STi | Sonoma Technology

Standard Operating Procedure for Synspec GC955 Hydrocarbon Analyzer

October 31, 2024

STI-7984

APPROVED:

_____

Sonoma Technology date

_____

Fenceline Monitoring Refinery Representative date

Contents

1. Scope and Application

This appendix refers to the use of the Synspec GC955 analyzer for the continuous measurement of volatile organic compounds (VOCs) at community air monitoring stations. It includes procedures on the operation, quality checking, and calibration of the unit. Maintenance forms can be found in Section 9.

2. Summary of Method

An automatic gas chromatograph (AutoGC) collects air samples via vacuum pump (ambient) or pressurized source (span/calibration) and separates compounds according to their retention time in an internal separation column. Following separation, compounds are measured with a photoionization detector (PID). This combination of separation and detection allows for identification and quantification of a range of VOCs. **Figure 1** from the GC955 manual shows the unit configuration.

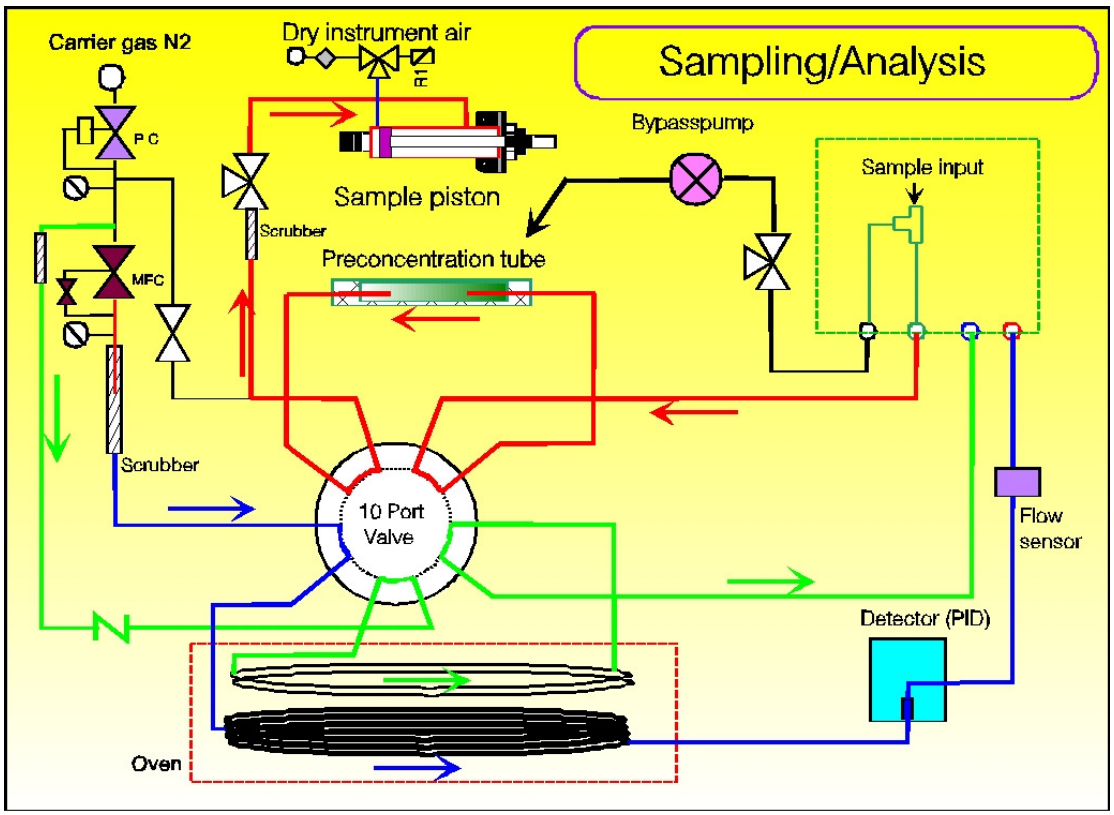


Figure 1. Instrument configuration in analyzing/sampling mode from the GC955 manual.

The major processes in getting from a sample to a concentration value are described in Section 3 of the GC955 manual. They include:

- **Sampling**: collecting a sample of ambient air.
- **Pre-concentration**: accumulating enough samples for analysis.
- **Desorption and Stripping**: moving sample from the pre-concentrator into the separation column.
- **Separation**: separating compounds based on their interaction with the separation column.
- **Detection**: measuring separated compounds with a PID to allow identification and quantification.

3. Definitions

Abbreviation	Meaning
AC	Alternating current
BAM	Beta attenuation monitor
BC	Black carbon
C14	Carbon 14
CFR	Code of Federal Regulations
CO_2	Carbon dioxide
CPU	Central processing unit
CV	Coefficient of variance
DAS	Data acquisition system
DOT	Department of Transportation
DQO	Data quality objective
DRV	Documented reference value
EC	Elemental carbon
FEM	Federal equivalent method
GC	Gas chromatograph
H_2O	Water
H_2S	Hydrogen sulfide
IO	Input/output
IR	Infrared

Abbreviation	Meaning
IZS	Internal zero/span device
kV	Kilo volts
LPM	Liters per minute
MFC	Mass flow control/controller
MSDS	Material safety datasheet
N/A	Not applicable
NH_3	Ammonia
NH_3_CE_FACTOR1	The ammonia converter efficiency factor
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_2_CE_FACTOR1	Nitrogen oxide efficiency factor
NO_x	Oxides of nitrogen
O_2	Oxygen
PC	Personal computer
PID	Photoionization detector
PM	Particulate matter
PM_{10}	Particulate matter with aerodynamic diameter less than 10 um
$PM_{2.5}$	Particulate matter with aerodynamic diameter less than 2.5 um
ppb	Part per billion
ppm	Parts per million
psi	Pounds per square inch
QA	Quality assurance
QC	Quality control
QS	Quality standard
RH	Relative humidity
RS-232	Analyzer digital communication port
SO_2	Sulfur dioxide
SOP	Standard operating procedure

Abbreviation	Meaning
TM	Trademark
TNX	The sum of the ammonia and the oxides of nitrogen concentrations
UPS	Uninterrupted power supply
U.S. EPA	United States Environmental Protection Agency
UV	Ultraviolet
VAC	Volts alternating current
VSCC	Very sharp cut cyclone
Z/S	Zero/span

4. Health and Safety Warnings

The following is a summary of risks and qualifications relevant to analyzer operations. See the GC955 manual for additional information.

- Compressed gas at pressures from 0.5 to 5 bar will be connected to the analyzer. Personnel must be qualified to work safely with pressurized systems.
- The analyzer contains a high-voltage power supply in a protective housing. Personnel must be qualified to work safely with high-voltage power supplies.
- The pre-concentrator operates at temperatures of 100°C to 260°C. Personnel must be qualified to work safely with heated systems.

5. Interferences

Individual analyses can be affected by the peaks from other compounds in the gas mixture. These can be mitigated by the following actions.

- Ensuring peak breadth is as expected, following the recommendations of the instrument manufacturer.
- Performing monthly zero and span checks with a known concentration of reference gas (Section 7.5).
- Performing quarterly checks for analyzer linearity and precision (Section 7.5).

6. Equipment and Supplies

Monitoring Apparatus: GC955 with PID detector.

Instrument Shelter: A shelter is required to (1) protect the analyzer from precipitation and adverse weather conditions, (2) maintain operating temperature within analyzer specifications, (3) provide sufficient and consistent electrical power, and (4) securely operate the analyzer.

Spare Parts and Incidental Supplies: See Section 6 in the GC955 manual for a list of recommended spare parts.

Calibration System: A system that generates known concentrations of high-quality reference gas is required for monthly and quarterly services (Section 7.5).

DAS: A data acquisition system (DAS) is required for collection, telemetry, and storage of data from the GC955.

7. Sampling Procedures

7.1 Sample Collection

Sample collection for hydrocarbons is performed by drawing ambient air through a sample manifold into the analyzer using a vacuum pump. The inlet is constructed of Teflon™ and borosilicate glass. The siting of the community monitoring station containing the GC955 was completed according to the U.S. EPA Quality Assurance Handbook Volume II.

7.2 Sample Handling and Preservation

The sample is pre-concentrated in the analyzer before being desorbed, delivered into the separation column, and sent to the PID. Nitrogen is used as a carrier gas.

7.3 Sample Preparation and Analysis

This section does not apply to the Synspec GC955 analyzer.

7.4 Instrument Startup/Shutdown, Operation and Maintenance

This section describes the operation and maintenance of the GC955. The operator of the instrument should be familiar with the GC955 manual before attempting to operate the unit.

7.4.1 Sample Collection

The following are excerpts from Sections 2 and 4 of the GC955 manual. See the GC955 manual for additional information.

1. The instrument can be switched on once the gases are connected and the filter is in place. The AutoGC must be connected to a mouse and a keyboard, the oven cover must be closed, and the L-shaped cover must be put on.

2. After starting the GC, the Windows system starts and the GC955 graphical user interface (GUI) appears. A self-test is performed on electronics and the PID lamp, and the oven is heated to the base temperature of the default application program. The PID lamp is subsequently turned on.

3. Carrier gas flows through the capillary and packed columns at programed flow rates maintained by mass flow controller(s). Checking for leaks or obstructions is advised after long transports or after working without adequate filters.

4. A pressure sensor monitors the switching of the internal diaphragm valve.

5. The program contains seven different functions: actual run, data file, program edit, calibration, graphs, auto-linearization, and IO-state diaphragm. See Section 3 of the GC955 manual for additional information.

6. The default mode is actual run. After an automatic check of the settings, the program is on standby to run. The oven must reach the desired starting temperature before the first cycle can be started by clicking **Start run**. Once the background zero adjust signal is set, the program begins. The detector needs to stabilize, which can cause the first reset to take longer. In automatic mode, the analyzer will either start immediately or once synchronization is reached. The measured values can be seen on the chromatogram. You can find clock time, cycle time, measured value for the detectors, ambient temperature, and oven temperature in the status lines below the chromatogram. Additional diagnostics include pressure of valve switching air and flow of carrier gas. Note that the ambient temperature is measured on the underside of the instrument. The baseline is normally set about 10 mm above the edge of the chromatogram window, but can be changed under **Actual run\Options\Adjust detector Y-offset** as needed.

7.4.2 Shutdown

There are three ways to shut down the analyzer.

1. The preferred method is to click **Stop Run**, which stops the program at the end of the present run.

2. If the program must be stopped between runs, click **Abort Run**. The program will stop immediately and the analyzer can be powered off. The next run of the GC may be contaminated by the aborted run.

3. Although not recommended, in the case of an emergency, the analyzer can be powered off without stopping the instrument software. The last run will not be saved and the analyzer has no way of saving open files.

7.4.3 Diagnostic Checks/Manual Checks

Field operators will perform diagnostic checks to ensure analyzer operation. Table 1 is an excerpt of checks from the GC955 manual.

Table 1. An excerpt of checks from the GC955 manual.

No.	Action	Dialog to Use	Optional
1	Switch on power.	--	--
2	Complete first run by clicking **Start Run.**	ViewMode \ actual run	Check temperatures, PID lamp functioning, attenuation.
3	Check peak windows.	ViewMode \ data file \ edit screen elements and edit peak windows	Wait for second run after start to get actual chromatogram.
4	Stop program.	ViewMode \ actual run – stop run	Click **Abort run** in emergencies. Close the GC955 program by clicking the left top pulldown menu.

7.4.4 Preventative Maintenance

Table 2 below summarizes the maintenance tasks for the unit.

Table 2. A schedule of maintenance tasks required for this instrument.

Activity	Quarterly	Annually	Two Years
Replace micro dust filter for sample	✓		
Remove dust from ventilator	✓	✓	
Clean the lamp		✓	
Clean the PID		✓	
Change the carrier gas filters		✓	
Clean the diaphragm		✓	

Activity	Quarterly	Annually	Two Years
Renew external sample tubing		✓	
Replace pre-concentration tenax tube		✓	
Replace cooled pre-concentration trap		✓	
Optimize hard disk		✓	
Clean internal gas tubing			✓
Clean lamp housing			✓

7.4.5 Troubleshooting

See Section 6.02 of the GC955 manual for the troubleshooting scheme.

7.5 Calibration and Standardization

Acceptance criteria for the GC955 are defined in Section A.7 of the QAPP.

If the measurements do not meet the data quality objectives listed in the QAPP, repeat the procedure without adjustment. If the repeated test also fails, initiate corrective action to include the following:

- Review data for potential interferants, including a detailed check of chromatograms and retention times, noting any unexpected features
- Review gas testing apparatus for leaks or other similar problems
- Review and confirm specifications of standard calibration equipment and gases (expiration dates, concentrations, etc.)

In the event of a failed test after following all steps outlined above, inform the Sonoma Technology Project Manager and Quality Assurance Manager, who will review the instrument performance parameters in the list above.

If all parameters indicate that the instrument was performing properly since the last test, data collected since the last test will be flagged as suspect. If an issue with the instrument is identified, data collected since the date and time of the instrument issue will be flagged as invalid. All data flagging will be performed by Data Analysts in consultation with the Quality Assurance Manager.

7.5.1 Adjustment to Zero Air

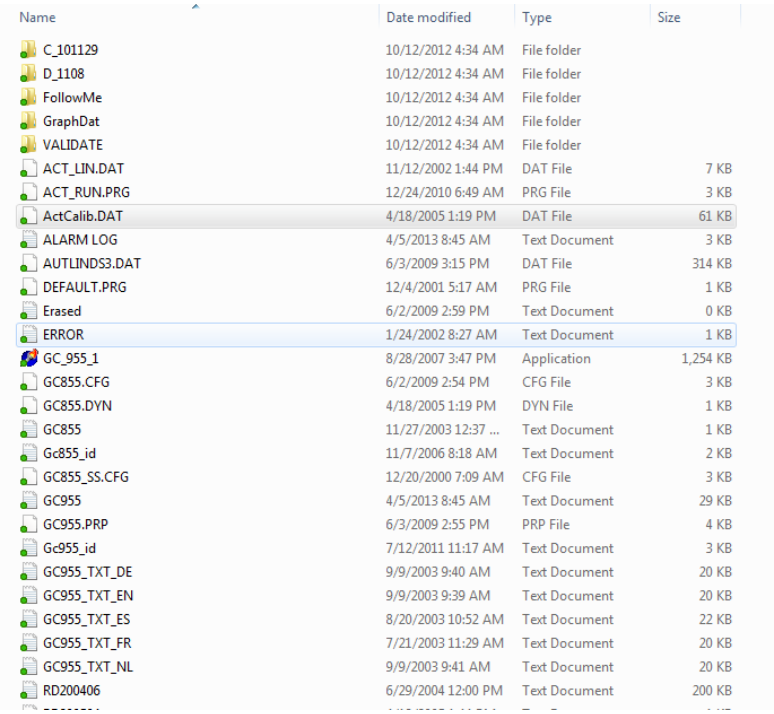
See Section 4 of the GC955 manual for additional information.

7.5.2 Adjustment to Calibration Gas

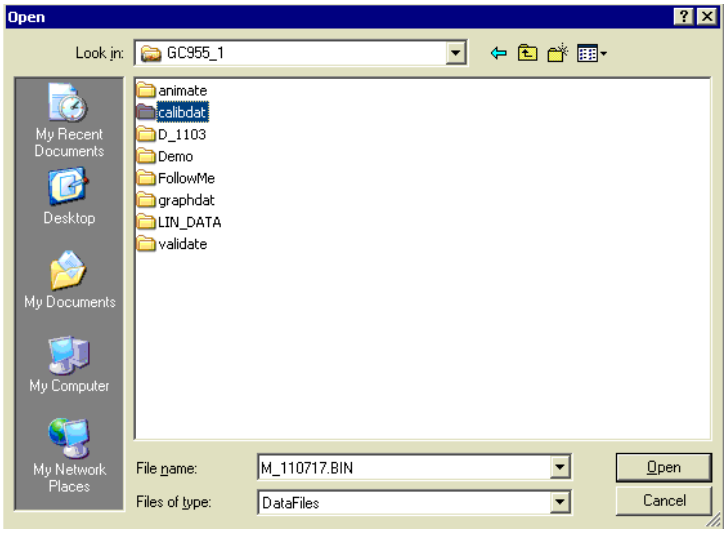
An overview of the calibration process is shown below. See Section 4.3 of the GC955 manual for additional information.

1. Go to the DAS and put it into Cal mode from the View screen.

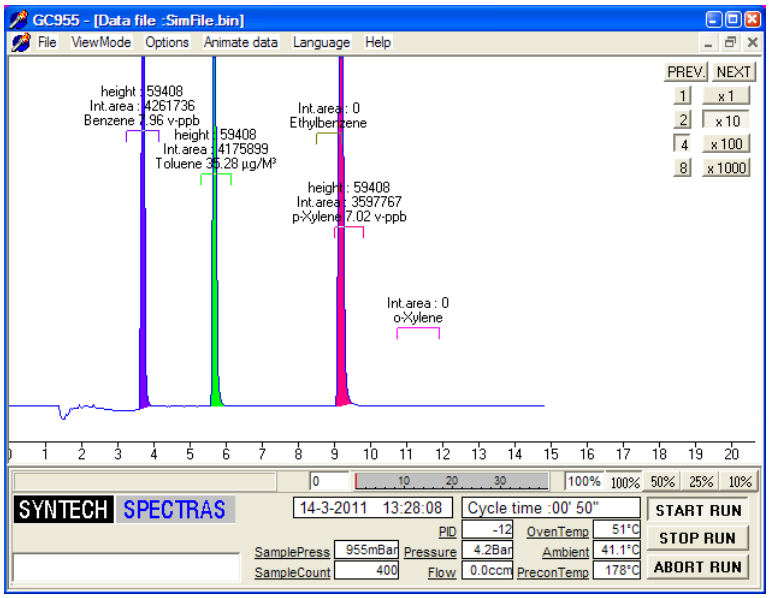
2. Use explorer and copy actcalib.dat from the GC955 root directory into the last valid calibration file folder as shown below.



Name	Date modified	Type	Size
C_101129	10/12/2012 4:34 AM	File folder	
D_1108	10/12/2012 4:34 AM	File folder	
FollowMe	10/12/2012 4:34 AM	File folder	
GraphDat	10/12/2012 4:34 AM	File folder	
VALIDATE	10/12/2012 4:34 AM	File folder	
ACT_LIN.DAT	11/12/2002 1:44 PM	DAT File	7 KB
ACT_RUN.PRG	12/24/2010 6:49 AM	PRG File	3 KB
ActCalib.DAT	4/18/2005 1:19 PM	DAT File	61 KB
ALARM LOG	4/5/2013 8:45 AM	Text Document	3 KB
AUTLINDS3.DAT	6/3/2009 3:15 PM	DAT File	314 KB
DEFAULT.PRG	12/4/2001 5:17 AM	PRG File	1 KB
Erased	6/2/2009 2:59 PM	Text Document	0 KB
ERROR	1/24/2002 8:27 AM	Text Document	1 KB
GC_955_1	8/28/2007 3:47 PM	Application	1,254 KB
GC855.CFG	6/2/2009 2:54 PM	CFG File	3 KB
GC855.DYN	4/18/2005 1:19 PM	DYN File	1 KB
GC855	11/27/2003 12:37 ...	Text Document	1 KB
Gc855_id	11/7/2006 8:18 AM	Text Document	2 KB
GC855_SS.CFG	12/20/2000 7:09 AM	CFG File	3 KB
GC955	4/5/2013 8:45 AM	Text Document	29 KB
GC955.PRP	6/3/2009 2:55 PM	PRP File	4 KB
Gc955_id	7/12/2011 11:17 AM	Text Document	3 KB
GC955_TXT_DE	9/9/2003 9:40 AM	Text Document	20 KB
GC955_TXT_EN	9/9/2003 9:39 AM	Text Document	20 KB
GC955_TXT_ES	8/20/2003 10:52 AM	Text Document	22 KB
GC955_TXT_FR	7/21/2003 11:29 AM	Text Document	20 KB
GC955_TXT_NL	9/9/2003 9:41 AM	Text Document	20 KB
RD200406	6/29/2004 12:00 PM	Text Document	200 KB



3. On the GC955, go to **ViewMode** and select **Act Run PID**.

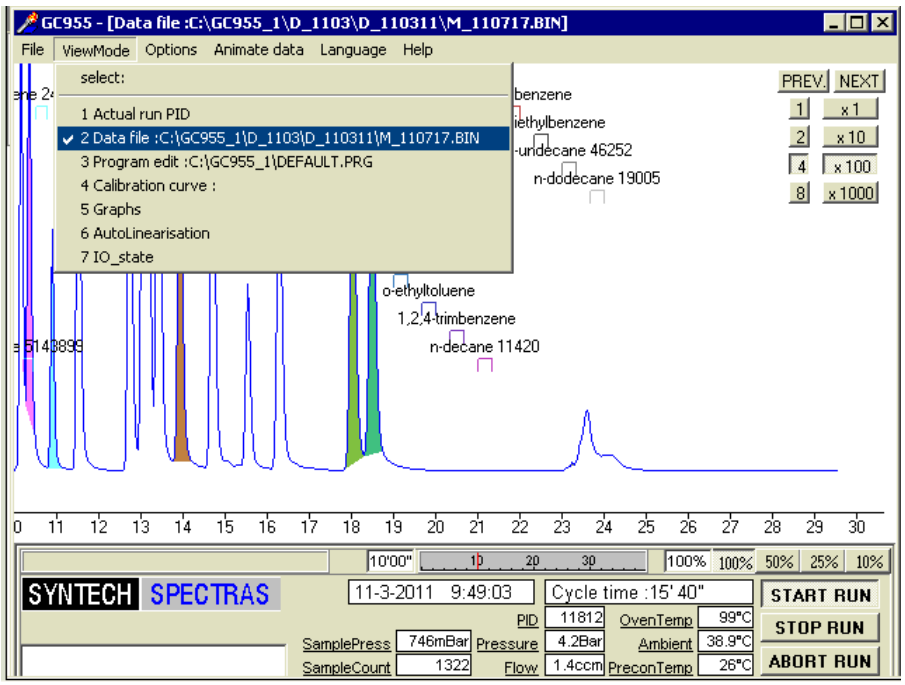


4. Connect the span gas to the span port on switchbox. Purge gas at the analyzer inlet so that calibration gas is available for measurement.

5. Under **Options**, click on **Open validation gas valve**.

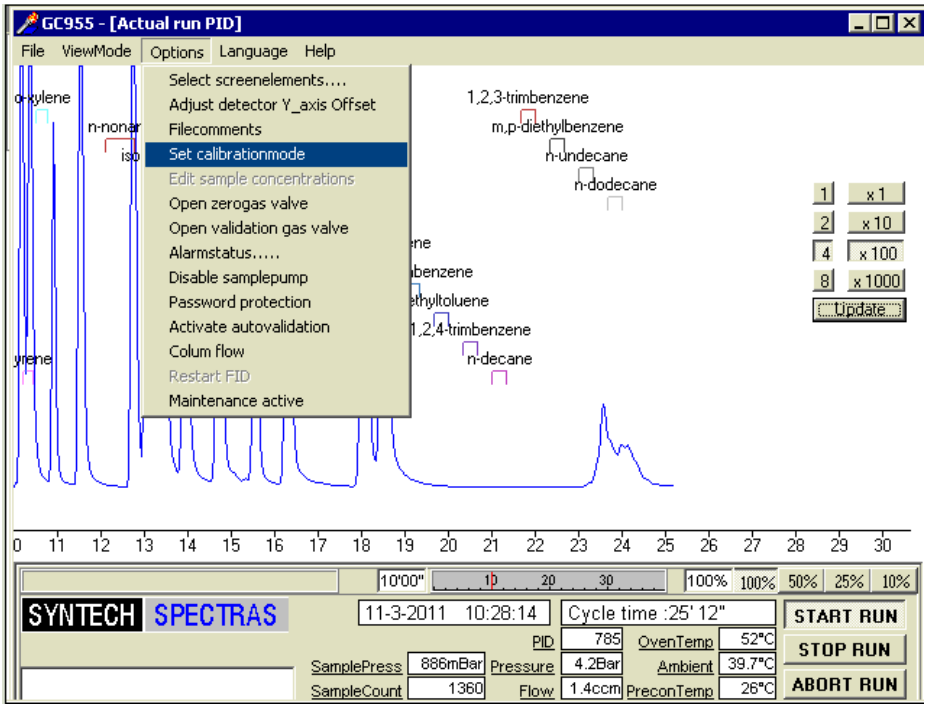
6. Let the unit run for four to five samples and observe peaks.

7. Go to the ViewMode data file and open recent files. Adjust the peak windows if necessary.

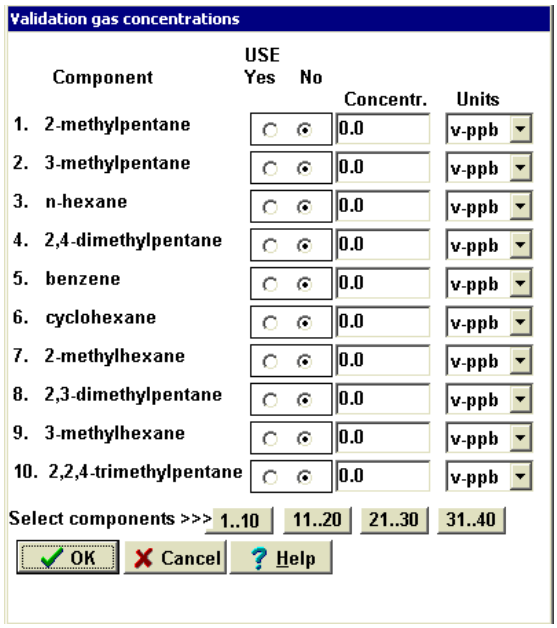


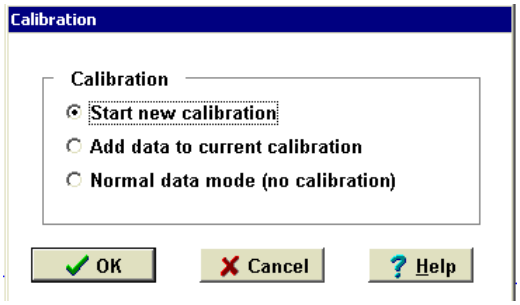
8. Go to **ViewMode act run PID** and put the unit into calibration mode – have gas flowing to the span valve inlet on the switch box.

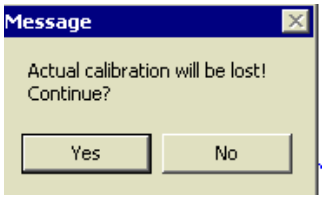
9. Select **Start New Calibration**.



10. Enter in known reference concentration values.
    a. Recall that m- and p-xylene co-elute, so those two values should be added together.
11. Click the **USE – Yes** radio buttons as appropriate.







Make sure you have the ACTCALIB.DAT backed up per instructions above.

12. Let the system run until it has generated two files or until data is stable.
13. Go to **ViewMode calibration mode**.
14. Go to **Data selection calibration files**.

15. Choose the component to calibrate.

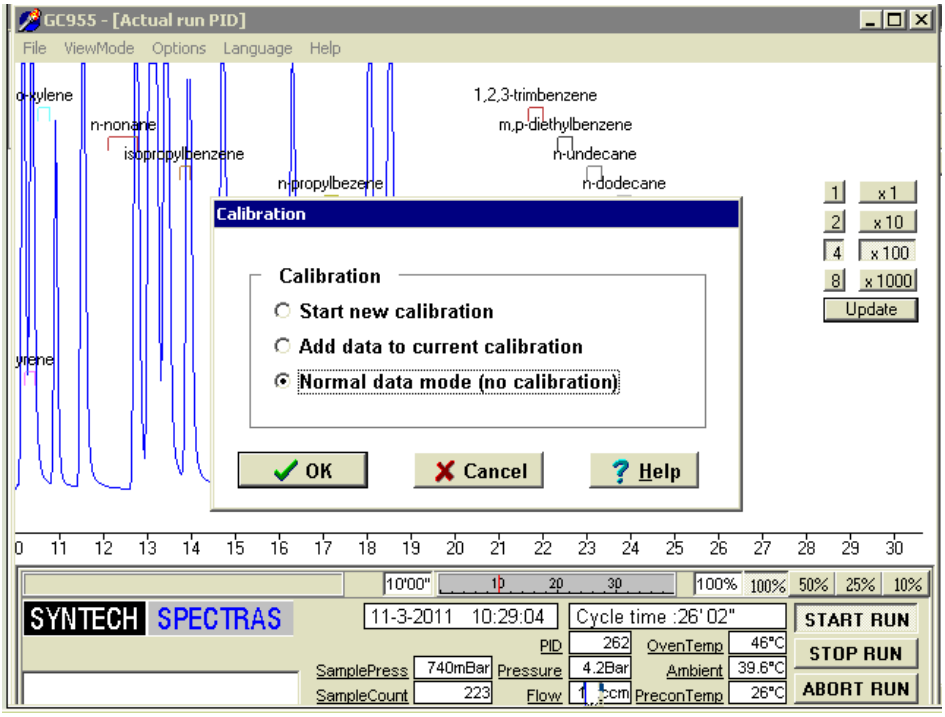
16. Select data files from the calibdat folder (YR/month/day) of data files collected – add to the display.

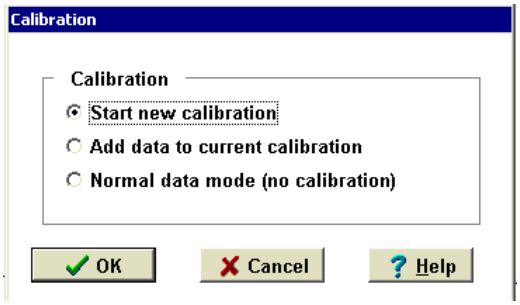
17. Select **Calculate calibration line** – select linear regression with fixed basepoint.

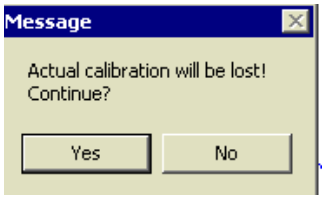
18. Calculate the calibration line.

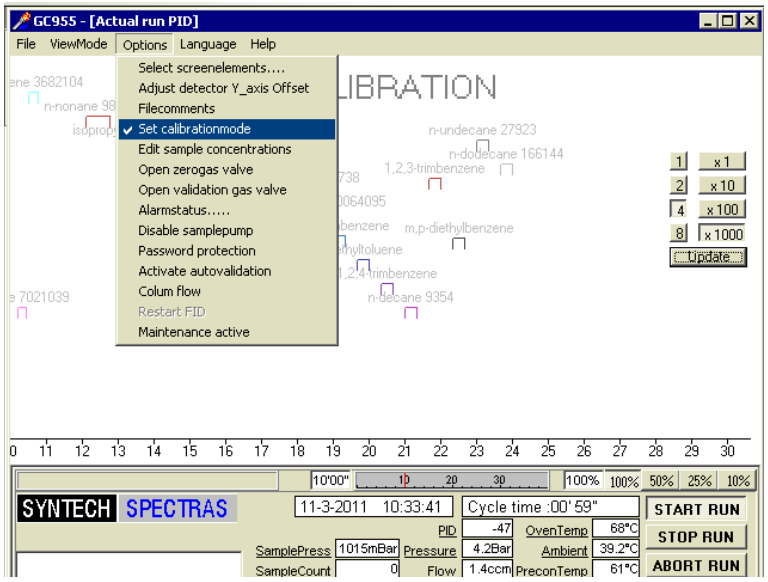
19. Repeat for all parameters.

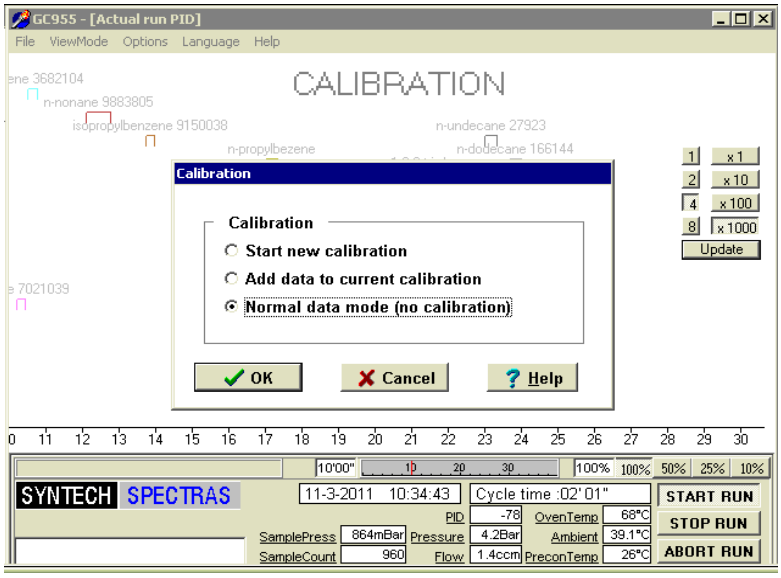
20. Let the DAS stay in calibration flag mode for 30 mins after the system finishes collecting calibration data so that the data are flagged in DAS.





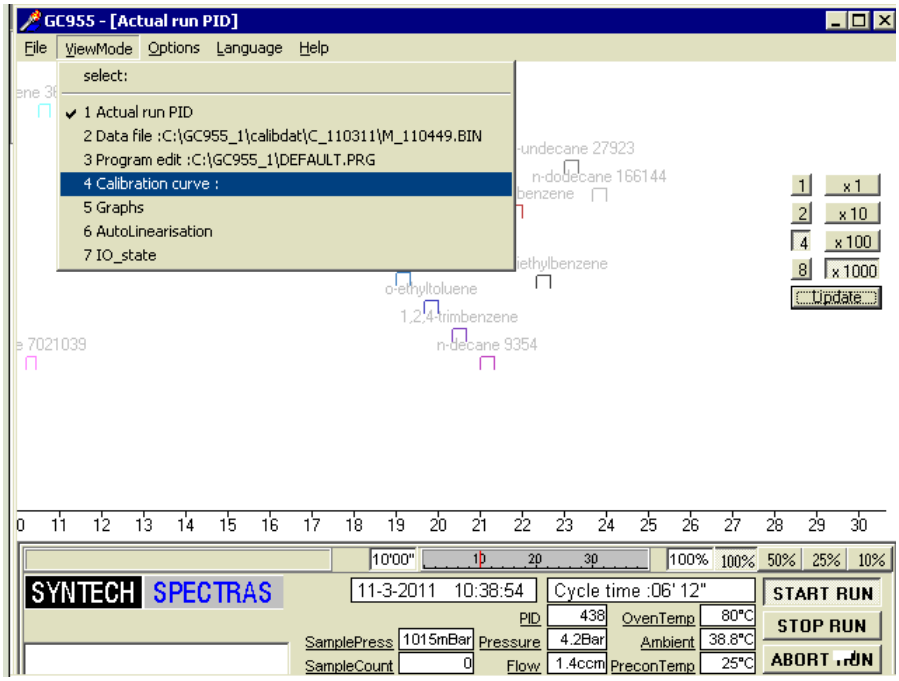

Message
Actual calibration will be lost!
Continue?
Yes
No


GC955 - [Actual run PID]
File ViewMode Options Language Help
Select screenelements....
Adjust detector Y_axis Offset
Filecomments
Set calibrationmode
Edit sample concentrations
Open zerogas valve
Open validation gas valve
Alarmstatus.....
Disable samplepump
Password protection
Activate autovalidation
Colum flow
Restart FID
Maintenance active
n-undecane 27923
n-dodecane 166144
1,2,3-trimbenzene
m,p-diethylbenzene
n-decane 9354
Update
SYNTECH SPECTRAS
11-3-2011 10:33:41
Cycle time :00' 59"
START RUN
STOP RUN
ABORT RUN
PID -47
OvenTemp 68°C
SamplePress 1015mBar
Pressure 4.2Bar
Ambient 39.2°C
SampleCount 0
Flow 1.4ccm
PreconTemp 61°C

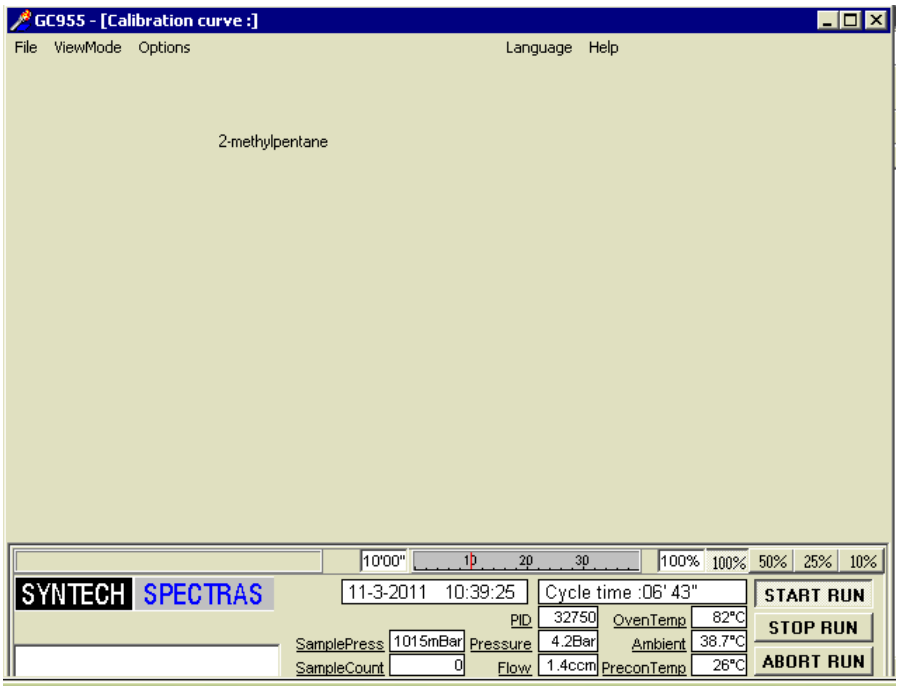

GC955 - [Actual run PID]
File ViewMode Options Language Help
CALIBRATION
n-nonane 9883805
isopropylbenzene 9150038
n-propylbezene
n-undecane 27923
n-dodecane 166144
Calibration
Calibration
Start new calibration
Add data to current calibration
Normal data mode (no calibration)
OK
Cancel
Help
Update
SYNTECH SPECTRAS
11-3-2011 10:34:43
Cycle time :02' 01"
START RUN
STOP RUN
ABORT RUN
PID -78
OvenTemp 68°C
SamplePress 864mBar
Pressure 4.2Bar
Ambient 39.1°C
SampleCount 960
Flow 1.4ccm
PreconTemp 26°C

To construct a calibration curve:

1. Select **ViewMode** and then **Calibration curve**.



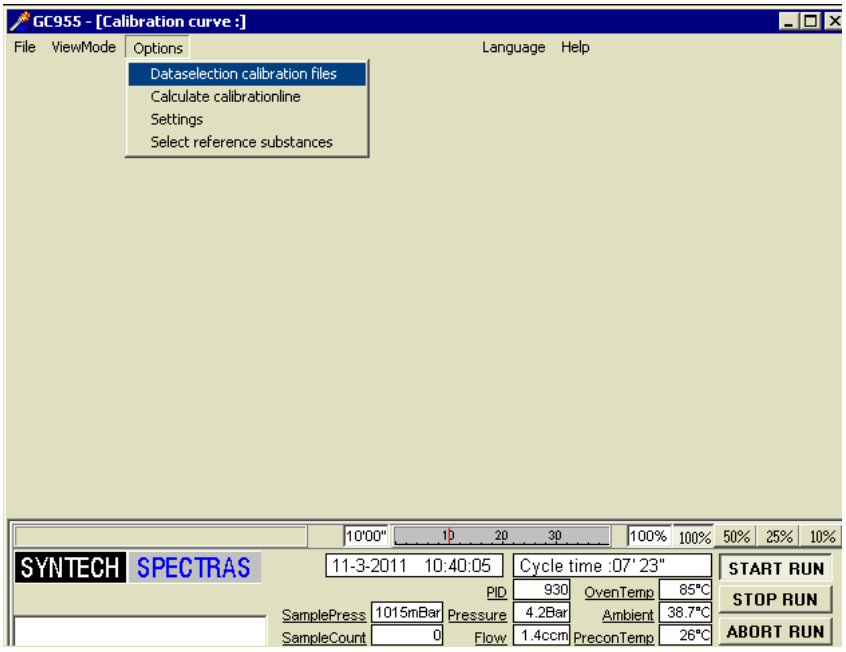
2. You will see:



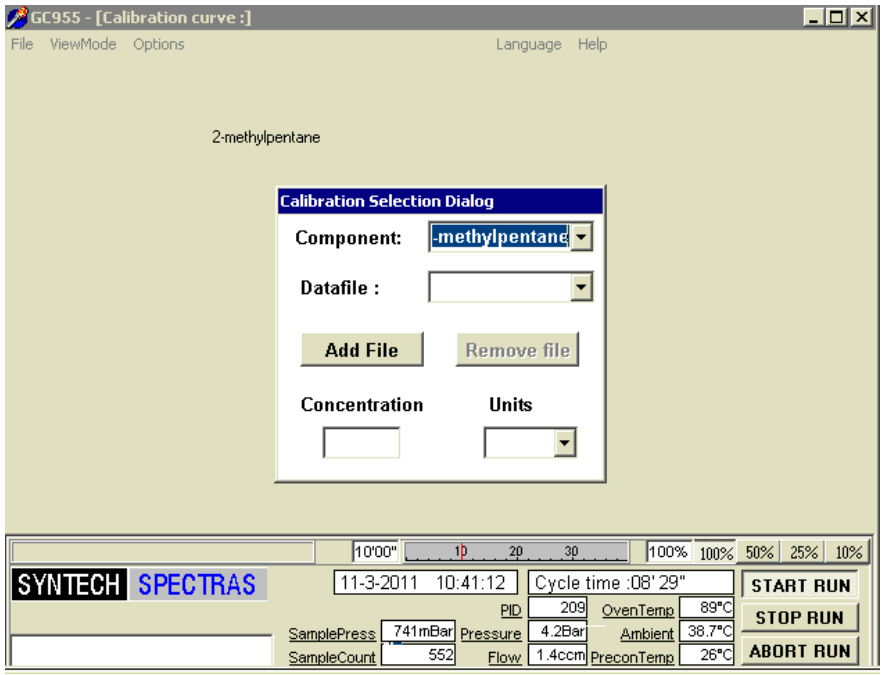
Click on:

- **Options**
- **Data selection calibration file**

3. You will see:



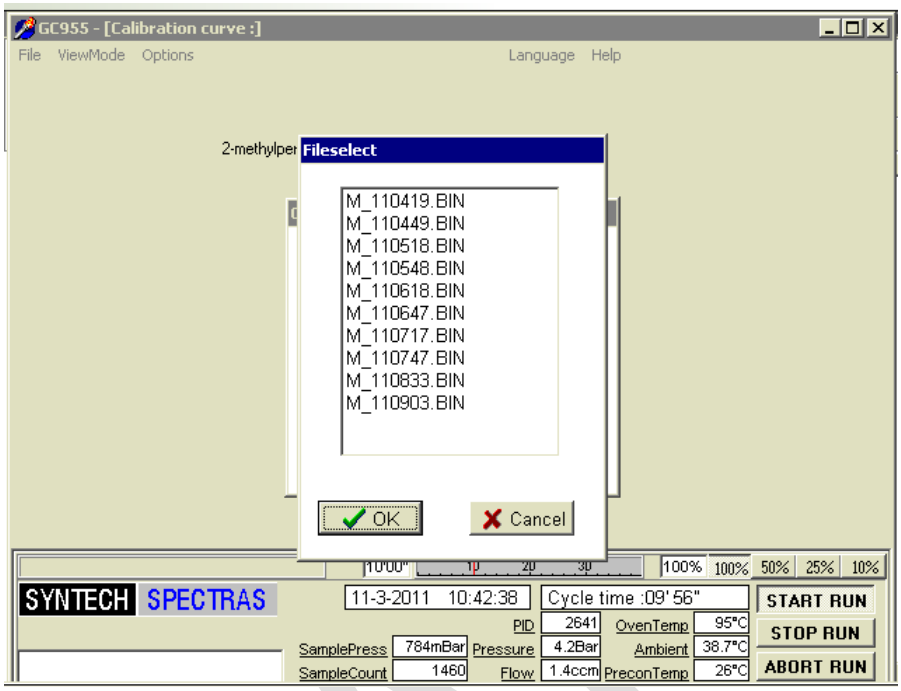
4. You will see:



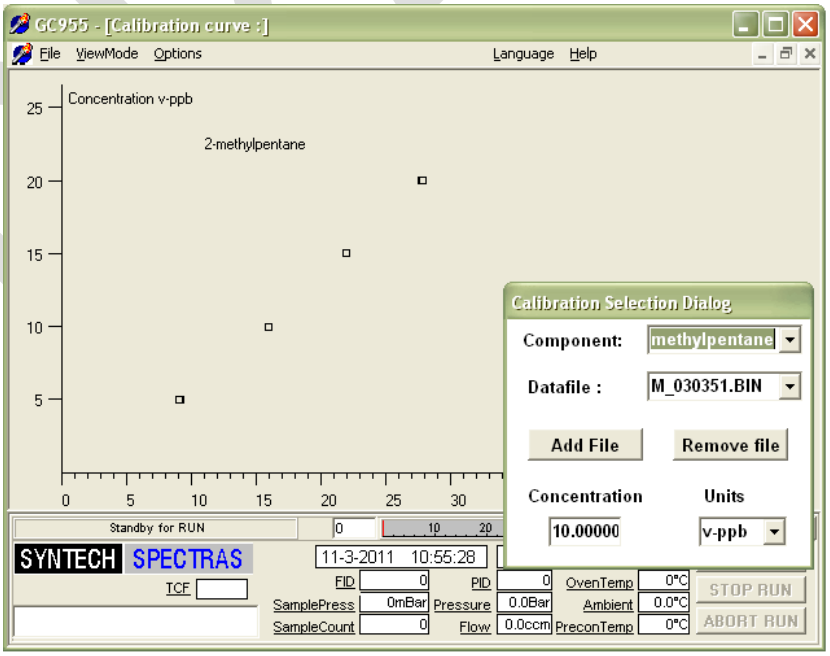
Click on:

- **Add File**

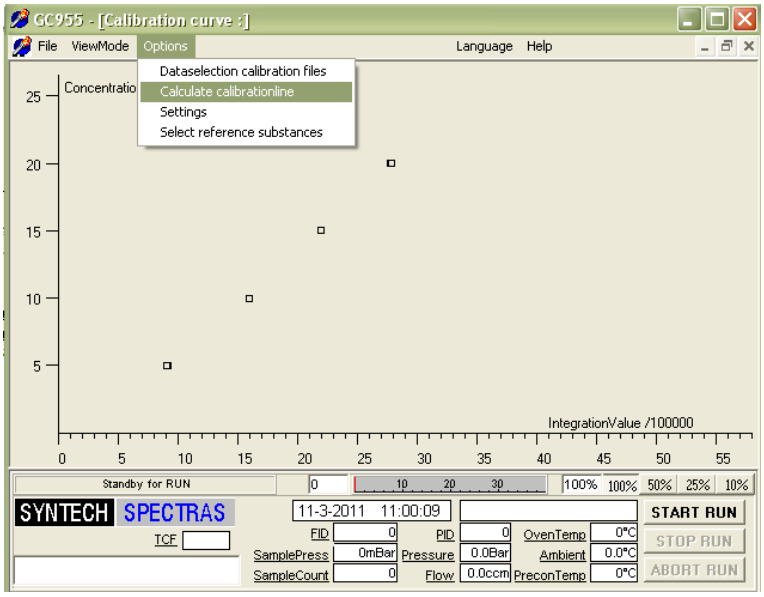
5. You will see:



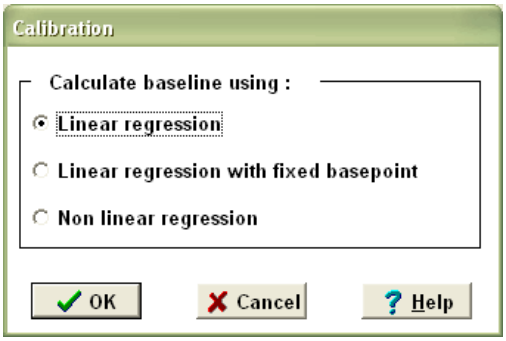
6. You should select:
   - **All Files**, in this case M_110419 to M_110903
   - **OK**



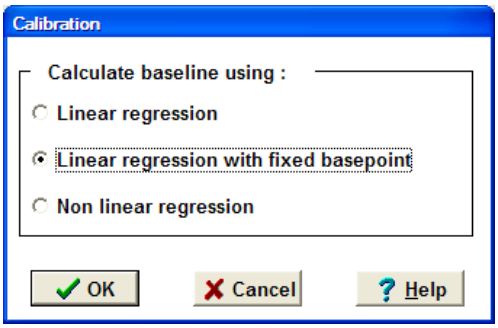
7. You will see that there is no calibration curve but only points, so you have to make a calibration curve. Click on:
   - **Options**
   - **Calculate calibration line**



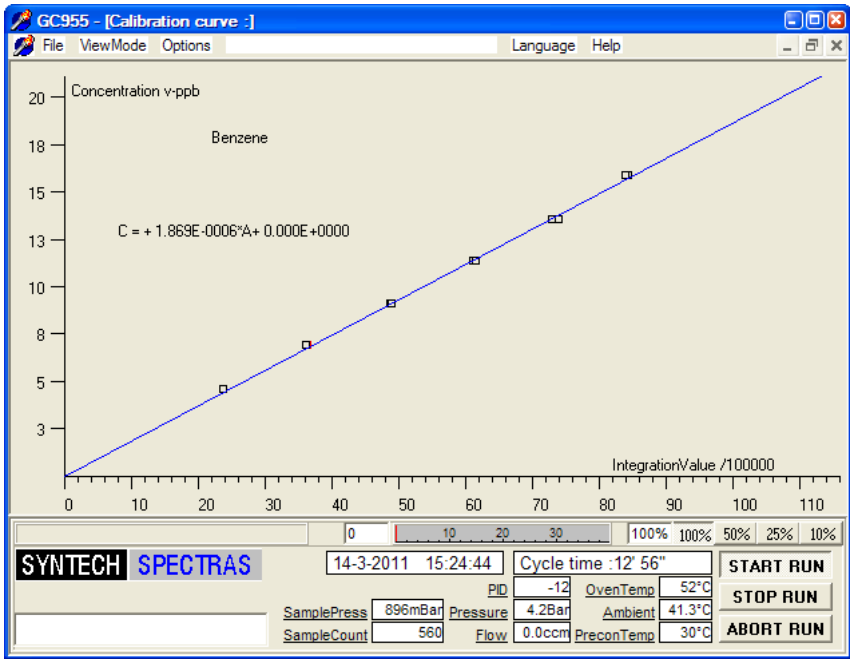
8. You will see:



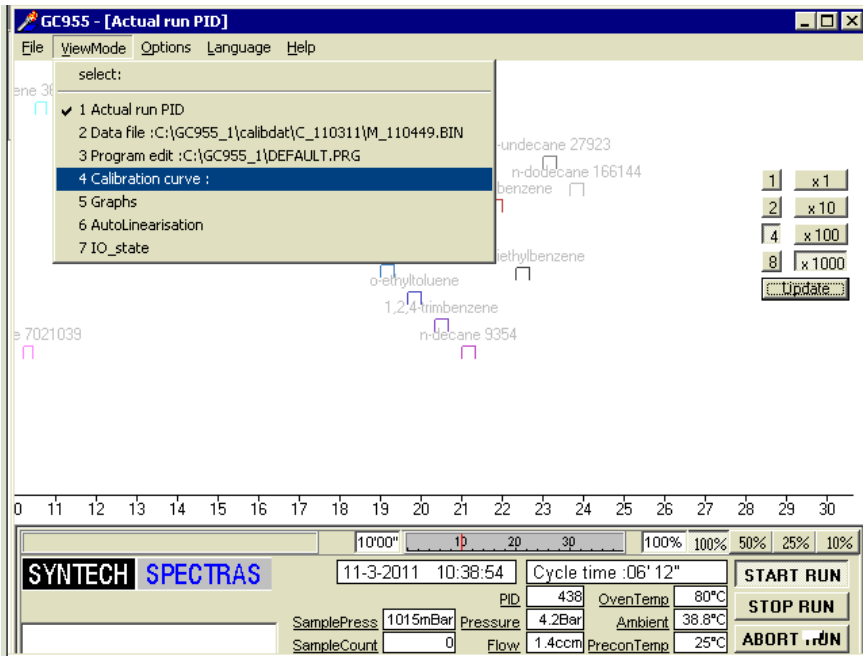
9. Click on:
   - **Linear regression with fixed basepoint**
   - **Ok**



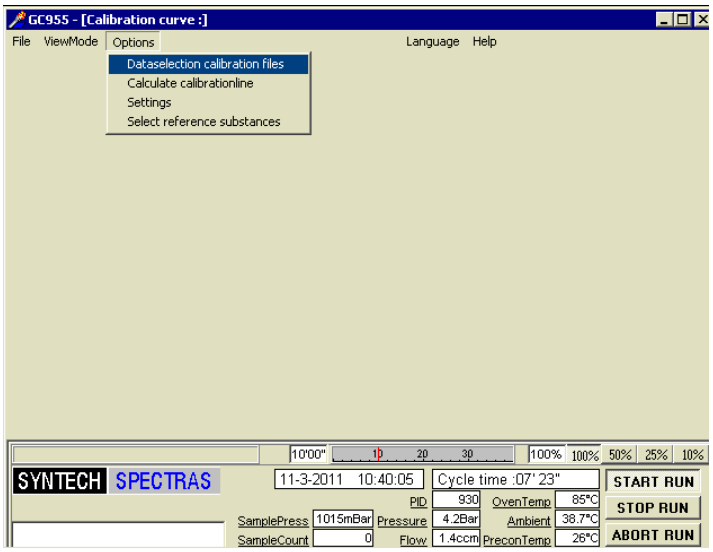
A calibration line like example below should now appear.



This may be repeated for additional compounds, if applicable. To do this, click **ViewMode** and then **Calibration curve.**



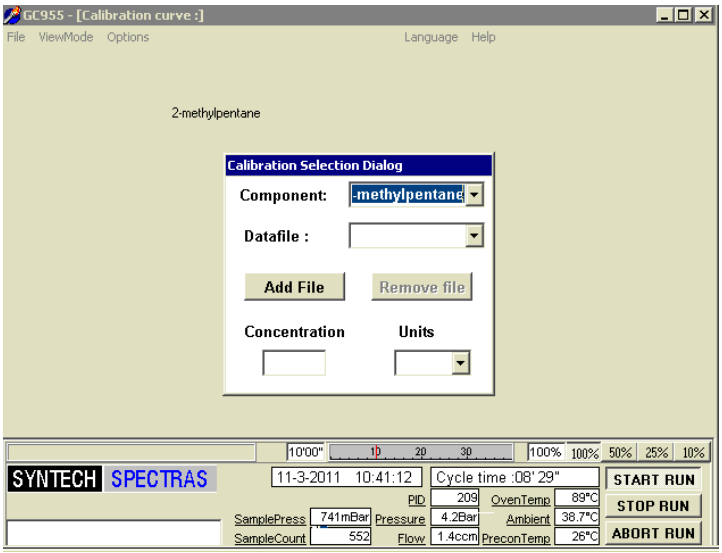
10. You will see:



Click on:

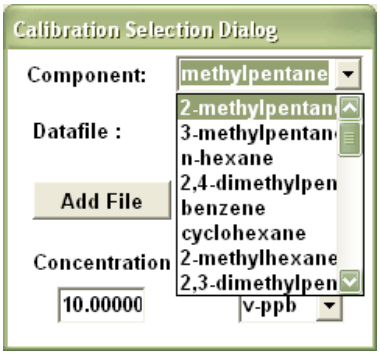
- **Options**
- **Data selection calibration files**

11. You will see:



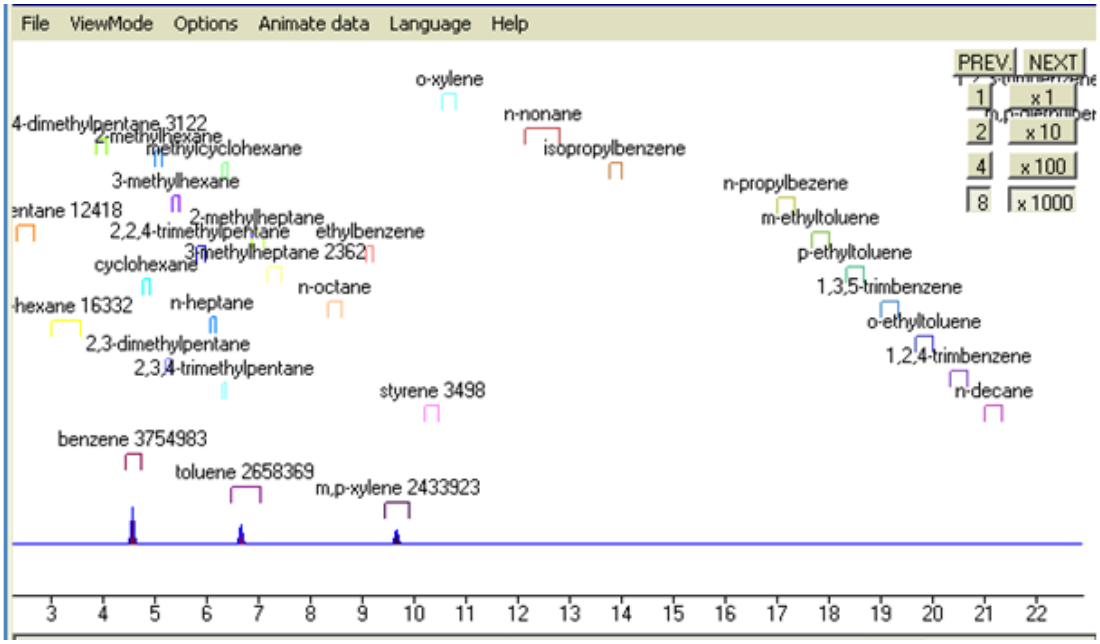
Select a component by clicking the arrow in the component drop down box.

You will see:

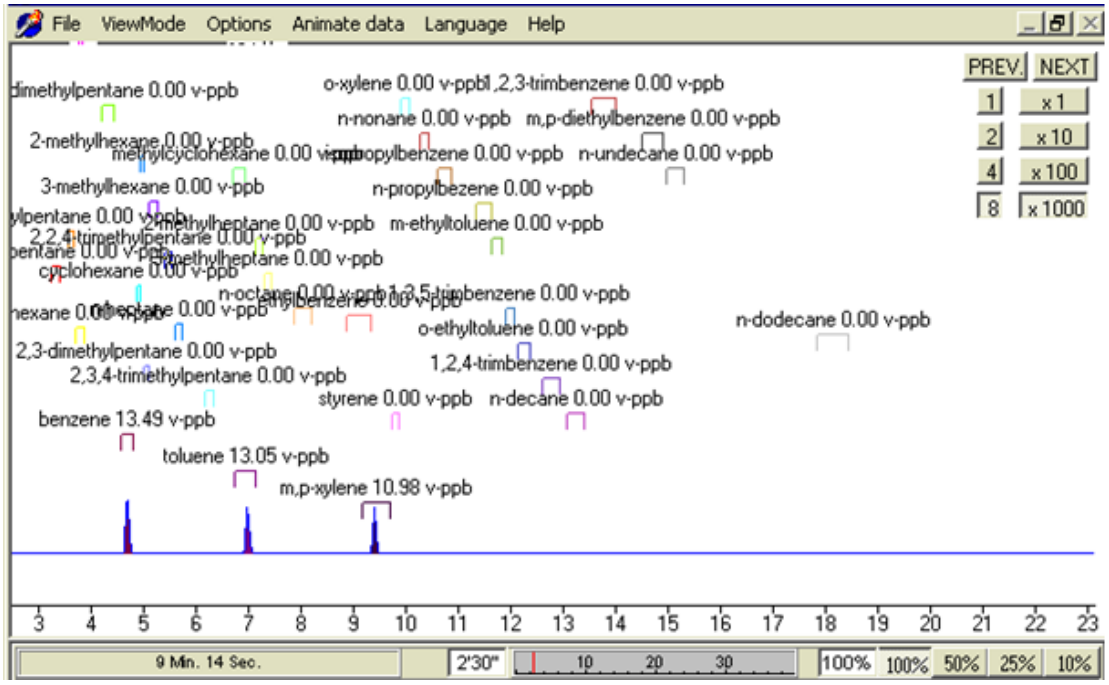


12. Click on **Next compound** and start again with **Add File** and so on.

    Chromatograms with the concentrations, but not areas, are now visible in calibdat.

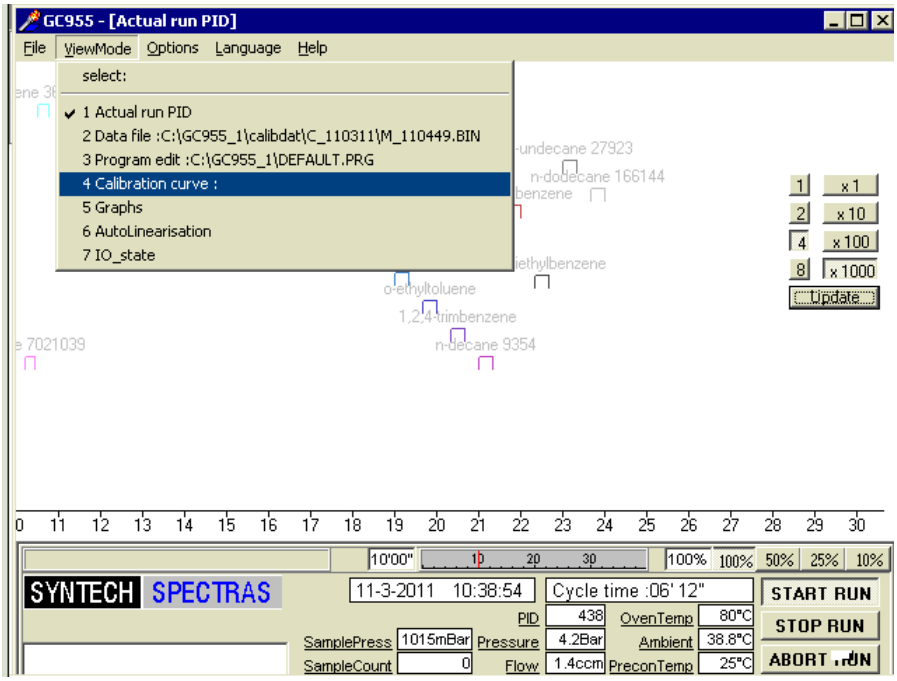


After calibration, the concentrations are visible in ppb:

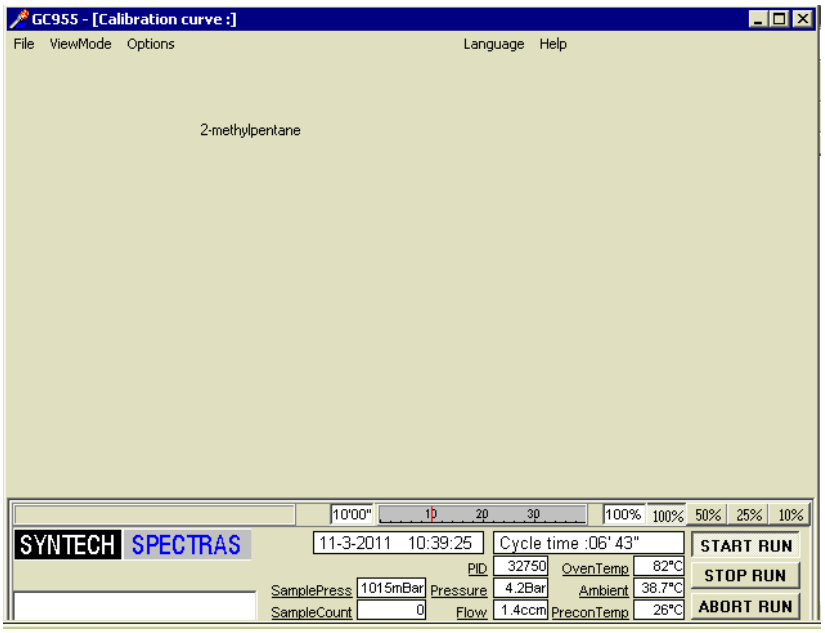


Using the calibration setting

1. Click in the **ViewMode** on **Calibration curve**:

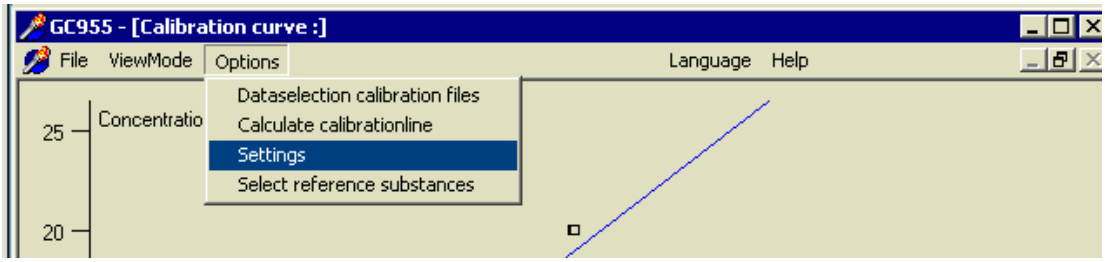


2. You will see:

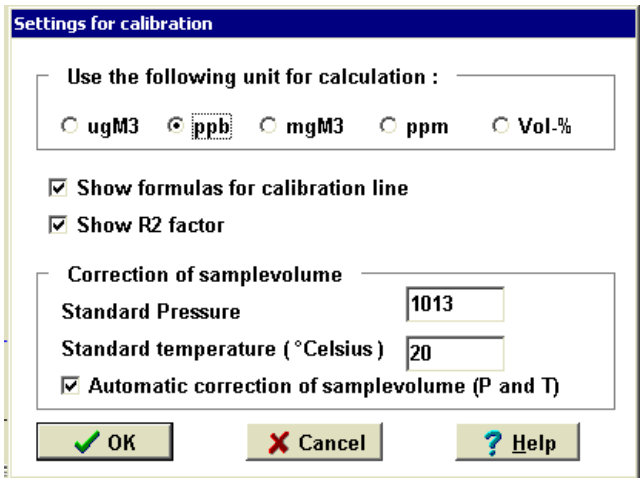


Click:

- **Options**
- **Settings**



3. You will see:



You can choose the unit for calculation.

8. References

Manual for the Syntech Spectras GC955-series Version 4, Synspec b.v, March 2009.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, U.S. EPA Ambient Air Quality Monitoring Program, December 2008.

9. Analyzer Checklist

Criteria	Value	Notes
SN		
Power on functional		
Column flow		
Pressure		
Ambient temp.		
Oven start temp.		
Pre-concentrator start temp.		
Syringe sample strokes		
Peak windows		
Zero check (if applicable)		
Span check (if applicable)		