

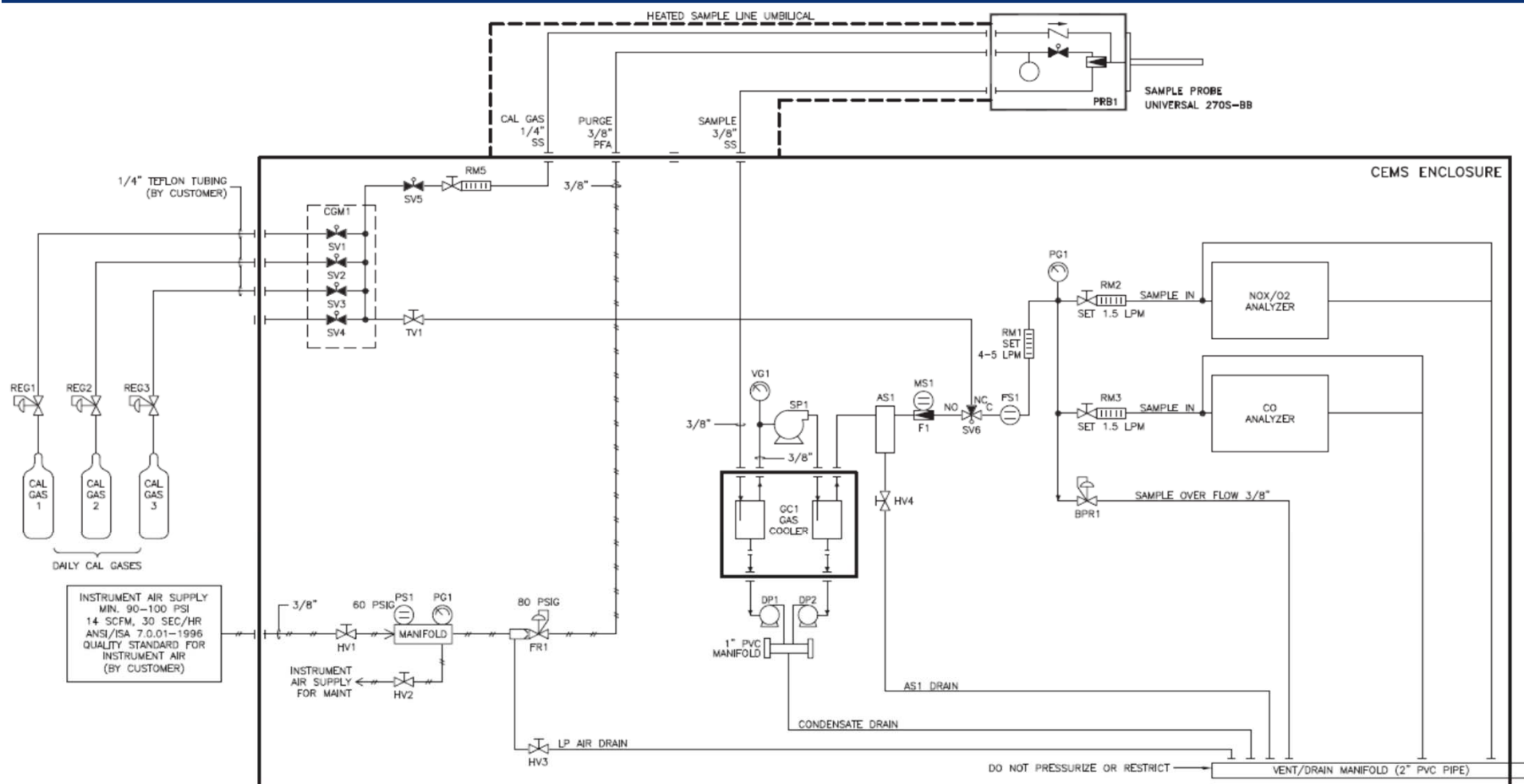
CEMS: Fully Extractive System (Dry Basis)



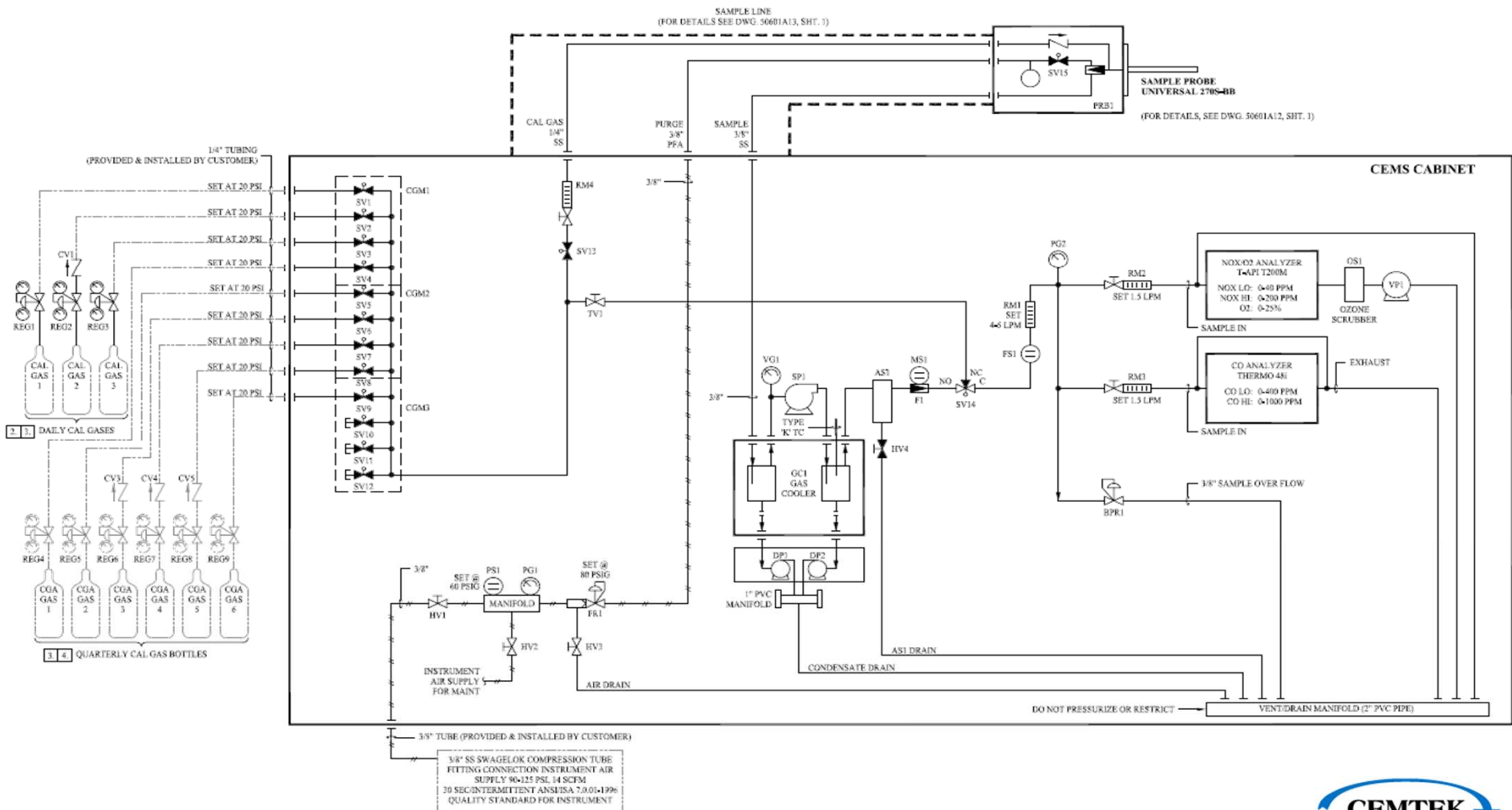
Fully Extractive – Dry Basis

- Sample Gas Dried To A Dew-point Of +2°C
- Excellent Performance In Low Concentrations
- Good Performance In High Concentrations
- Requires Preventative Maintenance
- MEASUREMENT TYPES: Chemiluminescence, NDIR, UV Absorption, UV Fluorescence, Paramagnetic, Zirconia, FTIR, DOAS, IR-GFC
- Heated Probe Filter And Heated Sample Line
- Moisture Volume Needs to be Determined – Constant or Measured

System Overview



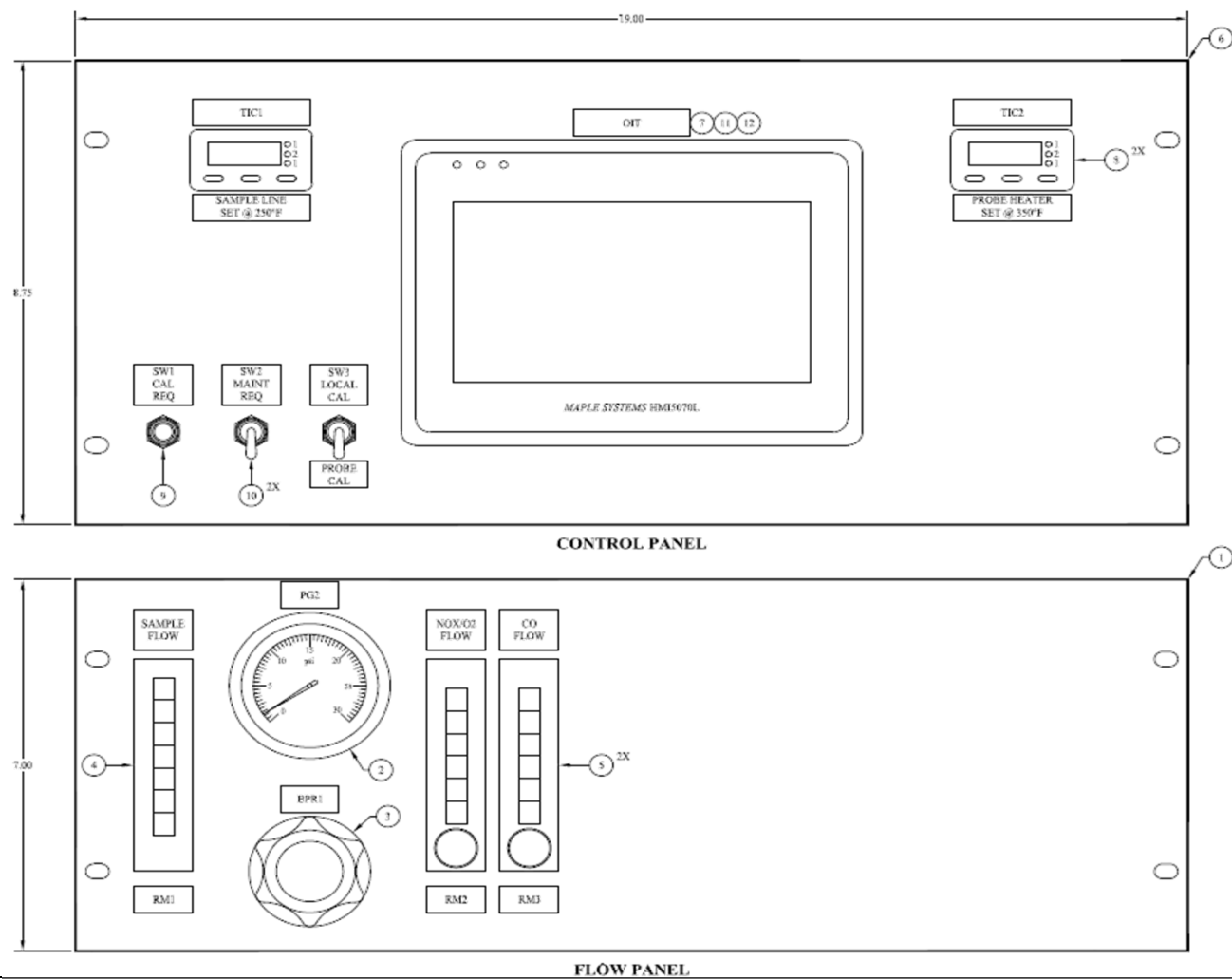
Fully Extractive CEMS Flow Schematic



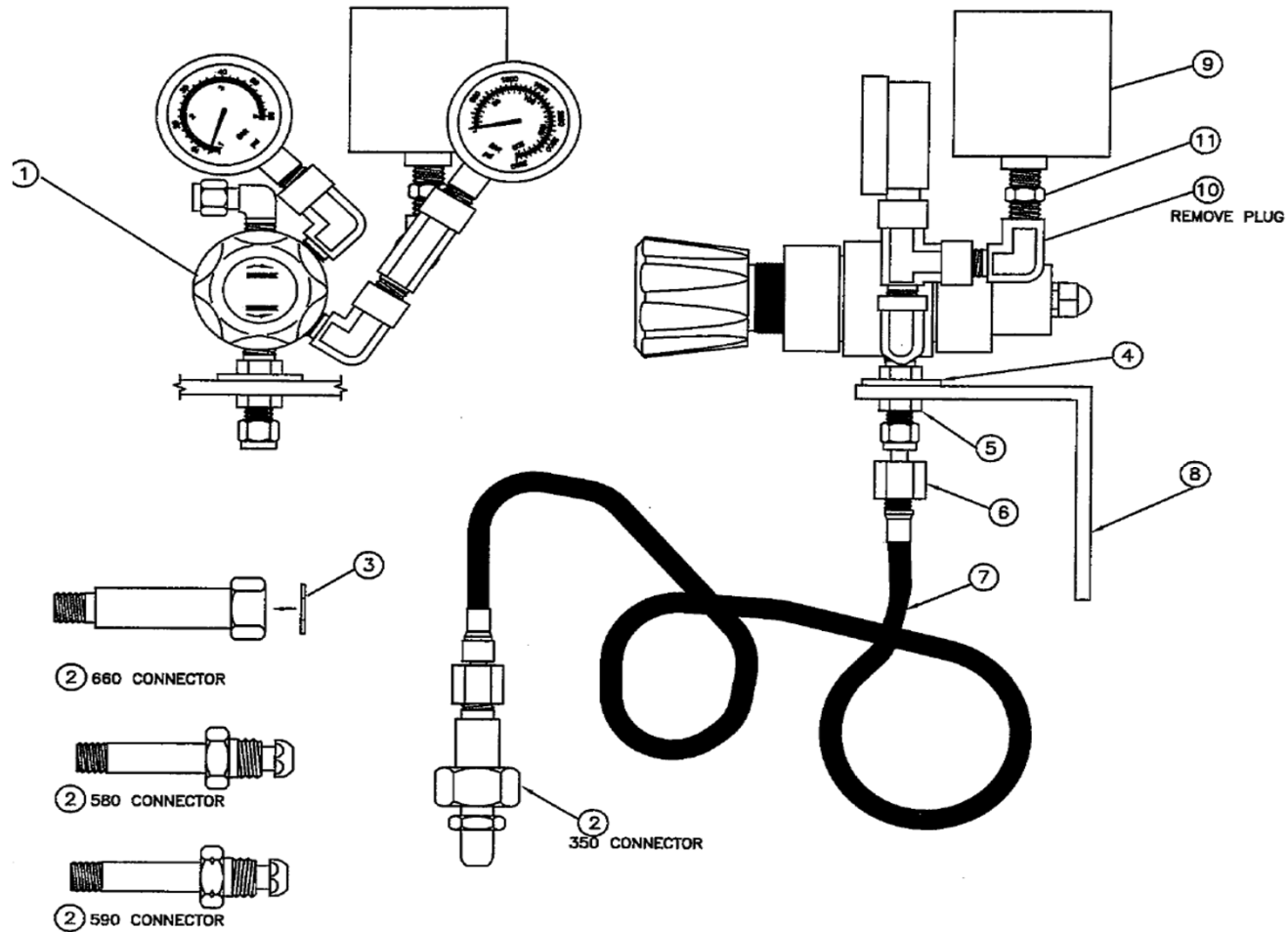
Analyzer Rack



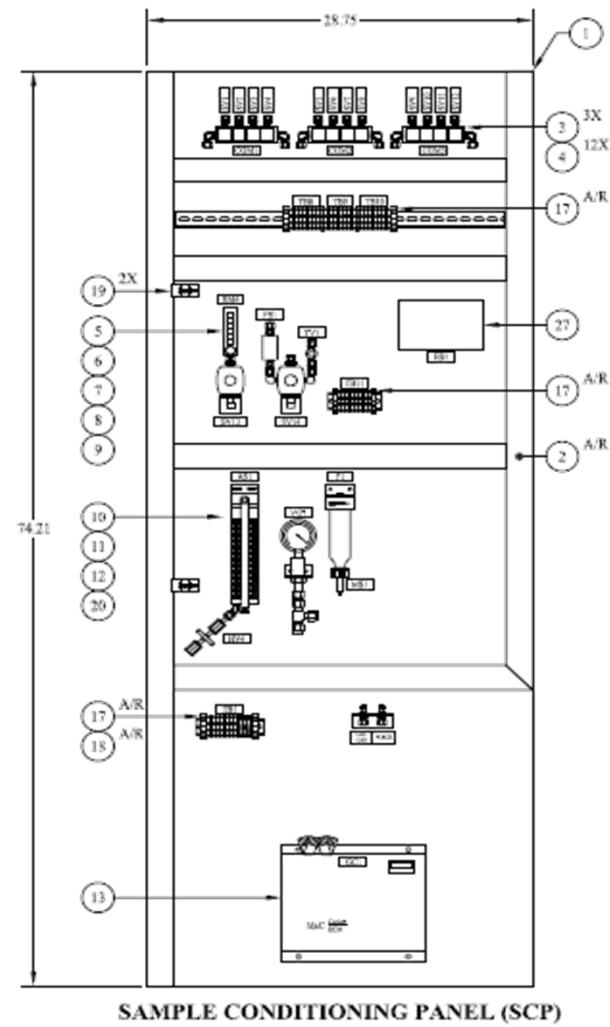
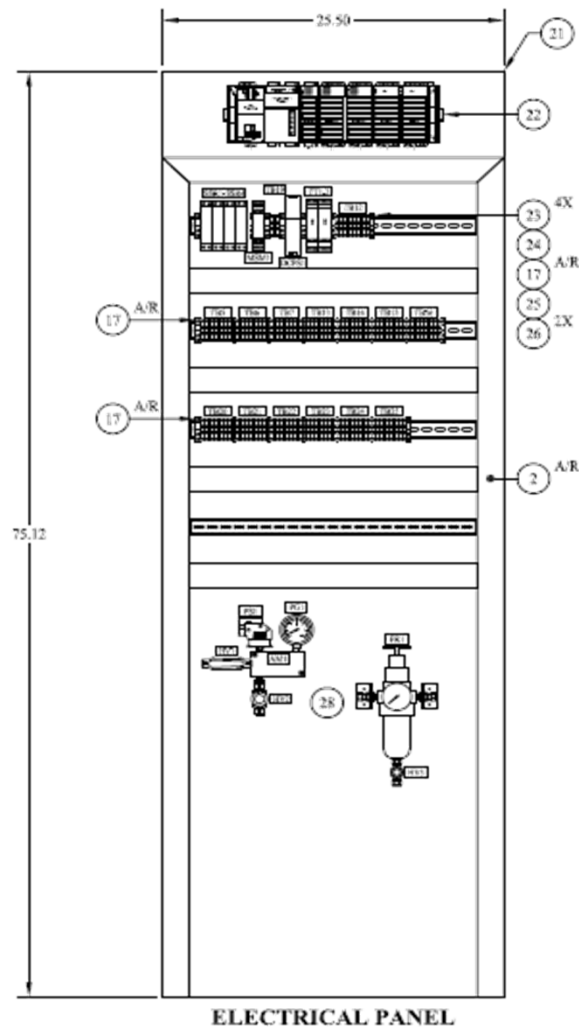
Analyzer Rack Details



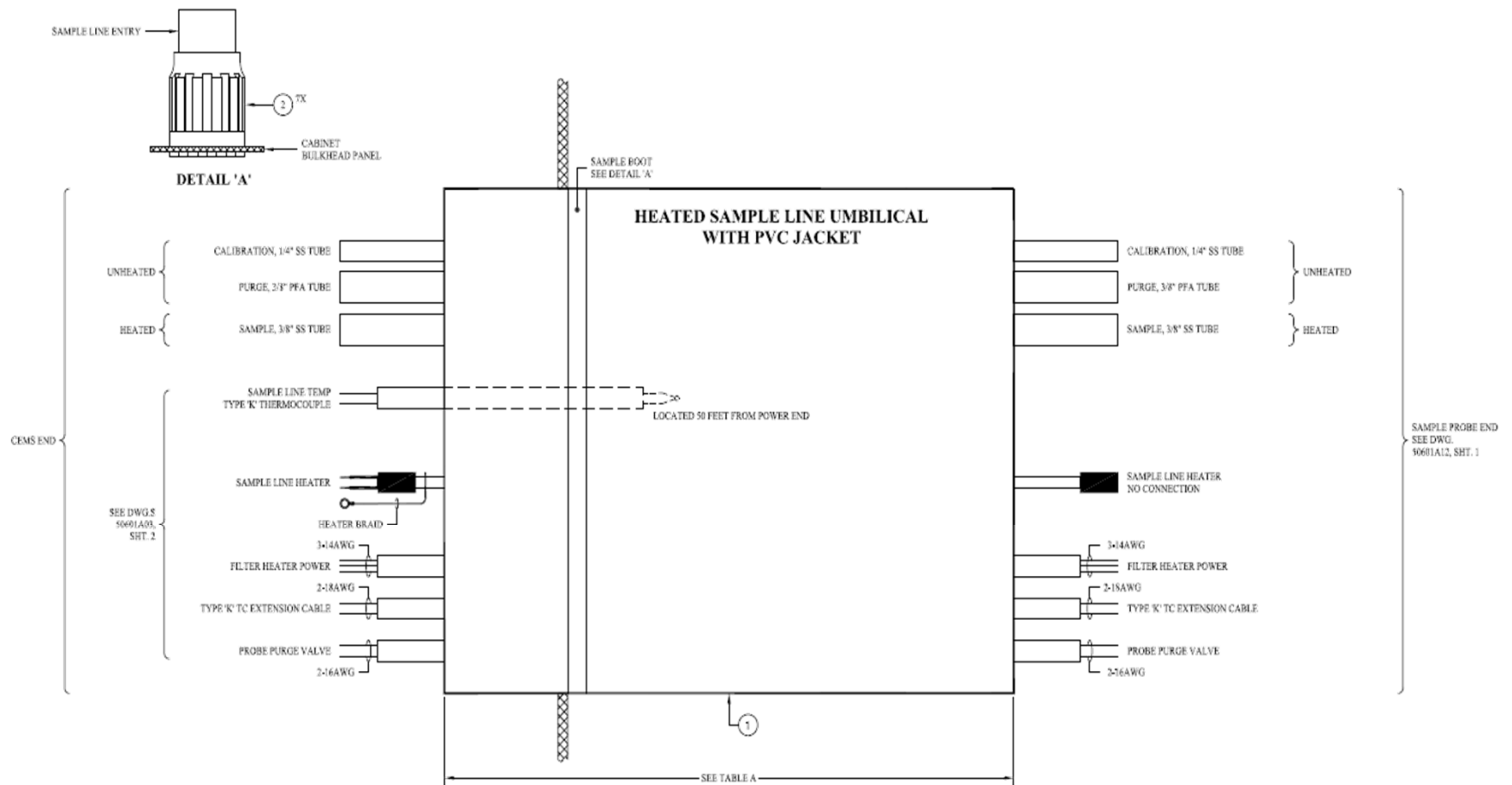
Calibration Gas Regulators



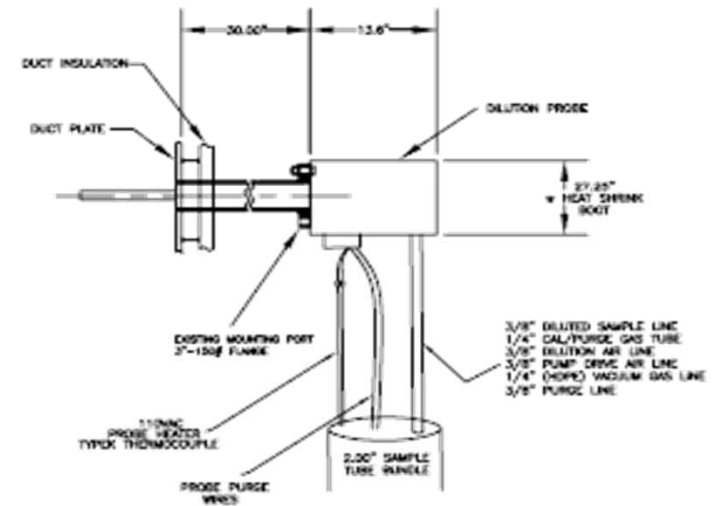
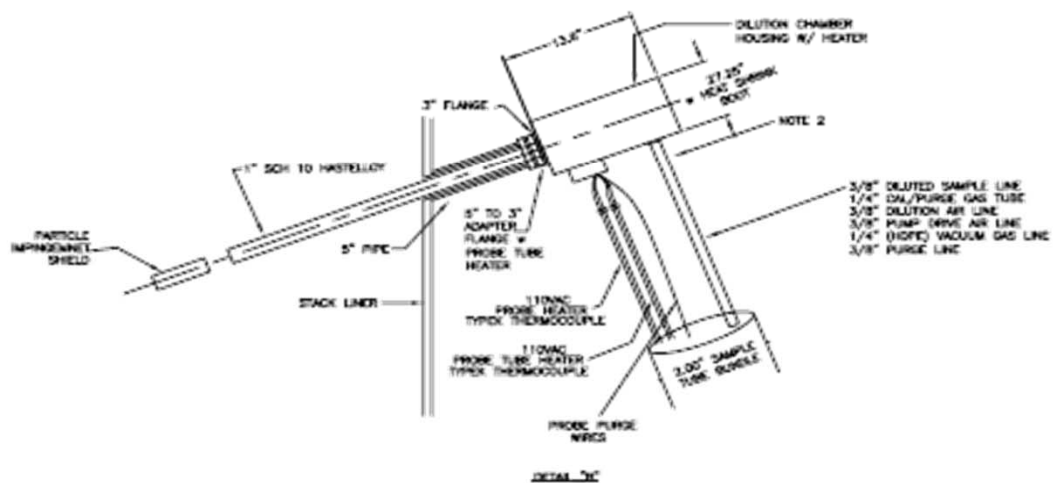
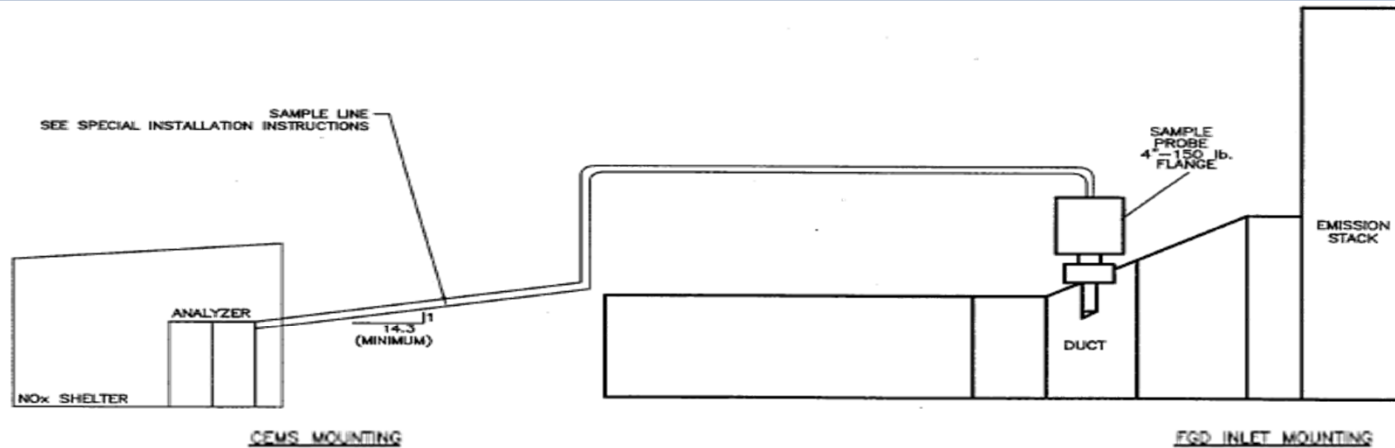
Sample Conditioning Panel



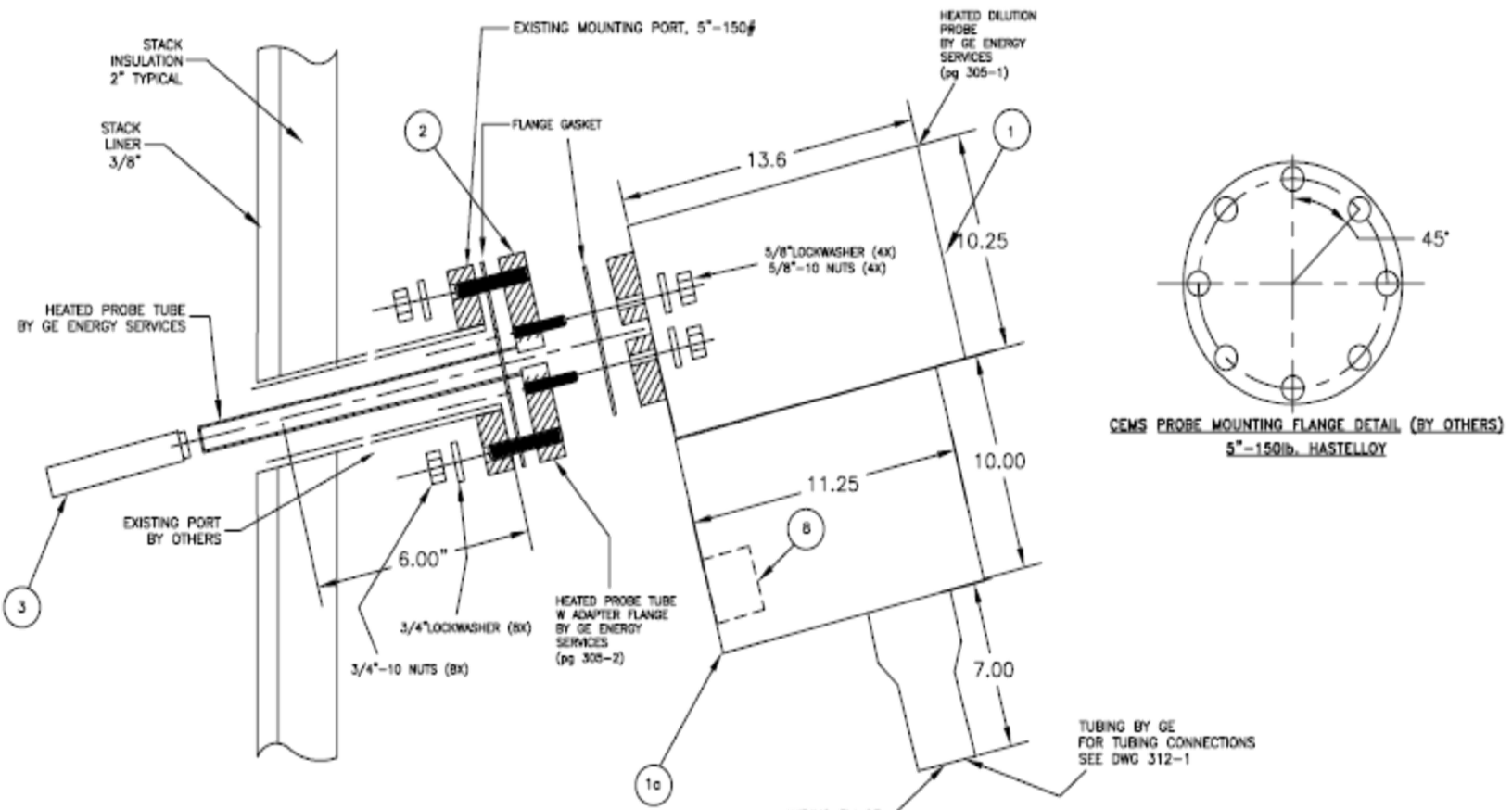
Sample Line



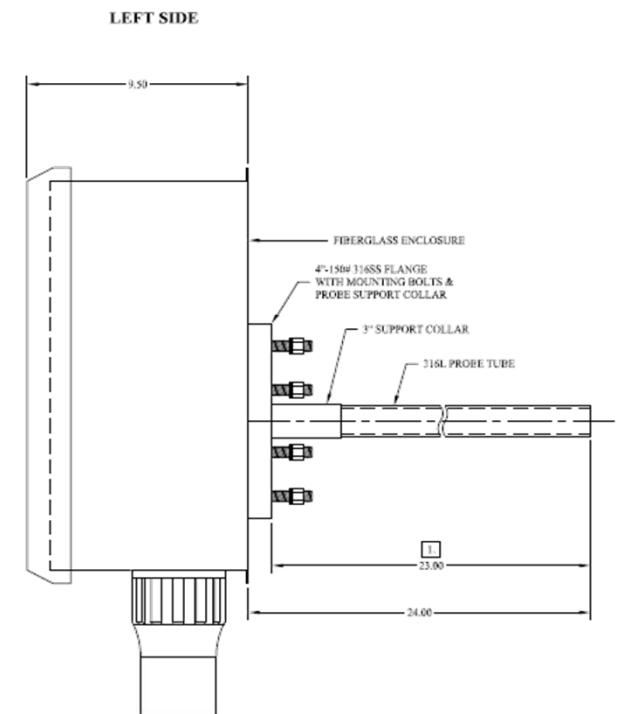
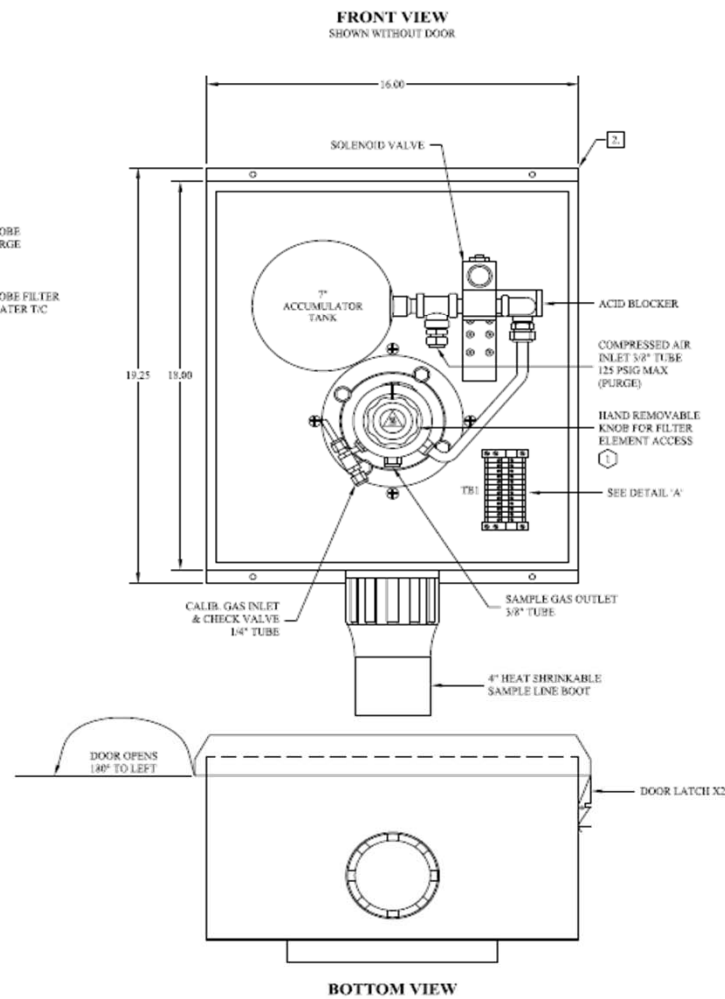
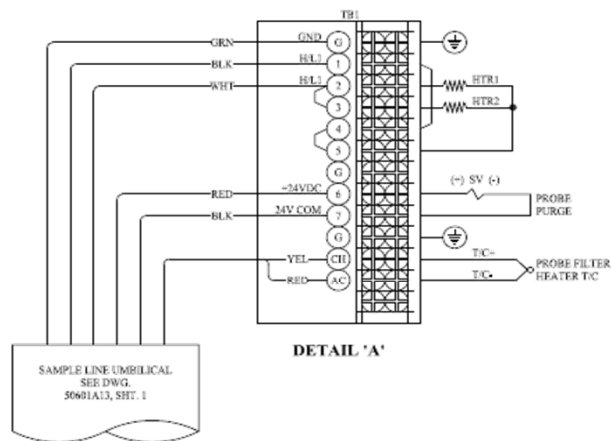
Probe Installation



Probe Installation

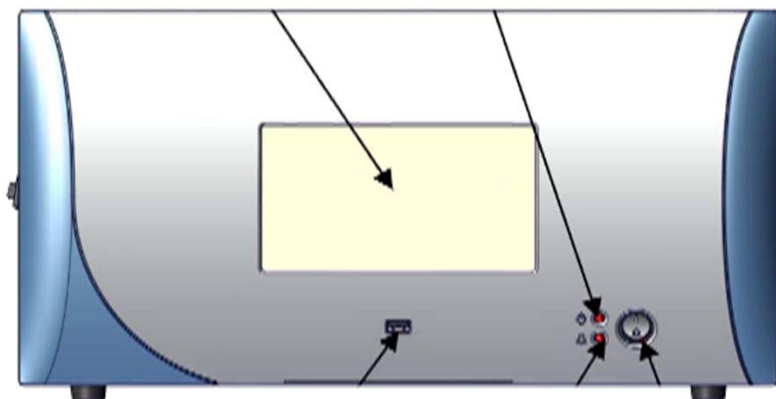


Probe Detail



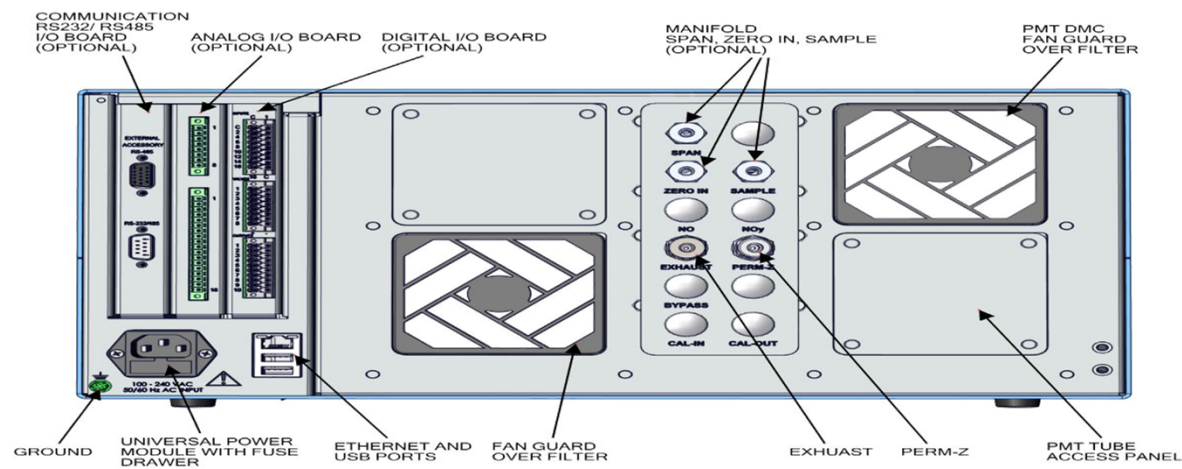
NOx Analyzer

Example; Actual Model(s) May Vary



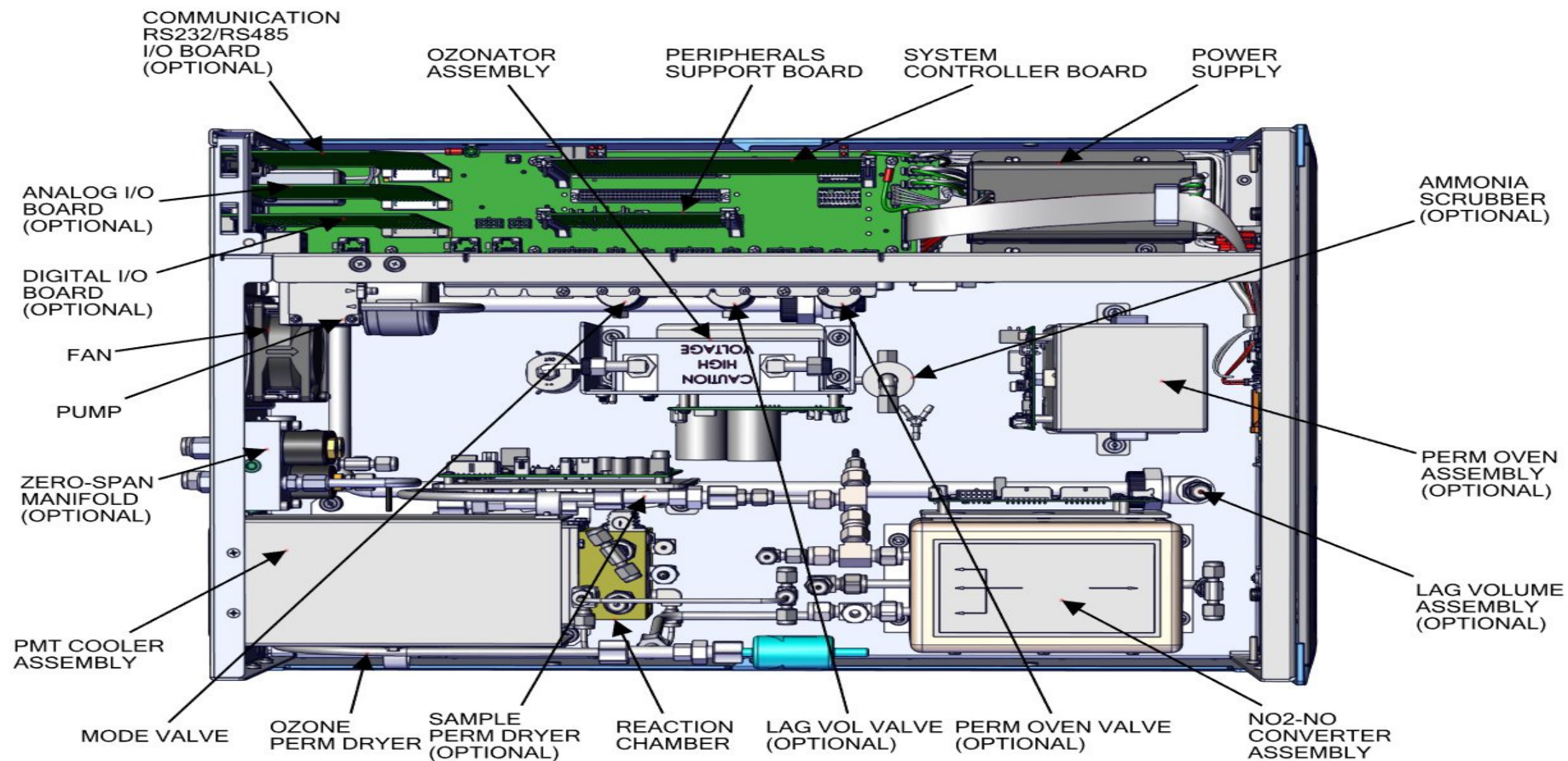
Front

Rear

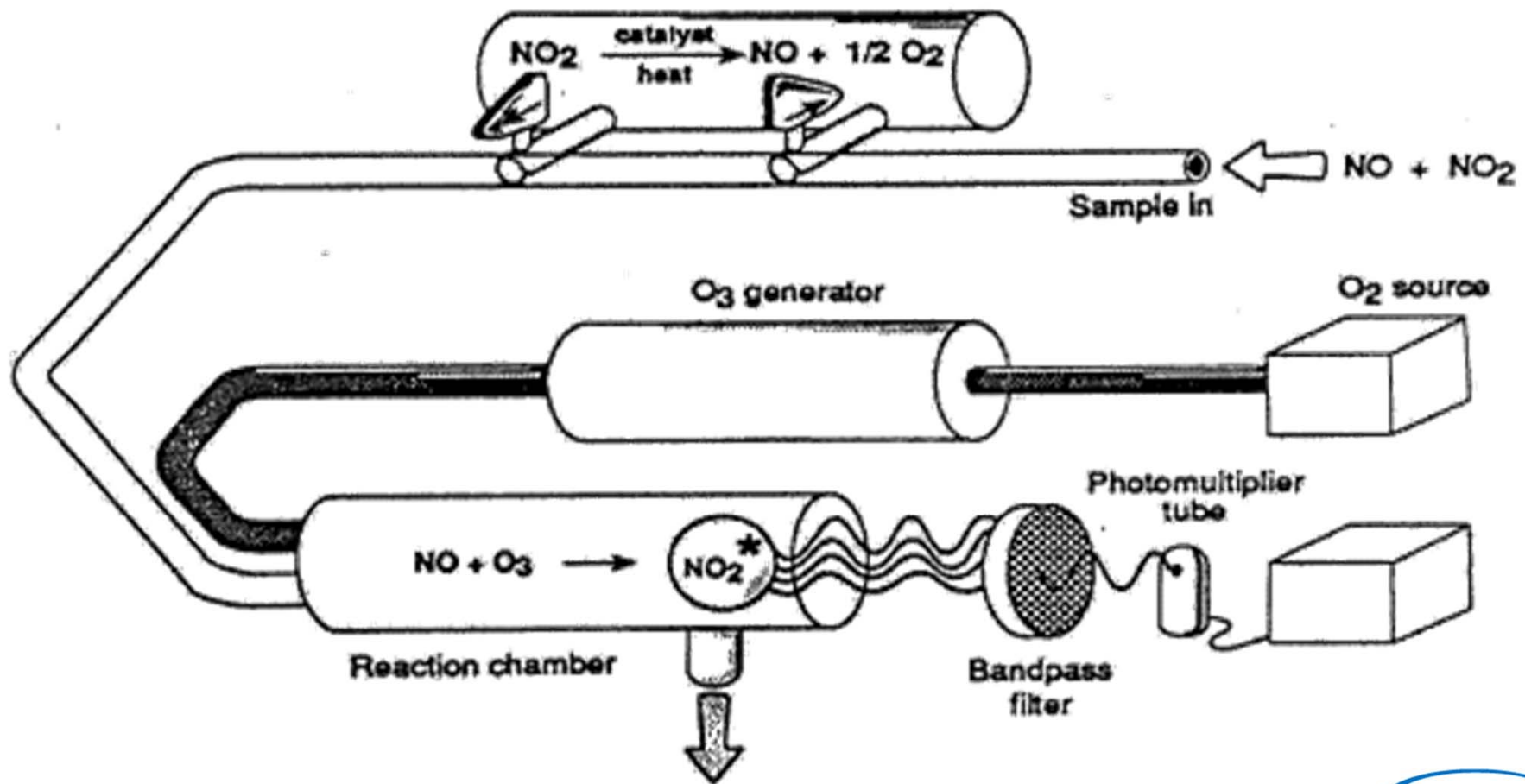


NO_x Analyzer Component Overview

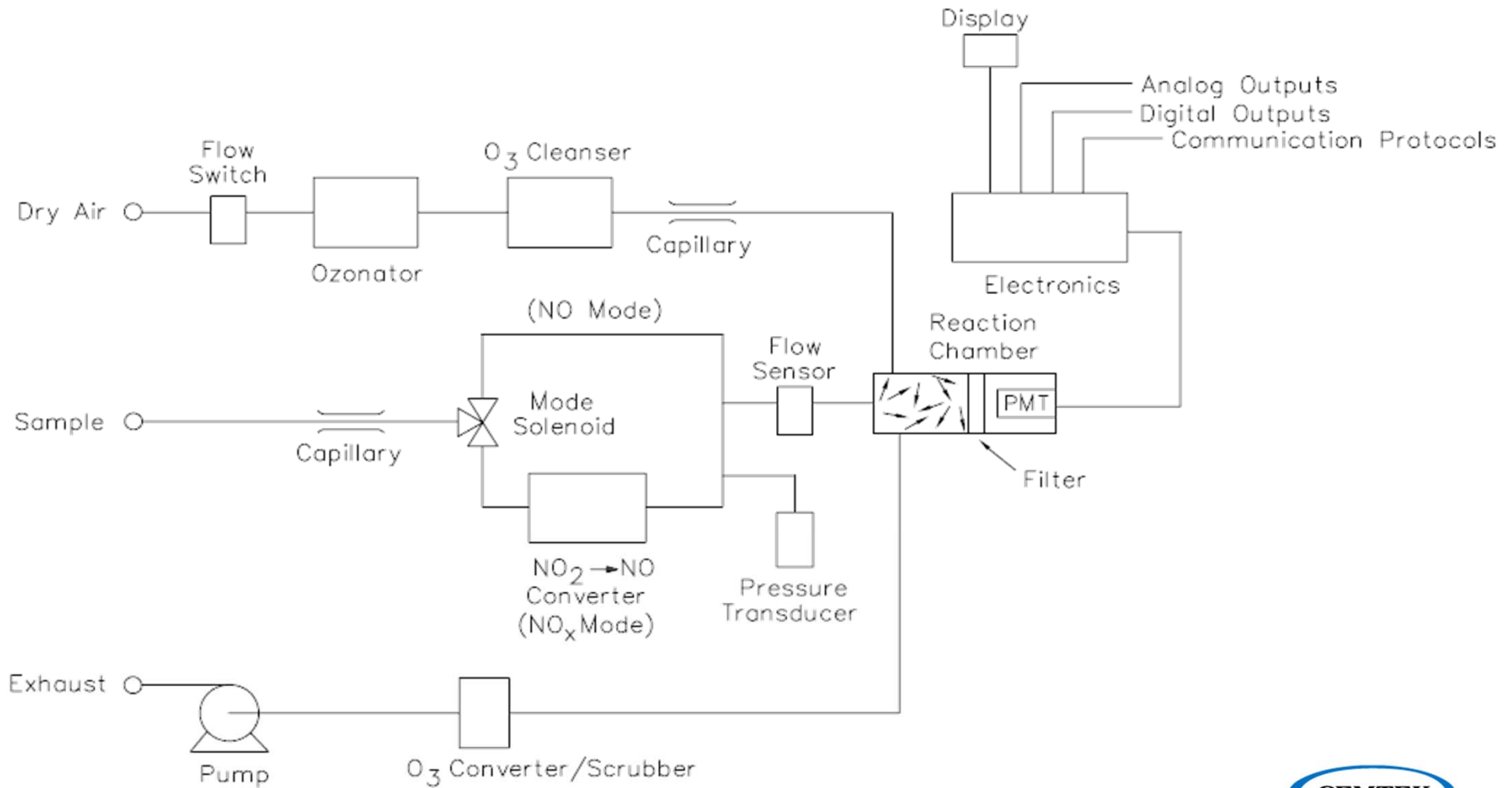
Example; Actual Model(s) May Vary



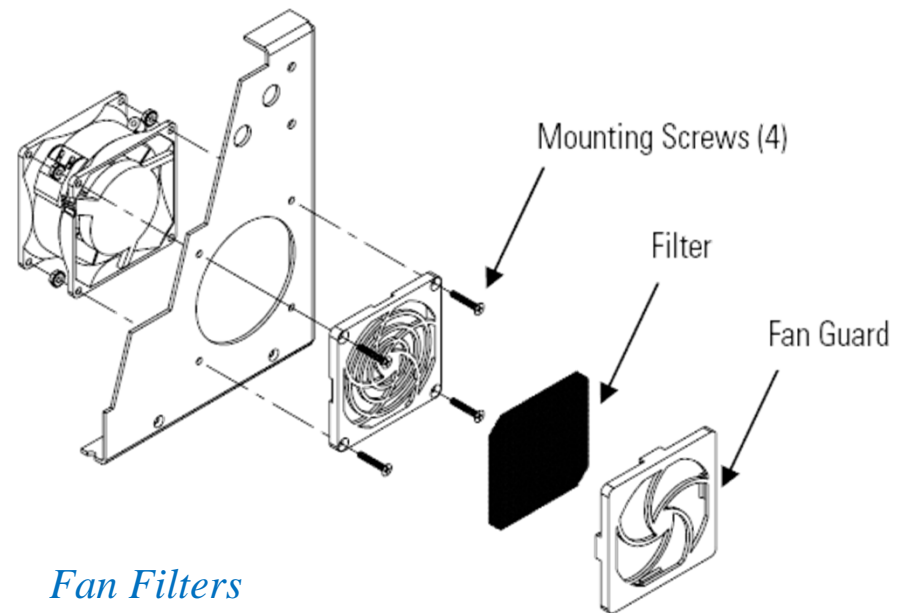
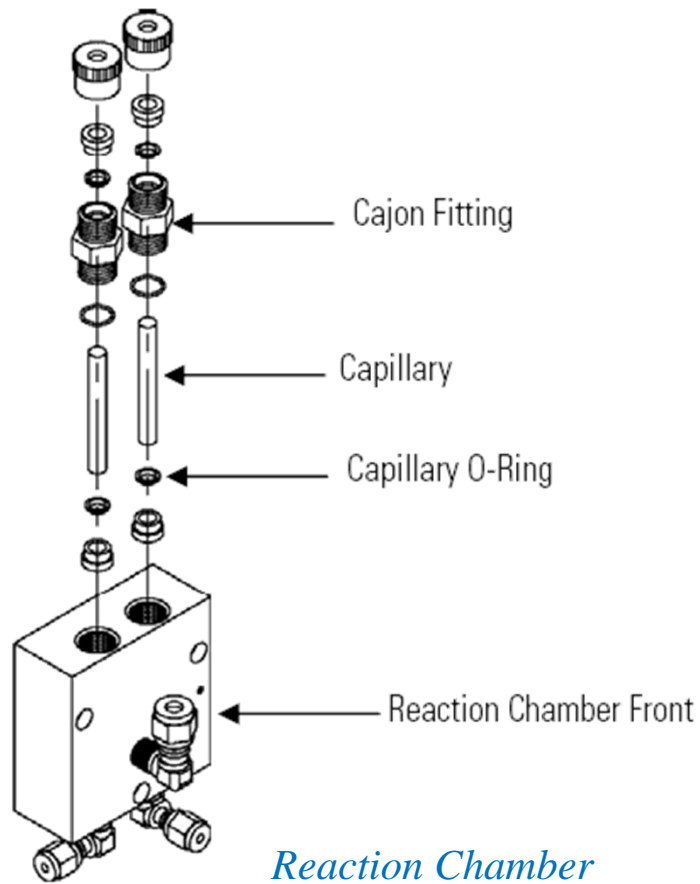
NO_x Measurement Principle



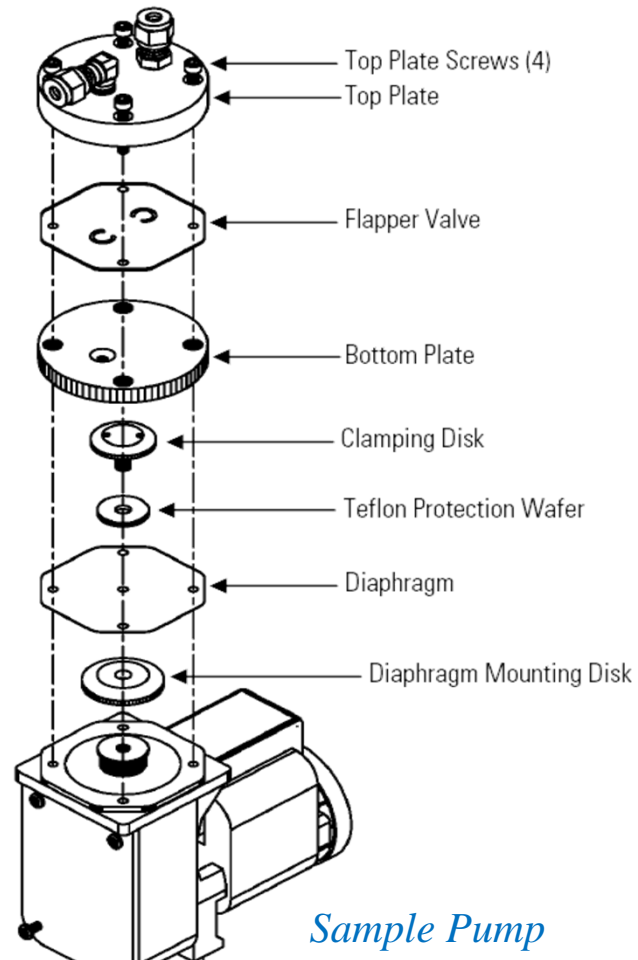
NO_x Flow Diagram



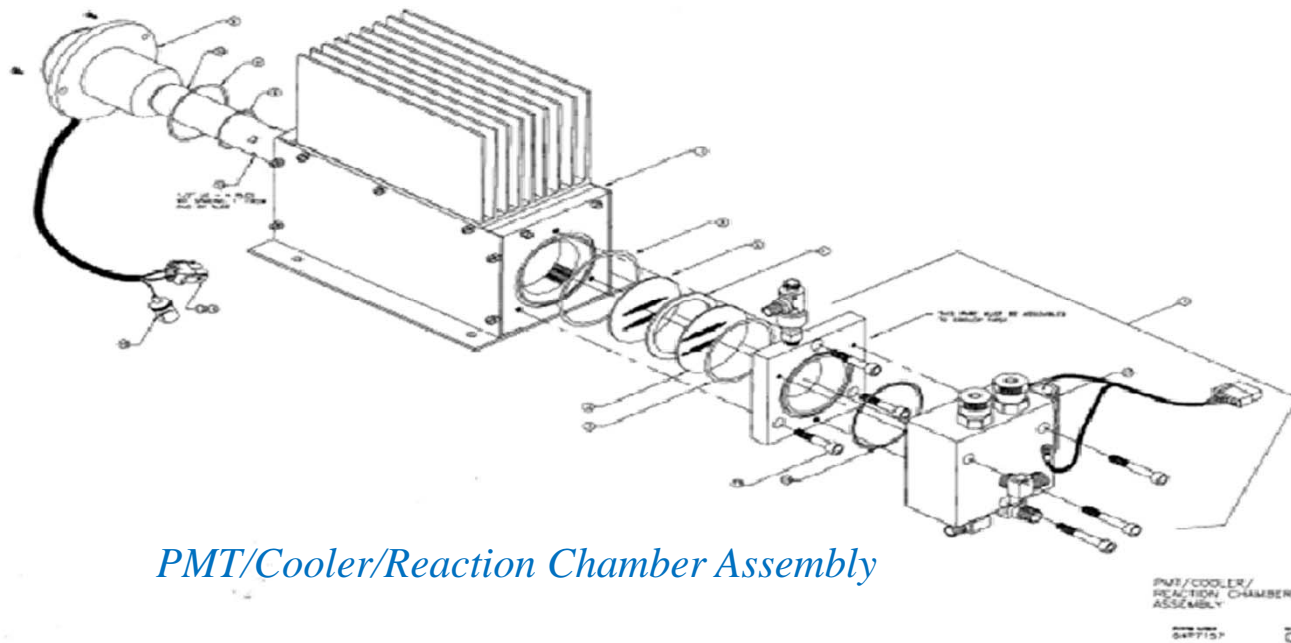
NOx Analyzer Components



NOx Analyzer Components



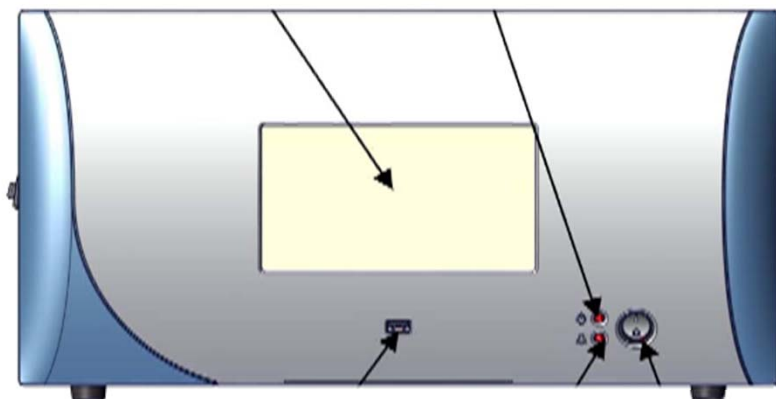
NOx Analyzer Components



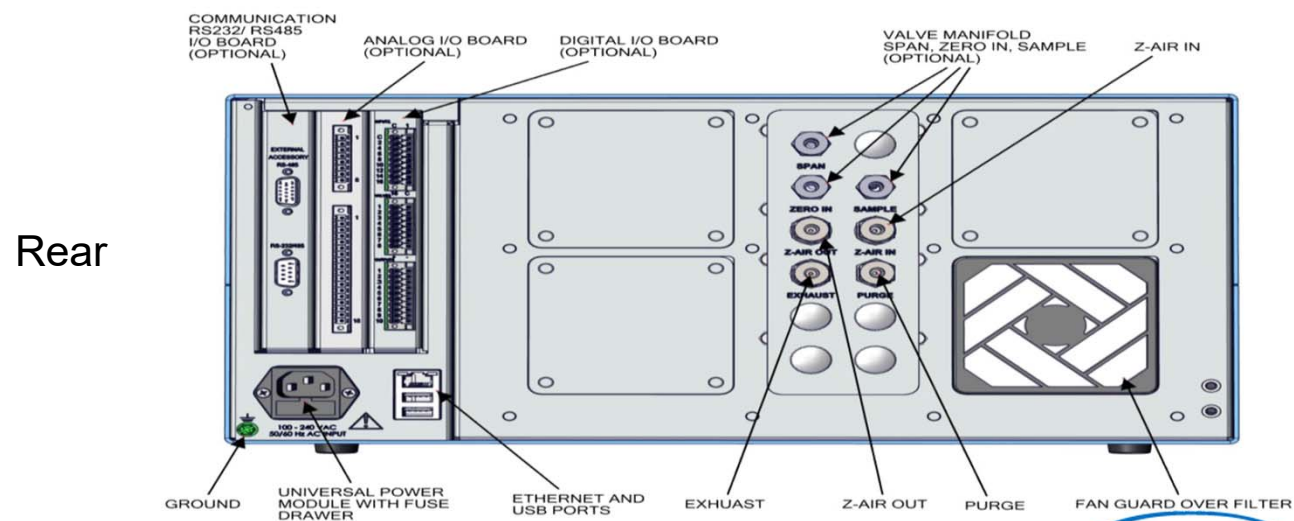
PMT/Cooler/Reaction Chamber Assembly

CO/CO₂ Analyzer

Example, Actual Model(s) May Vary



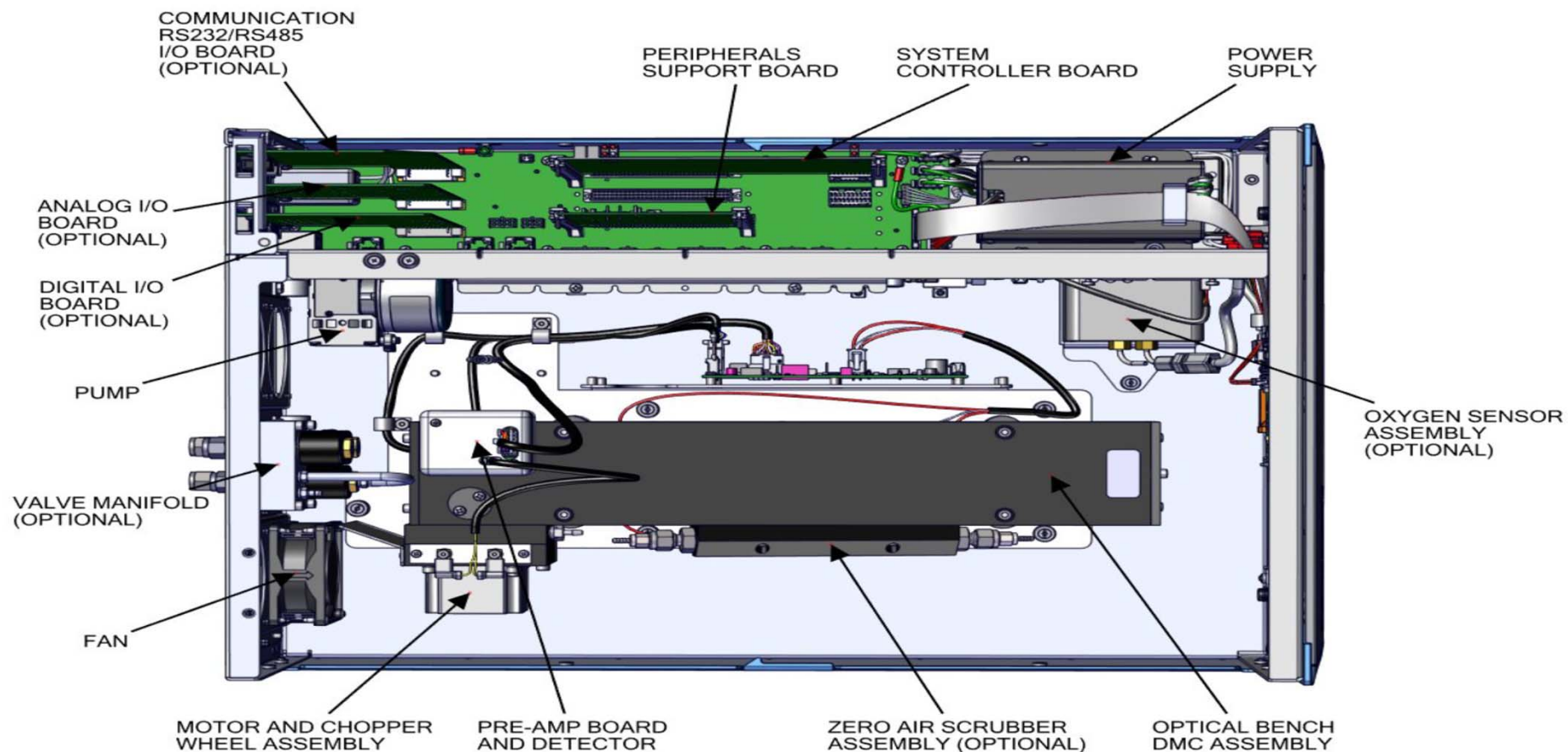
Front



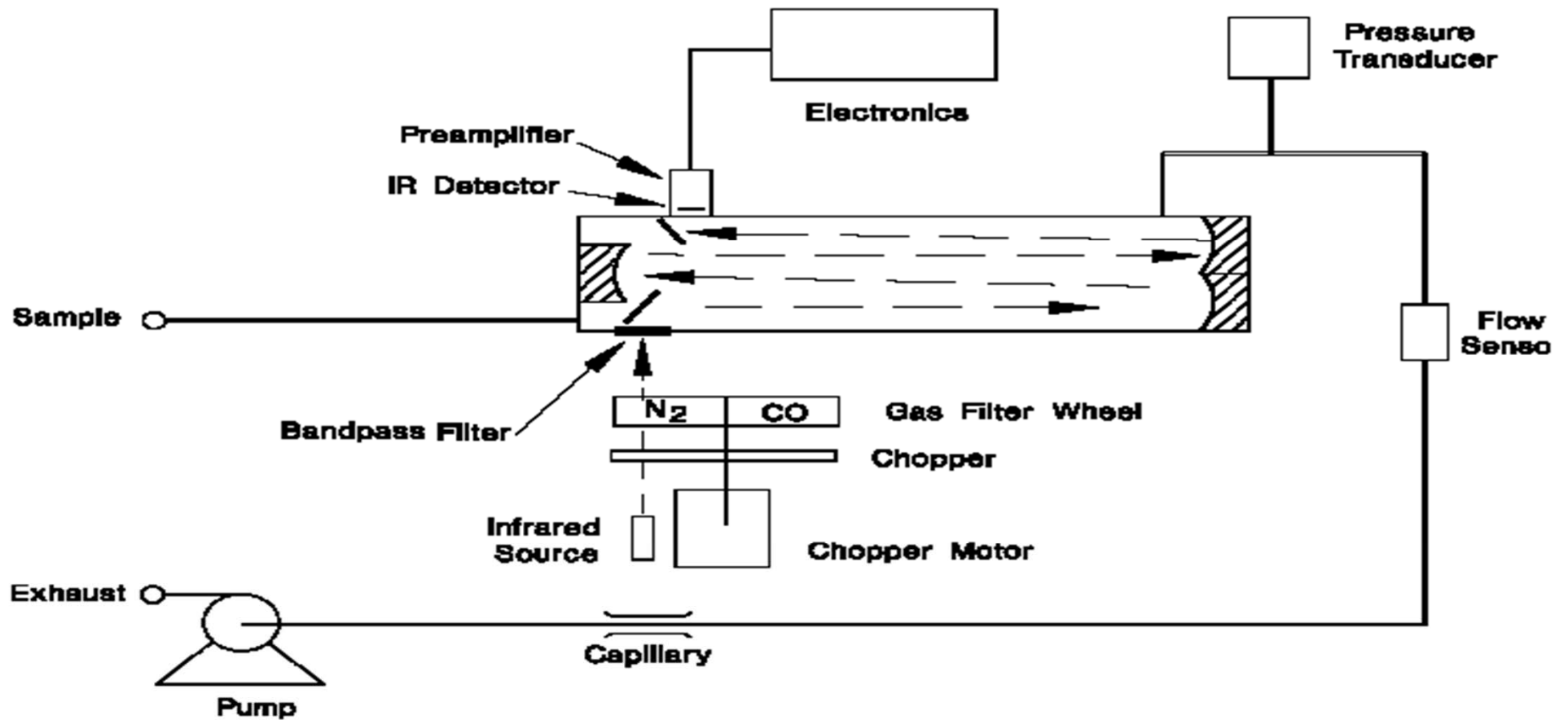
Rear

CO/CO₂ Analyzer Component Overview

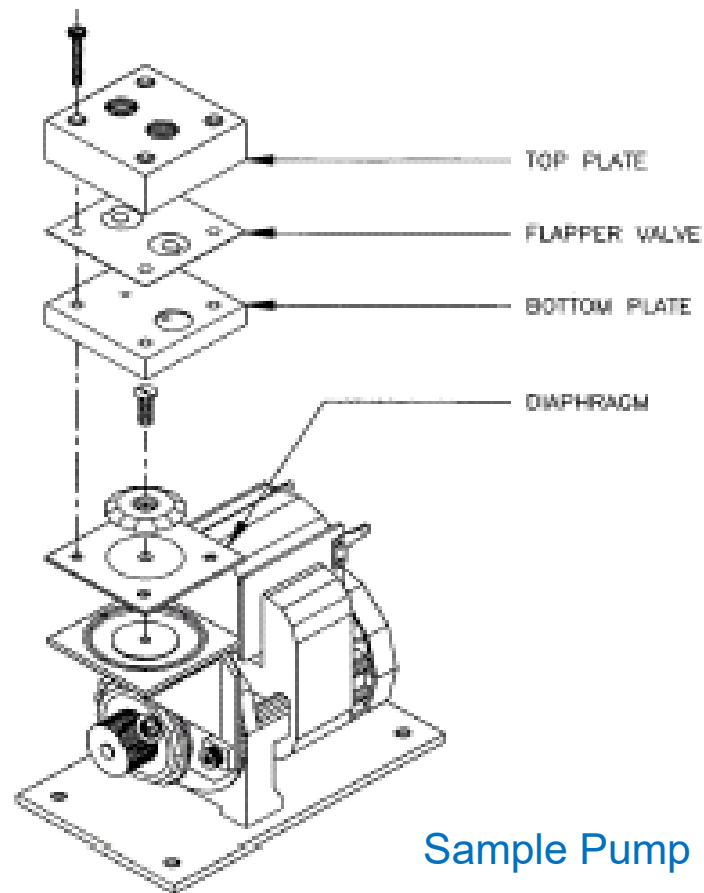
Example; Actual Model(s) May Vary



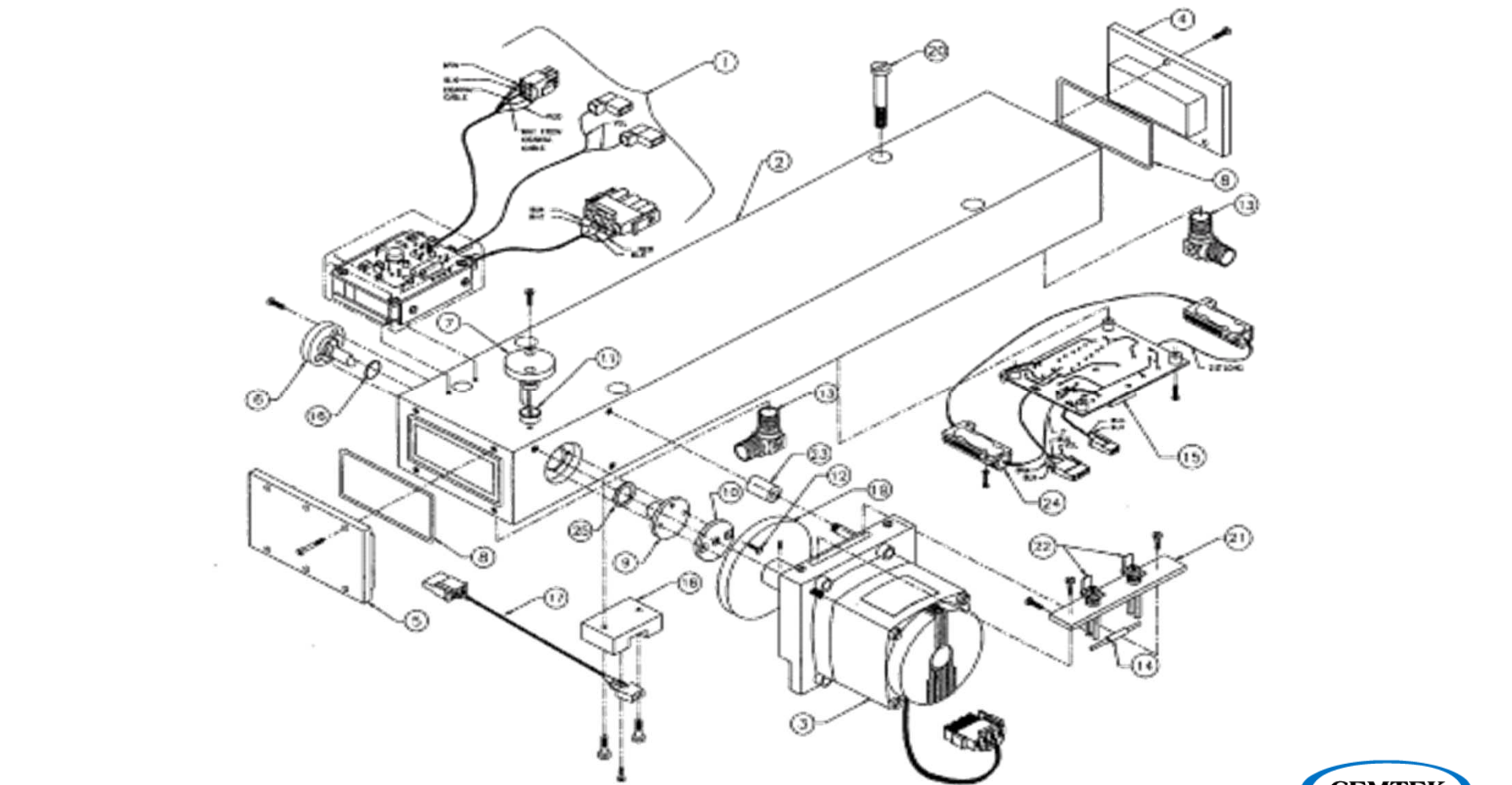
CO₂ Flow Diagram



CO/CO₂ Analyzer Components



CO2 Optical Bench



Recommended Daily System Maintenance

Sample System Checks – Daily				
	Item	Tag	Set Point	Record Daily Value or Status
Pressures	Instrument air	PG1	90-125 psig	
	Sample pressure	PG2	>2 psig	
	Probe vacuum	VG1	<10 inch Hg	
	Instrument air filter regulator	FR1	80 psig	
Flows	Total sample flow	RM1	4-5 lpm	
	NO _x /O ₂ analyzer flow	RM2	~1.5 lpm	
	CO analyzer flow	RM3	~1.5 lpm	
	Calibration gas flow	RM4	5-7 lpm	
Sample System Checks – Daily				
	Item	Tag	Set Point	Record Daily Value or Status
Visual checks	Room/enclosure temperature	Check HVAC controls	72°F, ±5°F	
	Moisture sensor and sample system filter	MS1, F1	Clean and dry. If filter shows buildup and flow levels are dropping, replace filter.	
	Cooler temp	GC1	Status Indicators = okay. Temperature between 1-5°C with 2°C nominal.	
	Drain pump	DP1 and DP2	Turning approx. 6 rpm	
	Check NH ₃ scrubber media for moisture buildup.	AS1, HV4	Drain as needed with hand valve.	
	Sample line temperature control	TIC1	250°F, ±5°F	
	Probe heater temperature control	TIC2	350°F, ±5°F	
Additional Sample System Checks – Daily				
	Item	Value or Status (Completed, OK, Replaced)		
	Check daily calibration gas bottle pressures: 0-2000 gauge > 200			
	Replace cylinder if high pressure is below 150 psi. Order new calibration gases when needed			
	Keeping in mind the lead time required for some			
DAHS Checks – Daily				
	Item	Value or Status (Completed, OK, Replaced)		
	Check DAHS for normal operation. Is system logging data?			
	Check and archive alarms. Log reason codes and action codes for any alarm conditions.			
	Check printer for normal operation.			
	Check calibration drift report for all analyzers/monitors. Did all calibrations pass?			
	Print, review, and file all daily summary reports. Watch for and immediately report to supervisor any non-compliance/exceedance episodes. Initiate corrective actions as needed. Fill out downtime event forms as needed.			
Analyzer Checks – Daily				
	Item	Value or Status (Completed, OK, Replaced)		
	Check all analyzer displays for error messages.			

Note: Ensure system has been placed in maintenance mode before performing any maintenance or repair.


Recommended Weekly System Maintenance

Sample System Checks – Weekly	
Item	Value or Status (Completed, OK, Replaced)
Perform all daily checks.	
Watch for upward or downward trends in the daily calibrations for the week. Perform zero and span adjustment, if required.	
DAHS Checks – Weekly	
Item	Value or Status (Completed, OK, Replaced)
Check/change backup media (removable hard drive, etc.).	
If enabled, verify that automatic backups have occurred for the week.	
Verify there is sufficient disk space for another week of data.	
Analyzer Checks – Weekly	
Item	Value or Status (Completed, OK, Replaced)
TAPI Model T200M NO_x Analyzer	
Refer to the T200H/M manual located in the Appendices of the CEMS Operation and Maintenance Manual. Chapter 10 of the manual contains detailed procedures on routine maintenance and troubleshooting. Chapters 6 and 7 contain analyzer operating and calibrating information. Note that the O ₂ bench has no specified maintenance requirements.	
Check/change internal particulate filter.	
Verify analyzer test functions. Record status per below. (Also perform after any repair.)	
Test Function	Record Value
NO _x STAB (ppb/ppm)	
SAMPLE FLOW (cm ³)	
OZONE FLOW (cm ³)	
PMT SIGNAL WITH ZERO AIR (MV)	
PMT SIGNAL AT SPAN GAS CONC (MV, PPM)	
NORM PMT SIGNAL AT SPAN GAS CONC (MV, PPM)	
AZERO (MV)	
HVPS (V)	
RCELL TEMP (°C)	
BOX TEMP (°C)	
PMT TEMP (°C)	
O ₂ CELL TEMP (°C)	
IZS TEMP (if option is installed) (°C)	
CONV TEMP (°C)	
RCEL (inches Hg)	
SAMP (inches Hg)	
NO _x SLOPE	
NO _x OFFSET (mV)	
NO SLOPE	
NO OFFSET (mV)	
O ₂ SLOPE (if option is installed)	
O ₂ OFFSET (if option is installed) (%)	
PMT SIGNAL DURING ETEST (MV)	
PMT SIGNAL DURING OTEST (MV)	
REF_4096_MV	
REF_GND (MV)	

Recommended Monthly System Maintenance

Sample System Checks – Monthly	
Item	Value or Status (Completed, OK, Replaced)
Perform all daily and weekly checks.	
Check filter on cabinet HVAC system. Clean or replace as needed, usually every 2-3 months.	
Plan ahead for the upcoming CGA. Check CGA calibration gas bottle pressures > 500 psig. Also check expiration dates. Order new gas bottles as needed keeping in mind the lead time may be several weeks.	

Recommended Quarterly System Maintenance

Sample System Checks – Quarterly	
Item	Value or Status (Completed, OK, Replaced)
Perform all daily, weekly, and monthly checks. Note that all routine maintenance is to be performed prior to the required quarterly audit test.	
If sample gas vacuum at VG1 shows an increase, perform probe maintenance. Replace the filter element and clean the filter chamber as necessary. Replace O-rings. Verify probe box heater is operating. If flow is low, check sample pump SP1 .	
Perform CEMS sample system leak check and flow balance procedure (refer to next chapter).	
Check and replace ammonia scrubber media at AS1 as needed.	
Perform general housekeeping duties inside cabinet. Dust/clean all equipment surfaces.	
Analyzer Checks – Quarterly	
Item	Value or Status (Completed, OK, Replaced)
For all analyzers: Visually check for obvious defects such as loose connectors, loose fittings, cracked or clogged Teflon lines, and excessive dust or dirt accumulation. Dirt accumulation inside the instruments can cause overheating or component failure and may provide conducting paths for electricity. Clean the inside of each instrument by using compressed air to blow out dust. Clean all analyzer cooling fans.  CAUTION: Observe all safety warnings from manufacturers' manuals.	
For stack mounted equipment: Check all seals and mounting hardware. Any deposits or build-up in the mounting flanges should be removed.	
TAPI Model T200M NO_x Analyzer	
Refer to the T200H/M manual located in the Appendices of the CEMS Operation and Maintenance Manual. Chapter 10 of the manual contains detailed procedures on routine maintenance and troubleshooting. Chapters 6 and 7 contain analyzer operating and calibrating information. Note that the O ₂ bench has no specified maintenance requirements.	
If supplied, exchange the chemical in the external zero air scrubber.	
Thermo Scientific Model 48i CO Monitor	
Refer to the Thermo CO manual, located as an appendix in the CEMS operation and maintenance manual for detailed information on routine maintenance procedures. Chapters 5, 7, and 8 of the CO manual contain preventive maintenance, troubleshooting, and servicing information and diagrams. Chapter 3 of the CO manual contains information on the analyzers Diagnostics utility.	
Record diagnostics values from analyzer's menu screen in CEMS logbook.	
Inspect and clean the fan filter. After removing, flush with warm water and let dry or blow the filter clean with compressed air.	


Recommended Semi-Annual System Maintenance

Sample System Checks – Semiannual	
Item	Value or Status (Completed, OK, Replaced)
Perform all daily, weekly, monthly, and quarterly checks.	
Check instrument air filter FR1 . Replace as needed.	

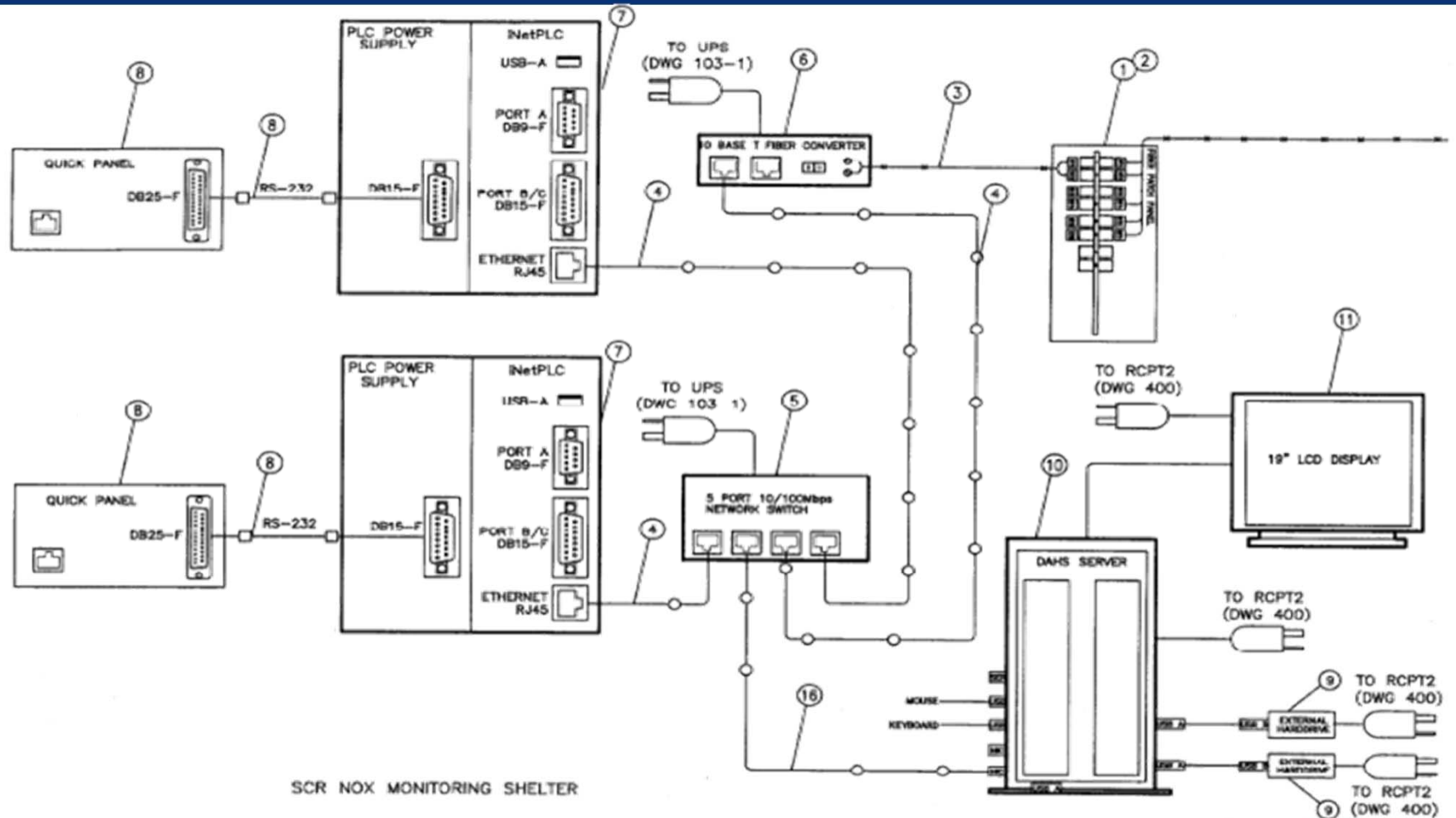
Recommended Annual System Maintenance

Sample System Checks – Annual	
Item	Value or Status (Completed, OK, Replaced)
Perform all daily, weekly, monthly, quarterly, and semiannual checks. Note that all routine maintenance is to be performed prior to the required annual RATA.	
Perform probe maintenance. Replace filter and O-rings.	
Replace sample system filter F1 .	
Inspect and clean sample cooler fan GC1 .	
Replace sample pump SP1 diaphragms.	
Replace peristaltic pump tubing DP1/DP2 .	
Check system alarms, calibrate as needed.	
Analyzer Checks – Annual	
Item	Value or Status (Completed, OK, Replaced)
TAPI Model T200M NO_x Analyzer	
Refer to the T200H/M manual located in the Appendices of the CEMS Operation and Maintenance Manual. Chapter 10 of the manual contains detailed procedures on routine maintenance and troubleshooting. Chapters 6 and 7 contain analyzer operating and calibrating information. Note that the O ₂ bench has no specified maintenance requirements.	
Replace the chemical media in the ozone filter.	
Clean optics; change O-rings in the reaction cell window annually or as necessary.	
Change particulate filter on the air filter inlet of the PermaPure dryer.	
Check the pneumatic sub-system for leaks in the gas flow paths. Perform check annually or after repairs.	
Replace all critical flow orifice O-rings and sintered filters.	
Rebuild pump head.	
Replace the inline exhaust scrubber.	
Whenever the PMT/preamp changes perform a low-level hardware calibration.	
Perform NO _x converter check. Replace every 3 years or if efficiency drops below 90%.	
Analyzer Checks – Annual	
Item	Value or Status (Completed, OK, Replaced)
Thermo Scientific Model 48i CO Monitor	
Refer to the Thermo CO manual, located as an appendix in the CEMS operation and maintenance manual for detailed information on routine maintenance procedures. Chapters 5, 7, and 8 of the CO manual contain preventive maintenance, troubleshooting, and servicing information and diagrams. Chapter 3 of the CO manual contains information on the analyzers Diagnostics utility.	
Inspect the source control system. The wire wound resistor source has a finite life. The manufacturer recommends replacement after one year of continuous use. If the source is to be replaced on an as needed basis, replace when one of the following conditions hold true: <ul style="list-style-type: none"> No light output If after cleaning the optics, the IR light intensities remain below 100,000 Hz 	
Check for leaks around fittings.	
Replace capillaries and O-rings.	
Rebuilt sample pump diaphragm and valve sheet.	
Clean measuring cell; replace block and pipe cell windows and O-rings as needed.	
Check the optics. The mirrors should be cleaned any time the AGC intensity is below 20,000 Hz.	
Check calibration of the pressure and temperature transducers.	

Troubleshooting – Sampling System

Problem	Corrective Action
Power failure	Check circuit breakers. Check power wiring. Check alarm system.
Heat-trace failure	Check sample line temperature. Check voltage/current for heated sample line Check line for external damage.
Loss of sample (Flow switch tripped; pressure at the sample gas cooler outlet fell below 5 psig)	Check sample pump motor SP1 , wiring, diaphragm and seals. Check sample vacuum at VG1 . Check setpoint at pressure regulator PG2 > 2 psi. Check sample gas cooler GC1 . Check moisture/conductivity sensor MS1 . Adjust back pressure regulator BPR1 . Check gauges for sticking or fouling. Check sample system particulate filter F1 and sample line for blockage/leaks, proper connection. Check analyzer vents for blockages. Check flowmeters (RM1 , RM2 , RM3) for correct flow setpoint and readjust, if necessary. Remove, clean, repair or replace sample line components causing flow restrictions.
Problem	Corrective Action
High Vacuum (Flow switch tripped; sample pressure before in-line sample system filter is above 15" Hg)	Check probe for blockage. Check sample line for blockage. Check sample system particulate filter F1 for blockage/leaks, proper connection. Replace flow switch FS1 . Using ohmmeter, run switch up and down watching vacuum gauge or trip point; watch ohmmeter for contact closure.
Water in Line (Moisture sensor activates moisture alarm)	Check temperature alarm of sample gas cooler GC1 . Check sample line heating. The sample gas cooler peristaltic drain pump DP1/DP2 is inoperative. Solid state conductivity sensor MS1 needs replacing.
Instrument air loss (Instrument air pressure below 60 psig)	Check instrument air supply (PG1 , PS1 , and FR1). Check for proper set points.
Calibration Gas Cylinder Pressure	Check cylinder regulator gauges. Install new cylinders.
	Note: A calibration should be performed after any analyzer corrective preventive maintenance. Also be aware that certain types of maintenance events may require additional post maintenance testing per regulatory specifications.

PLC Configuration



PLC Configuration

