detectors.

## Connecting Columns to the FIDs

Connect the PLOT column to FID B and the fused-silica restrictor to FID A:

### Connecting the PLOT Column to FID B

To connect the PLOT column to FID B:

1. Mark the exit end of the PLOT column 70mm from the end with a felt-tipped pen. Figure 2-21

   ![Diagram of Column Marked]  
   **Caution** To prevent contamination of the system, make sure the nut and ferrule do not contact the mark on the column.

   **Figure 2-21.** 1/8-inch nut and graphite ferrule on the detector end of the column and restrictor.

2. Locate the FID B fitting protruding from the right rear of the oven roof.

3. Insert the end of the column into FID B keeping the mark just behind the nut.

4. While holding the column in position, hand tighten the nut.

5. Hold the FID steady with one 7/16-inch wrench and gradually tighten the fitting with the other 7/16-inch wrench only until the column cannot be pulled out. **DO NOT OVERTIGHTEN THE NUT!**

### Connecting the Fused-Silica Tubing to FID A

To connect the fused-silica restrictor tubing to FID A:
1. Mark the exit end of the tubing 70mm from the end with a felt-tipped pen. Figure 2-21

---

**Caution**

To prevent contamination of the system, make sure the nut and ferrule do not contact the mark on the column.

---
2. Locate the FID A fitting protruding from the right front of the oven roof.

3. Insert the end of the tubing into FID A keeping the mark just behind the nut.

4. While holding the tubing in position, hand tighten the nut.

5. Hold the FID steady with one 7/16-inch wrench and gradually tighten the 1/8-inch nut with the other 7/16-inch wrench only until the tubing cannot be pulled out. DO NOT OVERTIGHTEN THE NUT!

6. Arrange the fused-silica restrictor tubing neatly inside the GC oven.

**Sweep Gas Setting**

The Sweep Gas needle valve is set at the factory and should not be touched. If the setting is disturbed, reset it so that the valve is open no more than 1/4 turn. This gives a small purge flow on the other arm of the Deans' Switch, preventing diffusion of sample into that arm. If this diffusion is not prevented, tailing and ghost-peaks may be seen in the chromatogram. If the needle valve is opened too much, sample can pass down the other arm of the Deans' Switch and cause peaks to appear on the other channel and the Deans’ Switch will not work.

**Connecting the Sampling Stream**

To connect the sampling stream:

1. Connect the air-sampling stream to the Sample port of the air sampler using suitable tubing (usually 1/8-inch stainless steel).

   **Caution**

   To prevent blockage of the sample flow path, prevent rain from directly entering the system. Set up the sampling connection as shown below.

2. Connect the Calibration Gas port of the air sampler to a supply of calibration gas.

3. On a TurboMatrix 150, 350 or 650 System, place a capped, empty sample tube in carousel position 1.
Conditioning the Columns

When first installed and when the system has been idle for any length of time the columns will need a short conditioning period. This is especially true for the Al₂O₃ Plot column which will adsorb moisture which, in turn, will affect the selectivity of the columns. Components with treble bonds and conjugated double bonds are more likely to be affected by moisture and their retention times will be variable until the column has been conditioned. Once the system is running the moisture content of the Al₂O₃ Plot column remains constant by firstly removing most of the moisture in the sample with the nafion dryer and also by programming the columns to 200°C and holding at this temperature for 6 minutes.

Condition the columns by entering the following conditions using the Clarus 500 GC touch screen.

Caution

To prevent particles entering the system, some users install a 7µ in-line frit, obtainable from Swagelok.
In addition to the GC conditions above ensure that the column pressure on the TurboMatrix is set to 47 psi. Ensure that both detectors are lit and then press START on the GC touch screen.

### Conditioning the Cold Trap.

The TurboMatrix cold trap will also need conditioning before sampling can begin. This can be done at the same time as column conditioning. Using the Touch Screen on the TurboMatrix select the **Temp** screen and enter a Trap High Temperature of 400 °C and the Valve Temperature to 200 °C. On the **Timing** Screen touch the **<Trap>** button and set Temperature Hold time to 270 minutes. On the **Options** Screen set the **<Mode>** to **Trap Clean**. All other parameters are not important for Trap conditioning. Press **<Start>** on the Touch Screen.

---

**Clarus 500 GC Controlling Method Parameter**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVEN TEMP 1</td>
<td>46°C</td>
</tr>
<tr>
<td>OVEN TIME 1</td>
<td>0</td>
</tr>
<tr>
<td>OVEN RATE 1</td>
<td>5.0°C/min</td>
</tr>
<tr>
<td>OVEN TEMP 2</td>
<td>200°C</td>
</tr>
<tr>
<td>OVEN TIME 2</td>
<td>720 minutes</td>
</tr>
<tr>
<td>AUX GAS 1</td>
<td>18 psi</td>
</tr>
<tr>
<td>VALVE 1 INITIAL</td>
<td>ON</td>
</tr>
<tr>
<td>VALVE 2 INITIAL</td>
<td>OFF</td>
</tr>
<tr>
<td>VALVE 3 INITIAL</td>
<td>ON</td>
</tr>
<tr>
<td>FID A TEMP</td>
<td>250°C</td>
</tr>
<tr>
<td>FID B TEMP</td>
<td>250°C</td>
</tr>
</tbody>
</table>
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This chapter describes how to use the Ozone Precursor Analyzer to measure the atmospheric concentration of the volatile ozone precursors listed in Title 1 of the US Clean Air Act Amendment (USCAAA) 1990. In particular, this chapter describes how to:

- Set up the heart-cut and establish chromatography
- Change the sample stream selector
- Set up the system for automated sampling
- Set up the TurboMatrix method
- Set up the GC method
- Set up the TotalChrom data collection system
- Create a sequence
Setting Up the TotalChrom Data Collection System

You should be familiar with TotalChrom before attempting to set up and run a method. This section briefly describes the steps necessary to create a typical TotalChrom method that is used to collect data from the Ozone Precursor System. For complete detailed TotalChrom operating instructions, refer to the TotalChrom User's Guide.

Before setting up TotalChrom, it is strongly recommended that paths are set up for GC methods, sequences and data files. When the system is running it will collect data files each hour and each hour it will generate a Raw data file and a Result data file for each detector. In a 24 hour period 4 x 24 = 96 data files will be stored so the data directory will soon contain a large number of data files. It is strongly recommended that the data is subdivided into monthly files. The following format is suggested and needs to be generated from the Windows OS using <My Computer> or <Explore> before TotalChrom can be set up.

c:\Ozone\method

c:\Ozone\sequence

c:\Ozone\data\Jan07

c:\Ozone\data\Feb07

c:\Ozone\data\Mar07 etc.

The TotalChrom Navigator

Note: The Clarus 500 GC must be configured according to the TotalChrom User Manual prior to applying these instructions.

You access the various functions in TotalChrom from the Navigator window. Quite often this is set up as a shortcut on the desktop. If not it can be found from <start> <All Programs> <TotalChrom Workstation Ver 6.3.1> <TC Navigator>.

Note: - at the time of writing this manual TotalChrom Workstation Version 6.3.1 is the current product. If any upgrades to the software occurs the Version number displayed may be different to that shown above.

To open the Navigator window:

1. From the Windows Desktop, double-click on the TCNav icon.

Figure 3-1 TotalChrom Navigator Shortcut
The Logon dialog box appears:

![TotalChrom Logon Dialog Box](image)

**Note** You must logon to a user account that has manager permissions enabled. If you have any questions, consult your system manager.

2. Enter your Logon User Name and your Password. Then choose **OK**.

The Navigator window appears:

![TotalChrom Navigator Screen](image)

**Figure 3-3 TotalChrom Navigator Screen**

The Navigator window is a graphical representation of the major functions in TotalChrom. The Navigator has four main areas:
- Title Bar and Menu Bar on the top.
- Instrument Selection Panel on the left.
- Function Buttons in the central part of the screen.
- Status Bar at the bottom of the window.

Configuring Data Paths and Data File Names

Firstly the File paths need to be set up. From the Menu bar click on Admin and then select System configuration.

Figure 3- 4 Access to System Configuration

The System Configuration screen appears. Select the Users tab.

Figure 3- 5 System Configuration Screen
Select the User name that will be used to operate the Ozone Precursor System and Select Default Paths/Base Names. In the example above the user name is manager.

![Figure 3-6 Setting File Paths]

Set the Raw data, Result data, methods, sequences and Report Format paths as shown using the Folder Browse buttons at the side. Ensure that the Method path and the Report Format path are the same.

*Note:* the Raw data and Result data paths will have to be changed at the start of each month.

It is also possible to set Raw and Result data file names on this screen. This is achieved by either typing the required file names or by selecting the button by the side of each entry box which allows token strings to be used.
Figure 3-7 Setting Base Data File Names

To make file identification easier it is recommended that the following file name format is used.

<Year>_<Mon>_<DOM>_<Chan>

Data files will then be labeled with the Year_Month_Day of Month_Channel followed by a 3 digit number running from 001 to 999.

Accept the entries by clicking on <OK> and save the configuration using <File><Save>. Then return to the Navigator Screen.
Preparing for Sample Collection.

There are a number of ways that the System can be set up to collect samples and process the data. The TurboMatrix Thermal Desorption System is used to collect sample and pass it to the Clarus 500 GC. The TurboMatrix may either be controlled through its own touch screen or by Remote Control Software (RMS) installed on the PC whereas the Clarus 500 GC will be controlled from TotalChrom software installed on the PC. Although TotalChrom Rev 6.3 or later may incorporate TurboMatrix control as part of the GC method it is not recommended that this facility is used. The reason is that the GC method will be used to switch between the sample stream and the calibrant gas and this will cause the TurboMatrix to stop and restart when this happens causing the sampling period to change.

Setting up the GC using TotalChrom

Firstly, the time at which the sample is prevented from entering the PLOT column needs to be established. This will be around 7-8 minutes but as each column set may vary slightly from another, the time must be established for each set of columns. To do this set the following conditions for the Clarus 500 GC by selecting the Method button on the Navigator Screen. Before this is done the GC columns and the TurboMatrix cold trap must be conditioned as described in Chapter 2.

![Method Button](image)

*Figure 3-8 The Method Button*

Select Build new method and select the instrument name and select **OK**. On subsequent screens select **Next** until the Data Acquisition Screen appears. Enter the following parameters:

Set Data Acquisition Data Channels to <Dual>, Set Data Rate to 3.75 pts/s (60Hz mains frequency) or 3.125pts/s (50Hz mains frequency) and select Store all data from Run.
Set the Oven temperature as shown below:

Set Aux Pressure 2 to 18psi.
Running an Analysis

Preparing for Sample Collection.

3-3

Figure 3-11 Instrument Control - Gas Pressures

Set the Detector Conditions as shown below:

Figure 3-12 Instrument Control - Detector Settings

On the instrument Timed Event Page make sure the Initial Settings for Valves 1 and 3 are ON and Valve 2 is OFF. Valve 1 selects the Calibration gas on the TurboMatrix, Valve 3 supplies carrier gas to the Deans’ Switch and Valve 2 directs the sample to the PLOT column. For the first run all of the calibration gas will be directed away from the PLOT column. Set an Instrument Timed Event at Time 0.15 minutes Valve 1 OFF. This will turn off the flow of calibration gas.
Click on Apply followed by Cancel and save the method with the name Ozone 1 and close the Method Editor.

Building a Sequence to Establish the Cut Time

Access the Sequence by selecting the Sequence Button

Select New Sequence and when the Global Parameter screen appears select the correct Instrument Name and Build from Template.
Running an Analysis

Preparing for Sample Collection.

Figure 3-15 Sequence Global Parameters

When the Template screen appears select in Method Ch A Ozone 1.mth

Figure 3-16 Sequence Template

Leave all the other parameters the same and select OK

When the Sequence list appears save the file with the name Set up and, when saved, select <Actions> <Setup>
Running an Analysis

Preparing for Sample Collection.

**Figure 3-17 Setting up the Sequence for the First Run**

On the Setup page ensure that first and last rows are set to 1. Leave <Start run when Ready> unchecked and select OK. The method will now be loaded to the Clarus 500 GC.

**Figure 3-18 The Set Up Screen**

TotalChrom is now set up and ready to start collecting data.

**Setting up the TurboMatrix Thermal Desorber**

The TurboMatrix needs to be set up to inject a calibration gas so that the Cut Time can be determined. Using the Touch Screen on the TurboMatrix Thermal Desorber enter the Temperatures as follows:-
Figure 3- 19 TurboMatrix Status Screen - Temperatures

Change to **Timing** and enter the following times:-

Figure 3- 20 TurboMatrix Status Screen - Timing

The trap hold time needs to be set to 6 minutes which is done under the **<Trap>** button:-

Figure 3- 21 TurboMatrix Status Screen - Trap Hold Time

Next Select **Option** and set up as follows:-
Figure 3-22 TurboMatrix Status Screen - Options

**Note:** Cycles per tube is left to 1 for the moment. This is because the GC method will need to be changed after the first run. When the system has been set up correctly this will be changed to 99 for continuous sampling.

Finally select Pnu and enter the following:

![Image of TurboMatrix Status Screen - Options]

Figure 3-23 TurboMatrix Status Screen - Pnuematics

In addition, for the TurboMatrix 100 and 150 it will be necessary to adjust the pressure manually to 47psi using the regulator at the top rear of the TurboMatrix and adjust the outlet Split to 2ml/min and the Desorb Vent flow to 15ml/min using an electronic flowmeter. See Page 3-9

For a TurboMatrix 300, 350 or 650 click <Trap> button and set <Column setting during trap desorb> to 47psi

Connect a Calibrant Gas to the Calibrant port at the back of the Air Sampler accessory and ensure that the gas bottle tap is open.

For the TurboMatrix 150, 350 and 650 ensure that a tube is loaded into position 1 on the carousel and then select the Run Screen and ensure that the tube numbers are set to Tubes 1 to 1
Running an Analysis

Preparing for Sample Collection.

For the TurboMatrix 100 and 300 load a tube manually.

Press Start. The system will collect a 600ml sample of the calibrant gas over a period of 40 minutes and then inject it into the Clarus 500 GC.

Setting Carrier Gas Pressure and Flows on TurboMatrix 100 and 150

Setting Carrier Gas Pressure

1. On the TurboMatrix 100 and 150 the carrier gas pressures and gas flows must be set manually before the system may be used. This must be done from the screen on the TurboMatrix, not from the Remote Control Software. Go to the <Pnu> screen and set the Column Pressure to 47 psi.

This will only be used to ensure that the carrier gas pressure has been set correctly. It will cause the system to STOP if the pressure is not correct. Select <Show Actual> and adjust the pressure using the large black knob mounted behind the transfer line until the pressure shows 47.0 psi. Adjust the pressure slowly by winding the knob in a clockwise direction, increasing from a lower pressure to 47.0 psi. If the pressure is higher than 47.0 psi wind the knob anti-clockwise and allow time for the pressure to decrease. The excess
pressure can only escape through the column and this may take several minutes. When the carrier gas pressure has fallen below the required pressure adjust to the correct pressure by turning the knob clockwise slowly.

![Figure 3-26 TurboMatrix 100 and 150 Display Actual Pressure](image)

### Setting Outlet Split Flow


2. Connect a flowmeter to the split vent on the TurboMatrix TD system behind the Transfer Line.

3. Adjust the outlet split needle valve until you achieve a flow rate of 2 ml/min of helium exiting the split vent. Once achieved, press the Stop button to close the split vent and return to normal operation.

![Figure 3-27 TurboMatrix 100 and 150 Setting Outlet Split](image)
Setting Desorb Flow Rate

1. Place an empty tube in Position 1 on the TurboMatrix 150 carousel or manually seal a tube into position on the TurboMatrix 100.

2. On the TurboMatrix touch screen display, select `<Tools> <Maintenance> <Inlet Split>`.

3. Wait until the tube has loaded and the Touch Screen displays IN SPLIT ADJ.

4. Connect a flowmeter to the Desorb vent on the TurboMatrix TD system behind the Transfer Line.

   Adjust the Desorb Vent needle valve until you achieve a flow rate of 15 ml/min of helium exiting the Desorb Vent. Once achieved, press the Stop button to close the Desorb vent and return to normal operation.

*Figure 3-28 TurboMatrix 100 and 150 Setting Desorb Flow*
Determining the Cut Time

Wait until the GC has finished running and examine the chromatogram collected.

The n-hexane peak should occur just after 8 minutes and can be identified by reference to the chromatogram above. The cut time should be set to mid way between the couplet just before n-hexane and n-hexane. (Figure 3-29).

Note: The cut time given above is recommended for systems used for measuring the compounds listed in USCAA. In Europe, where there is a requirement to measure isoprene, some users prefer to set the cut time just after n-hexane so both n-hexane and isoprene are separated by the PLOT column.

In TotalChrom, open the Ozone 1 method and Select Instrument Timed Events. Modify the Timed Event table so that Valve 2 is turned on at 0.1 minutes and Turned off at the Cut Time determined above.
Running an Analysis

Determining the Cut Time

Save the method as Ozone 1 and Set up the same sequence, this time starting and ending at Row 2. Restart the TurboMatrix Thermal Desorber and collect another sample of the calibrant gas. This time all components that elute before n-hexane on the BP1 column will be transferred and separated on the PLOT column and be seen by Detector B. All components from n-hexane and later will be separated by the BP1 column and will be seen by Detector A. A typical separation of a calibration gas on both columns is shown in Appendix 2.

When the chromatograms have been collected use Graphic Edit to open up the chromatogram (Raw data file) from Channel A, The BP1 Column.

Using the annotated chromatograms in Appendix 2 assign the correct names to each peak. Make any other changes to the method that may be necessary to ensure that the peaks are integrated correctly. Refer to the TotalChrom manual if in any doubt. Save the method as Ozone 1.

Now open up the chromatogram (Raw data file) from the PLOT column on Detector B. using <File><New Data File>. This will initially open with the Ozone 1 method again. From the tool bar select <File> <New> and again using the annotated chromatograms in Appendix 2 assign the correct names to each peak and make any other changes to the method to ensure correct integration of all peaks. Save this method as Ozone 2. Close the Graphic Edit window.
Open Method **Ozone 1**, Select from the Menu Bar **<Components><Edit Component>**

![Image](image1.png)

**Figure 3-32 Accessing Edit Components**

In the Components window select the Calibration tab and change the **Calibration Type** to **Avg calibration factor** for the first component in the list. Enter **Level 1** as A and, by referring to the certificate that came with the calibration gas, enter the amount and select **<Next>**. Repeat for each component in the list.

![Image](image2.png)

**Figure 3-33 Entering Calibration Amounts in Method**

Save the method and repeat for method **Ozone 2**.

**Note:** when a new calibration mix is used the amounts for each component in both methods will need to be changed.

Methods now need to be created to switch between Calibration gas and sample gas. This can be done by modifying the Instrument Timed Events list in Method **Ozone 1**.
Open Method **Ozone 1** and select <File><Save as> from the menu bar. Rename the Method **Ozone 3**. Select <Instrument><Control Options><Instrument Timed Events> from the menu bar.

![Image showing method editor interface]

**Figure 3-34 Accessing Instrument Timed Events**

On the Instrument Timed Events page change the Initial Setting for Valve 1 to Off.

![Image showing instrument control interface]

**Figure 3-35 Modifying the Method to collect an Air Sample**

Select OK and using <save as> save the method as **Ozone 1**. When informed that the file already exists select <overwite>.

Open the Instrument Timed Events page again and enter at 0.11 minute Valve 1 ON.
Running an Analysis

Determining the Cut Time

Figure 3- 36 Modifying the method to take a Calibrant Gas for the next analysis

Save this method as **Ozone 4**.

**Note:** Valve 1 in the GC method is used to switch RVC to take a sample of calibration gas. The timing of Valve 1 is controlled by the TurboMatrix software and providing Valve 1 is in the ON state when the cold trap reaches its lower temperature RVC will be switched to the Calibration Gas position. If Valve 1 is OFF RVC will take an air sample.

The 4 Methods are used as follows:

**Table 1 Clarus 500 Methods**

<table>
<thead>
<tr>
<th>Method</th>
<th>Sample Stream</th>
<th>Data Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone 1</td>
<td>Air Sample</td>
<td>BPI column data</td>
</tr>
<tr>
<td>Ozone 2</td>
<td>-</td>
<td>Al₂O₃ PLOT column data</td>
</tr>
<tr>
<td>Ozone 3</td>
<td>Calibration Gas (This Run in Sequence)</td>
<td>-</td>
</tr>
<tr>
<td>Ozone 4</td>
<td>Calibration Gas (Next Run) (Followed by Ozone 3)</td>
<td>-</td>
</tr>
</tbody>
</table>

**Note:** Ozone 3 must be used after Ozone 4 to maintain the Calibration gas flow when the current run finishes.
Building a Sequence to Collect Data

The sequence will control the frequency of calibration and specify which methods are used to control the GC and to process the data from the BP1 column and the data from the Al$_2$O$_3$/PLOT column. The sequence that is described below is designed to inject a calibrant gas and replace the Calibration Factors every 25 samples. This means that, assuming the TurboMatrix Thermal Desorber is set to take a sample every hour, the calibration run will occur at a different time each day. It is the responsibility of the user to decide on the calibration frequency for their own particular requirements and the following is given as an example. If other calibration frequencies are required then the sequence will need to be changed in order to accommodate the requirements of the user.

Select Sequence from TotalChrom Navigator page

![Sequence](image)

*Figure 3- 37 Accessing the Sequence*

Then Select <Create new sequence>

![Create new sequence](image)

*Figure 3- 38 Creating a New Sequence*

Select the name of the GC being used and Select Build from Template
Select the Configuration tab and under methods, chose <Multiple per Row> and then select OK.

On the Sequence Template window the entry for Study may be used to identify the site name or location. Under Method for Ch A select Ozone 1 method and for Ch B select Ozone 2 method. Set # samples between calibrations to 25 and Number of samples to 24. Ensure that Include Calibration Standards in checked and that First Injection is set to Calib:Replace. Then select OK.

Note: if the calibration data is to be averaged with previous calibration data then chose Calib: Average
When the sequence spreadsheet appears point the mouse at the grey header row and, using the right mouse button, select "unhide columns".

**Figure 3-41 Sequence Template**

**Figure 3-42 Showing Columns in Sequence Editor**
Ensure that Proc Method and Calib Method are moved from the <Columns hidden> list to the <Columns shown> list.

**Figure 3-43 Setting Columns to be shown**

The Sequence should show **Ozone 1** under the Inst Method and Channel A should also show **Ozone 1** as the Proc Method and Calib Method. For Channel B **Ozone 2** should be under Proc Method and Calib Method.

**Note:** The Vial Number will not be used with the Ozone Precursor System so may be moved to the Hidden Columns.

**Figure 3-44 Sequence showing Instrument, Processing and Calibration Methods**
In Row 1 change the Inst Method to **Ozone 3**. This is done by double clicking in the cell and selecting **Ozone 3** method from the list. Scroll down to row 25 and select **Ozone 4** for the Instrument method. This may be done to either Channel A or Channel B as columns colored yellow will apply to both channels. The sequence should then appear as below.

*Note:* The Channel A window has been expanded over the top of Channel B window to show both Rows 1 and 25.

---

**Figure 3-45 Changing the Instrument Method in the Sequence**

The sequence now contains enough rows for 25 hours of sampling (assuming 1 sample per hour). Row 1 will switch to sample the Calibrant gas for the first run and will calibrate the method ready for subsequent samples. Rows 2 to 25 will take an air sample and calculate the concentration according to the calibration performed in Row 1. Also for the last sample (Row 25) the Inst Method will switch the calibration gas on after 12 minutes ready to collect a calibrant gas for the next analysis.

The sequence now needs to be modified to provide sampling for longer than 25 hours. A simple way to do this is to save the sequence with a name such as 1day.seq. Then select **<Build>** from the menu bar and select **<append new sequence>**. When the file list appears select **<1day.seq>**. The sequence will now contain enough rows for just over 2 days (50 hours).
Building a Sequence to Collect Data

Repeat this step until enough rows have been added for 1 month of sampling.

Note: This can be speeded up by saving as 3 day.seq, 6 day.seq etc when sufficient rows have been added. The required number of hours in a month and hence rows required are:

**Table 2 Number of Hours per Month**

<table>
<thead>
<tr>
<th>Month</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 Day month</td>
<td>672</td>
</tr>
<tr>
<td>29 Day Month</td>
<td>696</td>
</tr>
<tr>
<td>30 Day Month</td>
<td>720</td>
</tr>
<tr>
<td>31 Day Month</td>
<td>744</td>
</tr>
</tbody>
</table>

When the sequence is finished save it.

Note: If the sequence has been generated using the method described above the last row will have the Inst Method as **Ozone 4**. This means that if the system is left idle with no more data collected the Calibration gas canister will be left in an open state and calibration gas will be wasted. As the sequence has been extended by adding 25 rows each time there is likely to be more rows than required for a month’s sampling. However, it is probably wise to change the last row of the sequence so that the Inst method is **Ozone 1** before it is saved. This will mean that if a new sequence is not set up before the current sequence finishes the calibrant gas cylinder will be remain closed.
Select Actions from the Menu Bar and Select Set Up

When the Set Up window appears it is possible to modify the number of rows to be analysed. If Supress Reports/Plots is selected nothing will be sent to the printer. Click OK. This will set the GC up by downloading the method and will be ready to acquire data.
All that remains is to start the analysis from the TurboMatrix Thermal Desorber. Before this is done it is necessary to select the <Options> tab and change Cycles/Tube to 99. This will ensure that the tube remains sealed in place until the system is stopped manually.

![Figure 3-49 TurboMatrix Option Screen Set for Continuous Sampling](image)

Once Start is pressed the System will take a sample every hour until stopped manually. The TotalChrom sequence will need to be re-started periodically and it is recommended that this is done at the start of each month when the Data path can be changed to a new month and a new sequence generated. At the end of each analysis there is a period of about 20 minutes whilst the GC cools down ready for the next sample when these changes can be made without interrupting the sampling.

**Starting a New Sequence.**

Each month the sequence will need to be replaced with a new sequence to ensure continuous operation. The simplest way to create a new sequence is to make a copy of the existing one. However the data path set in the sequence will take precedence over data paths entered elsewhere in TotalChrom If the data is to be saved in a different directory each month proceed as follows:-

1. Wait until the GC has finished an analysis and then Select <Run> <Clear Setup>

2. Open the existing sequence and find the column labeled Data in the channel A spreadsheet. Click on the Column header to highlight all the cells in the column.
3. Point the mouse in the highlighted column and click the right button. Select <Edit Token String>.

4. Change the Data Path and select OK.

5. Repeat for Channel B.

6. Save the Sequence and select <Action> <Setup>.

Note: The TurboMatrix does not need to be stopped and will continue to collect an air sample. From the end of the GC analysis there is about 12 minutes to make the above changes before the TurboMatrix wants to inject the next sample. This should be sufficient time but if you are not sure that you can do this in 12 minutes it may be easier to do the changes whilst the GC is in the middle of an analysis. Open the existing sequence. This will be in a “locked” state whilst the GC is running and will only open in a “read only” state. Make the changes to the data paths described above and then, using <save as>, save the sequence with a new name. Wait until the GC finishes its current analysis and then select <Run> <Clear setup>. Then select <Setup> and select the new sequence.
Setting Up Control of the TurboMatrix through Remote Control Software (RCS).

1. Install the TD Remote Control Software (P/N M091-3559) on the PC as described in the supplied instructions.

2. Start the TD Control Software program.

   The following screen appears:

   ![Figure 3-51 RCS Add Instrument](image)

3. Double-click on the **Add Instrument icon**.

   The TD Properties screen appears:

   ![Figure 3-52 RCS Properties Screen](image)
4. Set the TD Properties Name as Ozone and then select <Configuration>.

Ensure that the correct instrument type is selected from the list and that <On-Line> is also selected. It is not necessary to configure the PPC as the Ozone Precursor system must use pressure regulated carrier gas.

5. From the following screen select the <TD> tab

![Figure 3- 53 RCS Configuration Screen](image)

![Figure 3- 54 RCS Lab Screen](image)
6. A screen similar to the following should appear.

![Figure 3- 55 RCS Connect Button](image)

7. Click on the Connect button or select Connect from the Options menu. The software will begin to establish communications with the TD.

8. Once communication has been established, the screen should reflect the current conditions on the TD as shown below.

![Figure 3- 56 RCS Connected](image)
9 Generate and save a new method called Ozone containing parameters shown in the following four screens. Refer to the Remote Control Software manual for guidance in generating methods.

Create a Sequence in Remote Control Software

1. On the PC, click on the TurboMatrix software Sequence tab and build a sequence as shown below, with First Tube = 1 and Last Tube = 1. Save this sequence as Ozone.TDS using <File><Save> on the Menu bar.
2. Click on the Green “double arrow” to Start the TurboMatrix

Figure 3- 58 RCS Sequence Screen
Running an Analysis

Setting Up Control of the TurboMatrix through Remote Control Software.
System Maintenance

Replacing Gases ............................................................................................................. 4-2
  Using Hydrogen ............................................................................................................. 4-3
  Replacing a Gas Cylinder ............................................................................................. 4-4
Leak Testing ....................................................................................................................... 4-5
  To test for leaks: ............................................................................................................. 4-5
Lighting the FIDs .............................................................................................................. 4-7
  To light the FID flame: ................................................................................................. 4-7
The Cold Trap ..................................................................................................................... 4-10
  Conditioning the Cold Trap ......................................................................................... 4-10
  Replacing the Cold Trap .............................................................................................. 4-12
Column Conditioning ........................................................................................................ 4-12
Data File Maintenance ....................................................................................................... 4-14
  Changing the File Path in the Sequence ..................................................................... 4-14
This chapter describes typical system routine maintenance procedures you can perform. In particular, this chapter describes how to:

- replace gases
- light the FID flame
- replace and condition the cold trap
- condition the column set
- store/move data files collected by TotalChrom

For maintenance procedures on a specific instrument, refer to the instrument manual for detailed procedures.
Replacing Gases

Cylinders (tanks) of compressed gases should be handled with caution. Avoid knocking the valves against anything, and ensure that the correct valves and gauges are installed. We recommend storing gas cylinders outside the laboratory and connecting them to the instrument with copper lines. Take care not to kink or stress the gas lines. For safety, gas cylinders must be firmly clamped in the upright position.

When hydrogen is used special care must be taken to avoid buildup of explosive hydrogen/air mixtures. Ensure that all couplings used in the hydrogen lines are leak-free. Never allow hydrogen to vent within the GC oven.

Due to the continuous operating features of the Ozone Precursor Analyzer, there are some special requirements for the gas supplies of the chromatographic system. See figure 4-1.

**Table 4-1. Gas use for the Ozone Precursor Analyzer System.**

<table>
<thead>
<tr>
<th>Gas</th>
<th>Manual Pneumatics Supply Pressure (PSI)</th>
<th>PPC Supply Pressure (PSI)</th>
<th>Use</th>
<th>Flow Rate (mL/min)</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helium</td>
<td>&gt;60</td>
<td>70-90</td>
<td>Carrier</td>
<td>5</td>
<td>Lasts 3 months</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>&gt;40</td>
<td>70-90</td>
<td>FID Fuel</td>
<td>~80</td>
<td>Lasts 5 weeks</td>
</tr>
<tr>
<td>Air</td>
<td>80-120</td>
<td>70-90</td>
<td>Nafion Dryer</td>
<td>250</td>
<td>An air cylinder lasts 5 days</td>
</tr>
<tr>
<td></td>
<td>NOTE: Dew point must be &lt; -50ºC</td>
<td>NOTE: Dew point must be &lt; -50ºC</td>
<td>FID Fuel</td>
<td>900</td>
<td>(An air generator lasts indefinitely.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TurboMatrix Power</td>
<td>Negligible</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Peltier Purge</td>
<td>160</td>
<td></td>
</tr>
</tbody>
</table>

Each Ozone Precursor Analyzer system needs helium for carrier gas, hydrogen for FID fuel, and air for multiple purposes, including FID fuel, ATD power, and Nafion dryer operation. (Hydrogen must not be used as a carrier gas because it converts acetylene to ethane.) The helium gas should be the best chromatographic grade (99.999% purity) available, with an oxygen filter. This prevents oxidation of the methyl silicone phase and consequently keeps the column bleed to a minimum. Hydrogen gas should also be the best commercial grade available for normal chromatographic operation.

Air is a major concern since one Ozone Precursor Analyzer system will use one five-foot cylinder in about six days. The Peltier cooled cold trap always has some surfaces that are at -50ºC and to prevent ice formation the cold trap is purged with air continuously. The air must be as DRY and MUST HAVE A DEW POINT OF LESS
THAN -50°C. It is not recommended that standard breathing air or air from a laboratory compressor is used. Compressor air contains high levels of moisture which will damage the peltier cooler and eventually lead to component failure. An air dryer accessory (P/Nxxxx-xxxx) is available to remove moisture from the air supply to both the peltier cooler and the Nafion dryer.

However a laboratory air compressor may be used in conjunction with a Zero Air Generator such as the Whatman Model 78-30 (M130) with Receiver tank Type 72-007 and may be purchased from PerkinElmer as part of the system. This is a self-drying generator, so no additional filters are required. With a Zero Air Generator installed, a system can run for almost one month or more without a visit or tank change. This means that the highest level of system reliability is achieved and, hence, more hourly samples are collected. The payback period is about one year based on normal supply costs, in addition to the savings on visits, replacement filter dryers, etc. It is very desirable to have a system that runs at least three weeks without a tank change. However, if AC power is lost, the air generator stops and the FID flames will be extinguished. If the GC has Programmable Pneumatic Control (PPC) the GC can be programmed to light the flames automatically. However GCs with manual pneumatics require some user intervention to light the flames so it is recommended that a backup air tank is connected as well so that air will be provided if the air generator fails.

Using Hydrogen

<table>
<thead>
<tr>
<th>Warning</th>
</tr>
</thead>
</table>

Flame Ionization Detectors use hydrogen as fuel. If the hydrogen is turned on without a column attached to the injector and detector fittings inside the oven, hydrogen could diffuse into the oven creating the possibility of an explosion. To prevent possible injury, **DO NOT TURN ON THE HYDROGEN UNLESS A COLUMN IS ATTACHED AND ALL JOINTS HAVE BEEN LEAK TESTED.**

Before disconnecting a column from the injector and detector, make certain that the hydrogen has been turned OFF.

If two FIDs are installed and only one has a column attached to it, make certain that you cap off the unused detector inlet fitting with a 1/8-inch stainless steel plug (P/N N930-0061).
Replacing a Gas Cylinder

To replace a gas cylinder without extinguishing the FID flame:

1. Install the replacement tank next to the tank you are replacing and remove the safety cap to expose the tank valve.

2. Locate an adjustable wrench and adjust it to the proper size to remove the regulator fitting from the tank.

   **Note** Note the output pressure gauge reading. Once you turn the pressure regulator knob off, you have about 30 seconds to connect the pressure regulator it to the new tank.

3. On the tank you are replacing, turn the regulator pressure control knob completely counterclockwise (OFF).

4. Turn off the tank valve.

5. Using the adjustable wrench, disconnect the regulator fitting from the old tank and quickly connect it to the new tank.

6. Turn the new tank valve on and turn the regulator pressure control knob back until the pressure is restored.

7. Check the connections for leaks.
Leak Testing

You must perform a leak test whenever you change the column or transfer line.

The TurboMatrix Thermal Desorber automatically performs a leak test on the sample tube and the cold trap before starting the thermal desorption process. However, there are some parts of the system that are not included in this test, in particular the column connections.

Any leak in the system prior to the column is equivalent to an uncontrolled split vent, and as such renders quantitation impossible. As with any GC installation it is imperative to eliminate all leaks in order to achieve optimum chromatography.

The TurboMatrix can help with this problem since it automatically performs a leak test on the sample tube and the cold trap before the thermal desorption process starts. However, there are some parts of the total analytical system that are not included in this test, in particular the GC column connections.

It is strongly recommended that you perform a leak check on the total system at routine intervals, and whenever the column or transfer line is changed.

To test for leaks:

1. Disconnect the column and resistor from the GC detectors and cap. These may be capped by inserting the end into a septum.

2. With the TurboMatrix in standby, set the carrier gas pressure to the maximum 47psi using the pressure regulator on the TurboMatrix. At the Clarus 500 GC close Valve 3 (PPC units) or wind the Auxiliary gas control fully counter-clockwise (manual pneumatics). Allow 10 to 15 minutes for the gas pressure to stabilize throughout the system, and then monitor the actual pressure on the Clarus 500 GC auxiliary gas display. If it has not reached 47psi there is a leak.

3. If the auxiliary gas pressure reaches 47psi there may still be a small leak. To check turn the TurboMatrix 100 or 150 pressure regulator fully counter-clockwise and monitor the actual pressure. Initially, there will be a small pressure drop as the regulator is turned and the diaphragm is relaxed. Once the regulator has been turned fully counter-clockwise, the pressure should remain constant. If after 5 minutes the pressure has dropped by less than 0.5 psi (4 kPa), the system is leak free.

4. On the TurboMatrix 300, 350 or 650 select <Tools> <Maintenance> <Column Leak Test>
5. If a leak is present, indicated by a pressure drop greater than 0.5 psi (4 kPa), cool the heated valve and transfer line to 50°C. Re-pressurize the system to the maximum 47psi and test all gas connections with a solution of alcohol and water. Mix 50% alcohol with 50% water and apply to gas connection in a squirt bottle or with a fine paint brush. Carefully tighten any loose connection until bubbles no longer appear.

Note Graphite and graphitized Vespel ferrules only require one quarter turn beyond finger tight to give a leak free seal. Do not overtighten these ferrules.

Note An electronic leak detector is a good investment, but it may not find very small leaks.

5. Once all leaks have been corrected, repeat steps 1 to 4 to ensure the system is leak free.

6. Reconnect the column to the detector. If you capped the column with a septum, remove the septum, clip off 1/8th inch and then insert the column into the detector again. Repeat for the restrictor.

7. Replace all of the covers.
Lighting the FIDs

To light the FID flame:

1. On Clarus 500GCs with Programmable Pneumatic Control the GC may be configured to light the flames automatically and to check that the flame is alight before each analysis. On Clarus 500GCs with manual pneumatics the GC may be configured to check that the flame is alight before each analysis but will require lighting manually.

2. Ensure that the GC is released from TotalChrom control by selecting <Run> <Release Control> from the TotalChrom Navigator window.

3. On the Clarus 500 GC touch screen select <Tools> <Configuration>

4. From the Configuration Screen select <A – FID>

5. Set Flameout to 0.1mV

*Note:* The flameout value needs to be set to a value >0mV but lower than the usual background from the column at the GC starting temperature. If Range 1 is selected the background is usually in the region of 1mV although this will vary from column to column.
6. Repeat the operation for B - FID

**Note** For proper ignition to occur, the FID must be heated to at least 100 °C.

7. Enter a set point of 250 °C (or 50 °C higher than the highest temperature of your oven program). For each detector

8. Close the oven door.

9. For GCs with PPC the flame will light automatically before the GC becomes ready.

10. Select the FID A screen on the GC touch screen

11. For GCs with manual pneumatics turn the hydrogen control for FID A fully counter-clockwise and wait for the FID A temperature to reach 250 °C

12. Turn the Air Control for FID A fully clockwise. Press the `<Ignite>` button on the FID A screen and then turn the Air Control slowly counter-clockwise until fully open.
13. A slight “pop” should be heard. Check that the mV reading is greater than 0mV. It should be around 1mV on Range 1. If the flame has not lit repeat step 12 until a signal greater than 0mV is obtained.

14. Repeat for FID B

15. Confirm that the flames are lit by holding a shiny object (such as a mirror or small wrench) over the FID outlet. Condensation will appear on the object if ignition has occurred.

⚠️ **Warning**  The FID outlet is HOT! To avoid injury, do not place your hand over the FID outlet.
The Cold Trap.

During operation the cold trap is subjected to extremes of temperature being cooled to -30°C and heated at 40 °C/s to 325 °C every hour. It is also subjected to severe changes in pressure during each analysis. Over a period of time these thermal and pressure shocks may cause the packing in the trap to shift which in turn may lead to sample loss. The adsorbents in the trap consist of a bed of relatively weak adsorbent backed up by a bed of relatively strong adsorbent. The strong adsorbent is used to trap the very volatile components whilst the weaker adsorbent prevents the less volatile components reaching the stronger adsorbent where they may be irreversibly adsorbed. In particular, the strong adsorbent has a very strong affinity for the aromatics. Usually the first sign of movement or channeling of the packing is tailing or loss of benzene, the most volatile aromatic. If this is not corrected then eventually tailing and loss of other aromatics will also occur. When tailing of the benzene peak occurs it is usually necessary to replace the cold trap.

Excessive moisture in the cold trap may de-activate the weaker adsorbent. This is also indicated by tailing of the benzene peak. This can be corrected by re-conditioning the cold trap and it is recommended that the trap is reconditioned before it is replaced.

Conditioning the Cold Trap

1 Using the Touch Screen on the TurboMatrix select the Temp screen and enter a Trap High Temperature of 400 °C and the Valve Temperature to 200 °C.

![Temp Screen](image)

**Figure 4-5. Temp Screen**

2 On the Timing Screen touch the <Trap> button and set Temperature Hold time to 270 minutes.
3 On the Options Screen set the <Mode> to Trap Clean.

4 All other parameters are not important for Trap conditioning. Press <Start> on the Touch Screen.

5 If, after conditioning, there is no improvement of the benzene peak the trap will need to be replaced.
Replacing the Cold Trap

After the system has been in use for some time, you may observe loss of peaks, poor peak shapes, or loss of analytical precision. These may be indications of a defective cold trap. You can replace a cold trap to restore the system to its optimum condition.

⚠️ Caution

The materials used in the cold trap are PerkinElmer Proprietary Materials. Do not attempt to repack a cold trap! Purchase the replacement cold trap show below.

- Replace the cold trap (P/N M041-3628), as described in Routine Maintenance of the TurboMatrix Instrument Manual.

![Cross section of a prepacked Ozone Precursor cold trap (P/N M041-3628)](image)

Figure 4-8. Cross section of a prepacked Ozone Precursor cold trap (P/N M041-3628)

A new cold trap will need conditioning before use. Instructions for conditioning are given on Page 4-10.

Column Conditioning.

The column set may need re-conditioning from time to time. This is especially true if the Ozone Precursor Analyzer has not been used for any length of time. The Al₂O₃/PLOT column will deteriorate if not used continuously. Al₂O₃ will adsorb water if not used. This will affect the activity of the Al₂O₃ which in turn will affect the retention time of some compounds. Compounds containing treble bonds will be badly affected by moisture in the column as will compounds containing conjugated double bonds. In normal usage the activity of the Al₂O₃/PLOT column is maintained at a constant level by

a. Using a Nafion Dryer to remove moisture from the sample before it enters the column.
b. Heating the column to 200 ºC for 6 minutes at the end of each analysis. This removes any moisture that has passed through the Nafion Dryer and entered the column.

To condition the column proceed as follows:

1. Release control of the GC from TotalChrom by selecting `<Run> <Release Control>` on TotalChrom Navigator

2. On the GC touchscreen enter

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oven – Temp Initial</td>
<td>46 ºC</td>
</tr>
<tr>
<td>Oven – Time Initial</td>
<td>1 minute</td>
</tr>
<tr>
<td>Oven – Temp 2</td>
<td>200 ºC</td>
</tr>
<tr>
<td>Oven – Time 2</td>
<td>240 minutes</td>
</tr>
<tr>
<td>FID A Temp</td>
<td>250 ºC</td>
</tr>
<tr>
<td>FID B Temp</td>
<td>250 ºC</td>
</tr>
<tr>
<td>Aux Gas 1</td>
<td>18 psi</td>
</tr>
<tr>
<td>Valve 3</td>
<td>ON</td>
</tr>
</tbody>
</table>

3. Ensure that both FIDs are alight

4. On the TurboMatrix `Pnu` page ensure that the carrier pressure is set to 47psi.

5. Press `<Start>` on the GC touchscreen
Data File Maintenance

Periodically you should transfer your TotalChrom data files to a data storage device (for example, a CD-RW disk drive, or file server). Because of the large number of data files that are generated it is recommended that a new data directory is generated for every month. It is then a fairly simple procedure to archive data on a monthly basis. The following file paths is an example that is strongly recommended.

c:\Ozone\method
c:\Ozone\sequence
c:\Ozone\data\Jan07
c:\Ozone\data\Feb07
c:\Ozone\data\Mar07 etc.

Changing the File Path in the Sequence.

It is recommended that a new sequence is used each month to ensure that the data is collected in the right directory on the computer.

The simplest way to create a new sequence is to make a copy of the existing one. However the data path set in the sequence will take precedence over data paths entered elsewhere in TotalChrom. If the data is to be saved in a different directory each month proceed as follows:-

1. Wait until the GC has finished an analysis and then Select **Run** <Clear Setup>

2. Open the existing sequence and find the column labeled **Data** in the channel A spreadsheet. Click on the Column header to highlight all the cells in the column.
3. Point the mouse in the highlighted column and click the right button. Select `<Edit Token String>`.

4. Change the Data Path and select OK.

5. Repeat for Channel B.

6. Save the Sequence and select `<Action>` `<Setup>`.

**Note:** The TurboMatrix does not need to be stopped and will continue to collect an air sample. From the end of the GC analysis there is about 12 minutes to make the above changes before the TurboMatrix wants to inject the next sample. This should be sufficient time but if you are not sure that you can do this in 12 minutes it may be easier to do the changes whilst the GC is in the middle of an analysis. Open the existing sequence. This will be in a “locked” state whilst the GC is running and will only open in a “read only” state. Make the changes to the data paths described above and then, using `<save as>`, save the sequence with a new name. Wait until the GC finishes its current analysis and then select `<Run>` `<Clear setup>`. Then select `<Setup>` and select the new sequence.
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Basic Pneumatic Components

The basic pneumatic components are shown in Figure A-1. The system comprises three rotary valves, RVA, RVB and RVC. RVA is the heated valve that is central to the TurboMatrix TD system. The plumbing immediately surrounding this valve is associated with the normal thermal desorption processes. Refer to the TurboMatrix Thermal Desorber operator’s manual for further details on how these components operate. The TurboMatrix 100 and 150 have manual pneumatics, the 100 being a single tube system whereas the 150 can handle 50 sample tubes. The TurboMatrix 300 and 350 have Programmable Pneumatic Control (PPC), again the 300 is a single tube analyzer and the 350 is a 50 sample tube analyzer. The TurboMatrix 650 also has PPC but also has the ability to re-trap sample onto the tube, check the impedance of each tube and the cold trap and perform a dry purge on the sample tube. The TurboMatrix 650 may also be used for Air Toxics monitoring requirements. The TurboMatrix 100 and 150 have similar pneumatic paths, The 300 and 350 are similar and the TurboMatrix 650 has a more complex pneumatic arrangement.

The online sampling accessory introduces the other two rotary valves into the system. Valve RVB is designed to route the sample (or calibrant) stream through the (empty) tube into the adsorbent trap. A vacuum pump and flow controller regulate the flow of the sample (or calibrant) stream through the trap. A solenoid valve (ISV1) remains open unless the power supply to the instrument is lost. ISV1 will close in the absence of power thus reducing the risk of losing (expensive) calibrant under such circumstances. The valve RVC is used to select between the sample and calibrant streams.

A Nafion drier is located between RVC and RVB to remove moisture from the sample stream. The flow rate of the drying air through the Nafion drier is controlled via a simple needle valve.
*The shaded area is for the additional Online Accessory Components.
**An empty tube is required to simply complete the sample pathway.

Figure A-1a. TurboMatrix 100 and 150 System Components

Figure A-1b. TurboMatrix 300 and 350 System Components
Figure A-1c. TurboMatrix 650 System Components
Operational Sequence

Figure A-2 shows the various steps the plumbing undergoes during system operation. After the first run, the system will recycle back to the sample/calibrant injection step for subsequent runs. Note that the tube and trap leak tests are only performed during the first run.
Standby

*Note:* The flow paths/valves that switch during air sampling are common to all versions of TurboMatrix Thermal Desorber. For clarity, all following diagrams show only the TurboMatrix 300/350 pneumatics.

When the system is idle, it will be configured as shown in Figure A-3. Carrier gas is supplied to the GC column via SV2. The tube may not be present but is normally left in position for online sampling applications. The vacuum pump and flow controller will continuously draw sample through RVC, the Nafion drier and RVB while the system is idle. The calibrant will never be flowing at this time.

![Figure A-3. TurboMatrix 300 and 350 Standby](image)

The TurboMatrix 100 and 150 have manual pneumatic control. The carrier gas pressure must be adjusted using the pressure regulator mounted on the top left side of the TurboMatrix.
Tube Pressurization

After a run is started, an (empty) tube is loaded and pressurized in preparation for leak testing. SV1 is opened to allow carrier gas to pressurize the tube plumbing right through to the inlet-split valve SV5. Carrier gas continues to flow into the column via SV2 as does the sample stream through into the vacuum pump via RVC, the Nafion drier and RVB.

Figure A-4. Tube Pressurization
Tube Leak Test

After the tube plumbing has been pressurized, SV1 is closed to seal this section of plumbing. The pressure sensor monitors the internal pressure. A drop in pressure will indicate a leak and the analysis will be terminated.

Figure A-5. Tube Leak Test
Tube and Trap Pressurization.

RVA is operated to add the trap plumbing into the circuit. SV1 is opened and both the tube and the trap are now pressurized.

Figure A-6. Tube and Trap Pressurization
Trap Leak Test

SV1 is now shut and again the pressure sensor monitors the internal pressure. As the tube has already been leak tested at this point, any loss in pressure will now be the result of a leak in the trap plumbing.

Figure A-7. Trap Leak Test
Tube Purge

Before sample is collected air is purged from the tube, trap and associated plumbing through SV3. The TurboMatrix 100/150 will have a manually adjusted needle valve in place of the mass flow controller MFC2 (See Figure A-1a).

Figure A-8. Tube Purge
Sample Collection

RVB operates and the sample (or calibration gas – see Figure A-10) stream is redirected through the (empty) tube and into the trap. The trap is being held at its low temperature at this point. The sample flow rate is controlled by the mass flow controller MFC4 which precedes the vacuum pump. The user defines this flow rate and the sampling time in the TurboMatrix method.

Figure A-9. Sample Injection
Calibration Gas

If RVC is turned, the system will collect from the calibration gas port instead of the ambient air sample port. RVC will be operated just before and just after the sampling period to direct calibration gas into the cold trap. The vacuum pump and flow controller will regulate the flow rate of calibration gas during this stage. The flow rate and sampling time will usually be the same values as set for the air sample stream.

Figure A-10. Calibrant Injection
**Tube Desorb**

RVB is returned to its original position. SV1 and SV3 are opened to allow carrier gas to pass through the tube and trap at the Desorb Flow rate set in the method and controlled by a mass flow controller MFC2. TurboMatrix 100/150 have a manually adjusted needle valve in place of MFC2 (See Figure A-1a). The tube heater is applied to the tube during this step.

For ozone precursor analysis, this step is not really required but it does help keep the system clean and minimizes the chance of sample to sample carry-over.

Its real utility is with on-line analyses (such as on-line or canister air-toxics analysis) that require dry purge of the trap prior to desorption.

![Tube Desorb Diagram](image)

*Figure A-11. Tube Desorb*
Trap Desorb

Once the sample (or calibration gas) has been collected onto the cold trap, RVA is activated. The ESV2 is operated and carrier gas is diverted through the trap. The trap is heated to 325°C for 6 minutes (to vaporize the collected analytes) and the carrier gas sweeps these into the transfer line and column. An optional outlet split of approximately 2ml/min may be enabled through via SV4 (Outlet Split). On TurboMatrix 100/150 the split vent is controlled by a manually operated needle valve. (See Figure A-1a) The gas chromatograph and data handling system are started at the moment the trap starts heating.

Figure A-12. Trap Desorb
Analysis

The term Analysis is actually the recycle and hold time of the system. The system start to collect the next sample exactly 60 minutes after the previous sample collection started. Once the trap desorption has finished, the trap is allowed to cool and SV2 is returned to its previous standby position to supply carrier gas directly to the transfer line and column. The system will wait in this position until the cycle time has elapsed. The system will then collect the next sample.

Figure A-13. Analysis
Volatile Ozone Precursors

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These appendices contain a list of volatile ozone precursors, annotated chromatograms that identify the peaks in a sixty-component mixture that was separated using the VOC Ozone Precursor Analyzer.
Target Volatile Ozone Precursors

The following target volatile ozone precursor components are listed in their order of elution, with their corresponding AIRS* numbers, from the PLOT column and BP1 column shown in the Annotated Chromatograms.

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<th>PLOT Column</th>
<th>BP1 Column</th>
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* Aerometric Information Retrieval System

** These components are not detected, or their response is reduced in the presence of the NaFion dryer.
Annotated Chromatograms

- Ethane
- Ethylene
- Propane
- Propylene
- Iso-butane
- n-Butane
- Acetylene
- 2-Butene
- 1-Butene
- c-2-Butene
- Cyclopentane
- Iso-pentane
- n-Pentane
- 1-Pentene
- c-2-Pentene
- 2,2-Dimethyl-pentane
- 3-Methyl-pentane
- 2-Methyl-pentane
- 2,3-Dimethyl-pentane
- 2-Methyl-pent-1-ene
Concentrations of Volatile Ozone Precursors

Concentrations of PAMS Compounds

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<td>c-2-Pentene</td>
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