

STATE OF CALIFORNIA
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II
STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX AK
STATION OPERATOR'S PROCEDURES
FOR
THERMO ENVIRONMENTAL INSTRUMENTS INC.
MODEL 55C
DIRECT METHANE, NON-METHANE
HYDROCARBON ANALYZER

MONITORING AND LABORATORY DIVISION

JUNE 2000

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APPENDIX AK

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MODEL 55C DIRECT METHANE, NON-METHANE
HYDROCARBON ANALYZER**

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AK.1.0 GENERAL INFORMATION

AK.1.0.1 THEORY

The Model 55C measures methane and non-methane hydrocarbon gases through the science of gas chromatography and utilizes a column system specifically designed for this application. A basic understanding of chromatographic principals will be helpful for the installation and troubleshooting of the analyzer.

This analyzer is an automated batch analyzer that repeatedly collects and analyzes small amounts of the sample stream. The sample is drawn into the analyzer using a pump system. The system is based around an 8-port, two position rotary valve, which supplies sample gas to the analyzer and the column (see Figure AK.1.0.1).

AK.1.0.2 ANAYLTICAL CYCLE

There are two valve positions or modes, which are referred to as the “**Inject**” and “**Backflush**” (see Figure AK.1.0.2). The cycle starts with the **Backflush** mode. The sample is drawn into the sample loop (a coil of empty tubing) (see Figure AK.1.0.2). The rotary valve now switches to the **INJECT** position (see Figure AK.1.0.2). The valve connects the sample loop to the column and the sample is pushed through the column by the carrier gas. Since the methane component of the gas is lighter (low molecular weight), the methane moves quicker through the column and goes out the column through the rotary valve to the flame ionization detector (FID) for analysis. Once the methane has been detected by the FID, the rotary valve then reverses, returning to the **BACKFLUSH** mode. The heavy hydrocarbons that are left in the column are now pushed in the reverse direction by the carrier gas through the rotary valve to the FID for analysis. This completes the sample gas cycle (see Figure AK.1.0.2). Figure AK.1.0.3 shows a typical chromatogram as seen with calibration gas being injected into the analyzer. The graph is showing Volts (vertical) and Time (horizontal) and is connected to the FID output of the analyzer. Calibration gases suggested by the manufacturer are methane and propane (non-methane). The time required for the analysis of one sample is about 70 seconds. When you are only interested in hourly averages, it is recommended that you set the cycle time to about 224 seconds to extend the life of the rotary valve.

AK.1.0.3 CAUTIONS

The Model 55C uses hydrogen gas for the flame on the FID. Since hydrogen is a highly flammable gas, it is very important that the connections to the analyzer be checked periodically for leaks. Use soap solution or Snoop® Liquid Leak Detector to verify that there are no leaks. General safety guidelines include securing cylinders to the wall and venting gas regulators and exhaust lines to the outside. The use of clean regulators and lines is very important so that you do not contaminate the FID. Purge the lines (nitrogen, burner air) several hours before connecting to the analyzer to minimize contamination to the analyzer.

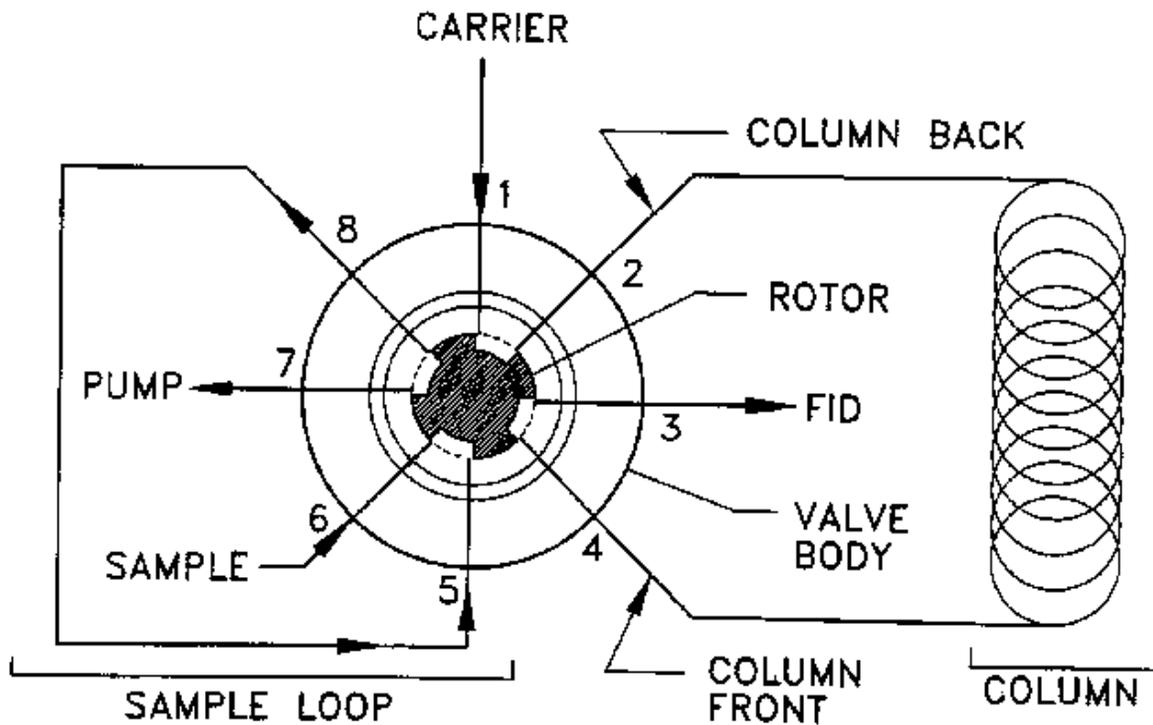


Figure AK.1.0.1
Rotary Valve

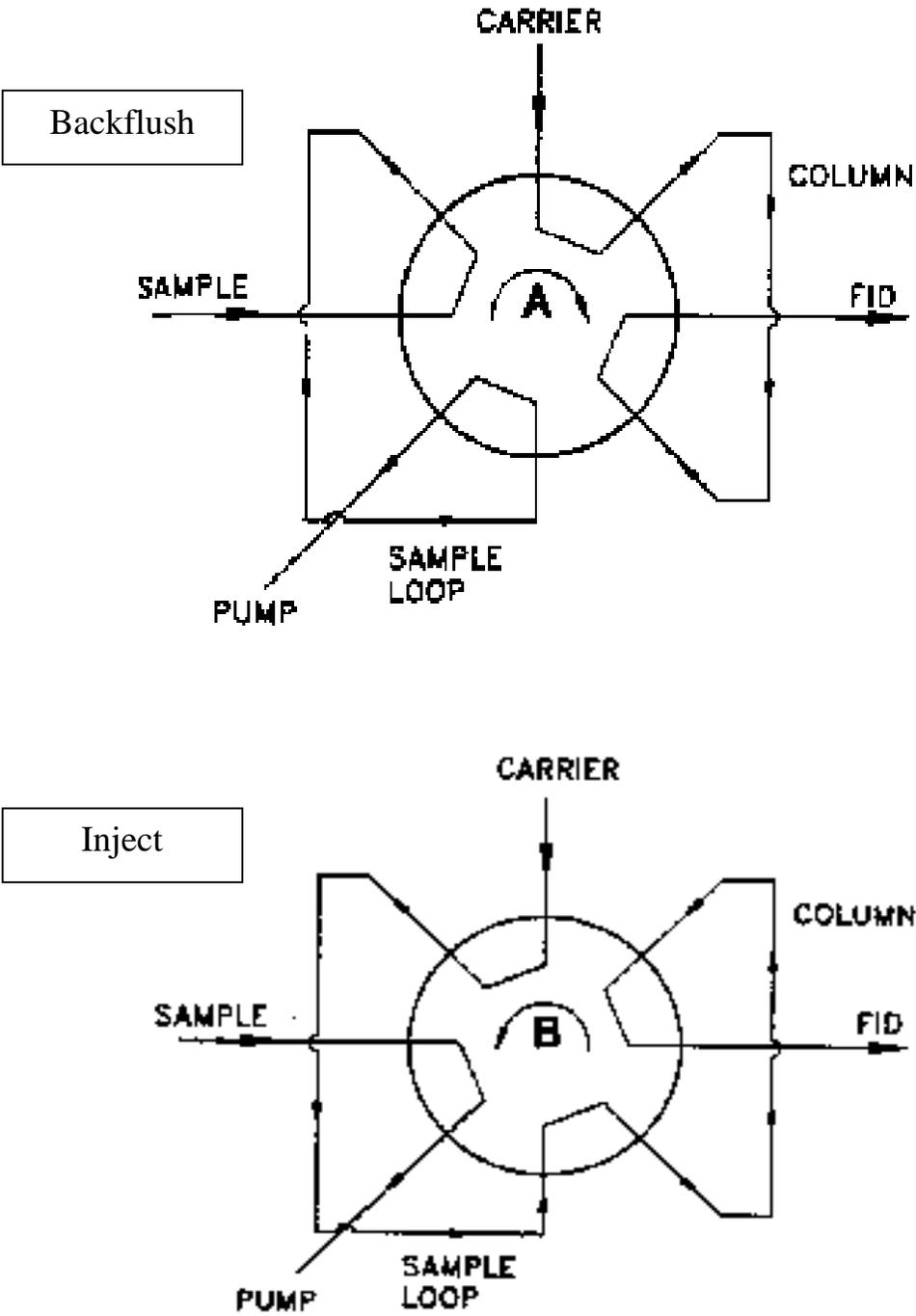


Figure AK.1.0.2
Backflush and Inject Position

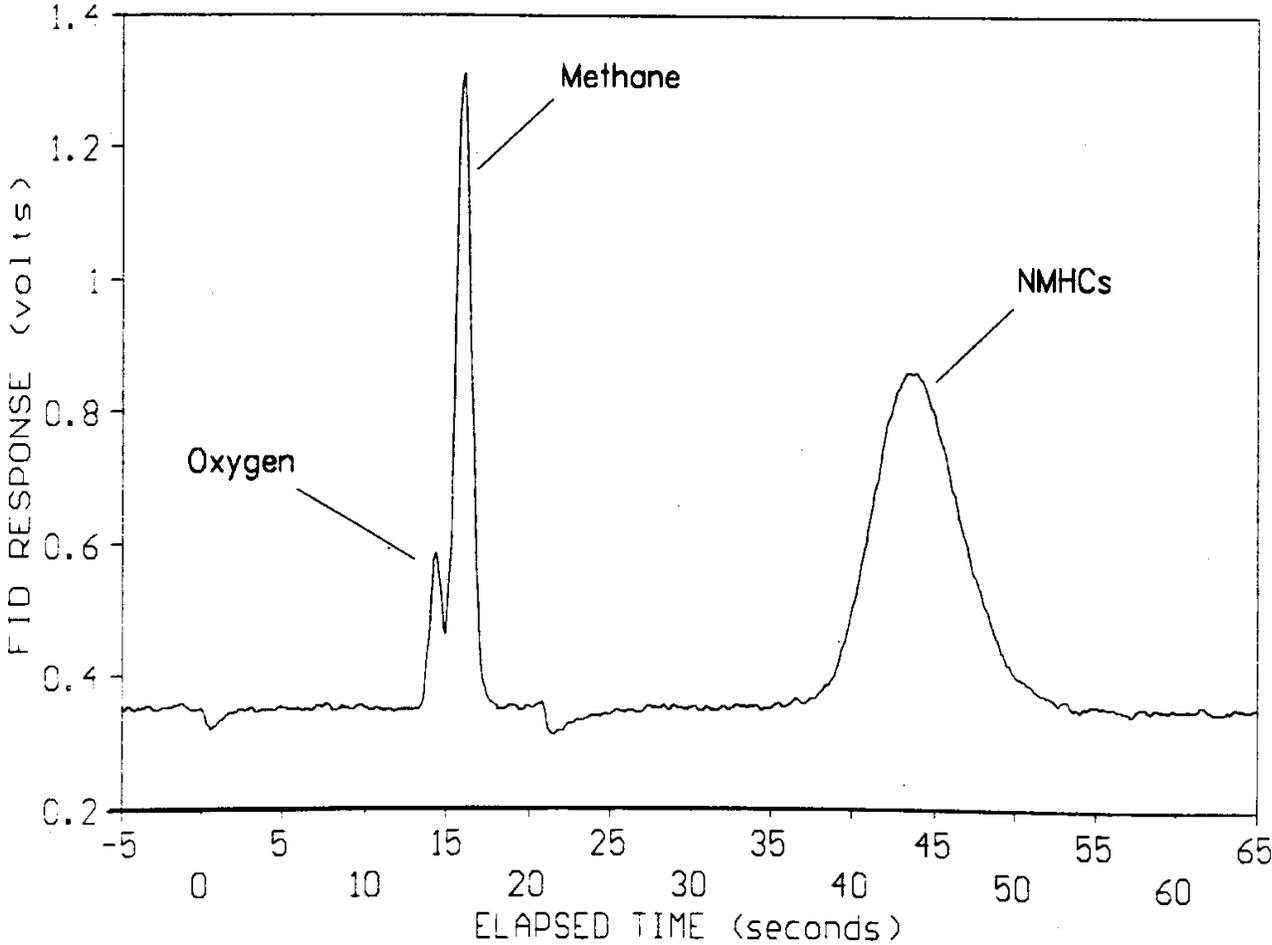


Figure AK.1.0.3
Typical Model 55C Span Gas Chromatograph

AK.1.1 INSTALLATION PROCEDURE

AK.1.1.1 INSTALLATION PREPARATION

Prior to installing the analyzer at the air monitoring site, the following support gases and equipment are needed for normal analyzer operation.

- 1) Hydrocarbon free air (45 PSI at 2 liters per minute minimum)
- 2) Nitrogen carrier gas (35 cc/min) Ultra High Purity
- 3) Hydrogen fuel (25 cc/min) Cylinder or Elhygen generator
- 4) Span calibration gas C₃H₈ (Propane) 2-liter flow. Cylinder- 750 ppbc
- 5) 19-inch Equipment Rack
- 6) Data logger for C₃H₈ output (1-channel) 0-1vdc Full Scale
- 7) Chart recorder for C₃H₈ output (1-channel) 0-1vdc Full Scale
- 8) Flat bed recorder to measure FID output (single-channel) 0-1vdc
- 9) Temperature controlled room (15 – 35° C)

NOTE: See Chapter Two of the analyzer instruction manual for specifications on the support gases.

AK1.1.2 PHYSICAL INSPECTION

Remove the analyzer from the box and check for shipping damage. Remove the cover, and check inside for damaged cards or loose components. If any damage is found, contact the shipper immediately for inspection of the damage by the shipper. Save the packing material and shipping box for possible shipment in the future. Assuming that all parts are in place and no damage to the analyzer is evident, install the analyzer into the rack on rack slides and shove back into place. Referring to Figure AK.1.1.1 and Figure AK.1.1.2, hook up the lines to the Air Supply, Fuel Supply, Carrier Gas, Sample Line, Calibration Gas, Data Logger, Chart Recorder, and Electrical Service connection ports.

AK.1.1.3 INITIAL SET UP

Set the support gases to the following approximate settings:

Air: 45 PSI
Fuel: 40-60 PSI
Carrier Gas: 40 - 60 PSI
Calibration Gas: 25 PSI
TNMOC Range = 5000ppbc
CH₄ Range = 20 ppm (Output not used)
THC Range = 20 ppm (Output not used)

The actual setting values should be found located inside the instrument on top of the oven. Slightly loosen the fittings at each line at the rear of the analyzer to bleed off air. About 30 seconds should be sufficient, then retighten the fittings. Turn on the main power switch and note whether error messages are reported. After a brief test period, the Model 55C will go into a warm-up mode, which will require about 90 minutes to stabilize. During the warm-up period, the fuel pressure will read zero.

Upon reaching the correct temperature, the analyzer fuel solenoid will open, and the FID will attempt to light. Check for the correct fuel pressure at this time. If the burner will not light, try enriching the mixture by turning the air pressure down and the fuel pressure up until the burner lights. Then return the fuel and air settings back to normal once the burner temperature stabilizes. The final settings should be those located inside the instrument on the top of the oven. Make sure the pump switch is on, and press the run button to begin automatic analysis of the sample gas. If the analyzer does not appear to go into run mode or if the burner will not light, refer to Chapter Five, Troubleshooting, of the Model 55C Instruction Manual for assistance. Check that the sampling time is set at 224 seconds by pushing the **MENU** button, and then down arrow to **RUN PARAMETERS** and hit **ENTER**, then down arrow to **SAMPLING TIME** and hit **ENTER**. Set the delay time to **224** then hit **ENTER**, then **MENU**, then **RUN**. This delay of 224 seconds will extend the life of the rotary valve and will still give approximately 12 runs per hour.

AK.1.1.3 INITIAL BURN IN AND COLUMN CONDITIONING

The factory suggests an initial burn in period of 8 hours after initial setup to condition the column. To accomplish this, interrupt the run by depressing the **MENU** key. Depress the **DOWN ARROW** until the display reads **# 7 - SERVICE**. Then hit **ENTER**. Use the **DOWN ARROW** again to **# 4 - CONDITION COLUMN** and press **ENTER**. After 8 hours, the analyzer will return to normal operating temperature.

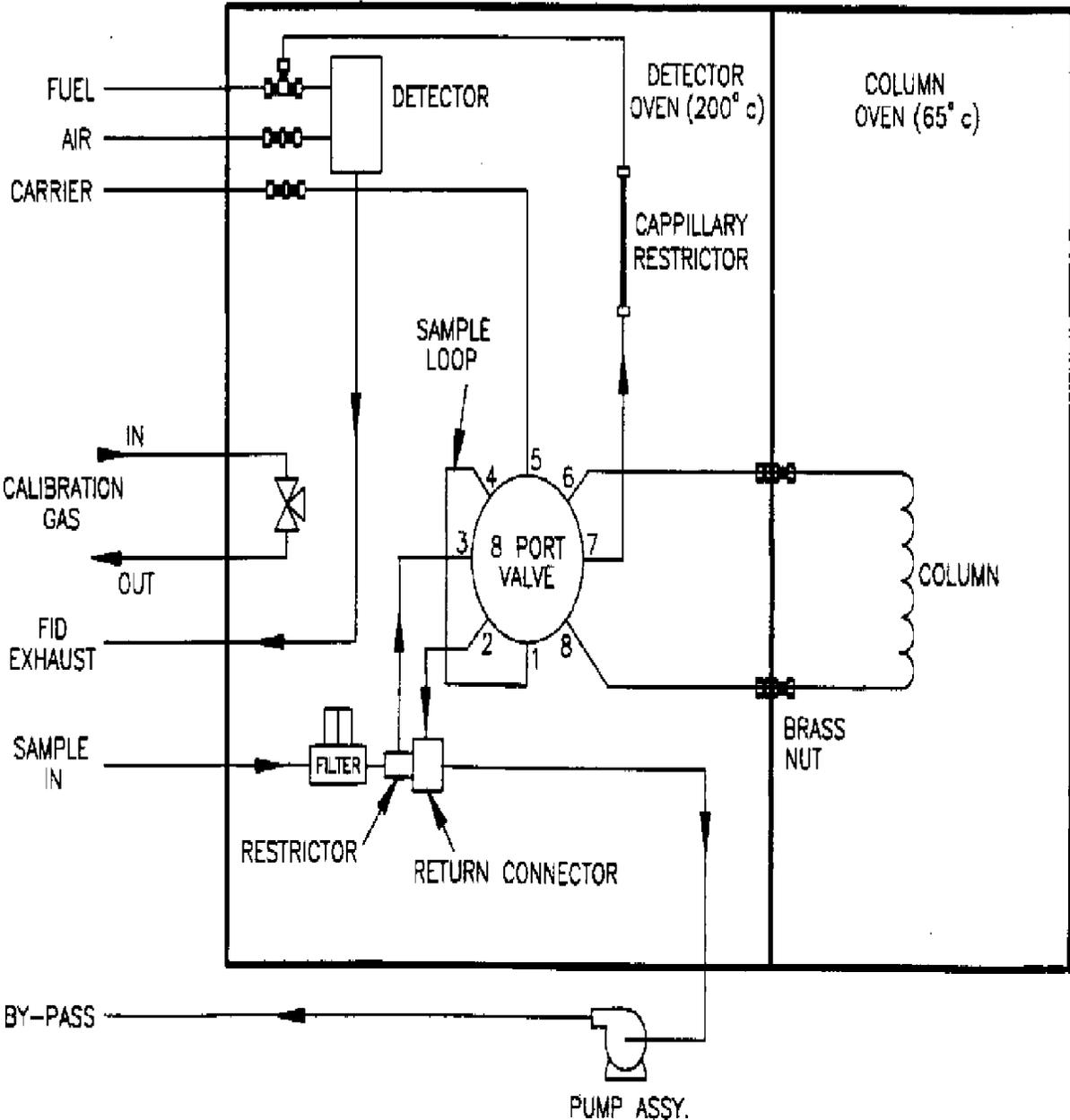


Figure AK.1.1.1
Model 55C Flow Schematic

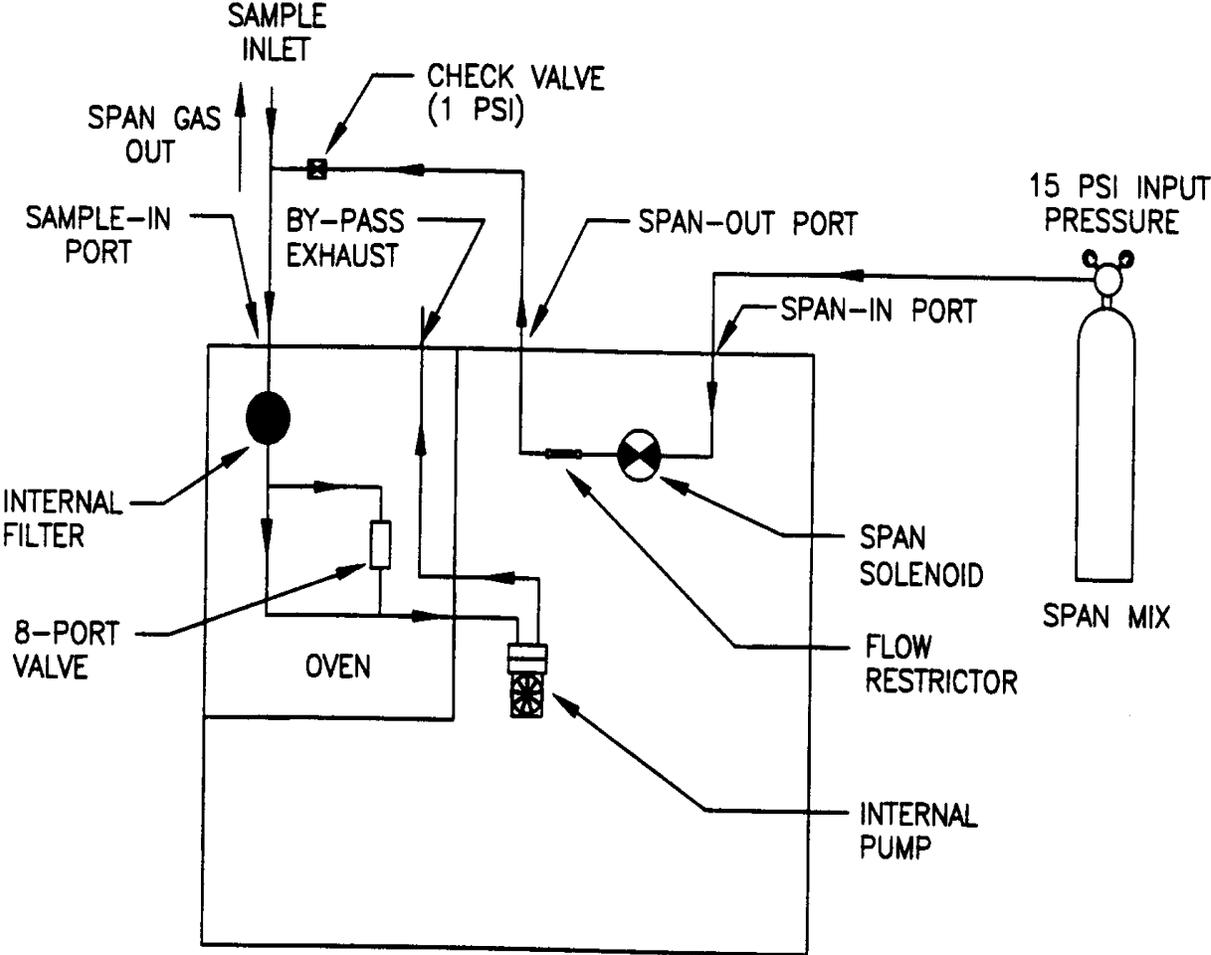


Figure AK.1.1.2
Sample and Span Connections for Use with Internal Pump

AK.1.2 **QUALITY CONTROL SECTION**

Menu Screens: The routine service checks are done using the **MENU** button and picking from the nine menu items. Figure AK.1.2.1 is a flowchart of the menu driven software that controls the operation and parameters of the analyzer. A detailed explanation of the nine categories is written in Chapter 3 of the instruction manual under the heading of “**Main Menu**”.

AK.1.2.1 WEEKLY CALIBRATION:

The analyzer should be challenged with zero and calibration gas each week by the station operator to determine the “**AS IS**” response of the analyzer. At stations that have an automatic calibration system, the “**AS IS**” response to propane can be determined by observing the response to the nightly precision or span gas from the calibration system. Once this is done, the analyzer should then be adjusted to calibration gas. The calibration gas is Propane blended in natural zero air and the concentration of the gas should be approximately 750 ppbc. The concentration of the calibration gases is entered into the **GAS CONCENTRATION** screen that is found under the subheading of **CAL PARAMETERS**. Also under **CAL PARAMETERS** is the **AUTO VERIFICATION** feature. This feature should be turned on so that the calibration cycle is repeated until two consecutive analyses are within 2%. This will generate an alarm and error message if the results are not repeatable. Start the calibration from the menu button, then down arrow to **CALIBRATE**, then chose **MANUAL CALIBRATE**. If the analyzer is not responding within +/- 5% following the calibration, check with your supervisor for corrective action.

AK.1.2.2 DAILY CHECKS

Daily checks, also referred as nightly calibration checks, (Precision and Span) are provided automatically each morning with an optional automatic calibration system. See Section AC of Volume II of the Quality Assurance Manual for details.

AK.1.2.2.3 WEEKLY MAINTENANCE

The external inline Teflon Sample Filter should be changed on a weekly basis to insure that the sample flow to the analyzer is not restricted. The filter must be changed at least monthly or more frequently if the nightly checks show response of the analyzer is falling off. Check the pressures on the front of the analyzer for air, carrier and hydrogen. Log all pressure readings on a Monthly Checksheet (Figure AK1.2.2). Adjust pressures to maintain correct pressures as recommended by the manufacture (See inside of the analyzer on top of the oven for recommended settings). It is also recommended that the pressures for the

cylinders of Carrier Gas (nitrogen), or Fuel (hydrogen) be recorded so that re-ordering of cylinders can be done on a timely basis before running out.

AK1.2.3 MONTHLY CHECKS

Once a month, during the calibration, a flat bed chart recorder is connected across pins 1 and 2 of the voltage out terminal on the rear of the analyzer. This output will trace the response of the FID to the calibration gas that is being presented to the analyzer. Refer back to Figure AK.1.0.3 for a typical chromatogram run during the calibration cycle. This monthly check is to determine proper operation of the chromatograph. These charts are to be filed along with the monthly checksheet.

AK.1.2.4 SEMIANNUAL MULTIPOINT CHECK

The first step of the Semiannual Check of the analyzer is to calibrate it to a 750 ppbc cylinder of propane gas. The analyzer should then be challenged with a calibration system different from the precision calibration system. A person different from the station operator should do the check and the system should also have a different cylinder of NIST traceable propane gas.

The multi-point check should be done at 80%, 40%, 20%, and 10% of 2000 ppbc. The first point should be at least 20 minutes in length and allowed to stabilize prior to recording the response. The next three points should be at least 15 minutes in length and allowed to straight line on the chart recorder prior to taking the response. These results can then be used to determine the response of the analyzer, the slope and intercept of the regression line, and the correlation coefficient of the analyzer. Report these values to the supervisor on the calibration report. Quality Control Criteria is under development.

The lower detectable limit should be also checked by challenging the analyzer with a cylinder of propane gas of 75 ppbc. A response of more than +/- 25 % at this point will be outside allowable limits and should be reported to the supervisor.

The last check is a single point check with decane gas at about 750 ppbc concentration. Record the analyzers response on the multipoint check form after the point has stabilized. This check needs to be done to verify the response of heavy hydrocarbons.

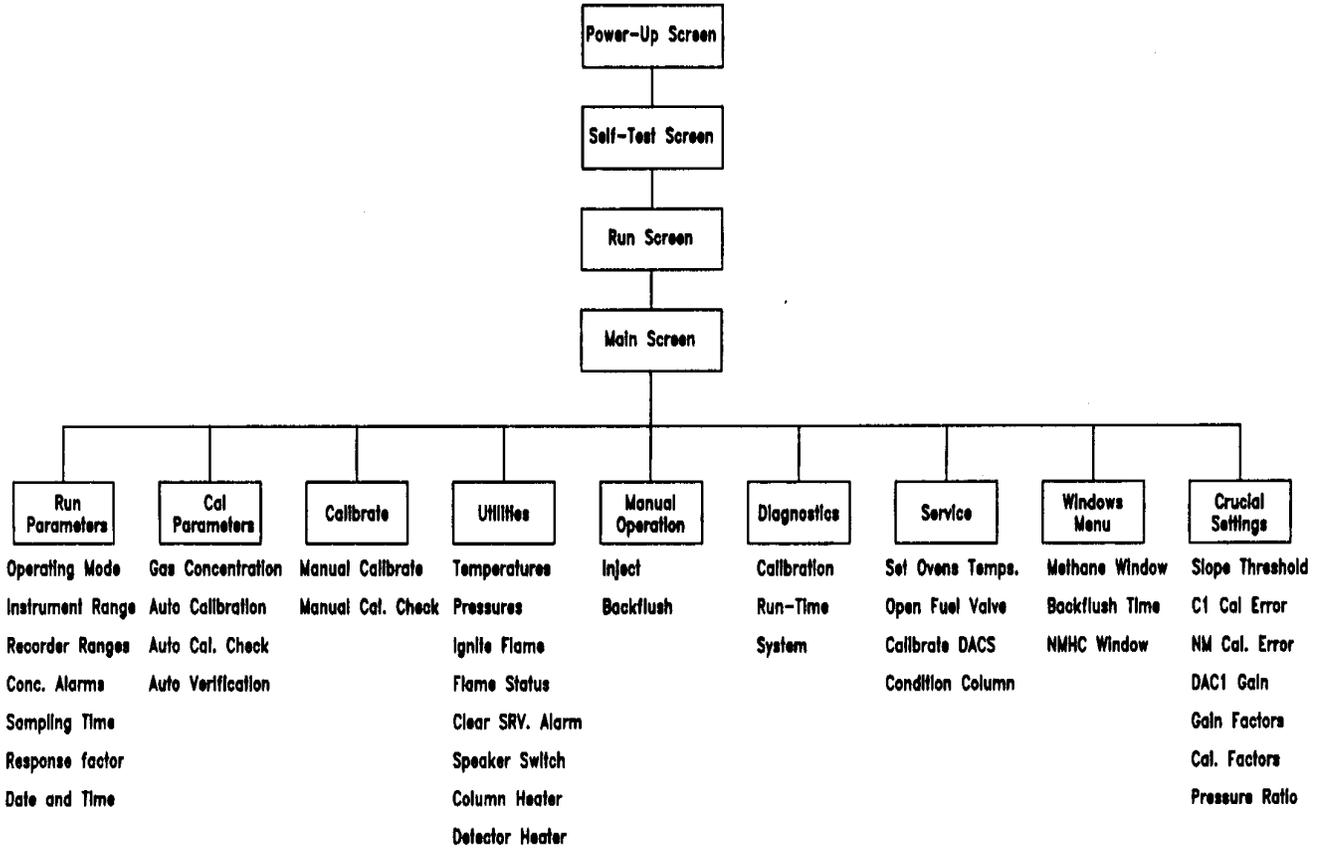


Figure AK.1.2.1
 Flowchart of Menu-Driven Software

California Air Resources Board
 Monthly Quality Control Maintenance Check Sheet
 TEI Model 55 NMHC Analyzer

Location: _____
 Station Number: _____
 Analyzer Property Number: _____

Month/Year: _____
 Technician: _____
 Agency: _____

Date	Air Pressure	Fuel Pressure	Carrier Pressure
/			
/			
/			
/			
/			

Date	Zero Air		Calibration	
		NMHC		NMHC
/			%	%
/			%	%
/			%	%
/			%	%
/			%	%

Date	Source	Span Gas		Source Propane	Data Logger	% Difference
		Data Logger	% Difference			
/			%			%
/			%			%
/			%			%
/			%			%
/			%			%

Filter Change Date: ____/____/____ ____/____/____ ____/____/____ ____/____/____

Condition Column Date: _____

Date	Comments or Maintenance Performed

AK1.3 MAINTENANCE PROCEDURES

AK1.3.1 TROUBLESHOOTING

A common problem with the Model 55C is contamination of the column. A symptom of this is “noise” in the trace and elevated baseline following the non-methane peak (see the figure on Page 5-12 of the instruction manual for details). This is easily corrected by using the “**Condition Column**” software. To access this, press the **MENUS KEY AND THEN WAIT** for the main menu to appear. Using the down arrow, move the cursor to item **#7 - SERVICE**. Move the cursor down to **CONDITION COLUMN** and press **ENTER**. The analyzer will now rise the oven temperature and start a timer. After eight hours, the analyzer will return to normal operating temperatures.

Another common problem with operation of the analyzer is incorrect pressures on the Carrier gas, Air supply, or Hydrogen fuel. Also the moisture content of the Air Supply has been a source of erratic output on the Model 55C.

Chapter Five of the instruction manual goes into great detail on fixing problems associated with the Model 55C.

AK1.3.2 SERVICING THE ANALYZER

An in depth description of the replacement of most of the major components of the Model 55C is covered in Chapter 6 of the instrument’s instruction manual.