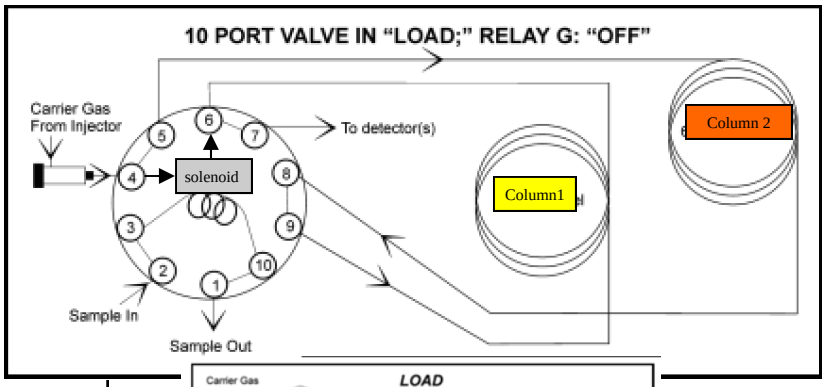
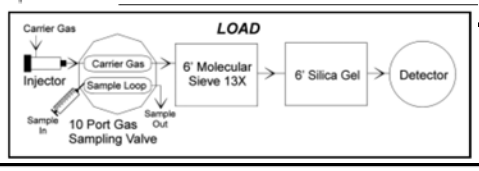
SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration

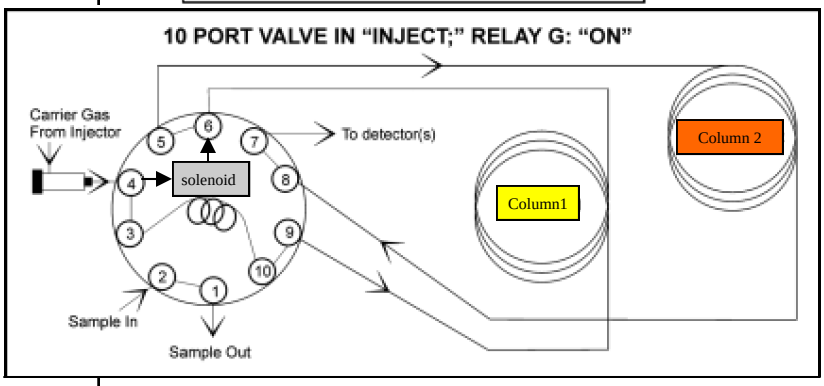
The SRI 8610C Gas Chromatograph Multiple Gas #3 GC configuration is a versatile low cost way of analyzing many different kinds of gas samples. The GC pictured at right has two Multiple Gas #3 (MG#3) configurations implemented in a single GC chassis so there are two gas sampling valves and four columns as well as four detectors. This is why the column oven looks so crowded.

The MG#3 GC configuration is almost identical to the MG#1 GC configuration except there is an additional solenoid valve which when activated by the PeakSimple data system stops the flow of carrier gas in column 1.



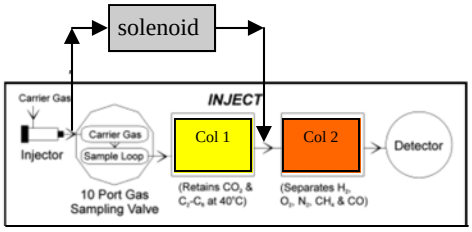


When the solenoid valve is actuated (typically while the gas sampling valve is in the INJECT position), column 1 has the same pressure applied to both its inlet and outlet. This stops the flow of carrier gas in column 1. The peaks which were in column 1 simply stop moving without broadening or distortion.



The flow of carrier gas in column 2 actually increases while the solenoid is actuated since the full carrier gas head pressure is now applied across a shorter restriction (one column instead of two in series).

The MG#3 GC configuration is slightly more flexible than the MG#1 because the stop flow capability allows a wider selection of columns to be used, where the MG#1 only works with silica gel as Column 1 and Mole-Sieve 13X as Column 2.



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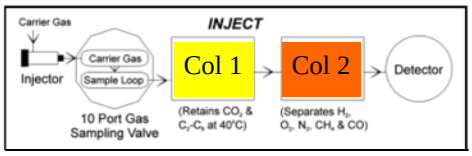
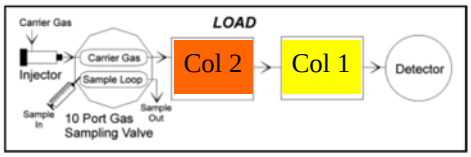
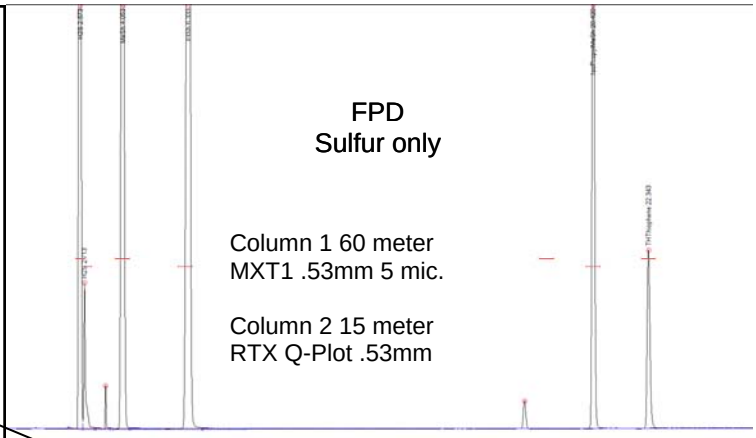
The chromatograms shown on this page are a mix of natural gas and sulfur compounds. The top chromatogram shows the sulfur selective FPD response.
The middle chromatogram shows the FID response.
The two lower chromatograms show the FPD response (black) overlaid with the FID response (red).

The PeakSimple event table shown at right rotates the valve from Load to Inject at .1 minutes and then back to Load at 1.00 minutes.
Because even the first peak (methane) has not migrated from Column 1 though to Column 2 at this time, the



equivalent effect is that the peaks are injected into and are separated by

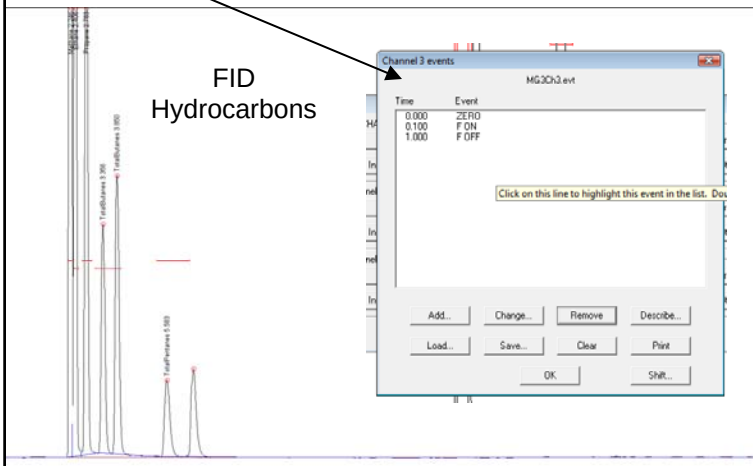




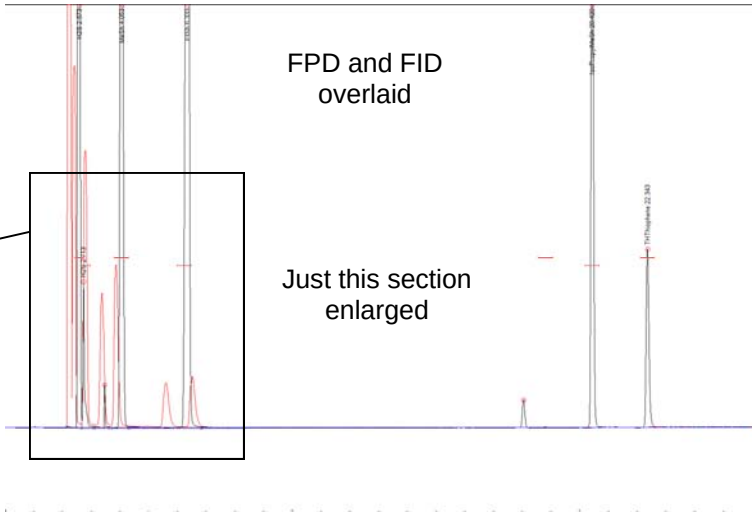
FPD
Sulfur only

Column 1 60 meter
MXT1 .53mm 5 mic.

Column 2 15 meter
RTX Q-Plot .53mm

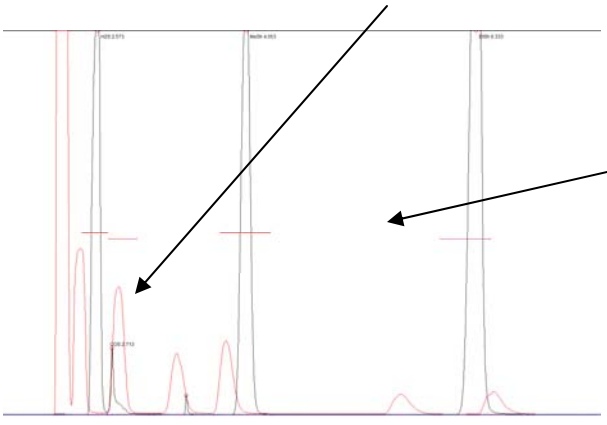


FID
Hydrocarbons



FPD and FID
overlaid

Just this section
enlarged



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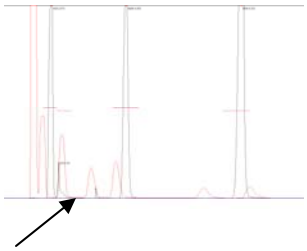
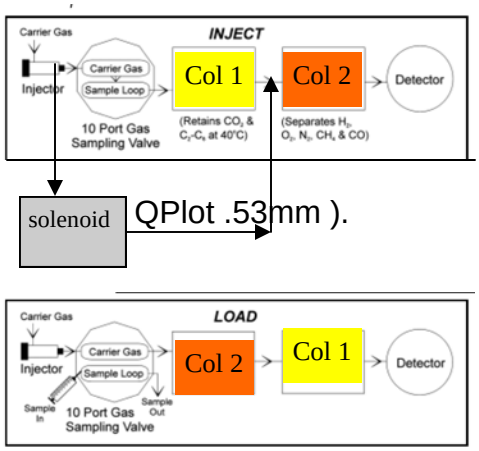
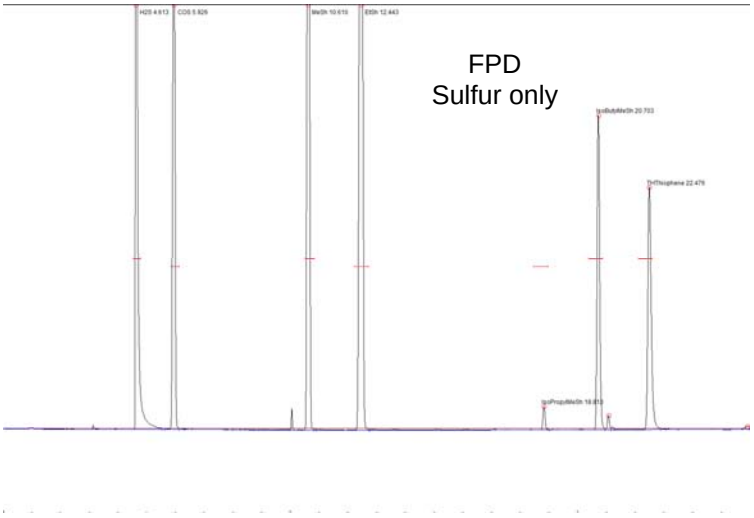
Instead, the MG#3 allows the Stop Flow solenoid to actuate at 3.5 minutes just after the Propane and COS migrate into Column 2 (15meter RTX

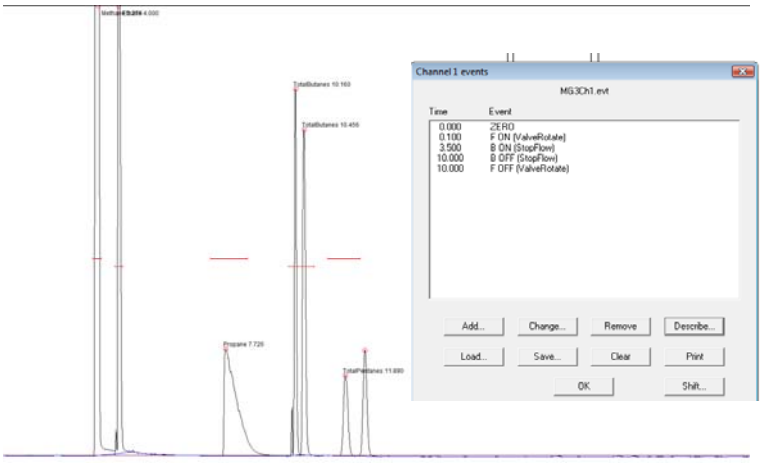




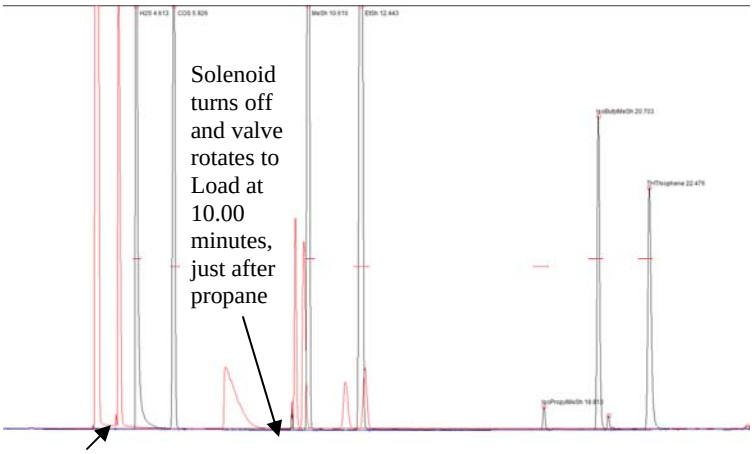
This traps the peaks after Propane in Column 1 while the peaks in Column 2 (Methane, Ethane, Propane, H2S and COS) separate and elute. Unlike column 1 which does not separate COS and Propane, the peaks are well separated on Column 2 so quenching does not occur.

Once Propane elutes from Column 2 (about 10 minutes) the valve rotates back to the Load position and the Stop





Oven temperature 40C for 10 minutes then 20C/min to 200C



Solenoid turns on at 3.5 minutes, stopping flow in Col 1

SRI 8610C Gas Chromatograph
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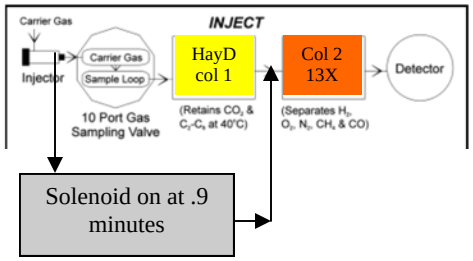
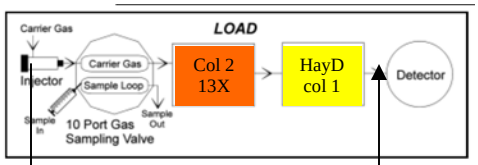
The MG#3 GC configuration is also useful with other column combinations. In this example, Column 1 is a 3' HaysepD and Column 2 is a 6' MS13X. The sample is first run on the 3' HaysepD using the event table shown at right. Because the valve is rotated back to the Load position almost immediately after injection

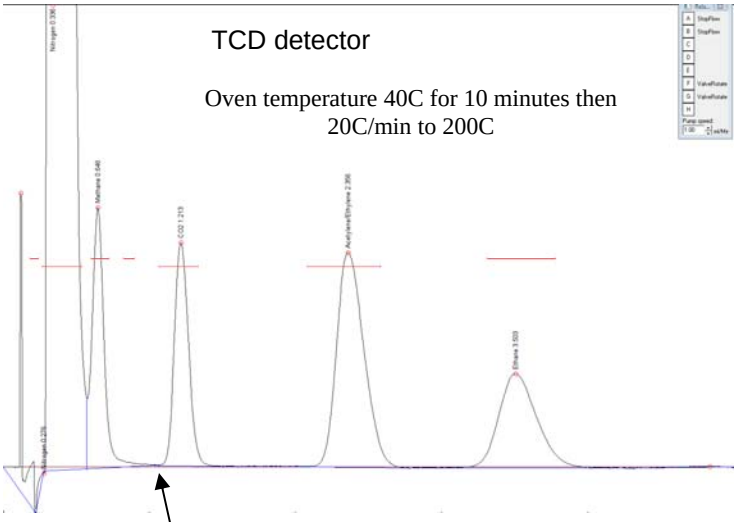


Solenoid on at .9 minutes

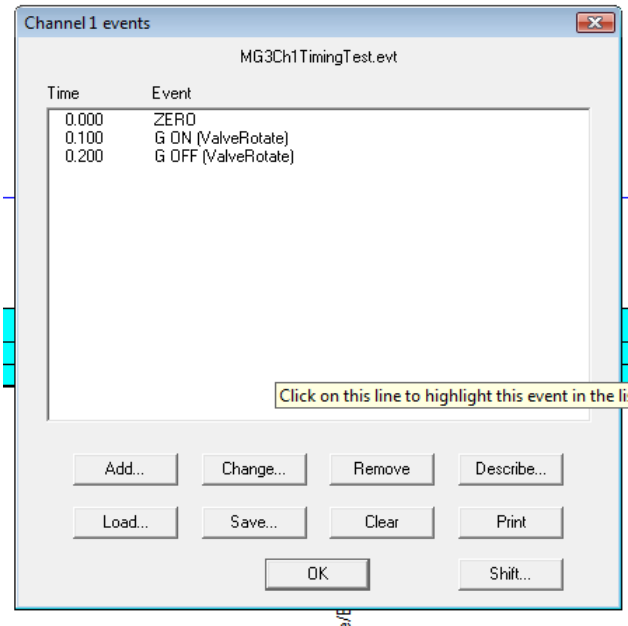


Solenoid off

(.1 minutes) the separation occurs as if Column2 was not even connected. (no hardware changes are required to produce this effect). There is a convenient gap between Methane and CO2 where it would make sense to activate the stop-flow solenoid valve to immobilize the CO2 and heavier peaks in Column1 while the H2, O2, N2, Methane and CO peaks elute from Column2.

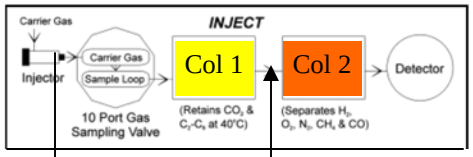


This would be a good time (.9 minutes) to activate the stop-flow solenoid. Just after the Methane migrates onto Column2 but before the CO2 and heavier peaks

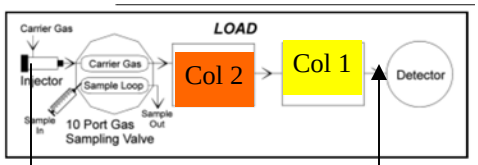


SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration

The same sample is injected again using the Event table shown at right. The valve stays in the Load position until 4.00 minutes. The Stop-Flow solenoid is actuated at .9 minutes (determined from the chromatogram on the previous page) and de-activated at 4.00 mintes. This results in H2, O2, N2, CH4 and



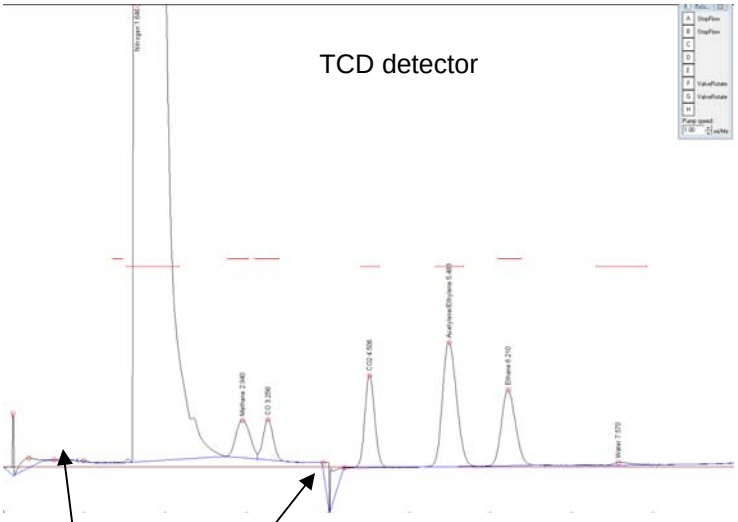
Solenoid on at .9 minutes



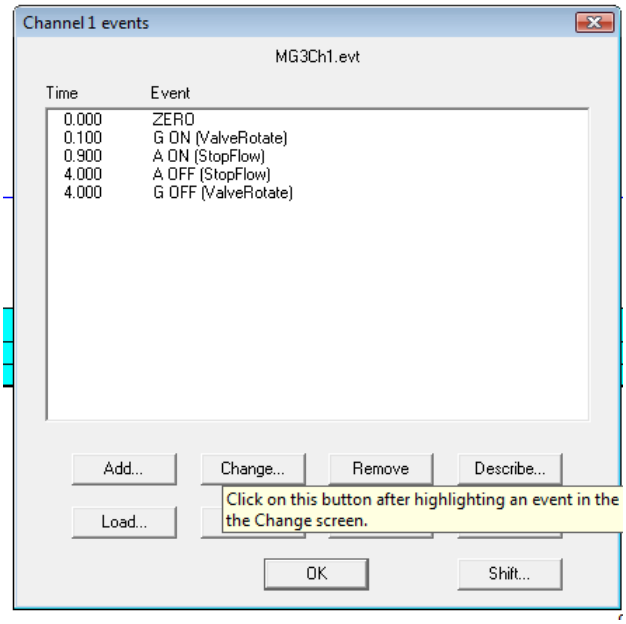
Solenoid off

CO migrating onto Column2 (Mole-Sieve13X) where they separate and elute into the TCD detector. Once CO elutes (about 4.00 minutes), the valve is rotated back to the Load position and the Stop-Flow solenoid is de-energized.

The concept of immobilizing peaks by stopping the flow is applicable to many situations and many column combinations, not just the two examples presented here.

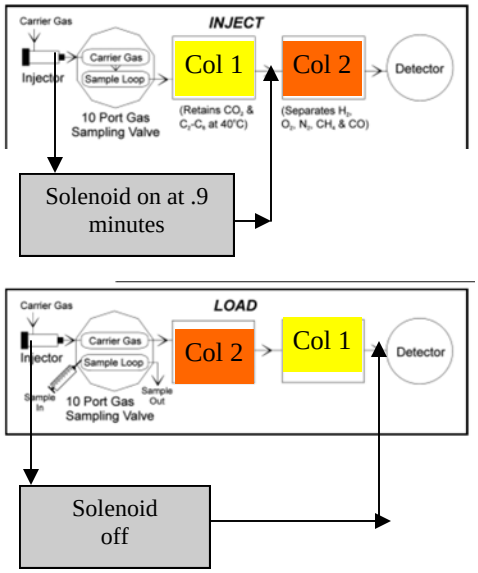


Stop-Flow solenoid on at .9 and off at 4.00 minutes.
Valve back to Load position at 4.00 minutes

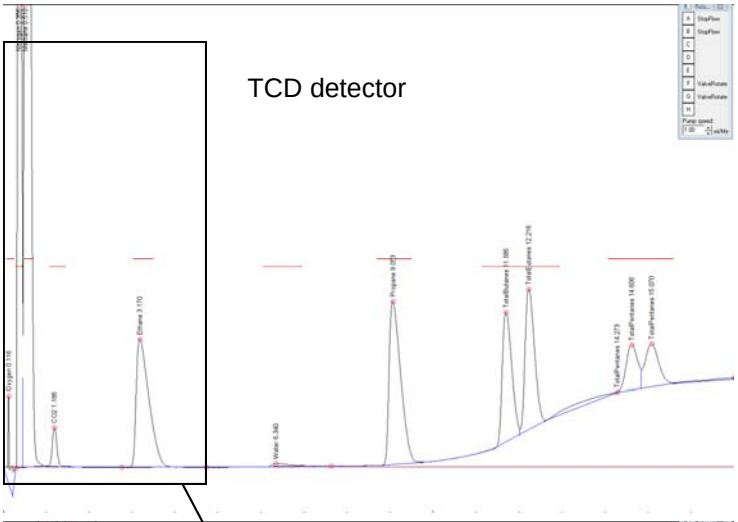


SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration

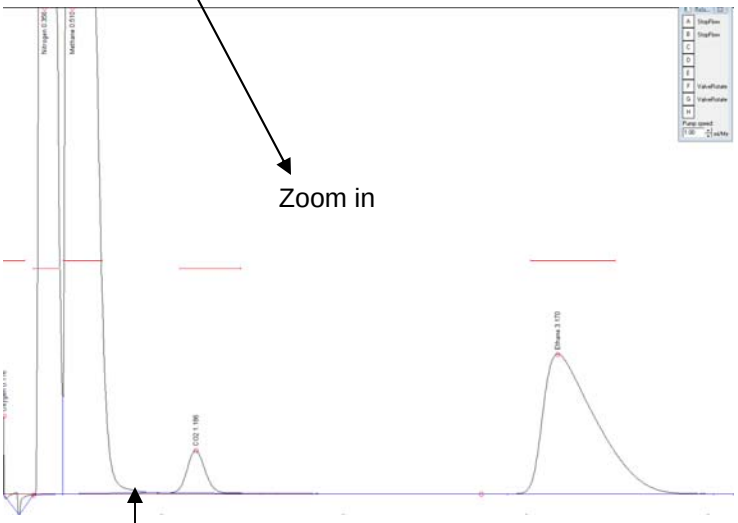
Another example is Natural Gas. Set the Event table up to inject and then immediately rotate the valve back to Load after .1 minutes in the Inject position. This has the effect of performing the analysis as if Column2 was not in the system. We call this the " Timing Mode"



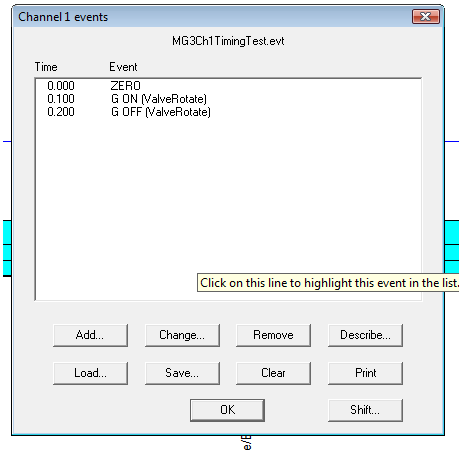
Column 1 is a 3' Haysep D and Column 2 is a 6' MS13X. The Haysep D does not separate Oxygen and Nitrogen or CO. Set the Stop-Flow solenoid time by finding the gap between Methane and CO2, in this case about .9 minutes.



Zoom in

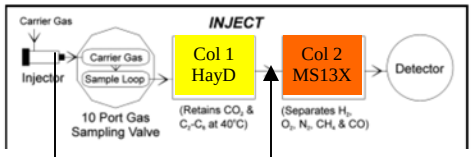


The gap between Methane and CO2 is a good time to actuate the Stop-Flow solenoid



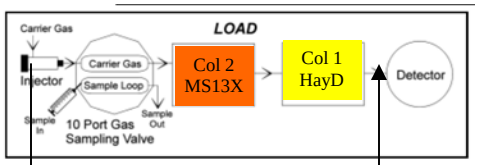
SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration

With the Event table modified, the Oxygen, Nitrogen and Methane separate on the MS13X. Then the Stop-Flow solenoid is de-energized and valve rotated back to Load position (both at 4.00 minutes) and the remaining peaks (Ethane, Propane, Water, Butanes, and Pentanes) which were immobilized on

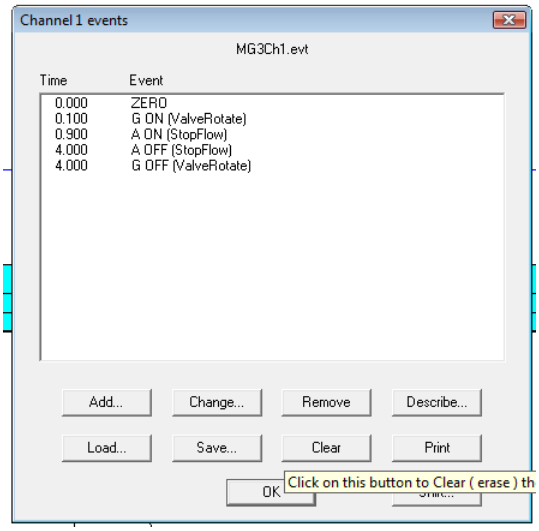


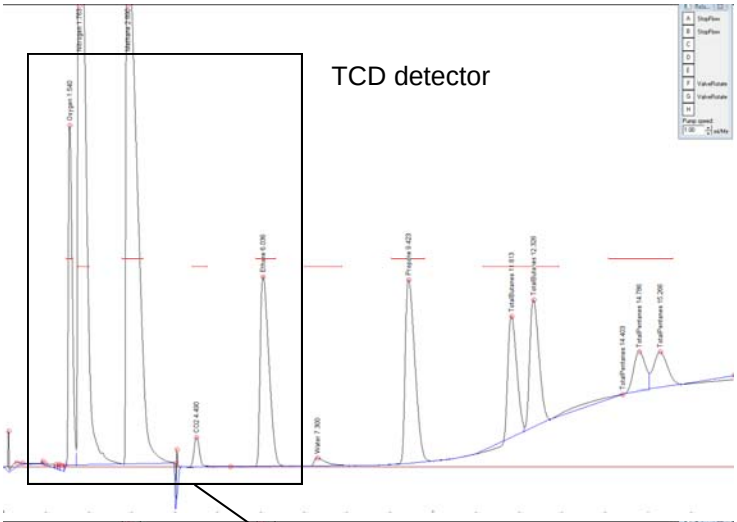
the

Solenoid on at .9 minutes

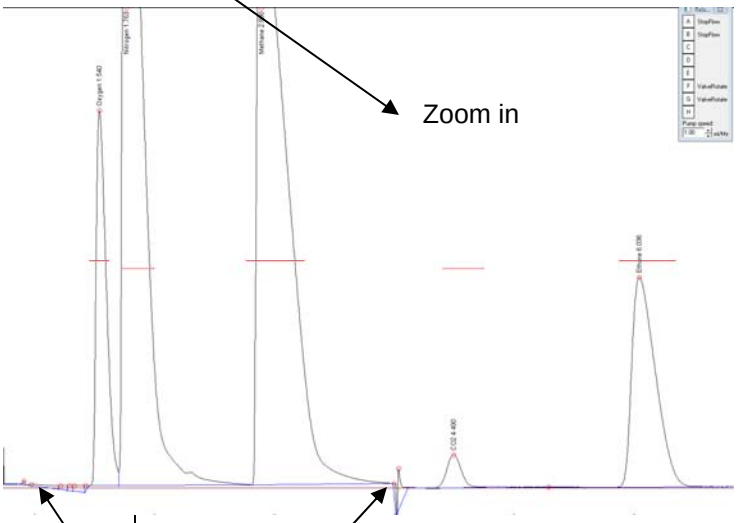


Solenoid Off at 4.00





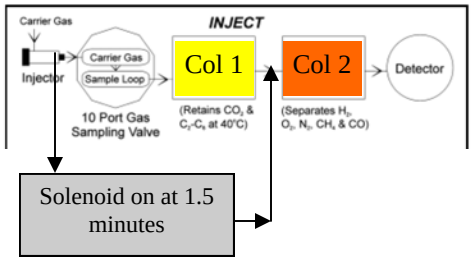
Zoom in



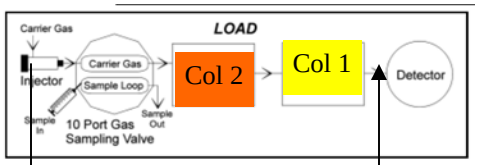
The Stop-Flow solenoid is actuated at .9 minutes and de-energized at 4.00 minutes. The valve is rotated back to Load also at 4.00 minutes

SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration

Another example uses a 9' Haysep D column and a 6' Mole Sieve 13X. With the event table set to the " Timing Mode" we can see there is a nice gap at 1.5 minutes where we can actuate the Stop-Flow solenoid. The Stop-Flow chromatogram separates the O2, N2 and CO on the 13X column, then the Methane and

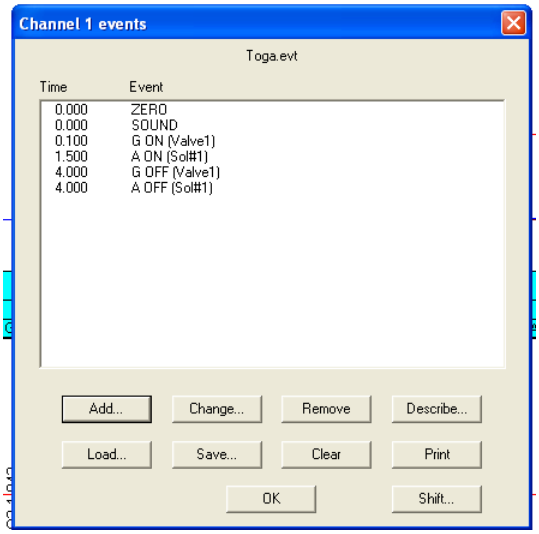


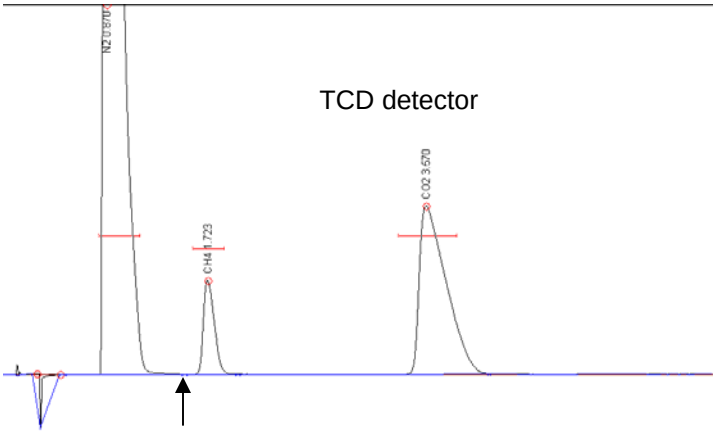
Solenoid on at 1.5 minutes



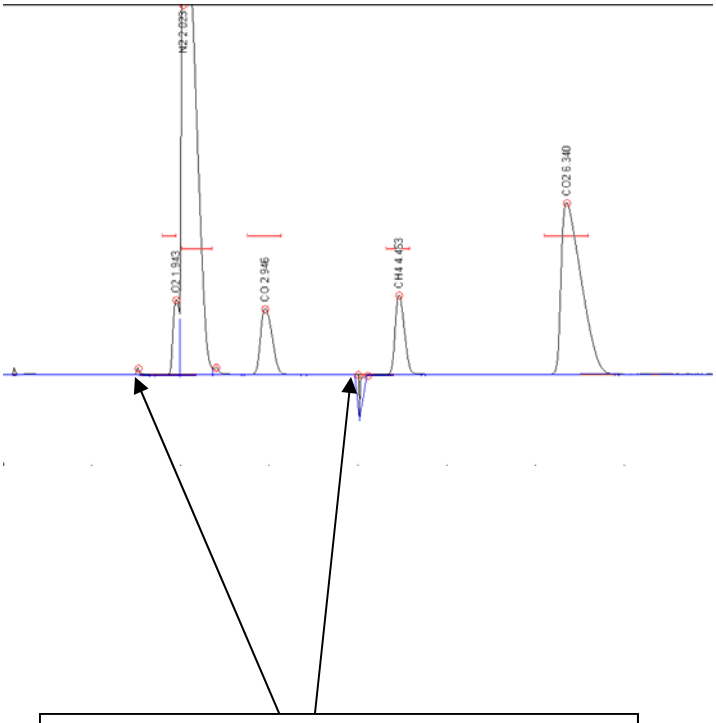
Solenoid Off at 4.00

CO2 on the Haysep column .





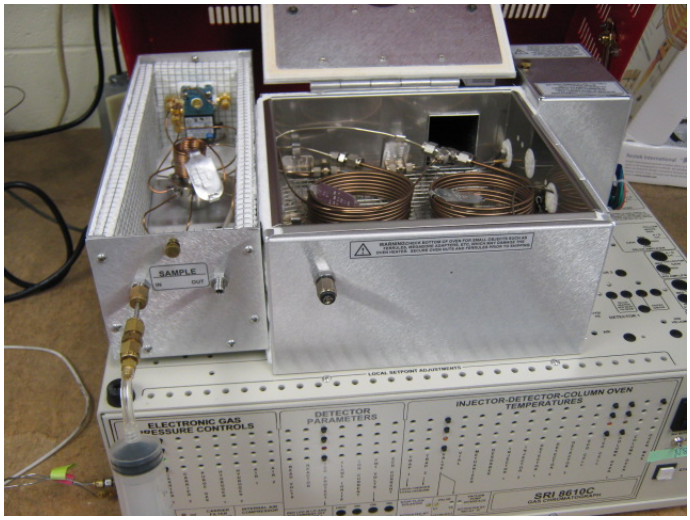
The gap in the chromatogram between the combined O2, N2 and CO peak and the Methane peak is a good place to actuate the Stop-Flow solenoid



The Stop-Flow solenoid is actuated at 1.5 minutes and de-energized at 4.00 minutes. The valve is rotated back to Load also at 4.00 minutes

SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration
Application Example-2 step process

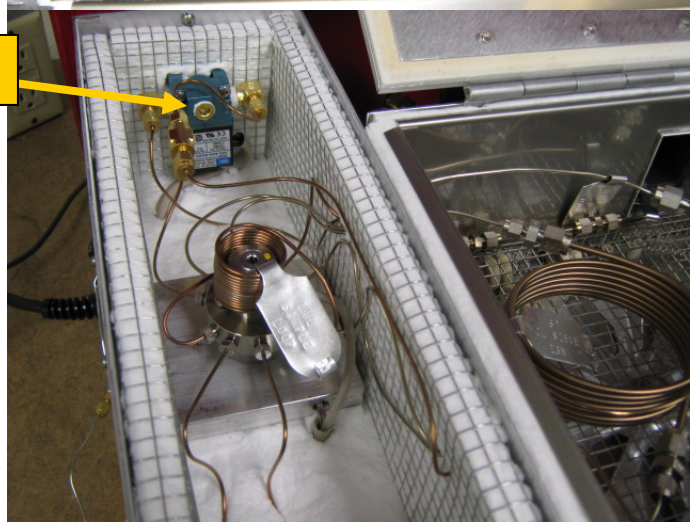
The SRI 8610C GC is configured as a Multiple Gas #3 with TCD detector.



There are two columns in the column oven, a 2 meter Haysep-D and a 2 meter MoleSieve 13X.

Stop-Flow Solenoid

There is a 10port gas sampling valve (Relay G) located in the valve oven as well as the Stop-Flow solenoid (Relay A).

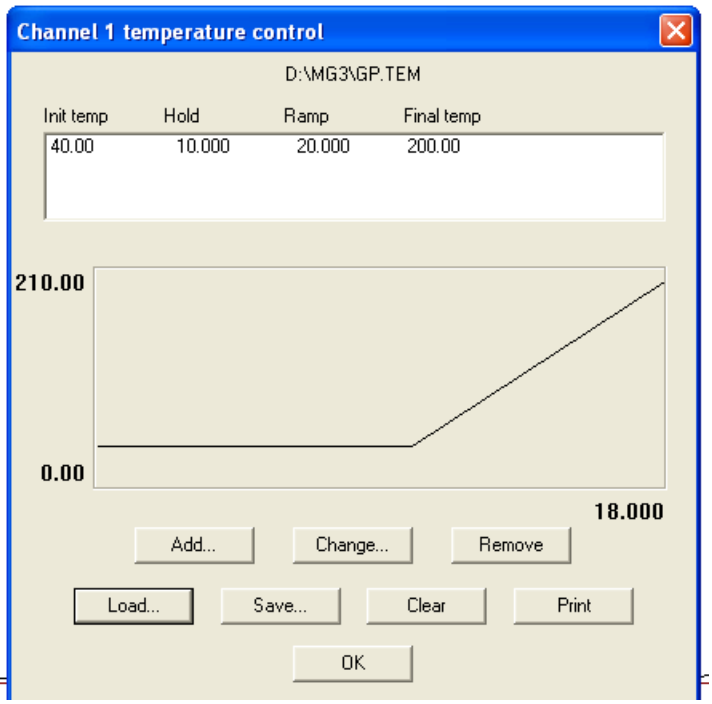


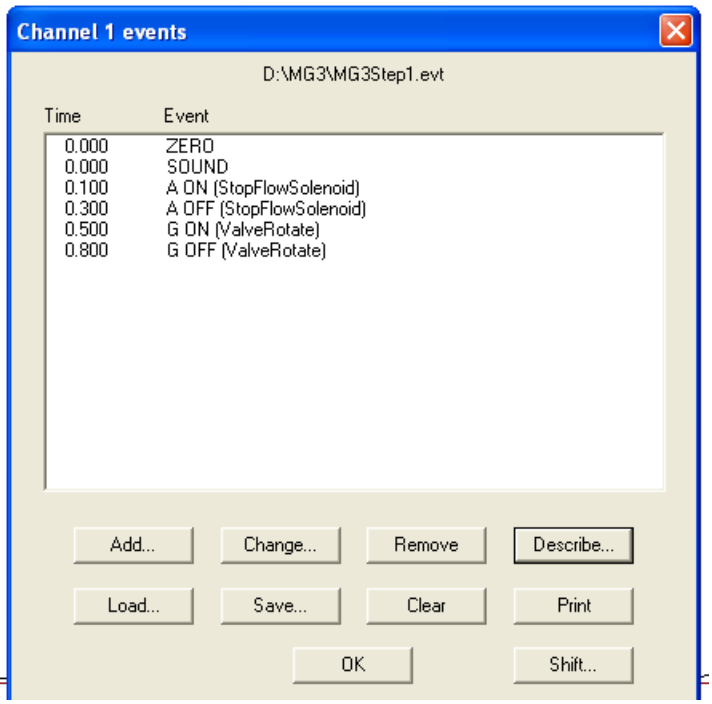
SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration
Application Example-2 step process

The oven temperature program is set to hold the column oven at 40C for 10 minutes, then ramp at 20 degrees per minute to 200C.

The Event table:

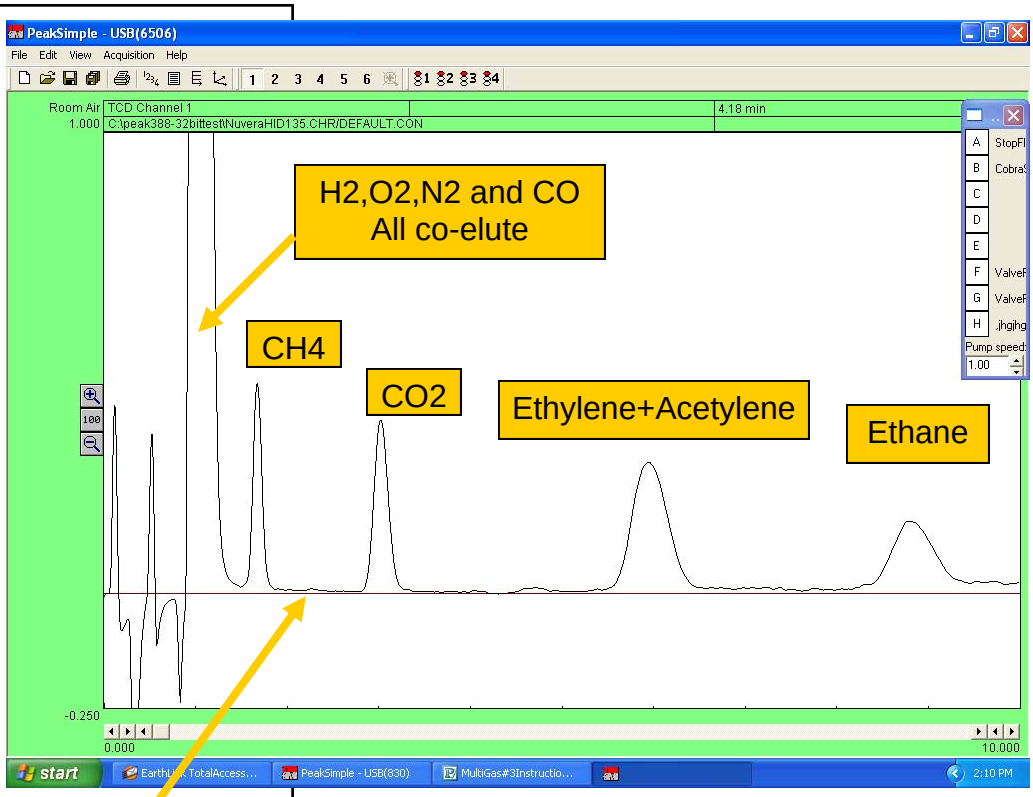
1) Auto-zeros the detector signal at 0.00 minutes.
2) Makes a sound at zero minutes to confirm to the operator that the analysis has begun.
3) Actuates Relay A (the Stop-Flow Solenoid) for .2 minutes (12 seconds).The purpose of this is to purge the Stop-Flow Solenoid of any air prior to the analysis.
4) The gas sampling valve (Relay G) is actuated at .5 minutes and deactuated at .8 minutes. This results in the sample being injected onto the Haysep-D column, which is upstream at the moment of injection. When the valve is rotated back to the Load position at .8 minutes the Haysep-D column becomes the downstream column and the sample will not have had enough time to make its way through so the peaks will elute directly into the TCD detector without going through the MoleSieve 13X column at all. The chromatogram which results will be identical to a system with just a Haysep-D column.



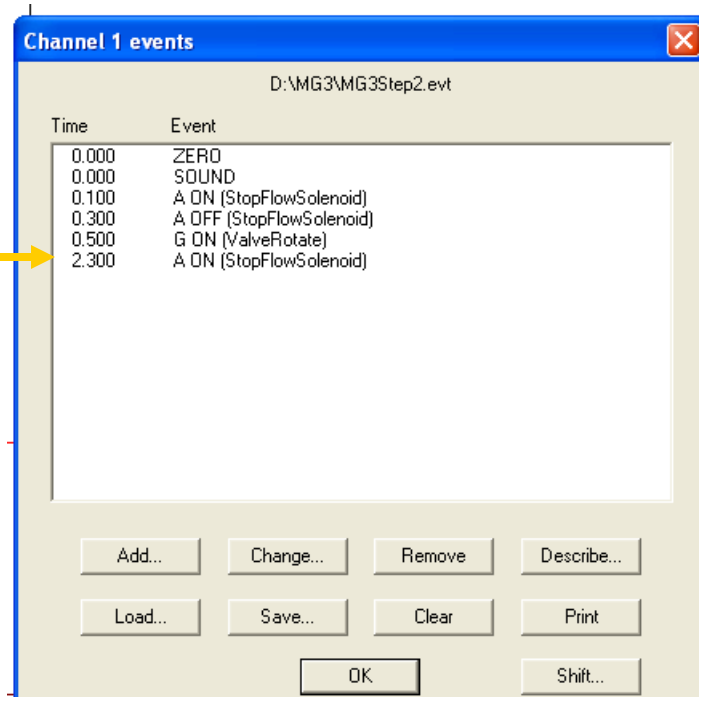


SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration
Application Example-2 step process

The results of the Step1 chromatogram is shown at right. Since the peaks only traveled through the Haysep-D column there is no separation of Hydrogen, Oxygen, Nitrogen or CO. Those peaks all elute together in one big peak. It is clear from the chromatogram that an appropriate time to actuate the Stop-Flow solenoid would be at about 2.3 minutes. This is just after the methane peak and before the CO2 peak.



The event table is modified so that Relay A which controls the Stop-Flow Solenoid is turned on at 2.3 minutes.

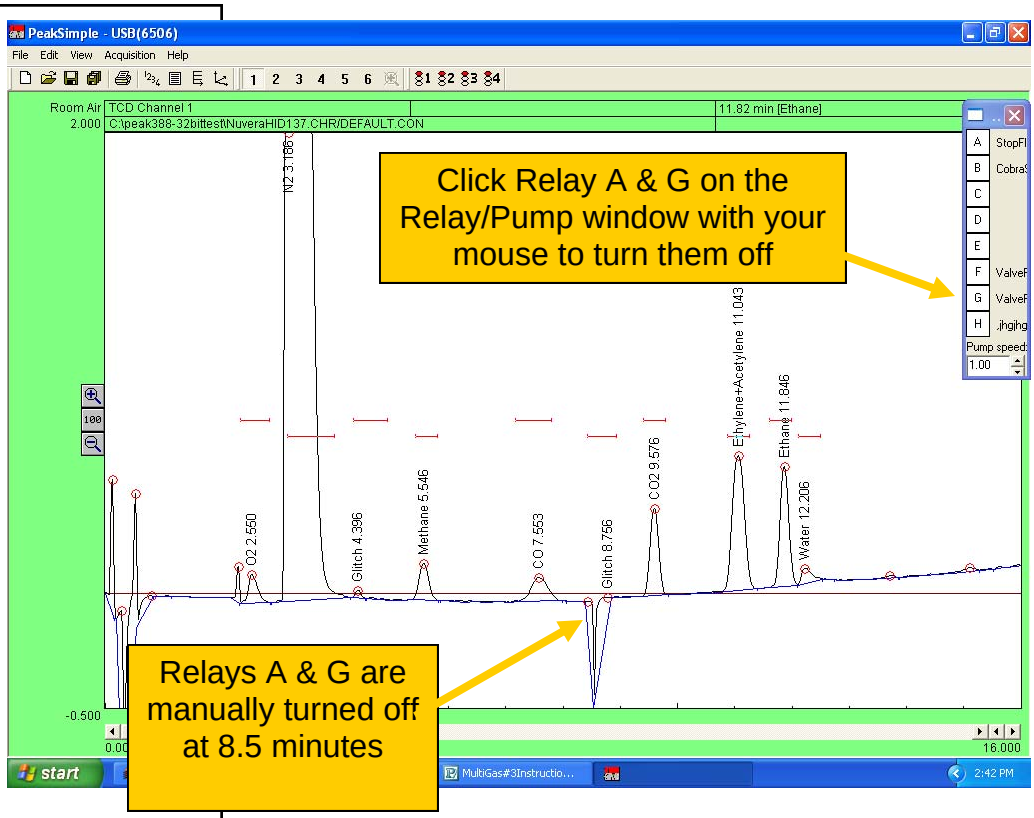


Notice that the entry for Relay G off is removed (compared to the first Event table) since we do not know at this time when to do this. This is what will be determined when we re-inject the same sample in Step 2.

SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration
Application Example-2 step process

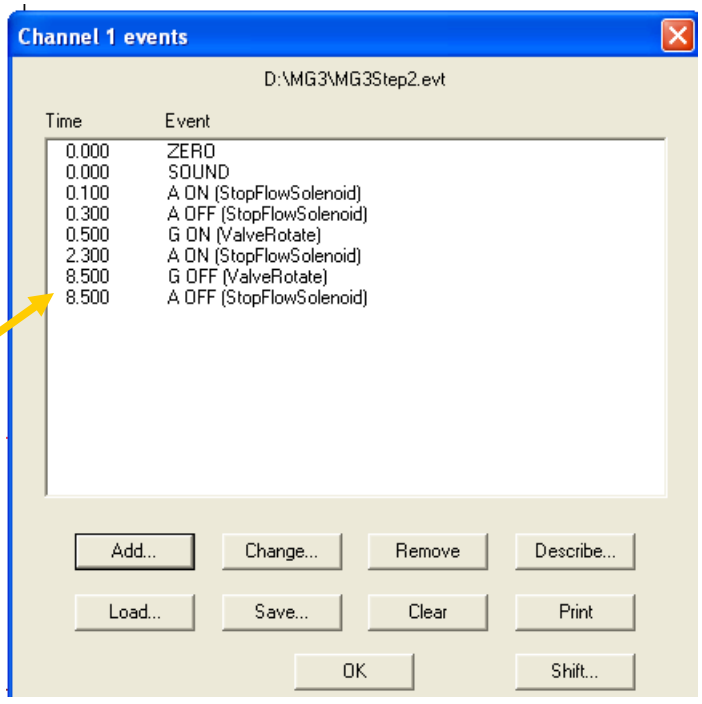
The same sample is re-injected and the chromatogram shown at right appears.

Watch the chromatogram as the peaks appear. When you see the CO peak finally elute and the baseline stabilize (about 8.5 minutes in this example), manually turn Relay A and Relay G off by clicking on the letters A and G in the Relay/Pump window. The Relay/Pump window can be made visible or hidden by clicking Acquisition/ Relay/Pump window.



After Relays A and G are manually turned off, the CO2, Ethylene/Acetylene, Ethane and Water peaks appear. These peaks had been stored temporarily in the Haysep-D column by the action of the Stop-Flow Solenoid.

The Event Table is modified once again so that Relays A and G are turned off automatically at 8.5 minutes, so that no manual actions are required in future chromatograms.

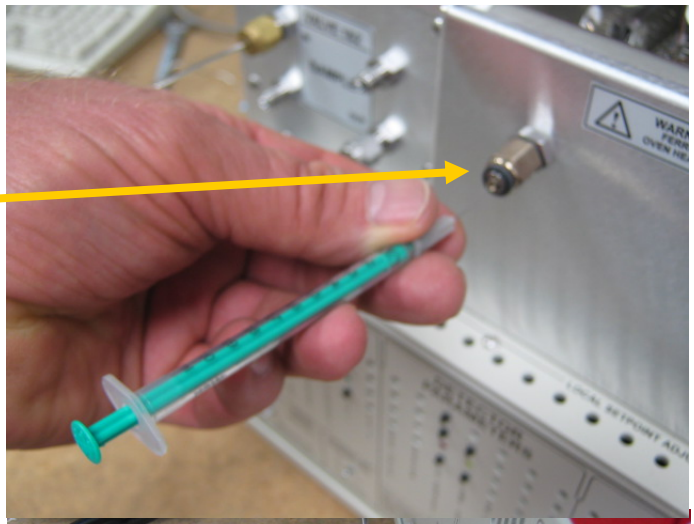


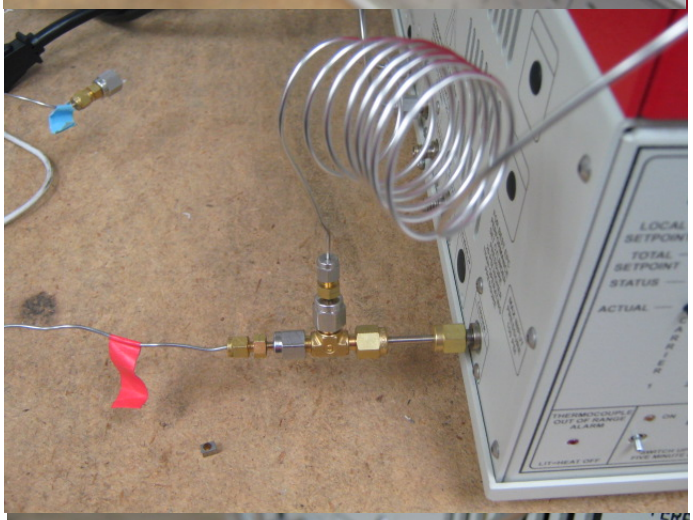
SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration
Application Example-2 step process

Some user's do not have enough sample to load the loop of the gas sampling valve (10ml). In this case, a smaller volume of sample can be injected via the on-column injector.

Refer to the valve diagram and you can see that in order to inject via the on-column injector, the valve must FIRST be positioned in the INJECT position. This puts the Haysep D as the first column the sample will encounter. When the valve is rotated to the INJECT position, the contents of the loop are unavoidably injected. For this reason, you must purge the sample loop with carrier gas.

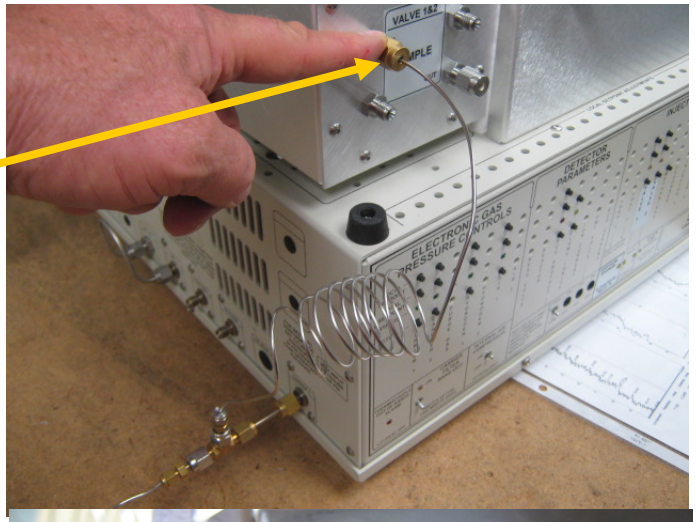
A simple way to do this is to fabricate a "tee" fitting at the point the carrier gas enters the GC. The third leg of the "tee" is connected to a restrictor tube which limits the purge flow to about 10ml/minute. We use 4meters of 1/16" stainless tubing with a .1mm id. At 30psi inlet pressure this limits the helium carrier purge flow through the loop to about 10ml/minute.





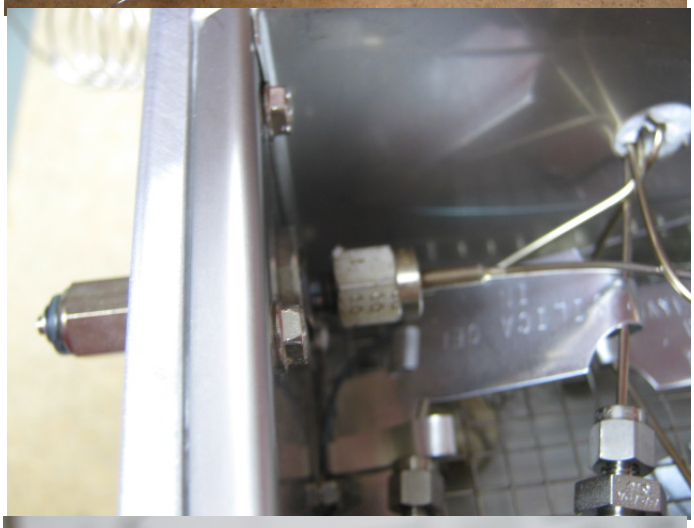
SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration
Application Example-2 step process

The other end of the restrictor tube is connected to the sample IN port on the front of the valve oven.



The purge gas keeps the loop filled with carrier gas (rather than air etc). The purge gas exhausts from the sample OUT port.

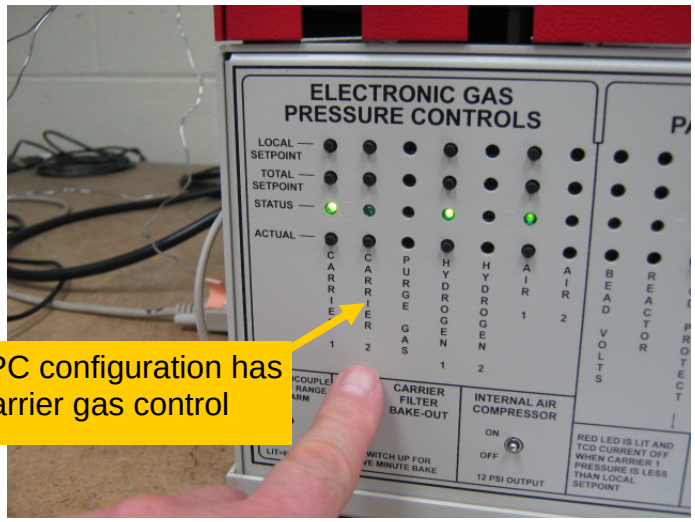
The on-column injector is plumbed with stainless tubing going from the injector to port#4 of the gas sampling valve. So when you make a syringe injection the sample takes the same path as it would have if you injected the usual way via the sample loop. All the timing (Relay A and Relay G) is the same whether you inject via the on-column injector or via the loop.



GCs manufactured after January 2014 have a special low dead volume injection liner which gives slightly sharper peaks when doing the on-column injection in this manner. The liner (SRI part# 8670-1503) looks like the photo at right.

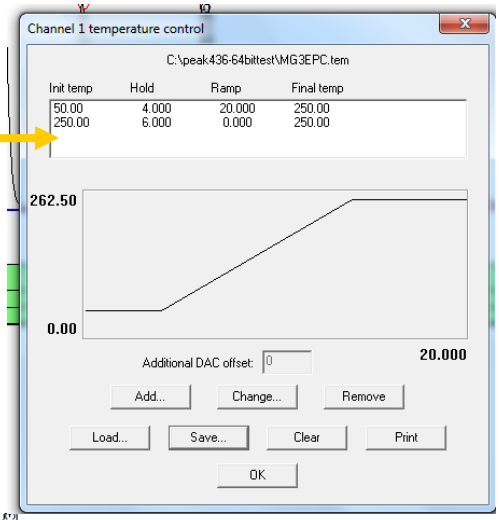
SRI 8610C Gas Chromatograph
MG3epc configuration
January 2015

The Multiple Gas #3 GC configuration has been slightly modified (for better performance) on all units manufactured after January 2015 to incorporate an Electronic Pressure Controller (EPC) instead of the Stop-Flow solenoid. These instructions assume you have a 6" Haysep D and 6'MS13X column installed. If you have different columns you may have to modify the temperature, pressure and events from what is shown.

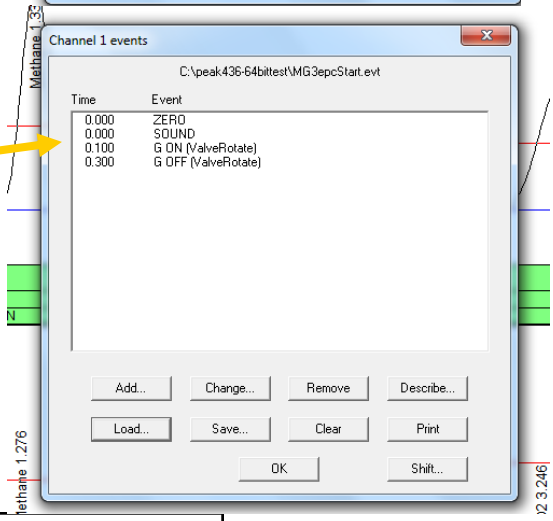


The MG3EPC configuration has a 2nd carrier gas control

Set up the Channel 1 temperature program as shown here.

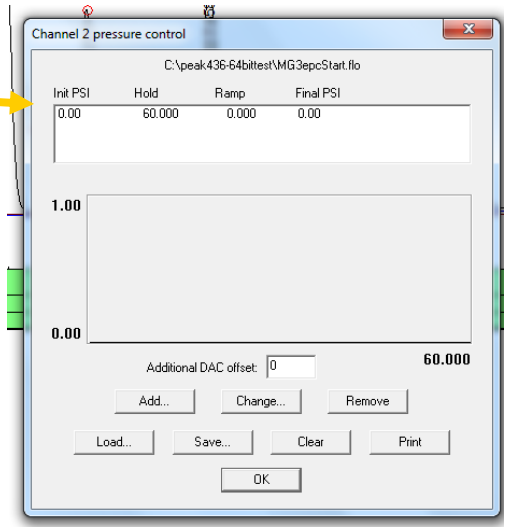


Set up the Channel 1 Event table as shown here. Call the Event table MG3epcStart.evt.

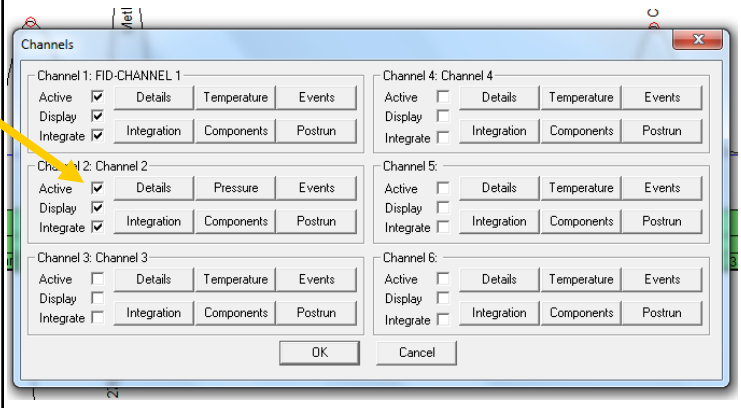


SRI 8610C Gas Chromatograph
MG3epc configuration
January 2015

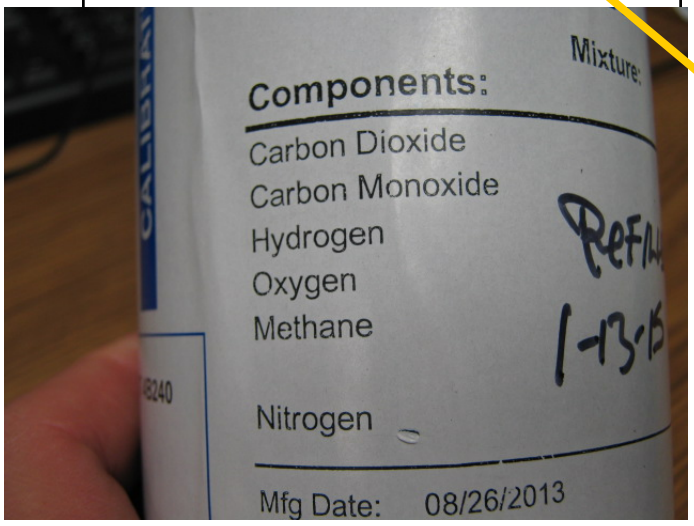
Set up the Channel 2 Pressure Program as shown. Save this as MG3EPCstart.flo.

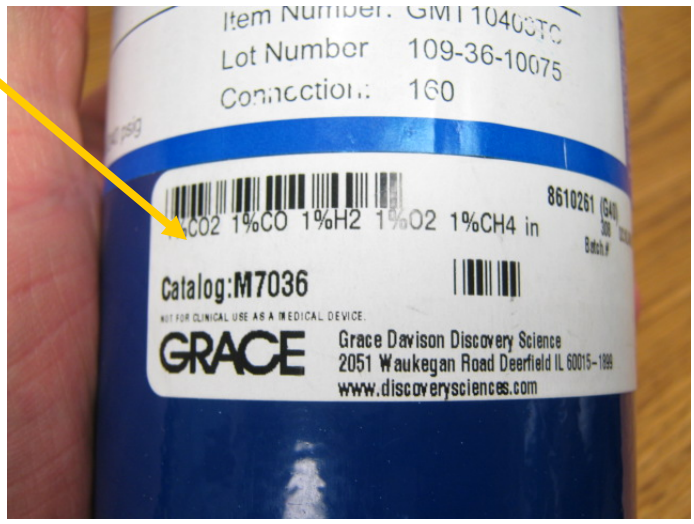


You may have to ensure that channel 2 is Active if it is not already.



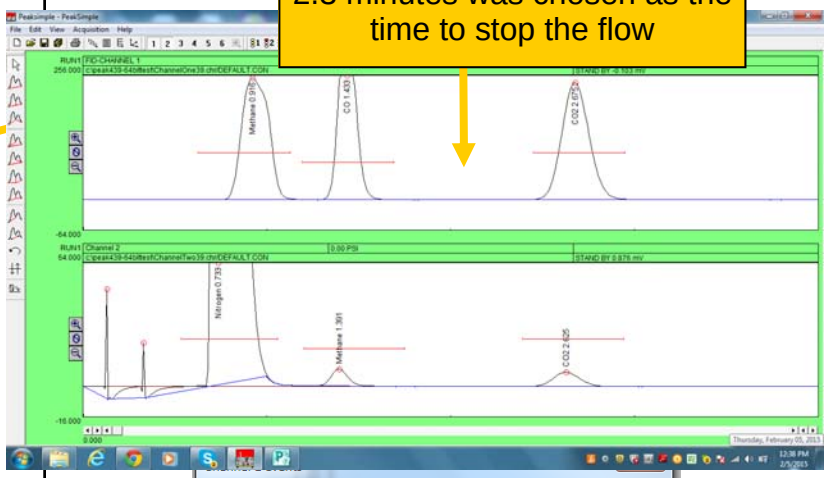
Inject a calibration gas standard such as the one shown below.



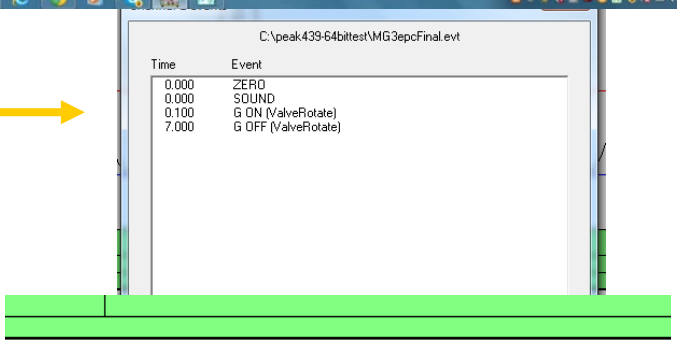


SRI 8610C Gas Chromatograph
MG3epc configuration
January 2015

The chromatogram which results from the initial timing experiment shows that 2.3 minutes would be a good time to stop the flow in the upstream column (the stop-flow time).



Modify the Channel1 Event table as shown here.



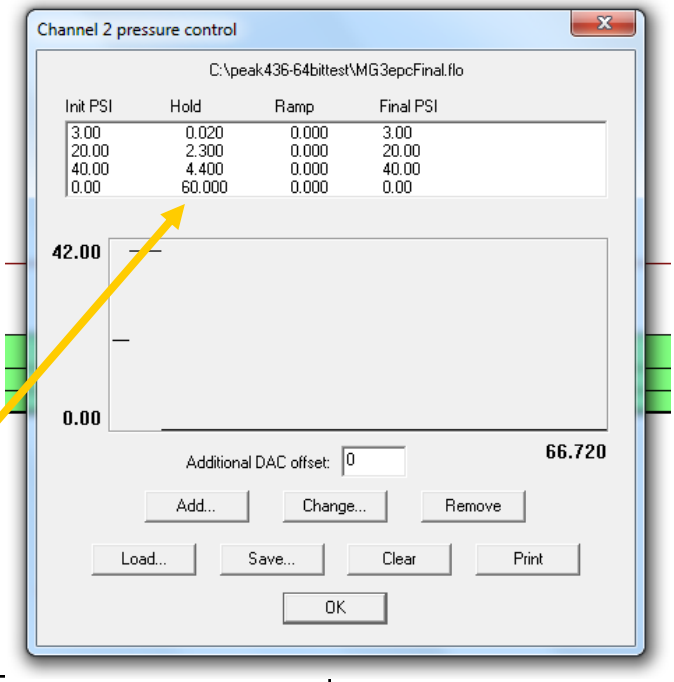
Save the Event table as MG3epcFinal.evt.

Note that the time for Relay G Off (7 minutes) is a guess, and may be adjusted later.

Modify the pressure program in Channel 2 as shown here.

Some of the pressures and times are also a guess, and will probably need to be fine tuned.

The pressure is allowed to drop from 40 back to 0 just a little before the 7 minute Relay G valve rotation so the pressure is not so high when the valve rotates. This makes the artifact peak a little smaller.



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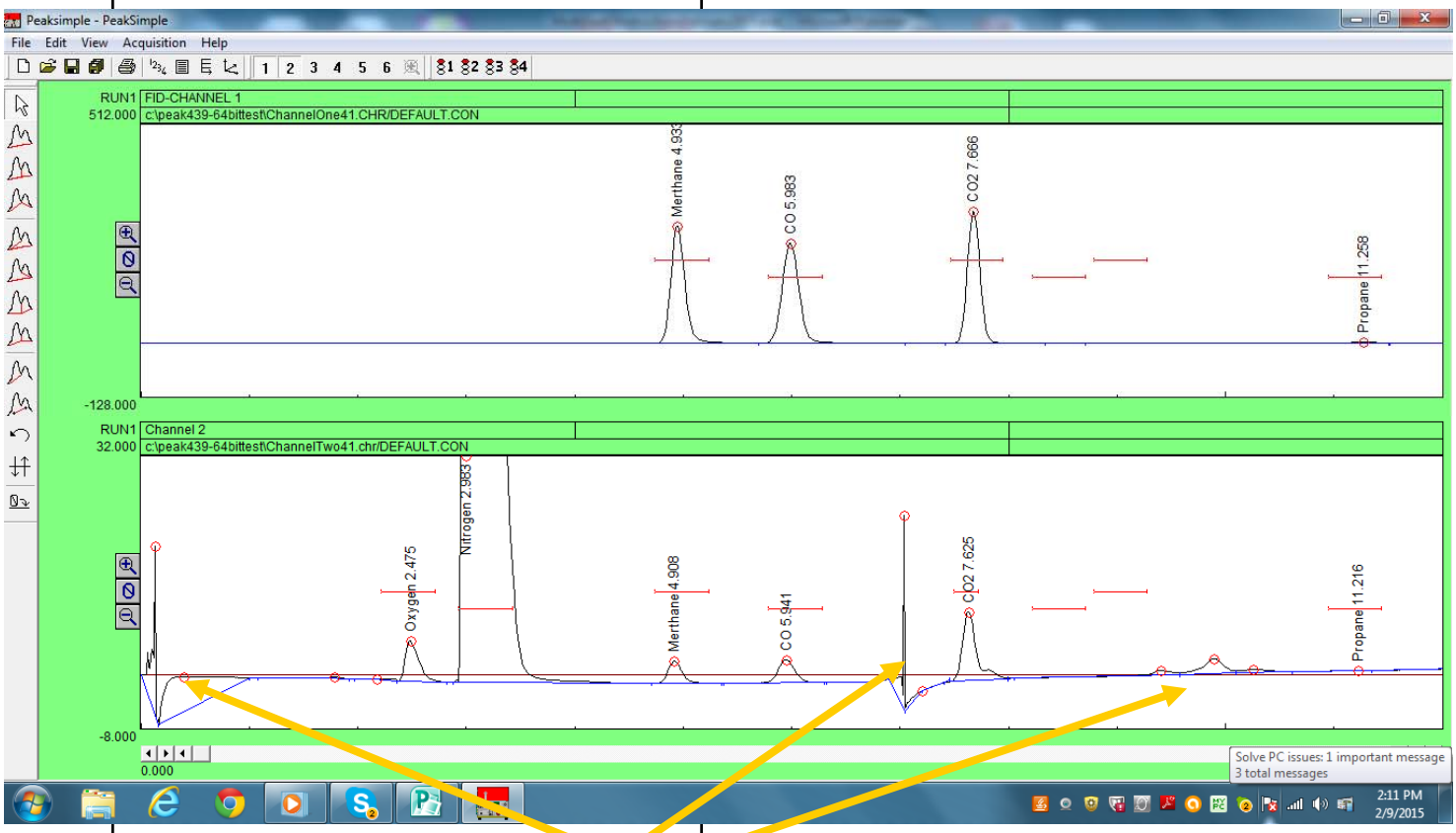
310-214-5092

SRI 8610C Gas Chromatograph
MG3epc configuration
January 2015

This is the final chromatogram using the temperature program, event table and pressure programs shown in the preceding pages.

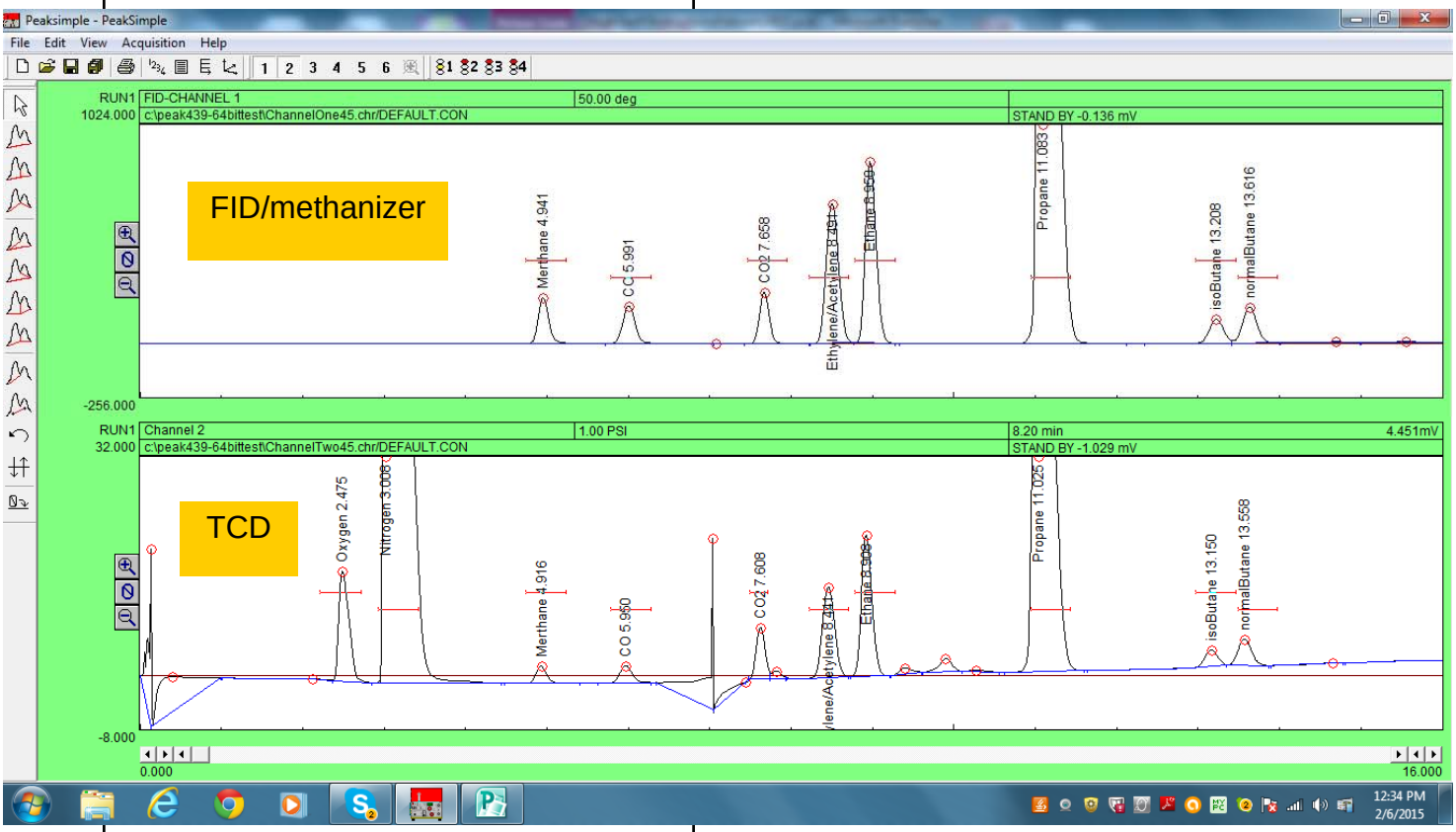


There are a couple of “artifact” peaks which occur as a consequence of the valve switch and pressure changes.

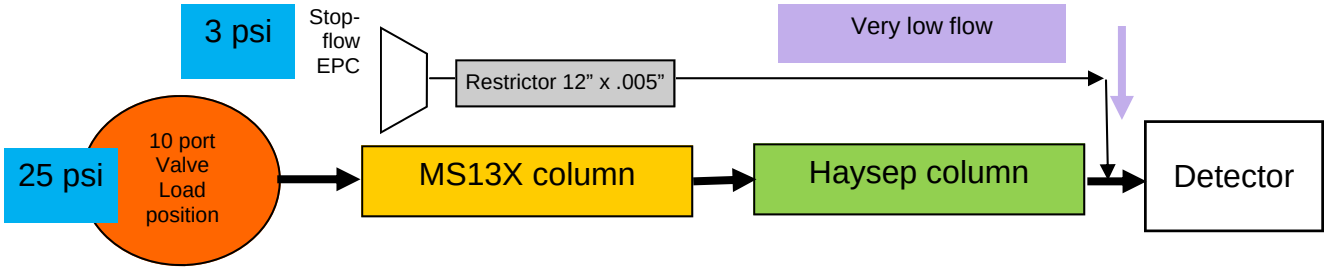
SRI 8610C Gas Chromatograph
MG3epc configuration
January 2015

Fortunately, the artifact peaks do not interfere with most of the other peaks normally measured.

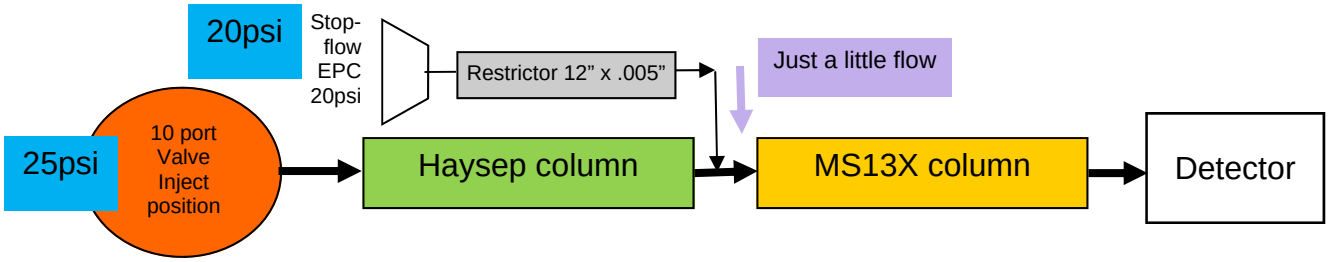
See the chromatogram below with C2-C4 hydrocarbons added to the test mix.



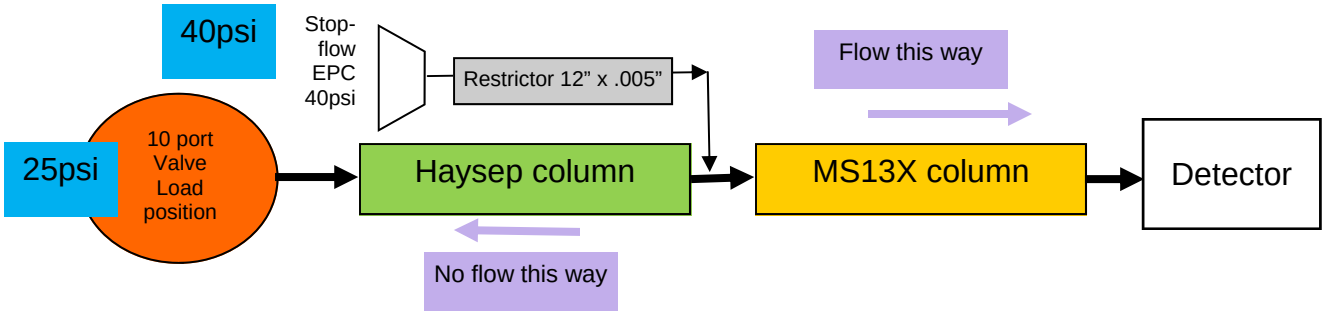
SRI 8610C Gas Chromatograph
MG3epc configuration
January 2015



This is the flow path at Time 0. The StopFlow EPC is set to 3 psi to save carrier gas since any flow from the EPC just merges with the carrier gas exiting the Haysep column prior to the detector.

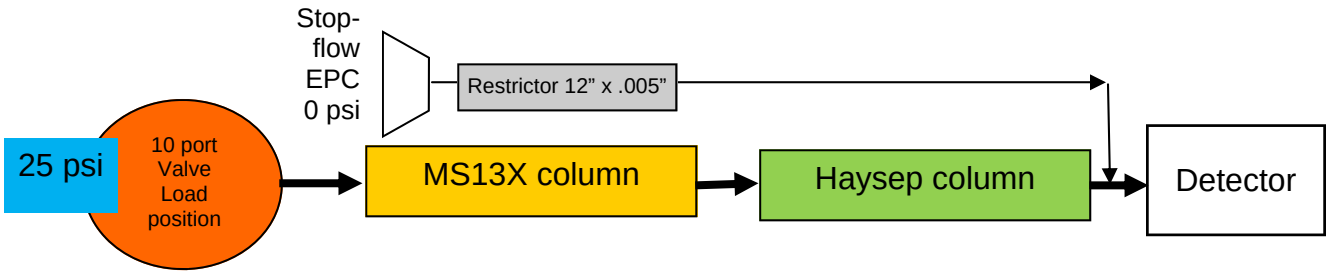


This is the flow path at Time 0.02 minutes. The StopFlow EPC is set to about 20psi to insure that as the peaks pass through the junction between the two columns no molecules diffuse backwards into the stop-flow tubing towards the EPC.



This is the flow path at Time 2.32 minutes. The StopFlow EPC is set to about 40psi to prevent the peaks which remain in the Haysep column from moving at all.
The peaks (H2, O2, N2, CH4 and CO) which have already passed into the MS13X column continue to move towards the detector

SRI 8610C Gas Chromatograph
MG3epc configuration
January 2015



This is the flow path at Time 7.00
The valve is rotated back to the Load position and
the StopFlow EPC is set to 0 psi to save carrier gas since any flow from the EPC just merges with the carrier gas exiting the Haysep column prior to the detector.