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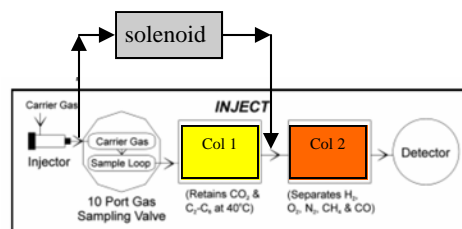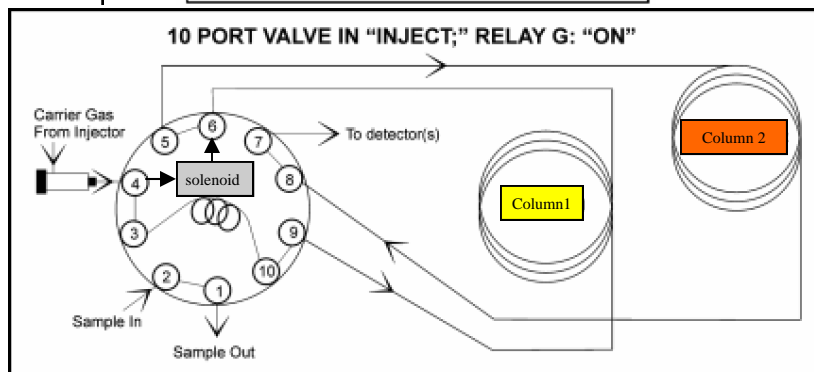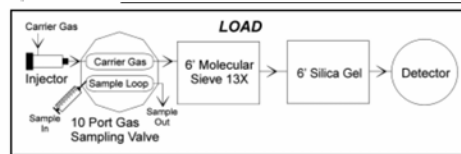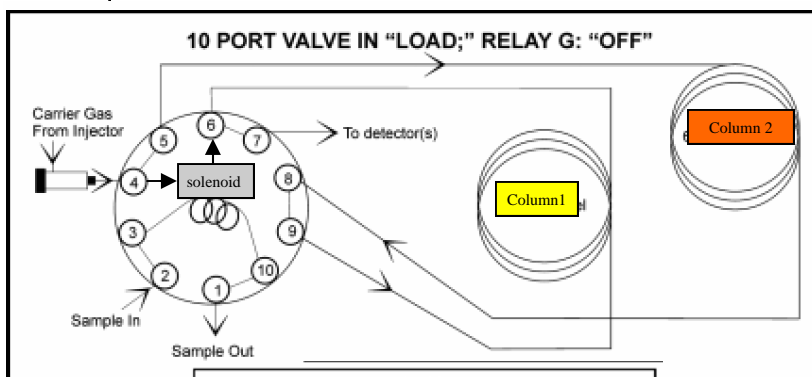
The MG#3 GC configuration is almost identical to the MG#1 GC configuration except there is an additional solenoid valve which when activated by the PeakSimple data system stops the flow of carrier gas in column 1.

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.


10 PORT VALVE IN "LOAD;" RELAY G: "OFF"

Carrier Gas From Injector — solenoid — To detector(s) — Column 2 — Column1

Sample In — Sample Out

Carrier Gas / Injector — Carrier Gas / Sample Loop — 6' Molecular Sieve 13X — 6' Silica Gel — Detector
Sample In — 10 Port Gas Sampling Valve — Sample Out — **LOAD**

10 PORT VALVE IN "INJECT;" RELAY G: "ON"

Carrier Gas From Injector — solenoid — To detector(s) — Column 2 — Column1

Sample In — Sample Out

solenoid

Carrier Gas / Injector — Carrier Gas / Sample Loop — Col 1 (Retains CO₂ & C₂-C₆ at 40°C) — Col 2 (Separates H₂, O₂, N₂, CH₄ & CO) — Detector
10 Port Gas Sampling Valve — **INJECT**

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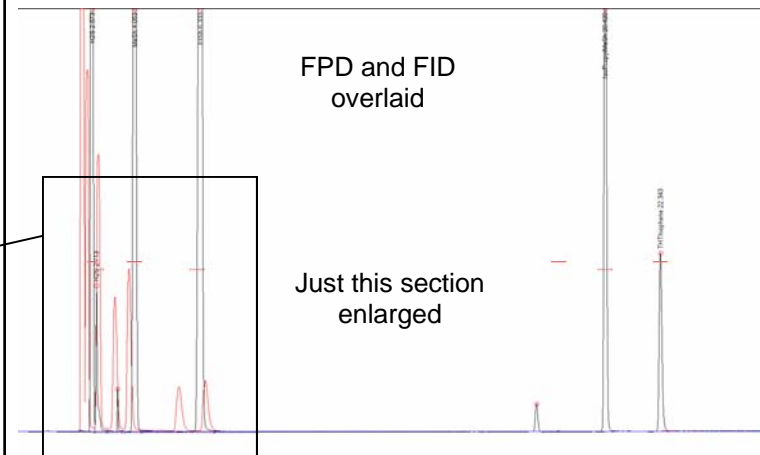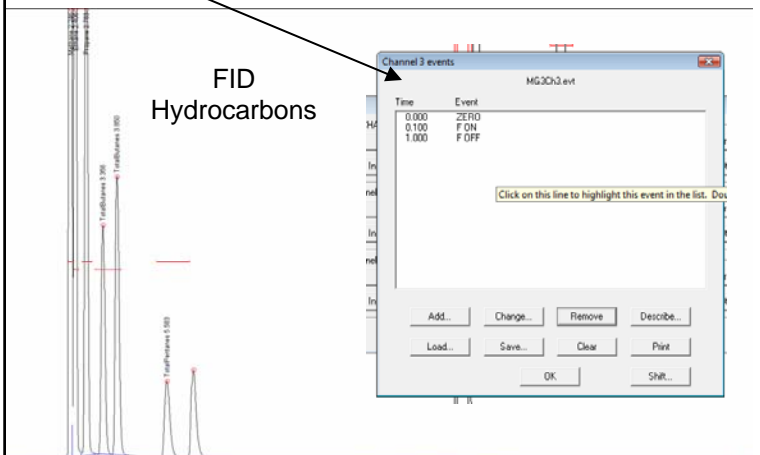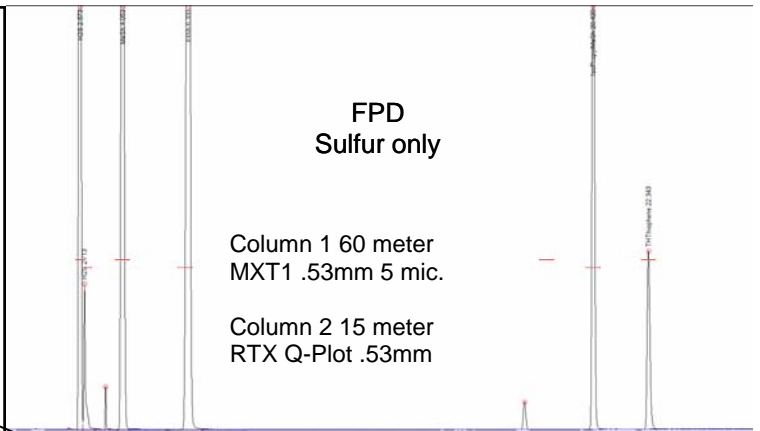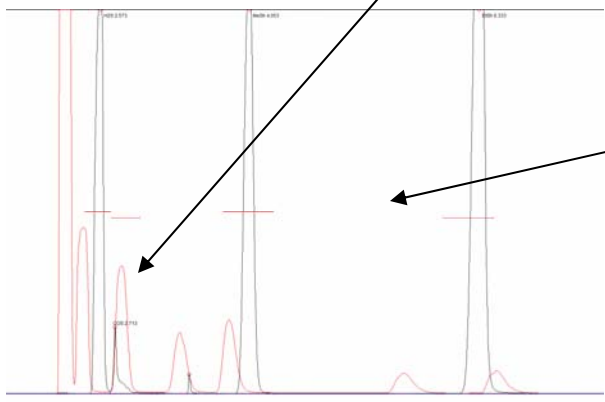
The PeakSimple event table shown at right rotates the valve from Load to Inject at .1 minutes and then back to Load at 1.00 minutes. Because even the first peak (methane) has not migrated from Column 1 though to Column 2 at this time, the equivalent effect is that the
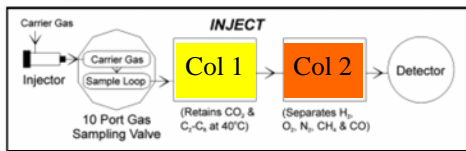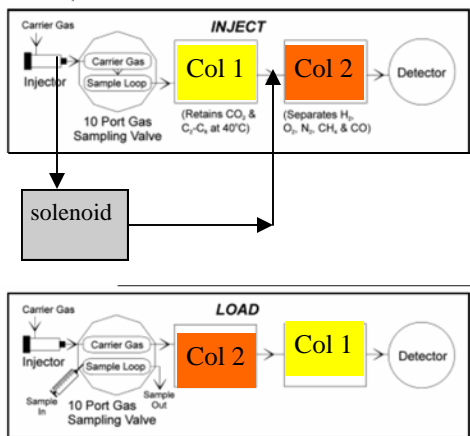

peaks are injected into and are separated by
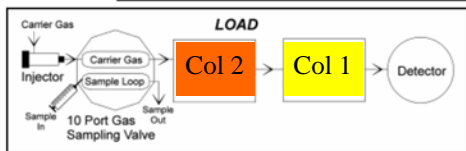
Column 1 only, as if Column 2 was not even connected. You can see by the overlaid chromatograms that COS co-elutes with Propane quenching its FPD response.
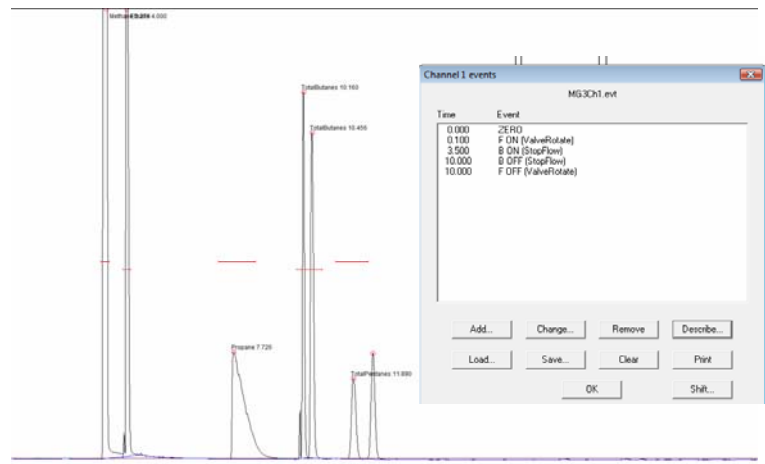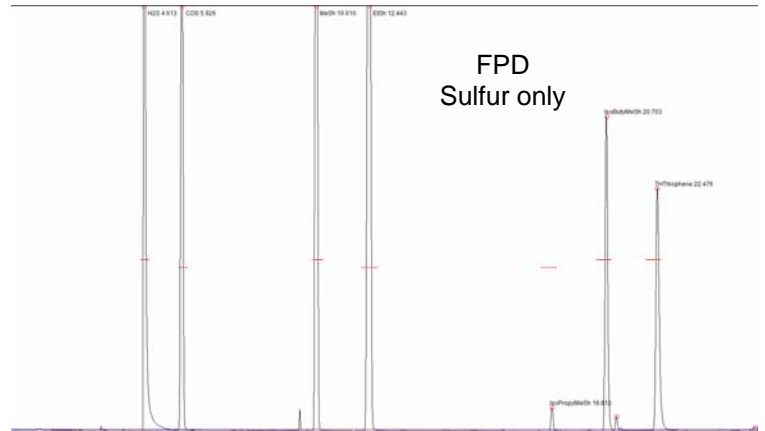

FPD
Sulfur only

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 QPlot .53mm).
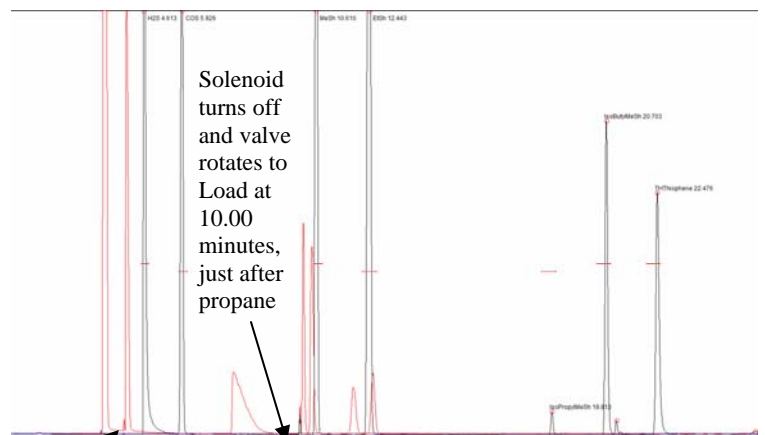

INJECT

Carrier Gas | Injector | Carrier Gas / Sample Loop | **Col 1** (Retains CO₂ & C₂-C₅ at 40°C) | **Col 2** (Separates H₂, O₂, N₂, CH₄ & CO) | Detector | 10 Port Gas Sampling Valve

solenoid

LOAD

Carrier Gas | Injector | Carrier Gas / Sample Loop | **Col 2** | **Col 1** | Detector | Sample In | Sample Out | 10 Port Gas Sampling Valve

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 Flow solenoid is de-energized. The peaks which were trapped on column 1 now elute to the detectors (Butanes, Pentanes, Mercaptans etc.)

FPD
Sulfur only

Channel 1 events

MG3Ch1.evt

Time	Event
0.000	ZERO
0.100	F ON (ValveRotate)
3.500	B ON (StopFlow)
10.000	B OFF (StopFlow)
10.000	F OFF (ValveRotate)

Add... | Change... | Remove | Describe...
Load... | Save... | Clear | Print
OK | Shift...

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

Solenoid turns off and valve rotates to Load at 10.00 minutes, just after propane

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

SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration

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
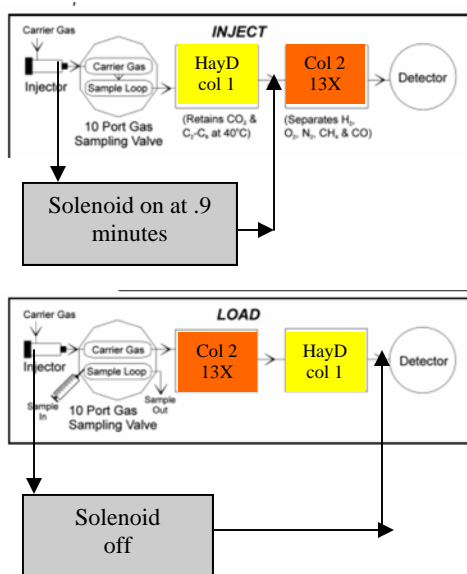
Solenoid off

(.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.

TCD detector

Oven temperature 40C for 10 minutes then 20C/min to 200C
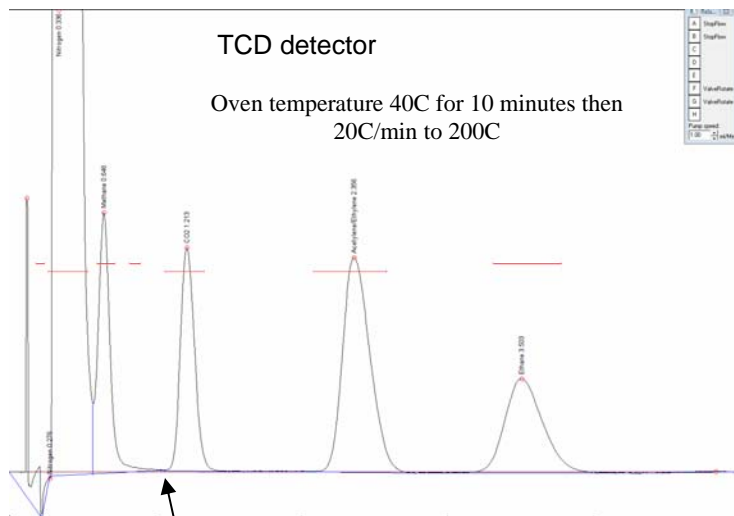
This would be a good time (.9 minutes) to activate the stop-flow solenoid. Just after the Methane migrates onto Column2 but before the CO2 and heavier peaks

Channel 1 events

MG3Ch1TimingTest.evt

| Time	Event
0.000	ZERO
0.100	G ON (ValveRotate)
0.200	G OFF (ValveRotate)

Click on this line to highlight this event in the list.

Add...   Change...   Remove   Describe...

Load...   Save...   Clear   Print

OK   Shift...

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
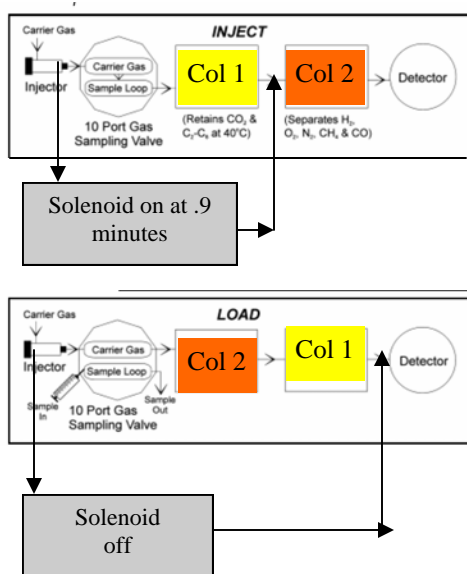
Solenoid off

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.

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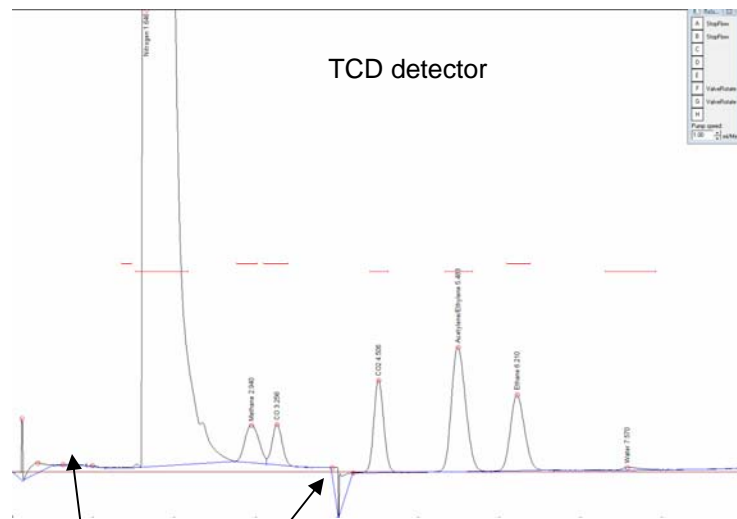
Stop-Flow solenoid on at .9 and off at 4.00 minutes. Valve back to Load position at 4.00 minutes

Channel 1 events

MG3Ch1.evt

Time	Event
0.000	ZERO
0.100	G ON (ValveRotate)
0.900	A ON (StopFlow)
4.000	A OFF (StopFlow)
4.000	G OFF (ValveRotate)

Add... Change... Remove Describe...

Click on this button after highlighting an event in the the Change screen.

Load...

OK   Shift...

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"

INJECT

Carrier Gas → Injector → Carrier Gas / Sample Loop → **Col 1** → **Col 2** → Detector

Col 1: (Retains CO_2 & C_2-C_6 at 40°C)
Col 2: (Separates H_2, O_2, N_2, CH_4, & CO)

10 Port Gas Sampling Valve

Solenoid on at .9 minutes

LOAD

Carrier Gas → Injector → Carrier Gas / Sample Loop → **Col 2** → **Col 1** → Detector

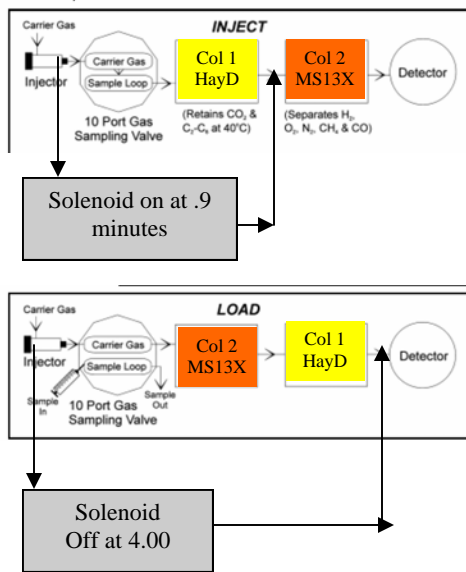Sample In / Sample Out / 10 Port Gas Sampling Valve
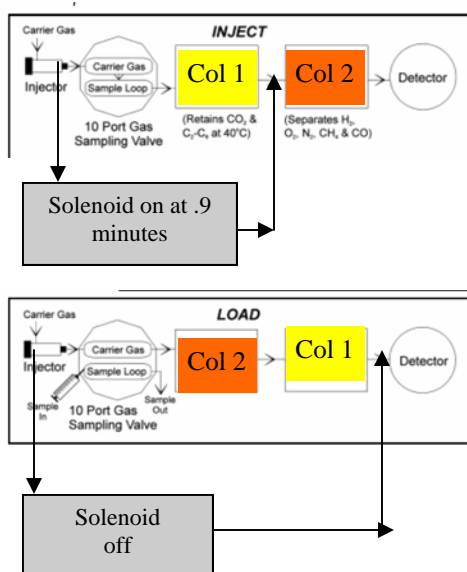
Solenoid off

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.

TCD detector

Zoom in

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

Channel 1 events

MG3Ch1TimingTest.evt

Time	Event
0.000	ZERO
0.100	G ON (ValveRotate)
0.200	G OFF (ValveRotate)

Click on this line to highlight this event in the list.

Add... Change... Remove Describe...
Load... Save... Clear Print
OK Shift...
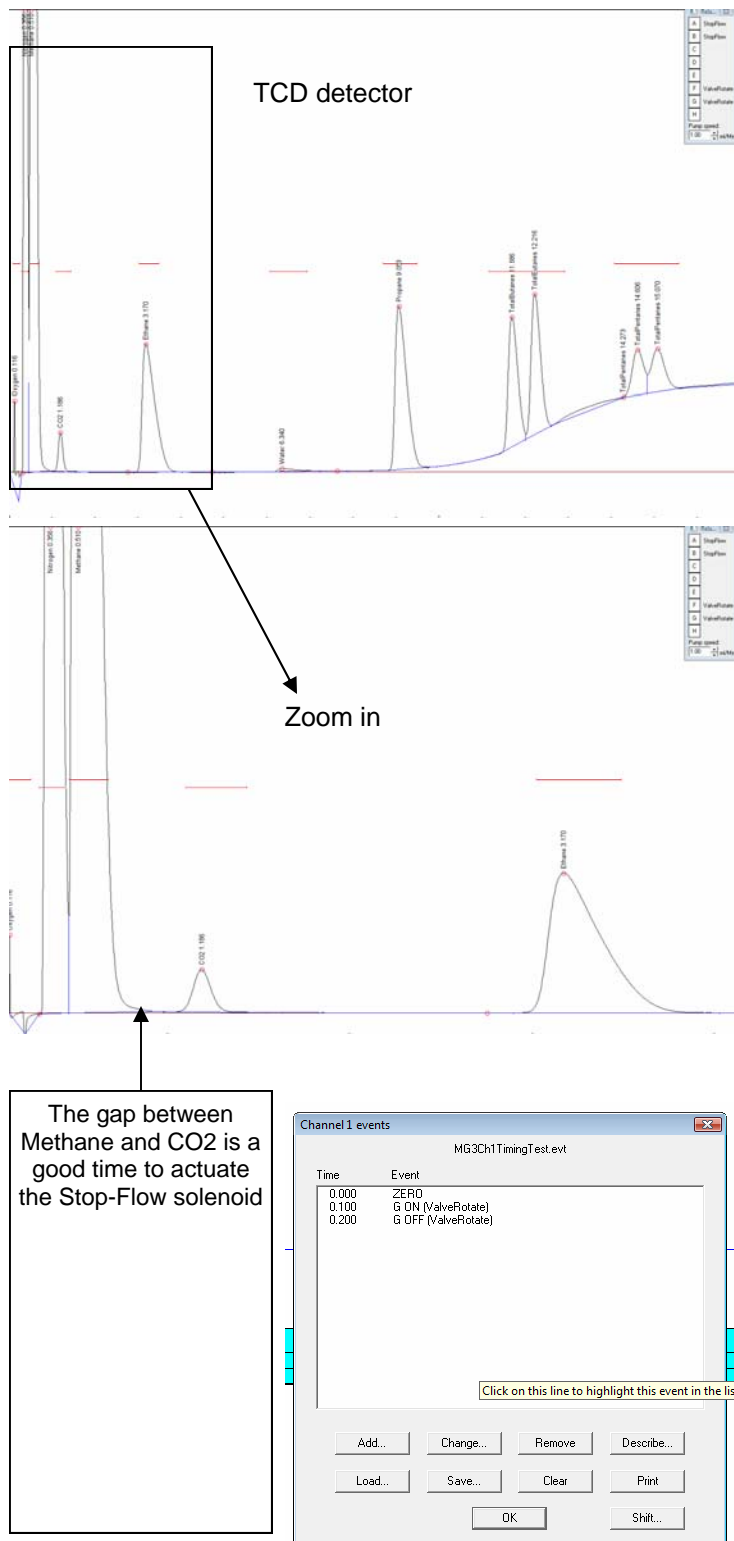
SRI 8610C Gas Chromatograph
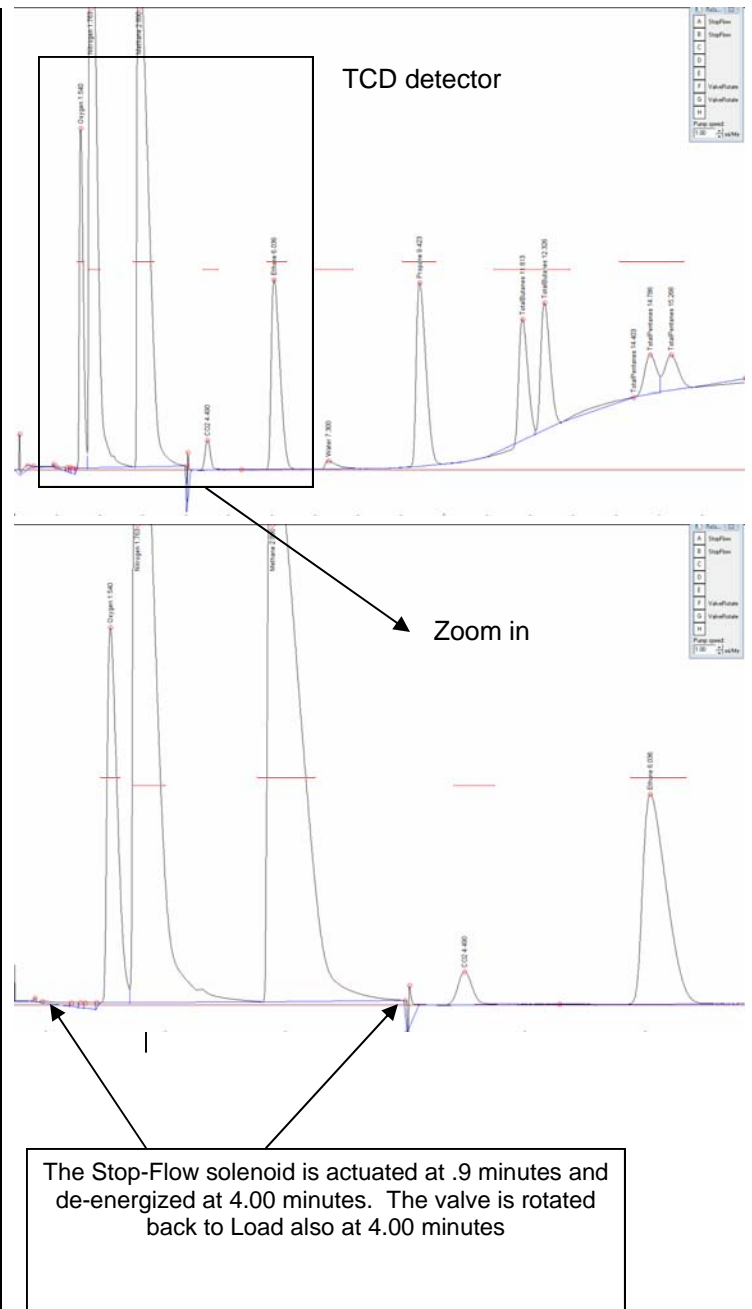# Multiple Gas #3 GC configuration

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

INJECT

Carrier Gas — Carrier Gas / Sample Loop — Col 1 HayD — Col 2 MS13X — Detector

Injector

10 Port Gas Sampling Valve

(Retains CO₂ & C₇-C₈ at 40°C)   (Separates H₂, O₂, N₂, CH₄ & CO)

Solenoid on at .9 minutes

LOAD

Carrier Gas — Carrier Gas / Sample Loop — Col 2 MS13X — Col 1 HayD — Detector

Injector

Sample In   Sample Out

10 Port Gas Sampling Valve

Solenoid Off at 4.00

Haysep D (column 1) elute normally.

Channel 1 events

MG3Ch1.evt

Time	Event
0.000	ZERO
0.100	G ON (ValveRotate)
0.900	A ON (StopFlow)
4.000	A OFF (StopFlow)
4.000	G OFF (ValveRotate)

Add...   Change...   Remove   Describe...

Load...   Save...   Clear   Print

Click on this button to Clear (erase) th

OK

TCD detector

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
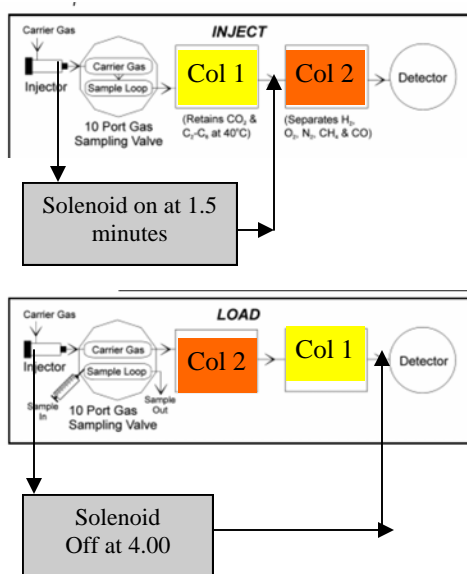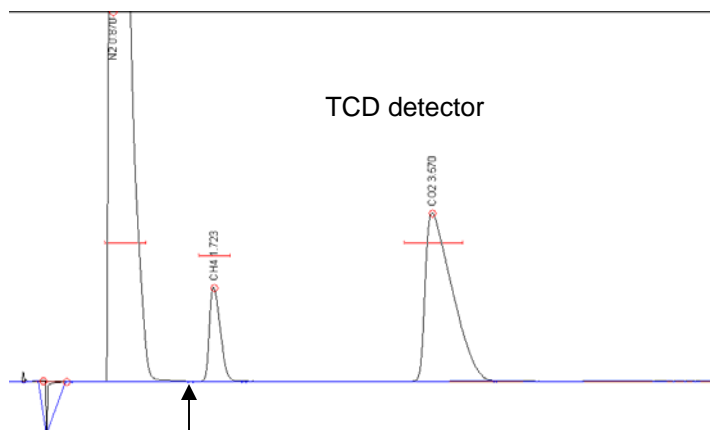

Solenoid on at 1.5 minutes

Solenoid Off at 4.00

CO2 on the Haysep column .

TCD detector

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
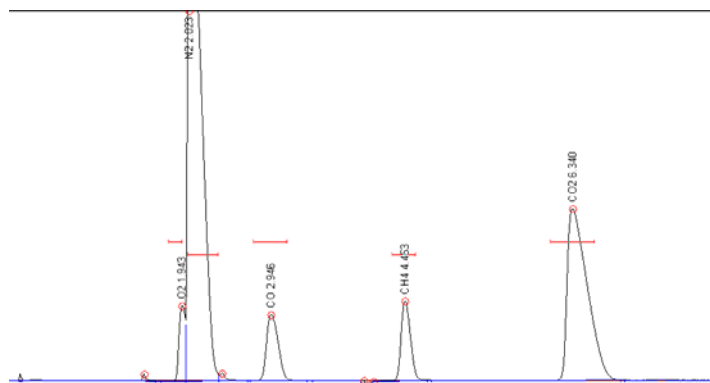

The Stop-Flow solenoid is actuated at 1.5 minutes and de-energized at 4.00 minutes. The valve is rotated back to Load also at 4.00 minutes

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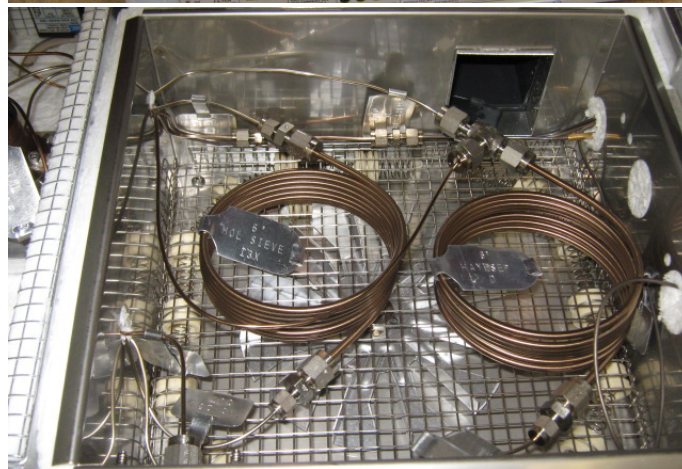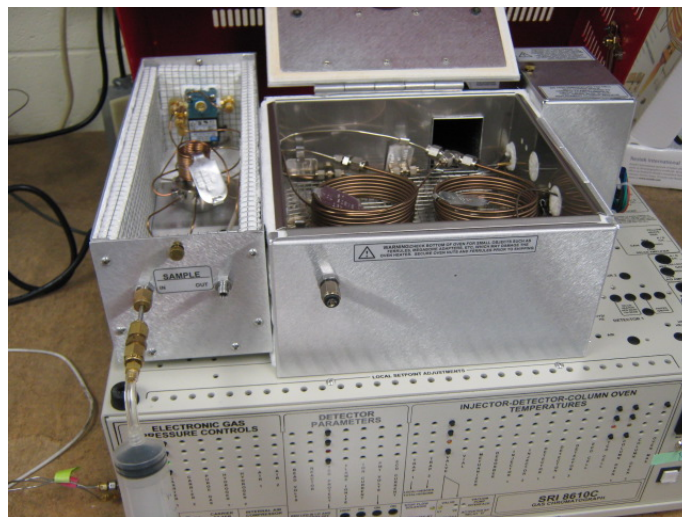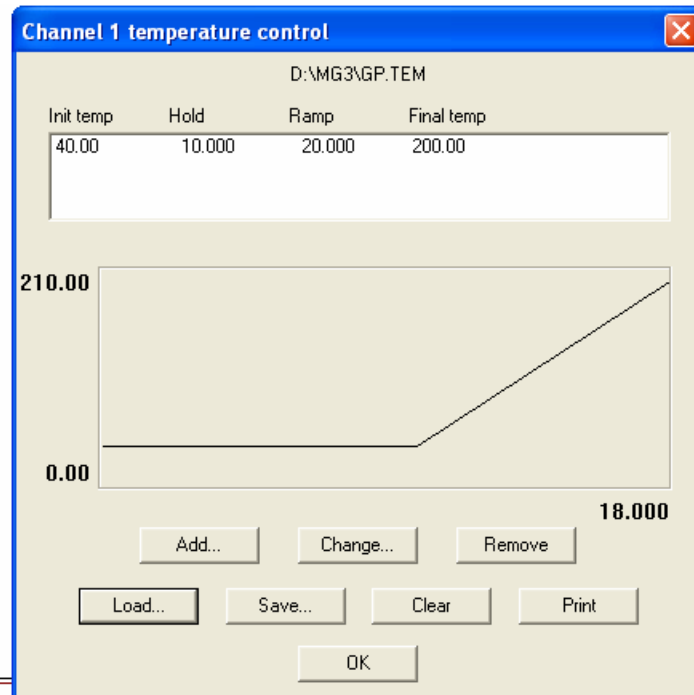
SRI 8610C Gas Chromatograph
Multiple Gas #3 GC configuration
Application Example-2 step process

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 de-actuated 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.
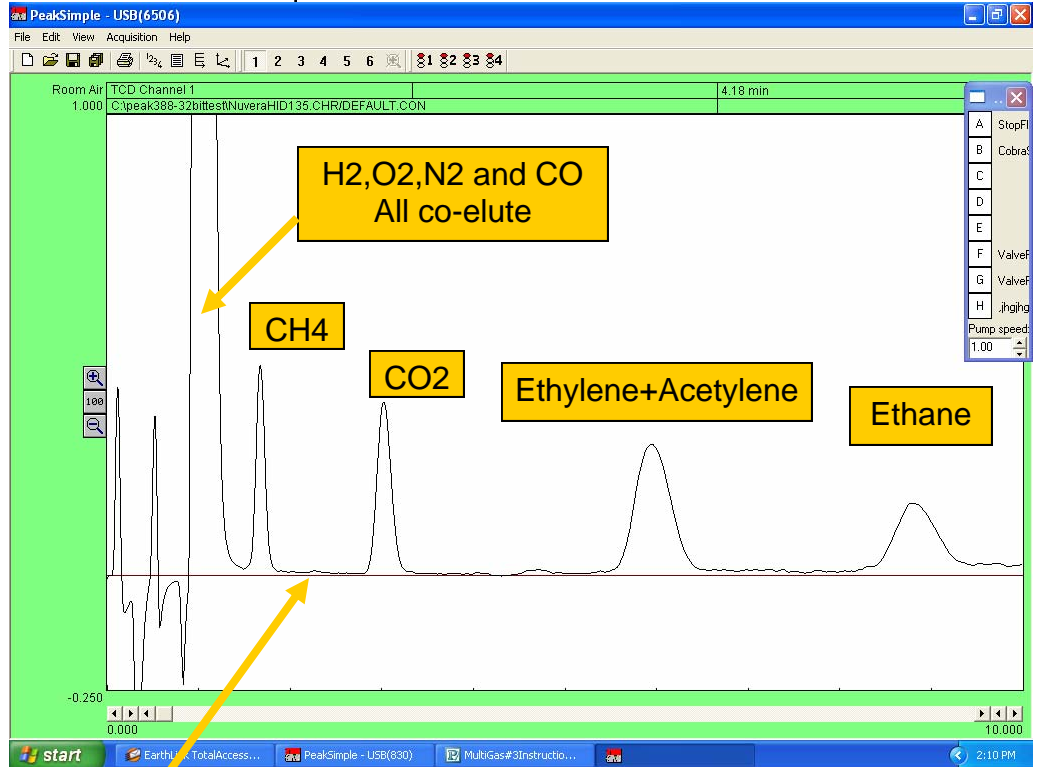
Channel 1 temperature control   D:\MG3\GP.TEM

Init temp	Hold	Ramp	Final temp
40.00	10.000	20.000	200.00

210.00

0.00

18.000

Add... Change... Remove

Load... Save... Clear Print

OK

Channel 1 events   D:\MG3\MG3Step1.evt

Time	Event
0.000	ZERO
0.000	SOUND
0.100	A ON (StopFlowSolenoid)
0.300	A OFF (StopFlowSolenoid)
0.500	G ON (ValveRotate)
0.800	G OFF (ValveRotate)

Add... Change... Remove Describe...

Load... Save... Clear Print

OK Shift...

SRI 8610C Gas Chromatograph
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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.

Click Relay A & G on the Relay/Pump window with your mouse to turn them off

Relays A & G are manually turned off at 8.5 minutes
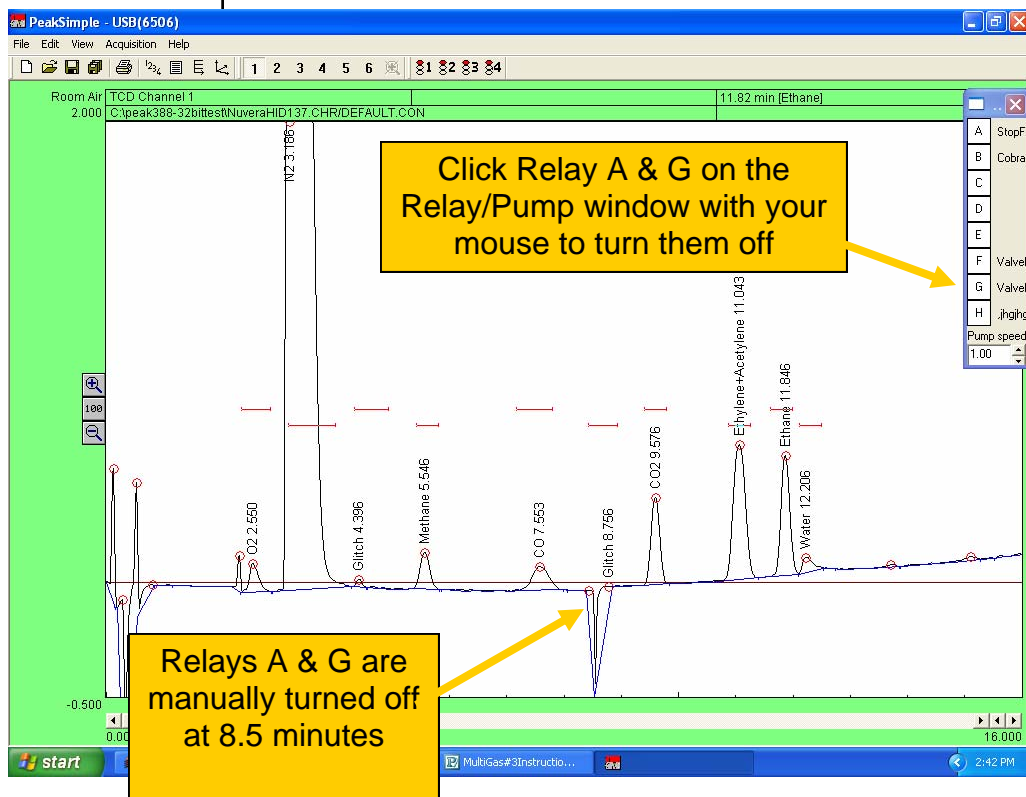
Channel 1 events

D:\MG3\MG3Step2.evt

Time	Event
0.000	ZERO
0.000	SOUND
0.100	A ON (StopFlowSolenoid)
0.300	A OFF (StopFlowSolenoid)
0.500	G ON (ValveRotate)
2.300	A ON (StopFlowSolenoid)
8.500	G OFF (ValveRotate)
8.500	A OFF (StopFlowSolenoid)

Add... Change... Remove Describe...
Load... Save... Clear Print
OK Shift...