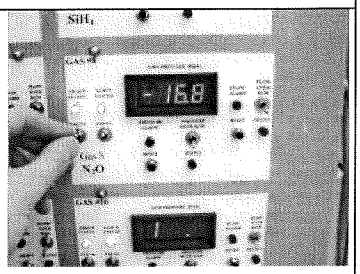
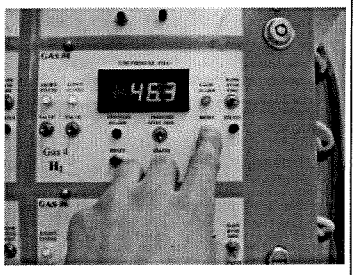
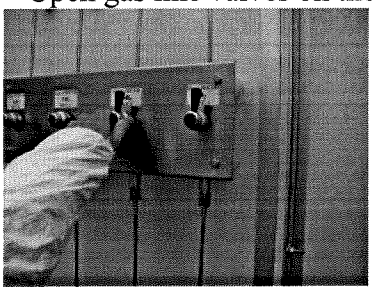
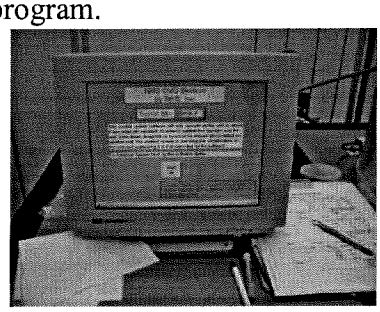
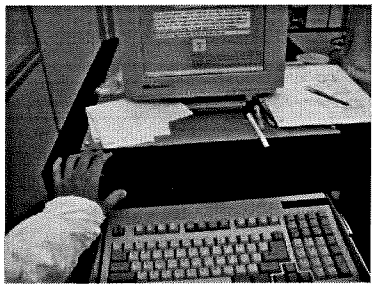
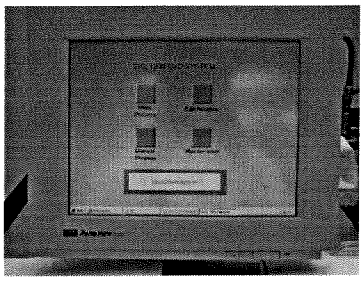
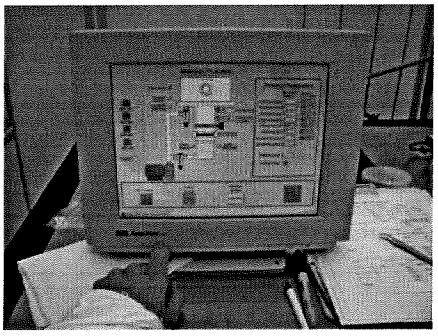
Plasma Enhanced Chemical Vapor Deposition (PECVD) Standard Deposition	
Instrument	Second Hand Semi 1200 PECVD system
Manufacturer	Secondhand Semi James L Corbin 408-956-1262
Property Number	ISU 438310
Location	2055A Gilman Hall (Clean Room)
Supervisor/Trainer	
In case of emergency	Push the emergency power off switch. Turn off emergency key on the gas panel.
Objectives	1. The user will become aware of all potential hazards involved in the procedure. 2. The user will lean the correct procedure for standard PECVD.
Related SOP	• Process gas handling procedure • Vacuum pump maintenance • Clean room
Required Safety Training	• AL-001 (General empolyee) • AL-133 (PPE) • AL-137 (Chemical hazard communication) • (AL-022) (recommended)
MSDS	• MSDS for process gases is located in 2831A Gilman Hall.
Authorization Process	1. Read this document. 2. Have an orientation from ST. 3. Take safety training listed above.
Personal Protection (PPE)	Powderless gloves, clean room suite, safety glasses.
Additional Safety Precaution	DO NOT OPERATE PECVD WHEN THE USER IS ALONE IN THE CLEAN ROOM.
Potential Hazards	High Voltage:
	High Temperature: Stage can be heated upto 300 C. Do not touch the stage with bare hand.
	Explosion: SiH_4 gas could potentially cause explosion when exposed to air.
	Chemical Hazard: The user must protect themselves from the chemical hazards associated with the chemicals used in conjunction with the equipment for photopatterning.

1. Vacuum pump	• Make sure vacuum pump is on. • If not, push "ON" switch on the panel in the machine room. • For the maintenance, see "*vacuum pump maintenance SOP*". ST will perform maintenance. • Contact ST if users find something unusual.
2. Water	• Make sure water circulator is in operation. • Backpressure is around 3 bar. • Check water level. • Contact ST if users find something unusual.
3. Gas Handling	• Open high-pressure valves by switches on the panel in the clean room. Green light indicates valves being open and red light indicates valves being closed.  • When sudden change in gas flow occurs, low-pressure valve is closed and error indicator blinks. Push the reset button until it stops blinking.  • Open gas line valves on the wall.  • After the experiments, users will close the high-pressure valves by the switches on the panel in the clean room. • If above procedure does not work, contact ST. • ST will perform maintenance of gas lines.

4. PECVD System	**1. Check the status of instruments.** 1. If both hardware and computer is off, turn on the computer and start the program.  2. Then, push the main hardware switch on the front panel.  3. Type **username** "Operator" and **password** "Start" (both are case sensitive) to go to menu. [Note: screen is touch penal.] 4. Main menu. (Main process, Edit Recipe, Manual Process, Maintenance)  5. Select **Manual Process** from the menu panel. 

6. Check following status.
   - Atomospheric Pressure Sensor → Vacuum (Brown indicator)
   - Pirani gage → less than 500mTorr
   - Turbo Speed → On (Green indicator)
   - **Gate Valve → Closed**
   - Rough Valve → Closed
   - Foreline valve → Open/Closed
   - Temperature → check.
7. **Close** the gate valve and foreline valve, then **open** rough valve. Is the valve working? The pressure start dropping (pirani gage)?
8. **Close** the rough valve. Make sure all valves are closed.
9. **Open** the vent valve until the atm sensor light turns on green.
10. **Close** the vent valve if the atm sensor light is on.
11. **You can open the chamber to load a sample now!!**
12. Once you have loaded a sample, close the chamber.
13. Open the rough valve.
    -> Check if the pressure is going down!
14. Set the desired temperature.
15. **Close** the rough valve if it reaches the temperature.
16. **Exit** the Program.

17. Trouble shooting

1. "Water not flowing" warning→ Is cooling water running? Does cooling water have enough flow rate? → If water is running, but still have the message, close the program and restart the program. → If still see the error message, contact ST.
- Atomospheric pressure "green" → this mean chamber is at the atomospheric pressure. Make sure gate valve and foreline valve are closed and open rough valve. Is the valve working? The pressure start dropping (pirani gage)?

2. Gate valve and foreline valve are closed and tried to open rough valve but it is not working → House nitrogen gas line may not have enough pressure (80psi). Ask supervisor to check main liquid nitrogen tank in the machine room.
3. Turbo speed indicator shows brown.→ Make sure turbo pump switch is turned on (green). Wait for a while. If still brown, check hardware panel. If problem still continue, consult with supervisor.

2. Edit Recipe.

1. Select **edit recipe** from the menu panel.
2. Edit recipe. See "PECVD edit recipe manual" for the details.
3. Save the recipe.
4. Exit to main menu.

3. Main Process.

1. Select **Main Process** from the menu panel.
2. Select **Select Recipe**.
3. Select desired recipe and select "return".
4. Select Autovent mode "on" or "off".
5. Select **Run**.
6. Following events will automatically proceed.

	Rough pump valve	foreline valve	gate valve	
Rough pumping	Open	Closed	Closed	
Check pressure				
Turbo pump	Closed	Open	Open	
Check pressure				
Rough pumping	Open	Closed	Closed	
Introduce Gasses	Open	Closed	Closed	• Throttle valve controlled • Gas line valve open
Plasma	Open	Closed	Cloased	• Plasma power on
Pump down	Closed	Open	Open	
Pump default	Open	Closed	Closed	
Vent*	Closed	Closed	Closed	• Vent valve open) *This step is optional.

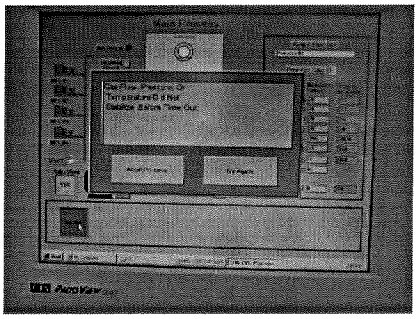
7. Exit the main process.

4. Unloading the sample

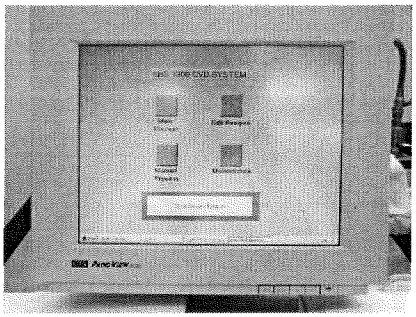
1. Enter to the **Manual Process**.
2. **Close** the foreline valve.
3. **Open** the vent valve for 1~2 sec.
4. **Open** the rough valve. And wait until the pressure reaches to ~20 mTorr.
5. **Close** the rough valve.
6. **Repeat the process #2 ~ #5 twice.**
7. **Open** the vent valve. Then wait until the atm sensor light will be on.
8. **Close** the vent valve.
9. **You can open the chamber to unload your sample !!**

Main Process Trouble Shooting

- Error messages may be displayed when the deposition parameters does not reach to the setting values within a certain period of time.
- For example, if stage temperature was at room temperature and set 200C for deposition condition. When you run Main Process, you will see the error message, saying "temperature did not stabilize before time out." In this case, you can click "try again" until the temperature reaches to the setting value.



- The acceptable error ranges and waiting time can be set in "Maintenance" in the main menu.



5.Shutting down the machine.

1. **Close all the gas valves on the front wall.**
2. Select **Manual Process** from the menu panel.
3. Make sure the foreline valve and gate valve are close.
4. Open the rough valve. Make sure the pressure is going down to <20mTorr
5. Close the rough valve if the pressure is <20m Torr.
6. Open foreline valve, then open the gate valve.
7. Set the setpoints of every MFC flow to **50** for each gas line.
8. Open the MFC controllers one by one from the touch panel.
9. The MFC readings for each gas should decrease to 0.
10. Close the MFCs.
11. Close the gate valve.
12. Exit program. Go to Main Menu.

♦ Recipe Examples

- MFC conversion factors

Actual Flow Rate of Gas =
Flow Rate of Nitrogen × Correction Factor

Silane (SiH_4)	0.605
Nitrous Oxide (N_2O)	0.715
Hydrogen (H_2)	1.00
Ammonia (NH_3)	0.74

- **SiO_2 deposition**

(**Note: This recipe is not optimized condition**, just a starting point. See JingNi's recipe & RonNowicki's notes for more recipes)

$$SiH_4 + 2N_2O \rightarrow SiO_2 + H_2O + 2N_2$$

SiH_4 (MFC2)	16 sccm
N_2O (MFC4)	42 sccm
Pressure	200 mTorr
Plasma Power	50W
Temperature	200 °C

*Use SiH_4/N_2O ratio of 1:3 (not 1:2) $16 \times 0.605 = \sim 10$, $42 \times 0.715 = 30$.

With this recipe, we obtained following characteristics.

Time [min]	Thickness* [Å]	Color**	Refractive index*
1	500		1.513
2	710		1.510
2.5	738		1.511
3	872		1.507
3.5	953	blue	1.490

*Deposition rate ~ 178 Å /min
*Thickness and refractive index were measured by ellipsometer located in carver lab.
** In general, color changes from golden (500-650 Å) to blue (1000-1300 Å), and red (4000-5000 Å).

- **Si_3N_4 deposition**

(Note: This recipe is not optimized condition, just a starting point. See JingNi's recipe & RonNowicki's notes for more recipes)

$$3SiH_4+4NH_3 \rightarrow Si_3N_4 + 12H_2$$

SiH_4 (MFC2)	16 sccm
NH_3 (MFC3)	40 sccm
Pressure	200 mTorr
Plasma Power	50W
Temperature	300 °C

*Use SiH_4/NH_3 ratio of 1:3 (not 3:4) $16\times0.605 = \sim10$, $40\times0.74 = \sim30$.

Secondhand Semi James L Corbin, 408-956-1262		
Subcontractors & Parts Supplier	General System Consultant	Jvk Services Jan Van Kort 541-297-2107, jvankort@earthlink.net
	Software Programmer	PC Lindsey,
	Pressure Control System	MKS, Inc John Hallahan, 408-988-4020 x238, John_Hallahan@mksinst.com
	RF generator	RFVII (RF seven) Steven R. Barber, 856-875-2121, rfvii@erols.com

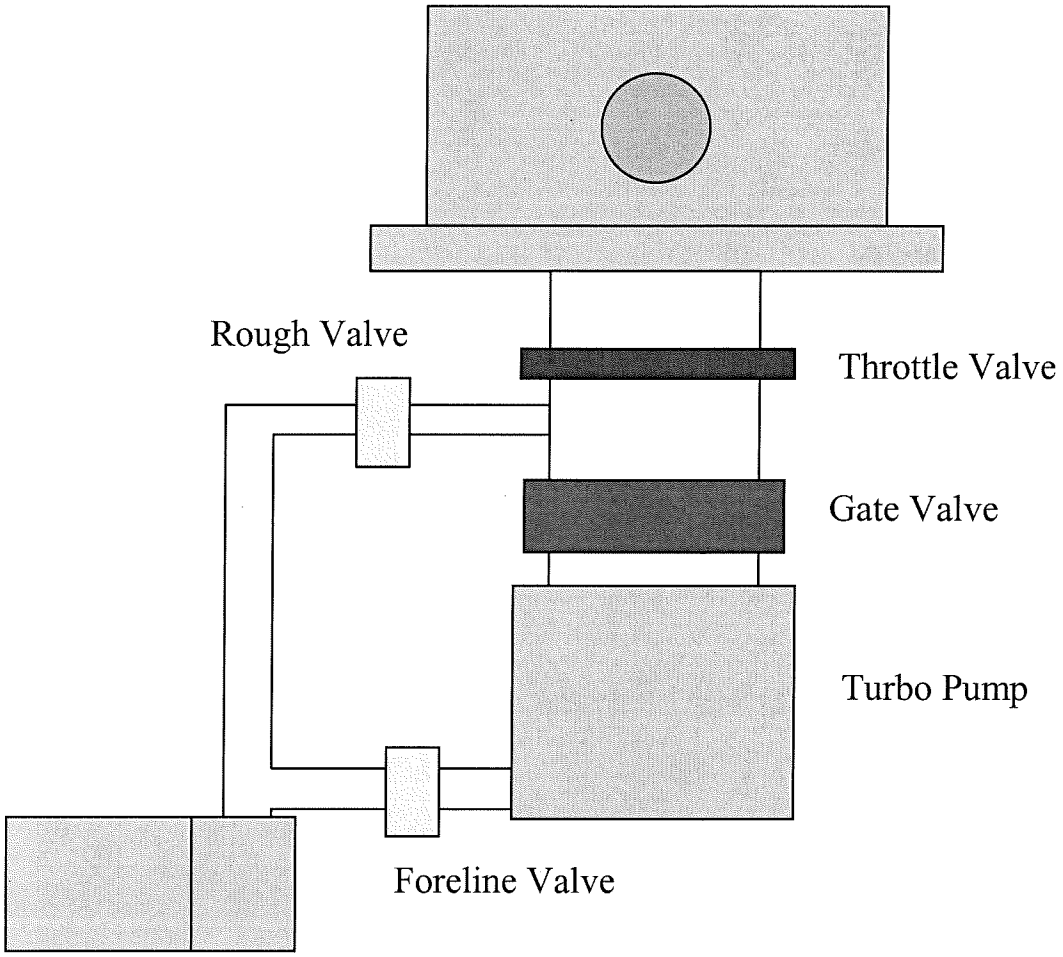
Former Keck Lab Membes (they know "processes"!)

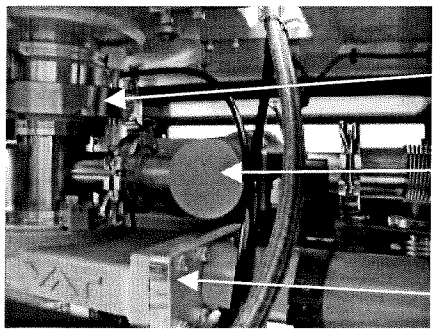
- Tony Witt witt@extremedevices.com
- Michael C. Granger mgranger@esainc.com
- Jing Ni jing.ni@am.amershambiosciences.com

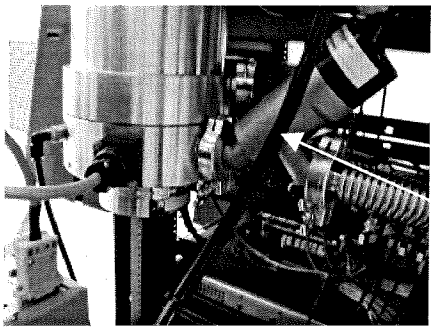
Other resources

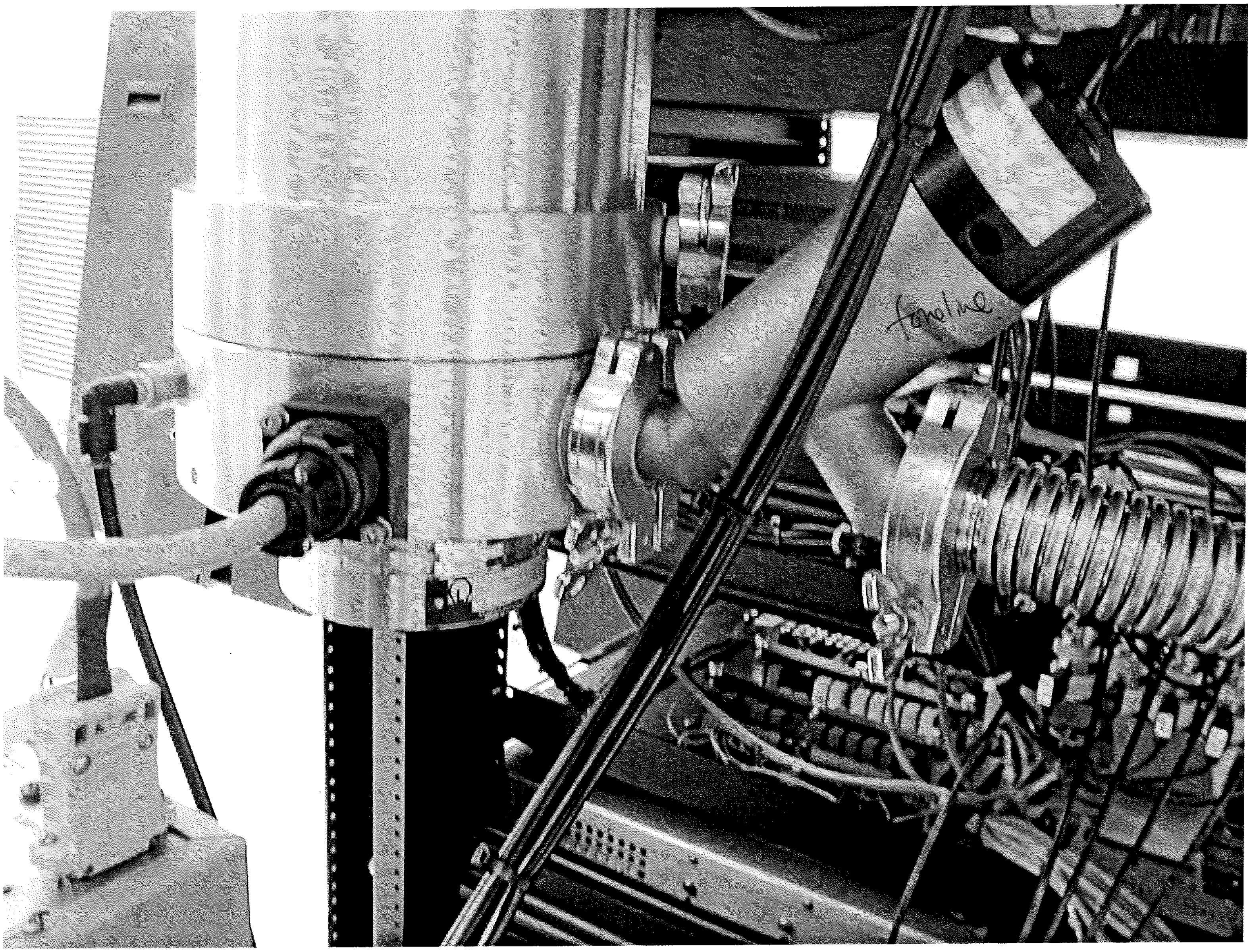
- Xxxxxx xxxxx (Dan Gazda)

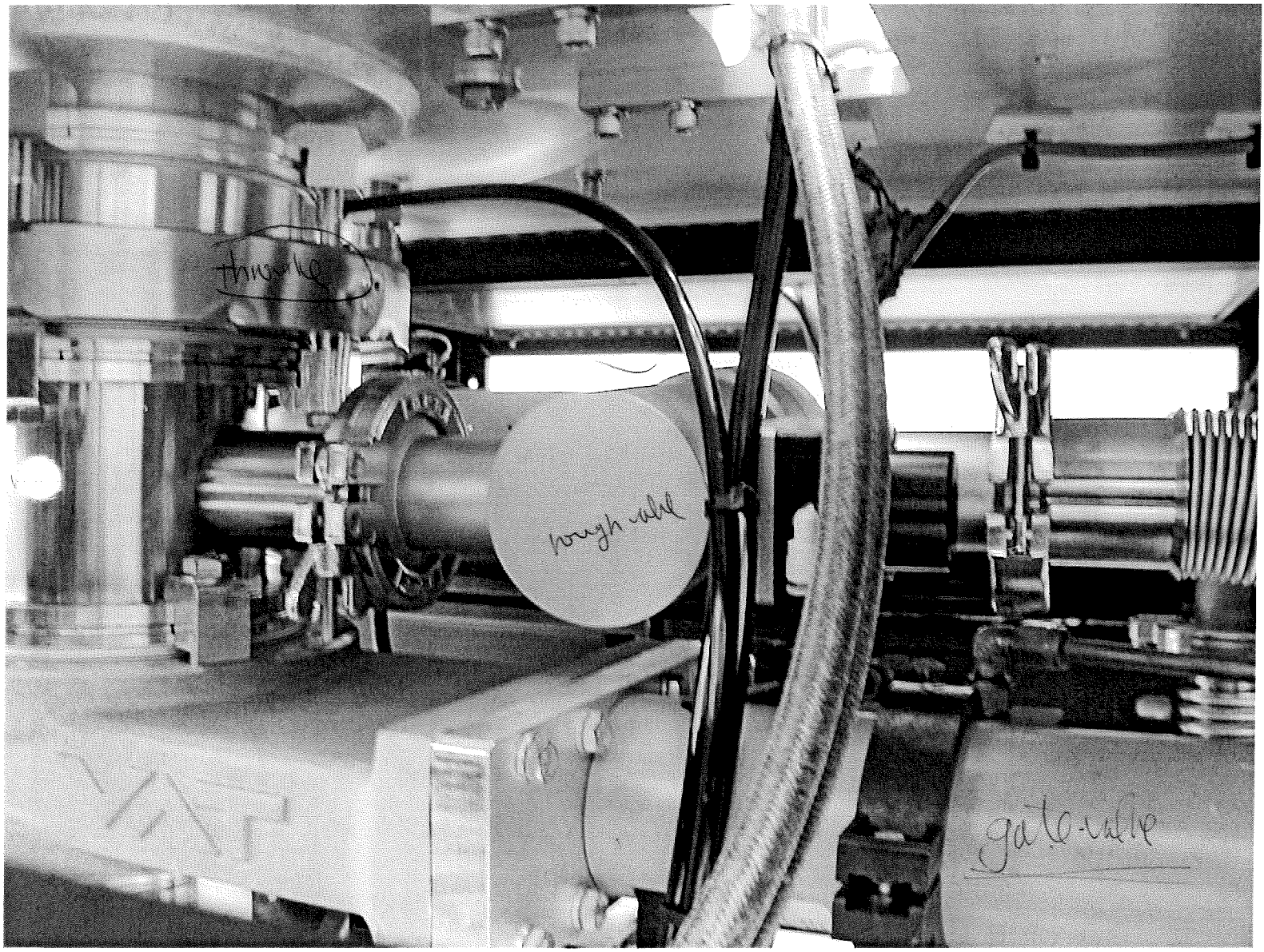
Schematics

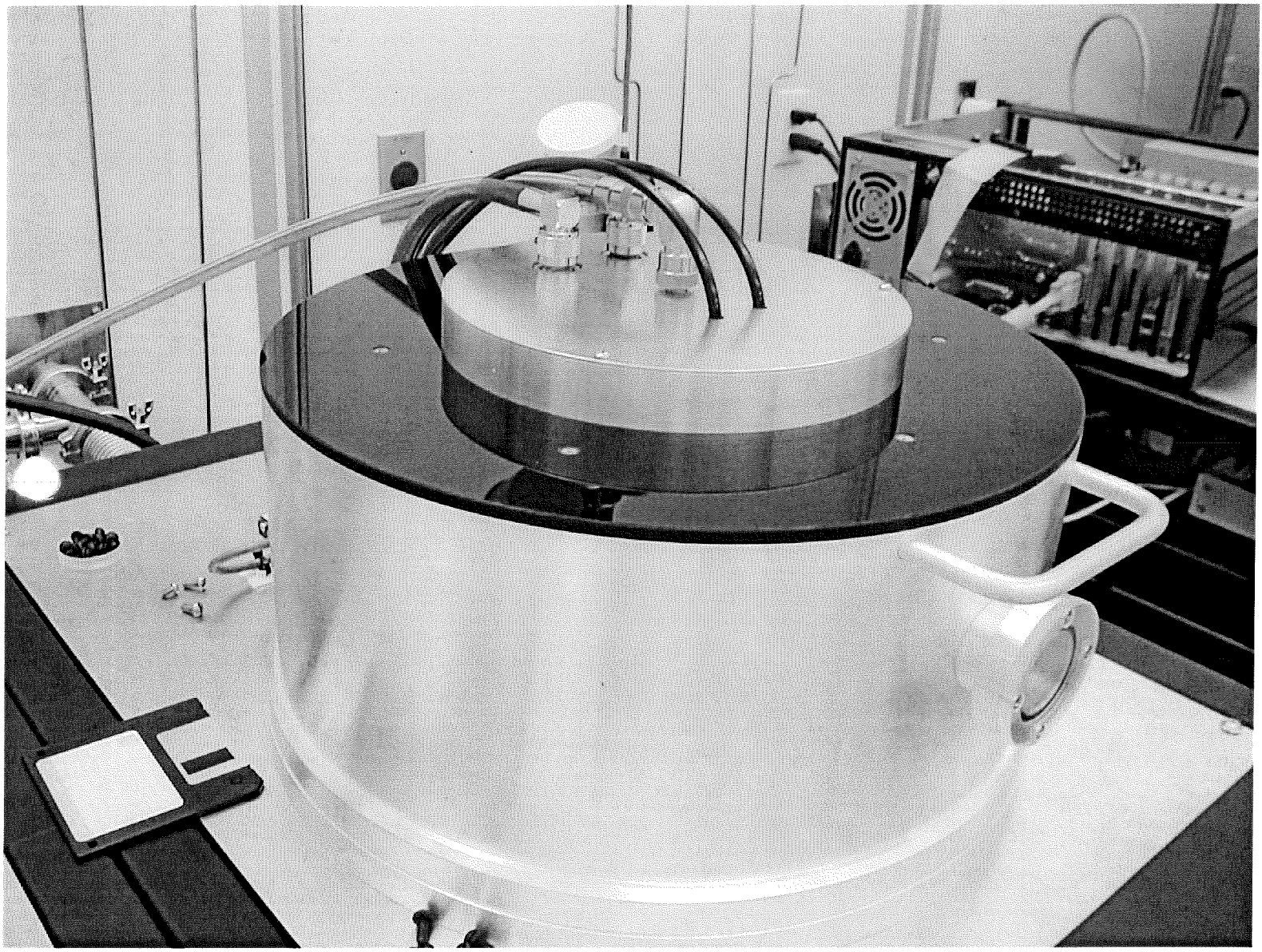

Rough Valve
Throttle Valve
Gate Valve
Turbo Pump
Foreline Valve

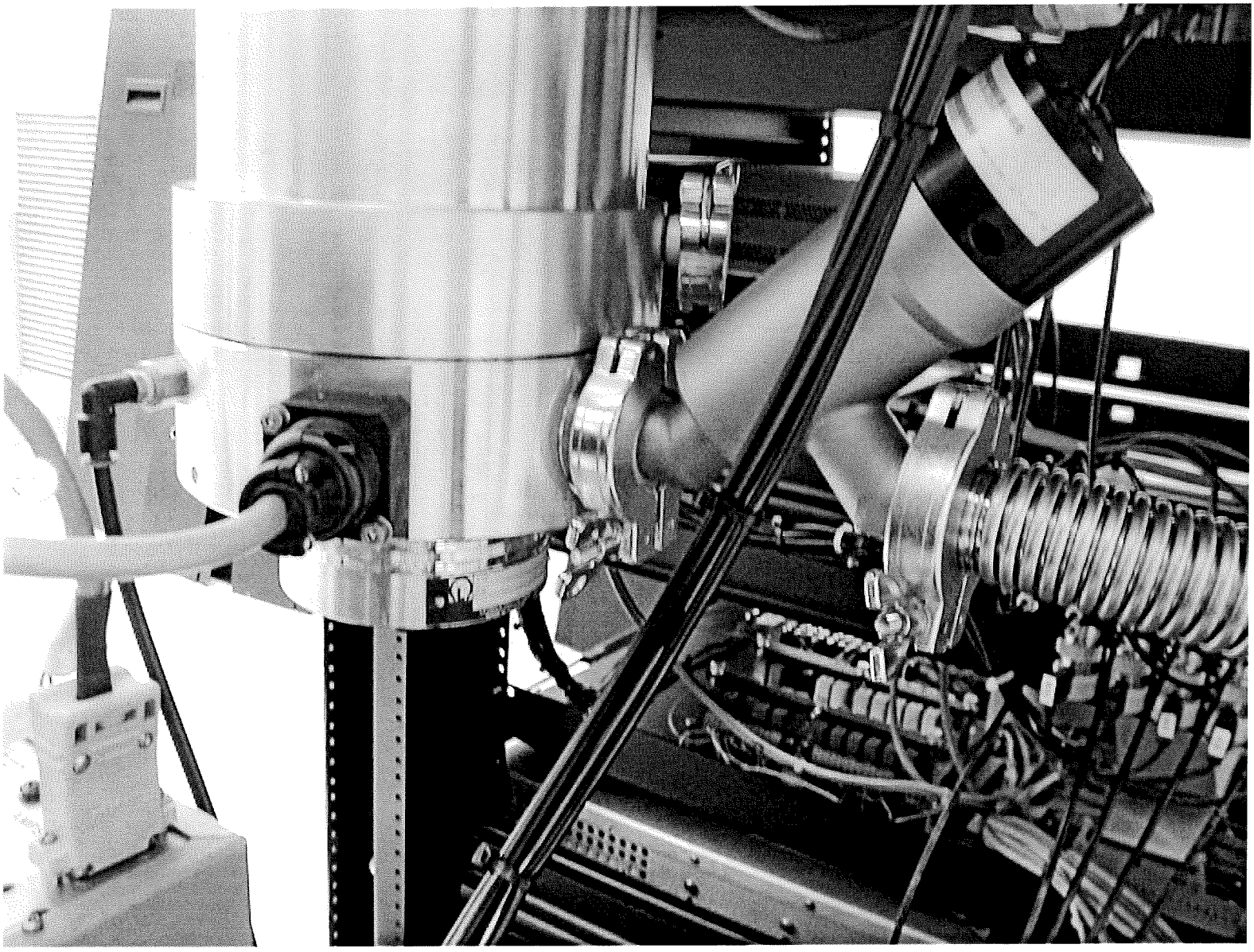

Throttle Valve
Rough Valve
Gate Valve

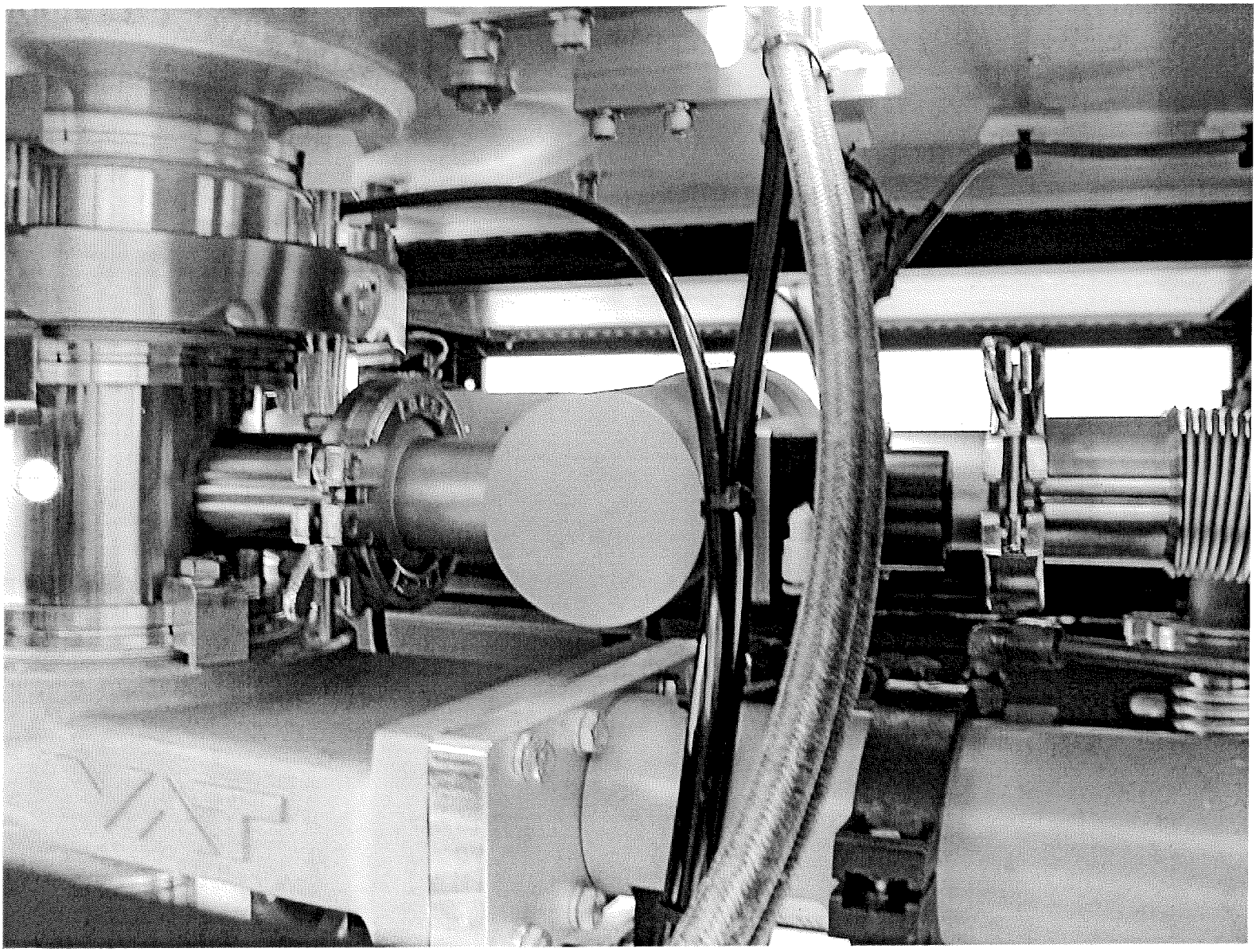

Foreline Valve

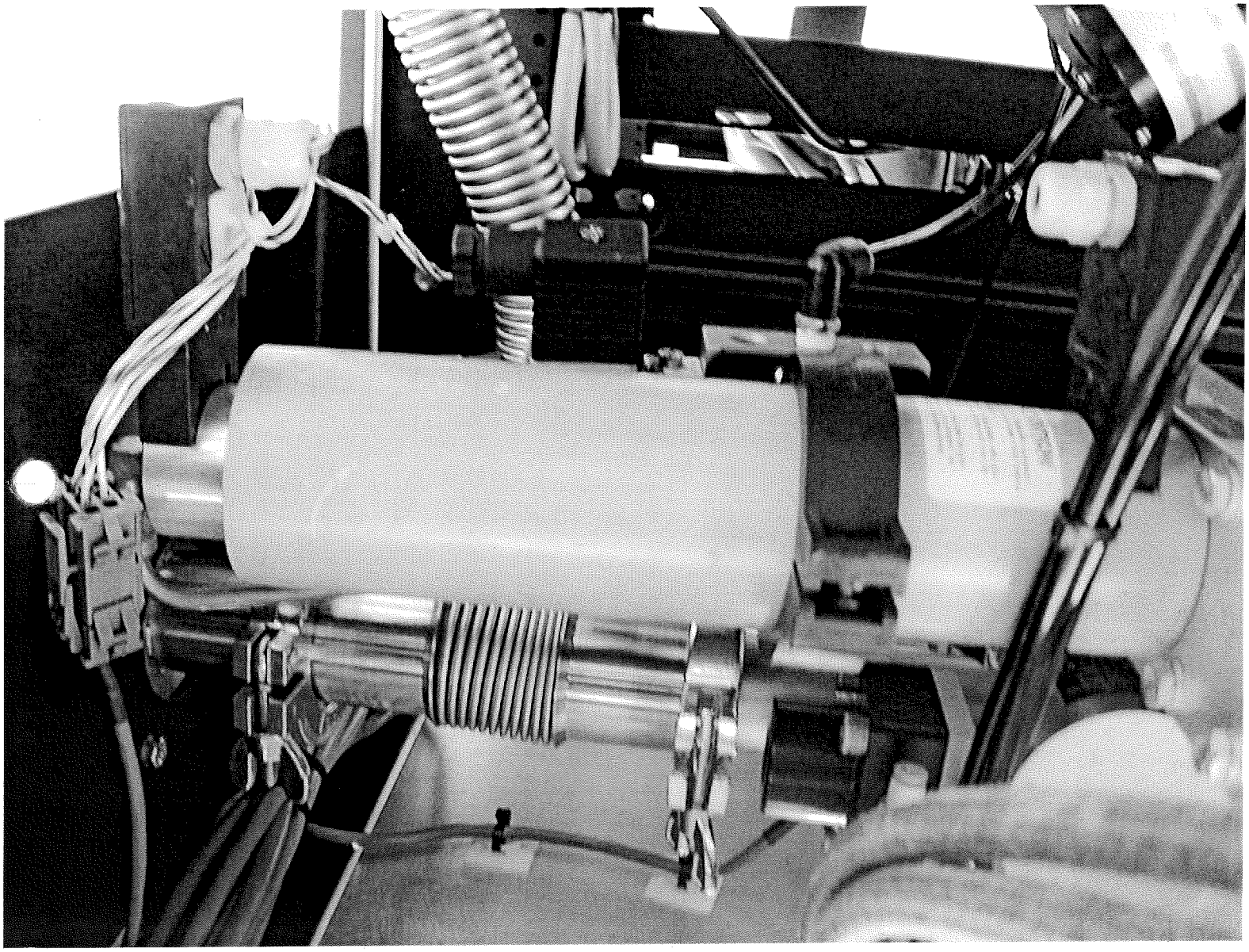

foreline.

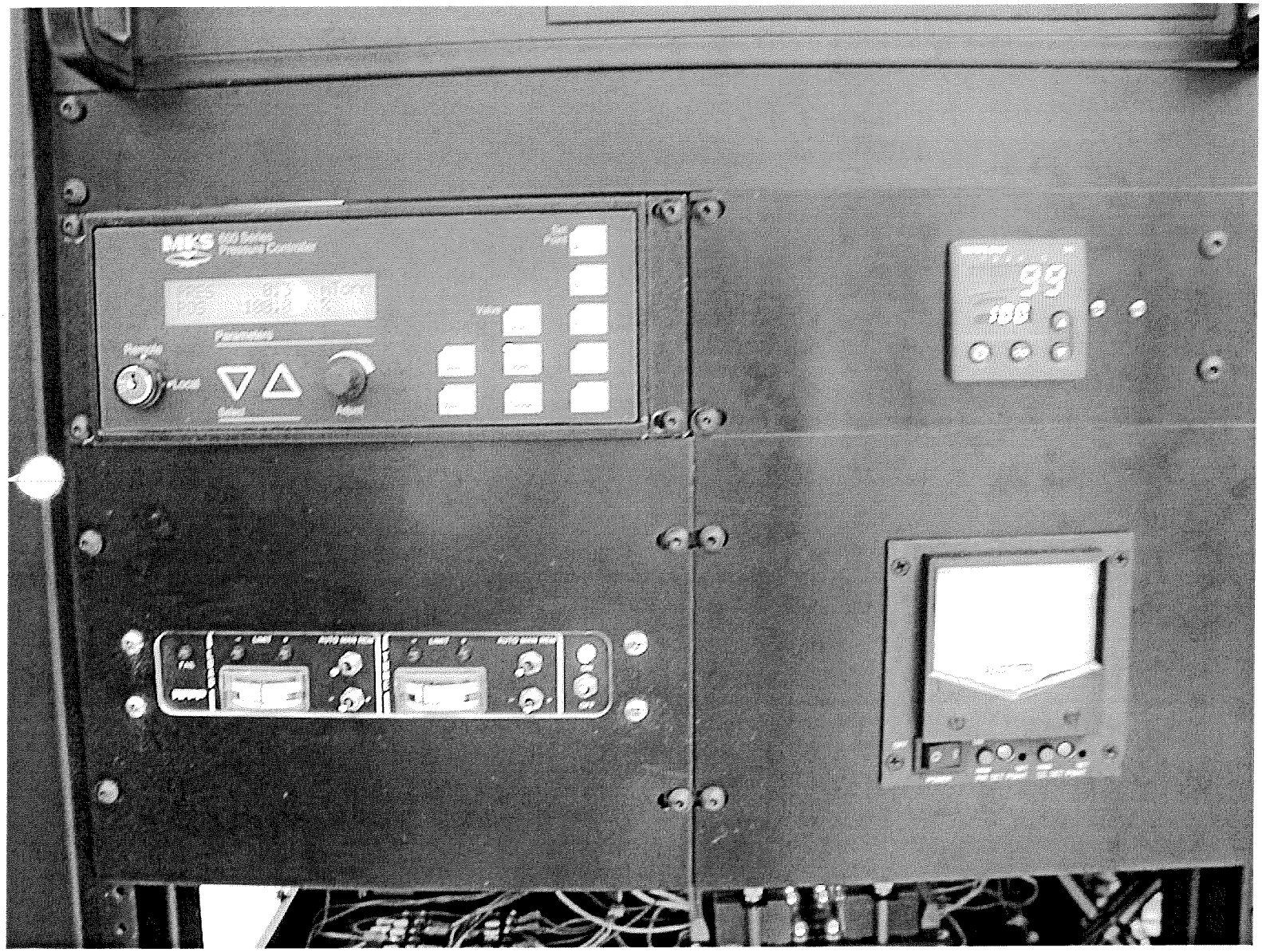

throttle
rough valve
gate valve

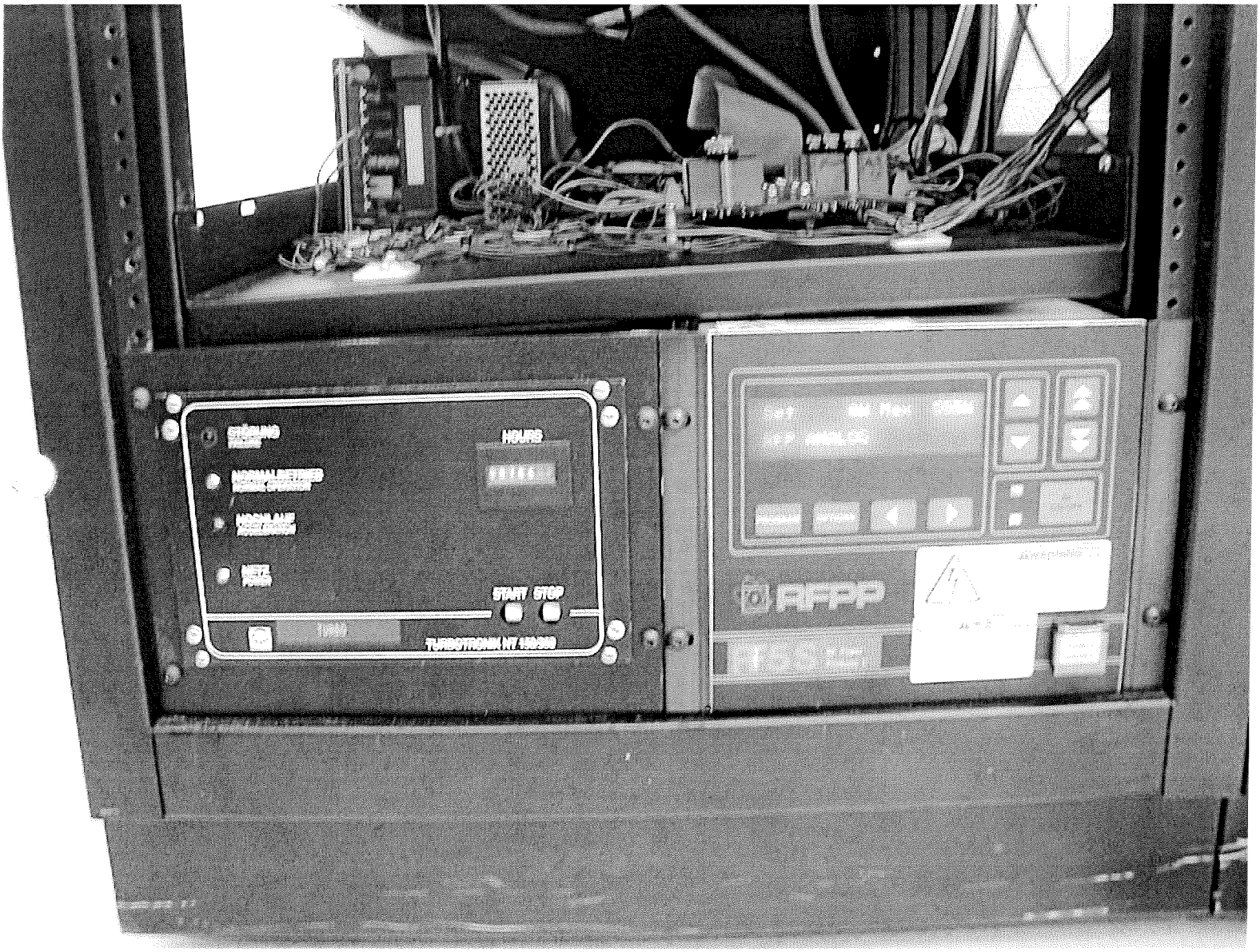


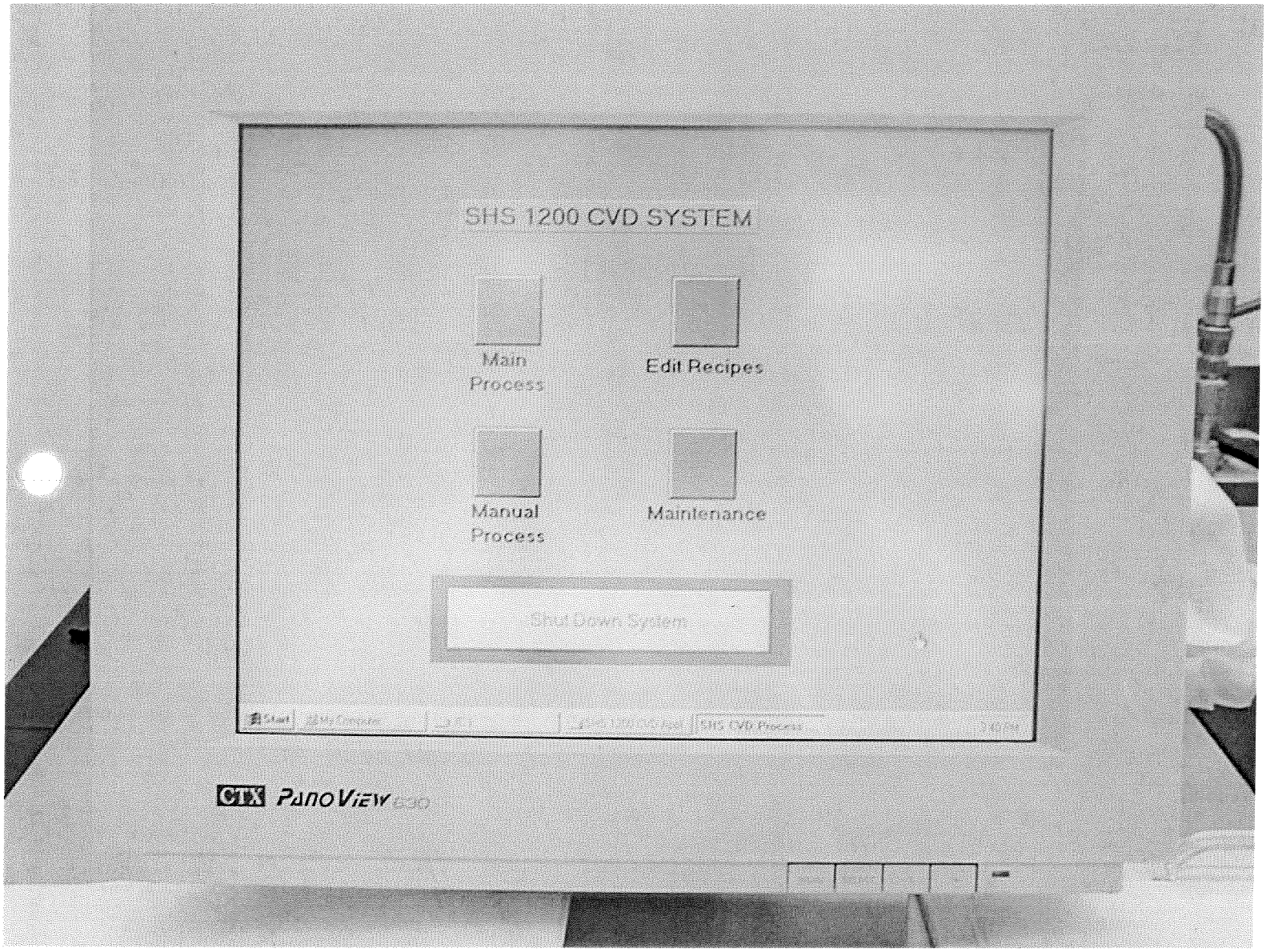


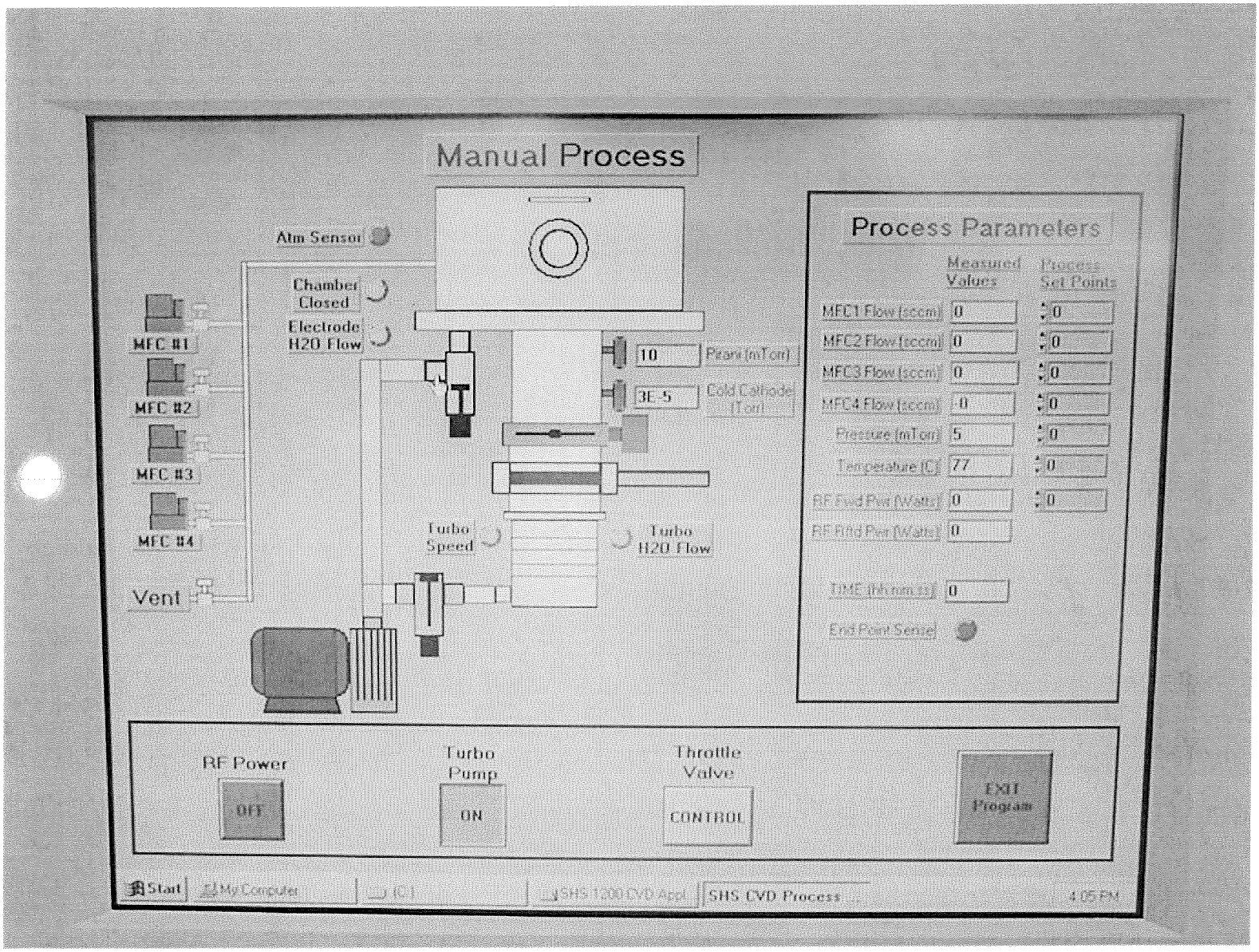


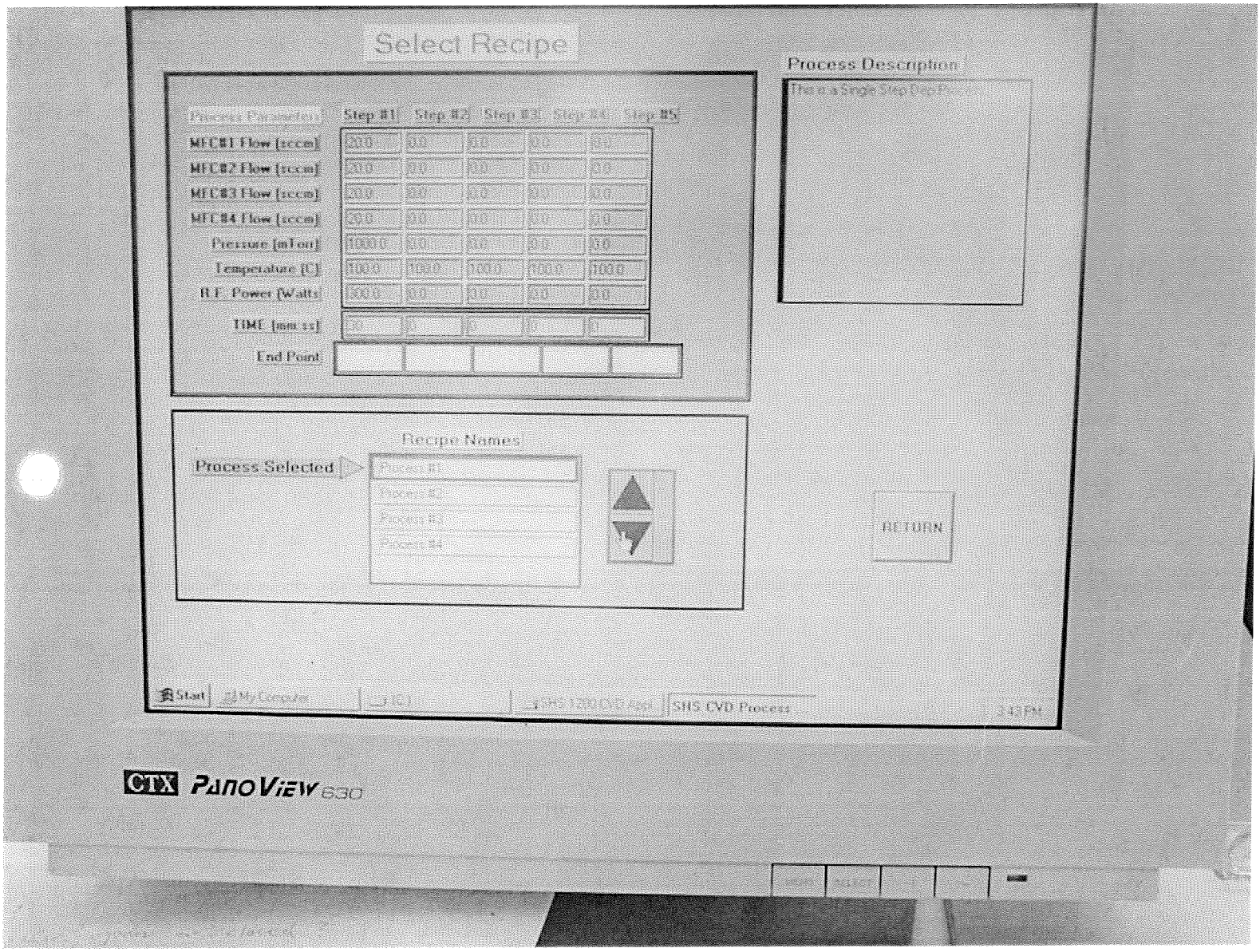


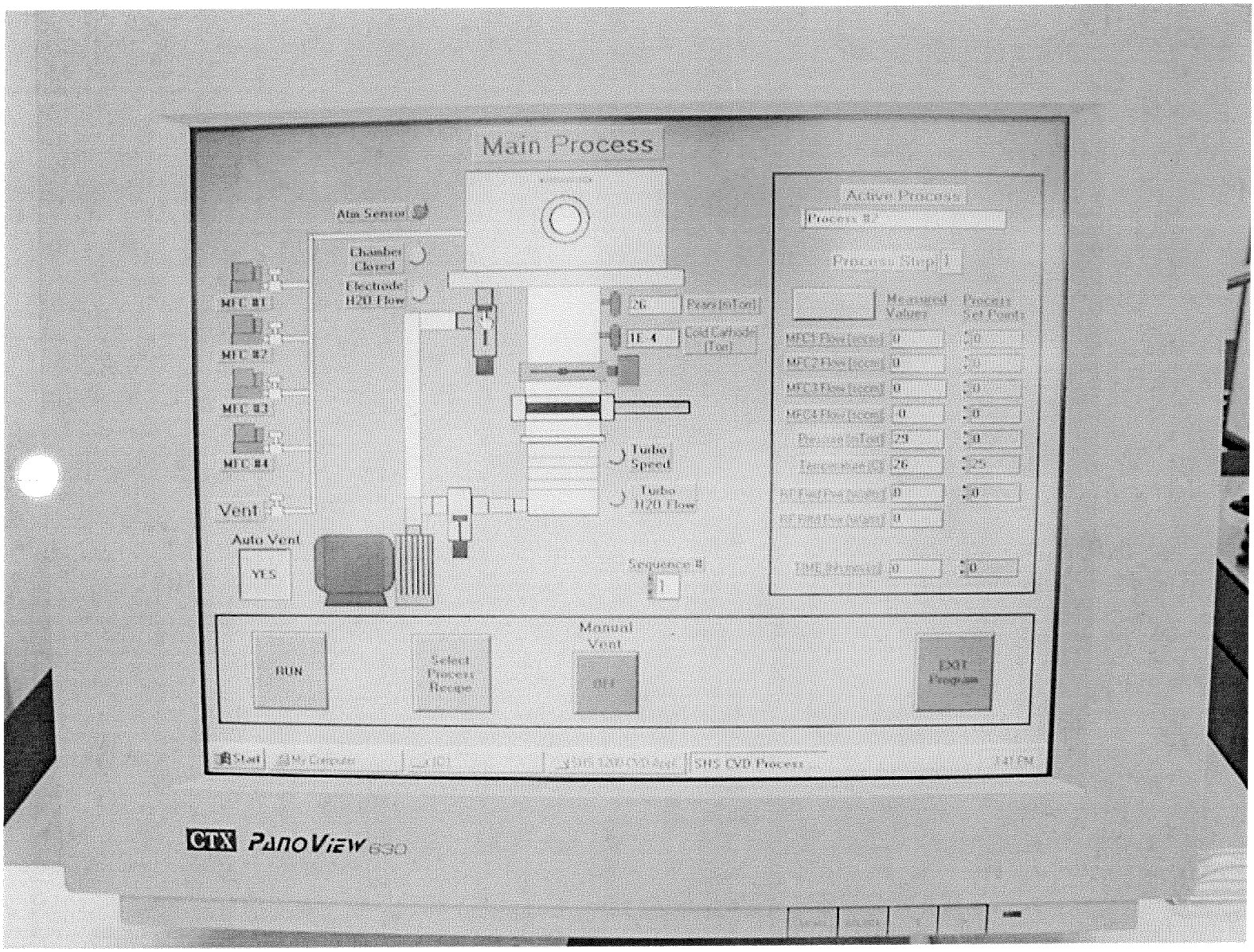

MKS
Parameters
Toggle
Select
Adjust
Set Point
Value


HOURS
START STOP
TURBOTRONIK NT 150/250
AFPP


SHS 1200 CVD SYSTEM
Main Process
Edit Recipes
Manual Process
Maintenance
Shut Down System
CTX PANOVIEW 630


Manual Process
Atm Sensor
Chamber Closed
Electrode H2O Flow
MFC #1
MFC #2
MFC #3
MFC #4
Vent
10
Pirani (mTorr)
3E-5
Cold Cathode (Torr)
Turbo Speed
Turbo H2O Flow
Process Parameters
Measured Values
Process Set Points
MFC1 Flow (sccm)
MFC2 Flow (sccm)
MFC3 Flow (sccm)
MFC4 Flow (sccm)
Pressure (mTorr)
Temperature (C)
RF Fwd Pwr (Watts)
RF Rfld Pwr (Watts)
TIME (hh:mm:ss)
End Point Sense
RF Power
OFF
Turbo Pump
ON
Throttle Valve
CONTROL
EXIT Program
Start
My Computer
SHS 1200 CVD Appl
SHS CVD Process
4:05 PM


Select Recipe
Process Description
Process Parameters
Step #1
Step #2
Step #3
Step #4
Step #5
MFC#1 Flow [sccm]
MFC#2 Flow [sccm]
MFC#3 Flow [sccm]
MFC#4 Flow [sccm]
Pressure [mTorr]
Temperature [C]
R.F. Power [Watts]
TIME [mm:ss]
End Point
Recipe Names
Process Selected
RETURN
Start
SHS CVD Process
3:43 PM
CTX PANOVIEW 630



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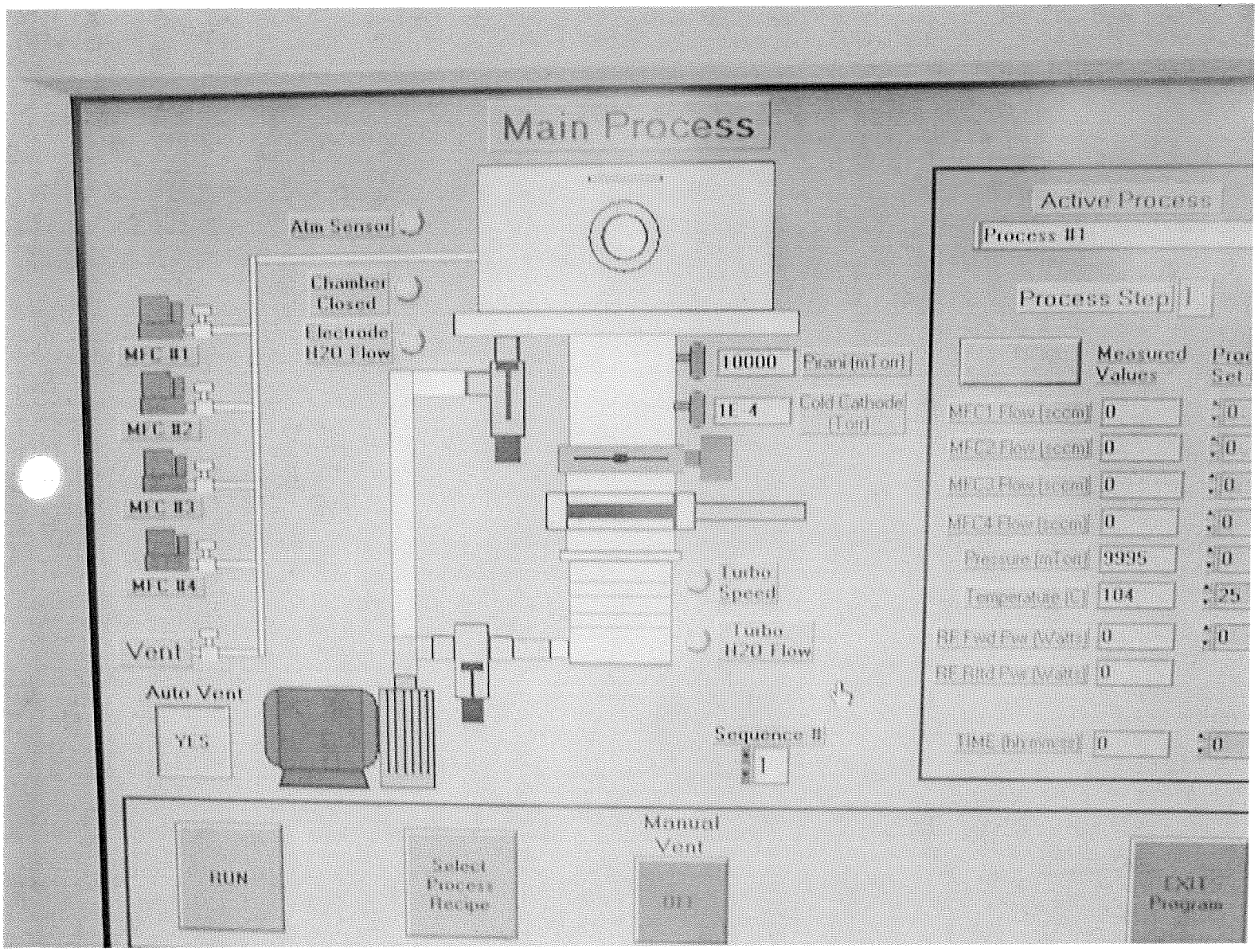
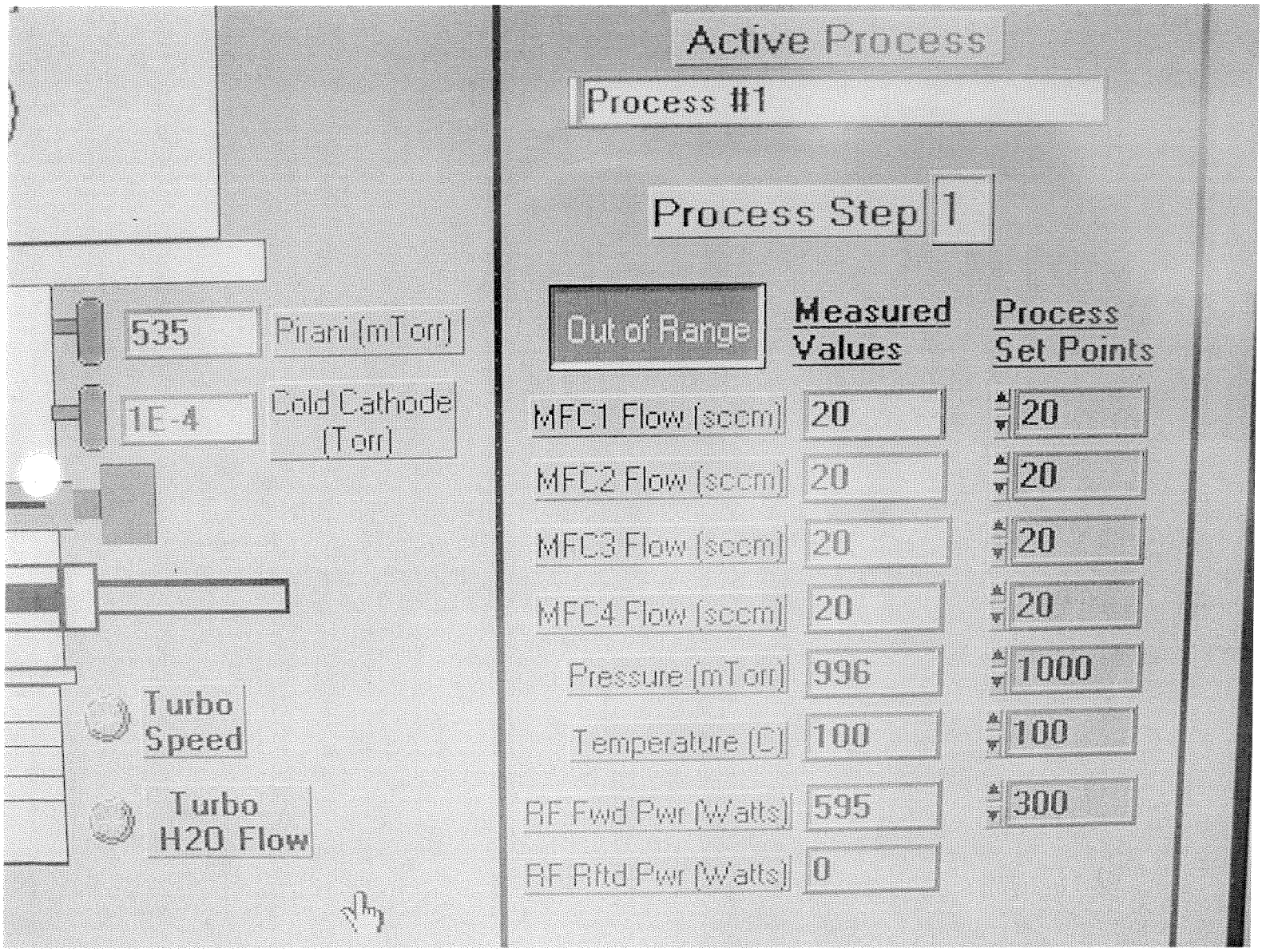
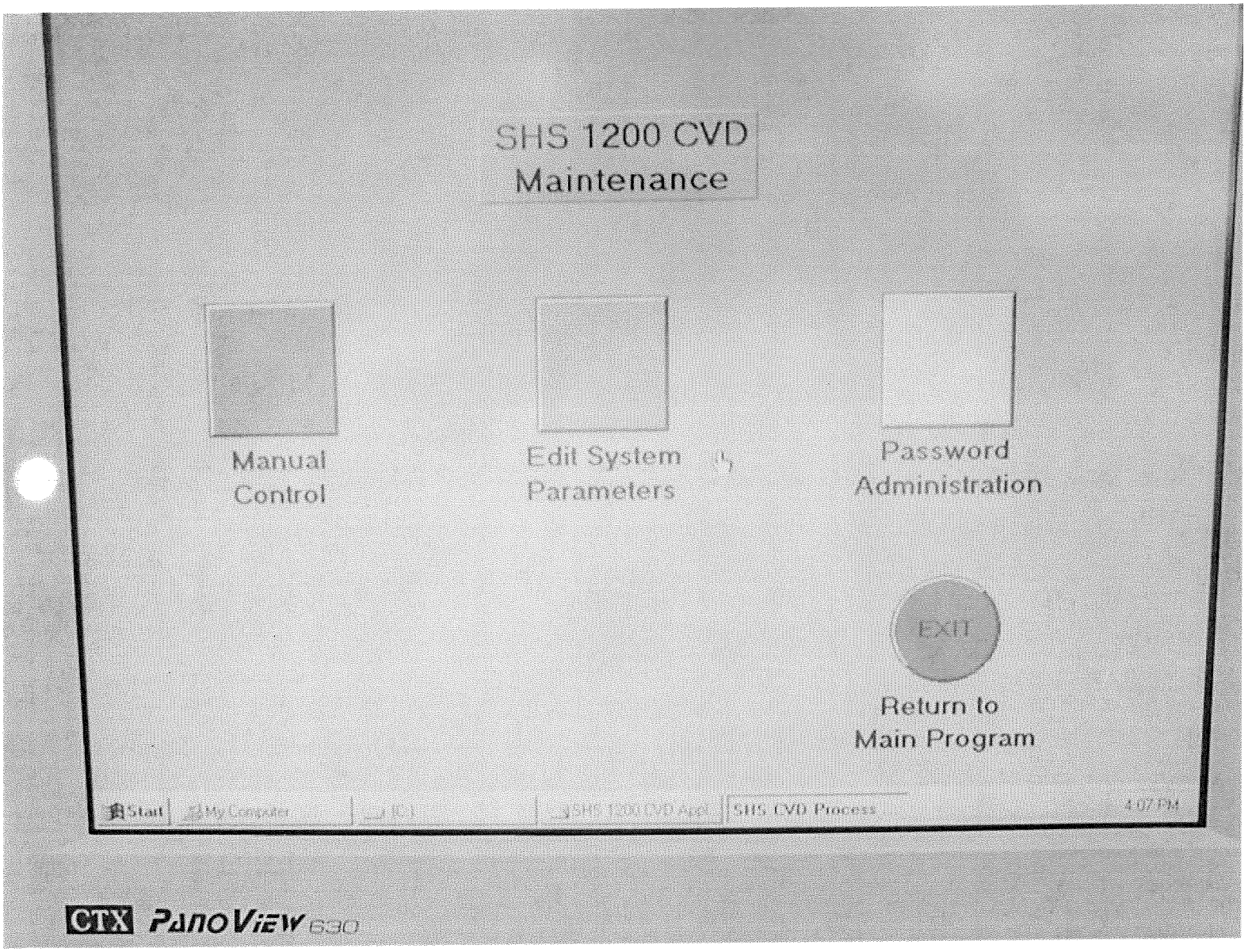
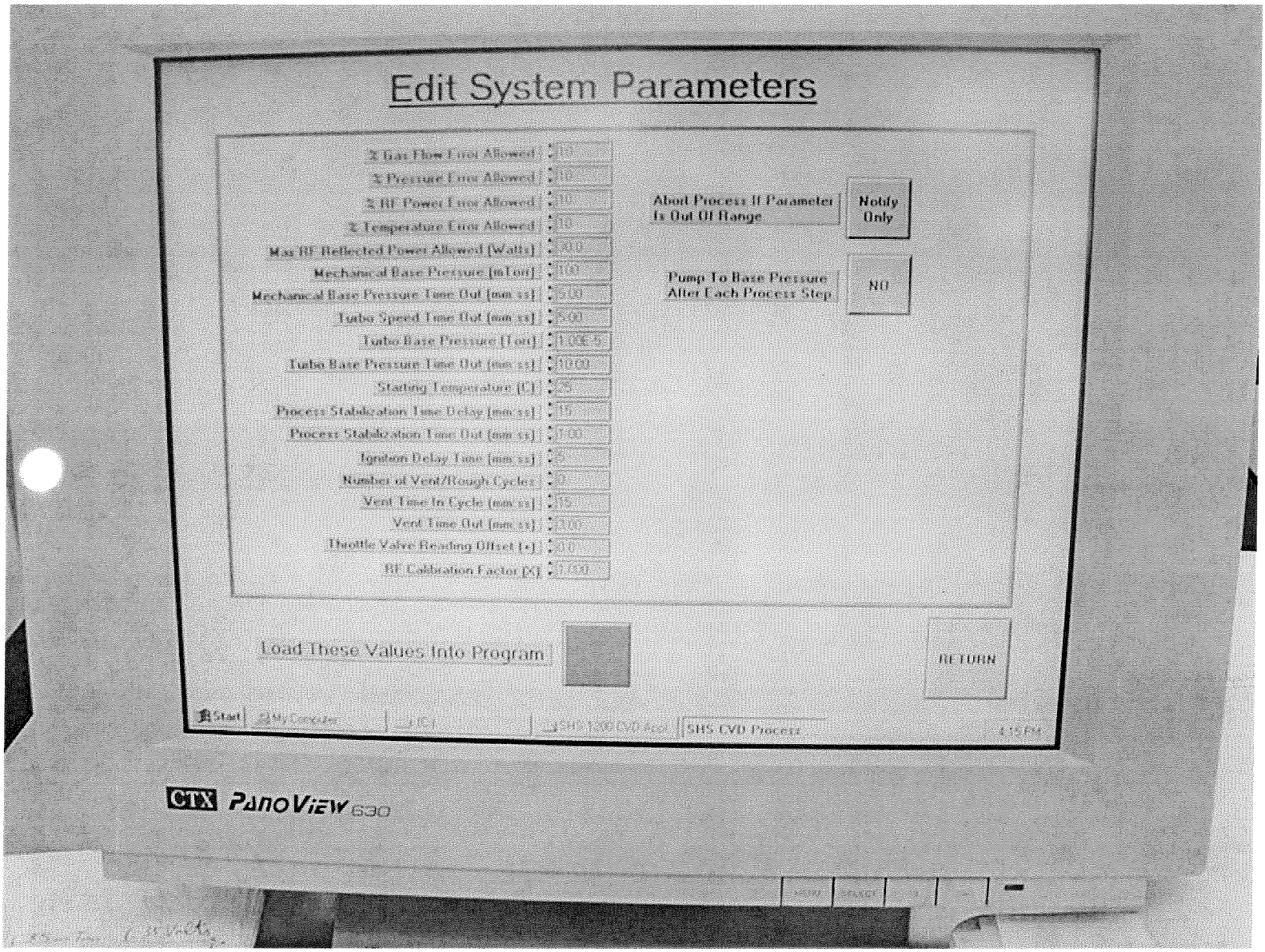
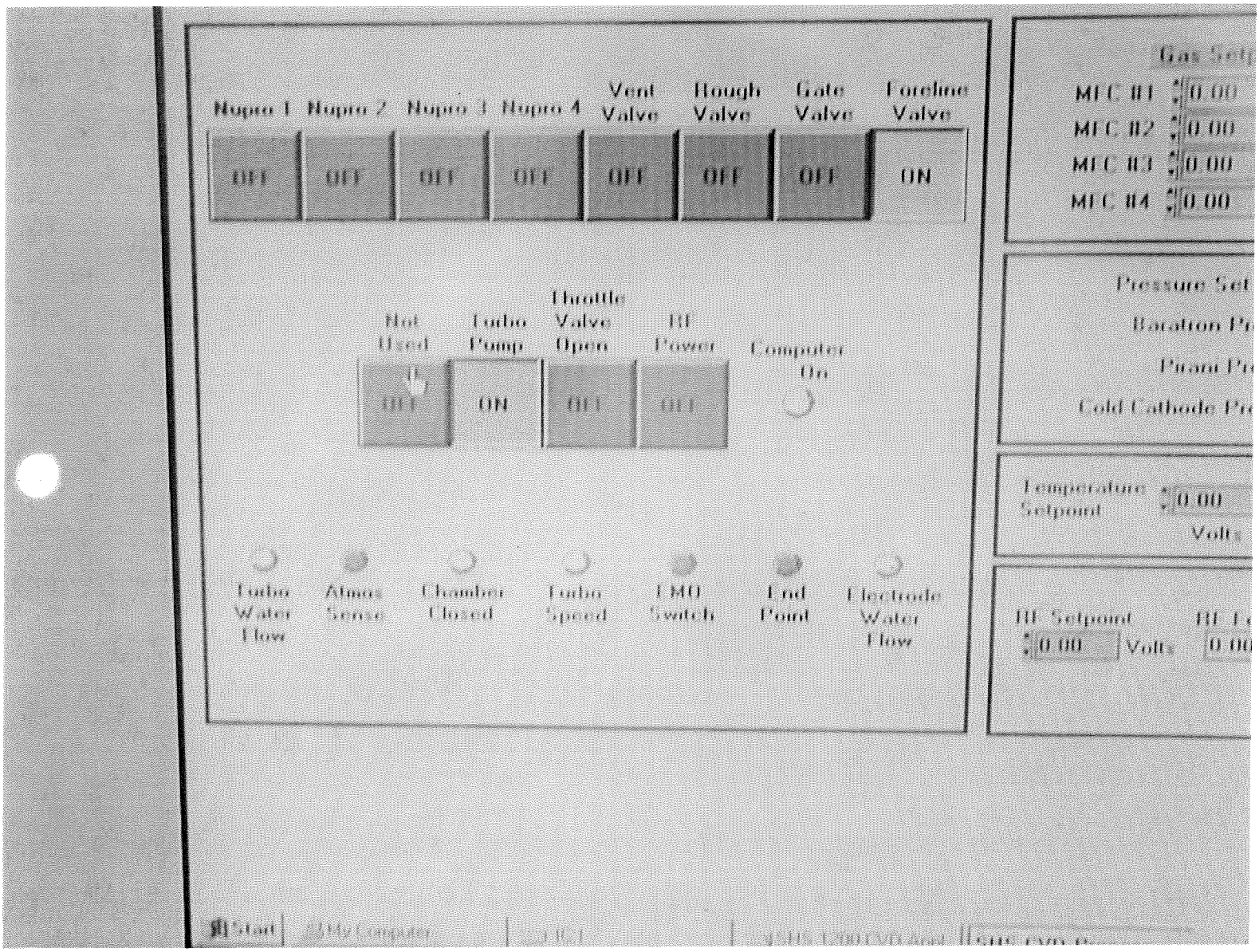

Main Process
Atm Sensor
Chamber Closed
Electrode H20 Flow
MFC #1
MFC #2
MFC #3
MFC #4
Vent
Auto Vent
YES
10000
Pirani [mTorr]
1E-4
Cold Cathode [Torr]
Turbo Speed
Turbo H20 Flow
Sequence #
1
Active Process
Process #1
Process Step 1
Measured Values
MFC1 Flow [sccm]
MFC2 Flow [sccm]
MFC3 Flow [sccm]
MFC4 Flow [sccm]
Pressure [mTorr]
9995
Temperature [C]
104
RF Fwd Pwr [Watts]
RF Rfld Pwr [Watts]
TIME [hh:mm:ss]
RUN
Select Process Recipe
Manual Vent
OFF
EXIT Program

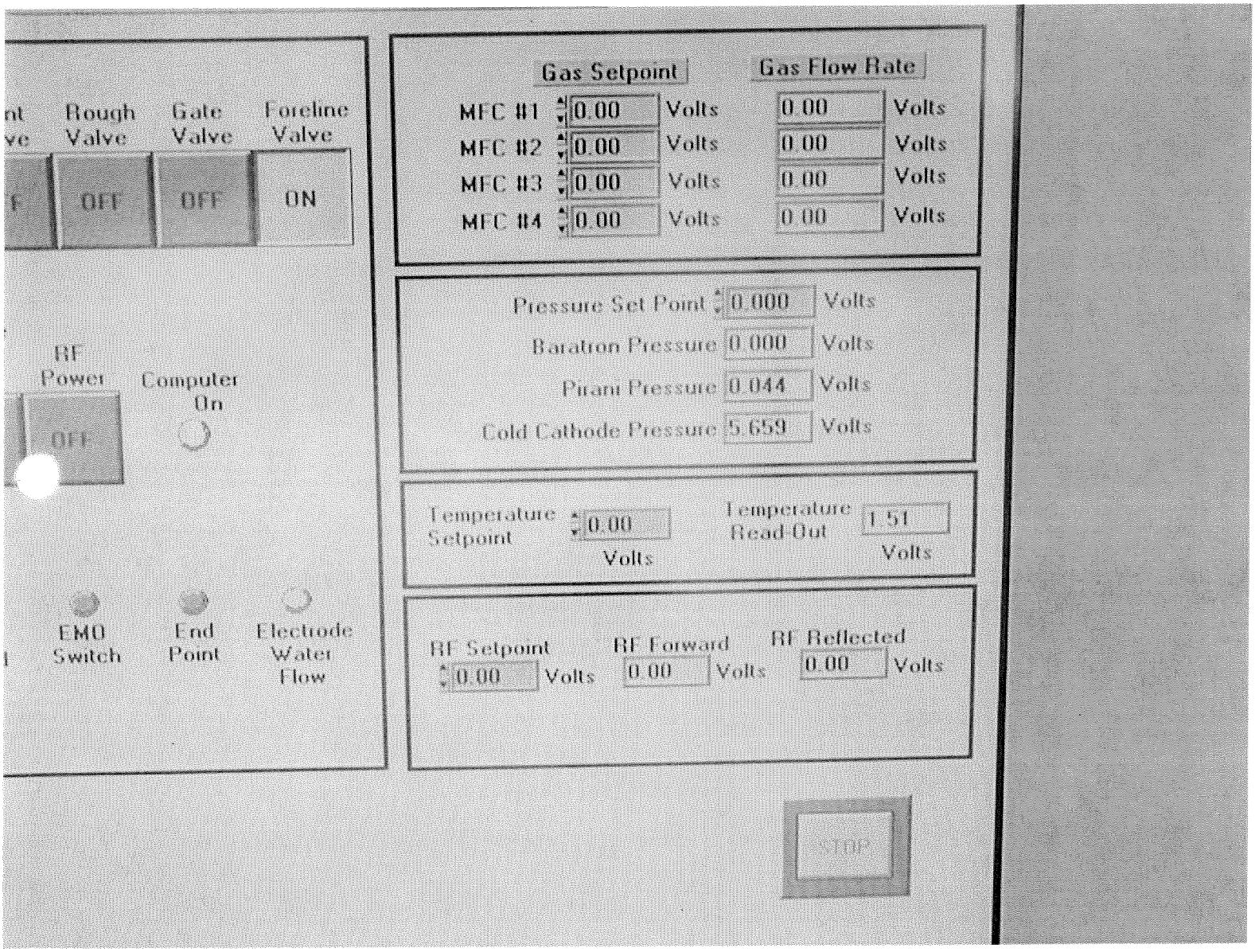

535
Pirani (mTorr)
1E-4
Cold Cathode (Torr)
Turbo Speed
Turbo H20 Flow
Active Process
Process #1
Process Step 1
Out of Range
Measured Values
Process Set Points
MFC1 Flow (sccm) 20 20
MFC2 Flow (sccm) 20 20
MFC3 Flow (sccm) 20 20
MFC4 Flow (sccm) 20 20
Pressure (mTorr) 996 1000
Temperature (C) 100 100
RF Fwd Pwr (Watts) 595 300
RF Rftd Pwr (Watts) 0



CTX PANOVIEW 630


Edit System Parameters
% Gas Flow Error Allowed
% Pressure Error Allowed
% RF Power Error Allowed
% Temperature Error Allowed
Max RF Reflected Power Allowed [Watts]
Mechanical Base Pressure [mTorr]
Mechanical Base Pressure Time Out [mm:ss]
Turbo Speed Time Out [mm:ss]
Turbo Base Pressure [Torr]
Turbo Base Pressure Time Out [mm:ss]
Starting Temperature [C]
Process Stabilization Time Delay [mm:ss]
Process Stabilization Time Out [mm:ss]
Ignition Delay Time [mm:ss]
Number of Vent/Rough Cycles
Vent Time In Cycle [mm:ss]
Vent Time Out [mm:ss]
Throttle Valve Reading Offset [+]
RF Calibration Factor [X]
About Process If Parameter Is Out Of Range
Notify Only
Pump To Base Pressure After Each Process Step
NO
Load These Values Into Program
RETURN
Start
SHS CVD Process
4:15 PM
CTX PanoView 630


Nupro 1
Nupro 2
Nupro 3
Nupro 4
Vent Valve
Rough Valve
Gate Valve
Foreline Valve
OFF
OFF
OFF
OFF
OFF
OFF
OFF
ON
Hot Used
Turbo Pump
Throttle Valve Open
RF Power
Computer On
OFF
ON
OFF
OFF
Turbo Water Flow
Atmos Sense
Chamber Closed
Turbo Speed
EMO Switch
End Point
Electrode Water Flow
Gas Setp
MFC #1
MFC #2
MFC #3
MFC #4
0.00
0.00
0.00
0.00
Pressure Set
Baratron Pr
Pirani Pr
Cold Cathode Pr
Temperature Setpoint
0.00
Volts
RF Setpoint
0.00
Volts
Start
My Computer


Rough Valve
Gate Valve
Foreline Valve
OFF
OFF
ON
RF Power
OFF
Computer On
EMO Switch
End Point
Electrode Water Flow
Gas Setpoint
Gas Flow Rate
MFC #1 0.00 Volts 0.00 Volts
MFC #2 0.00 Volts 0.00 Volts
MFC #3 0.00 Volts 0.00 Volts
MFC #4 0.00 Volts 0.00 Volts
Pressure Set Point 0.000 Volts
Baratron Pressure 0.000 Volts
Pirani Pressure 0.044 Volts
Cold Cathode Pressure 5.659 Volts
Temperature Setpoint 0.00 Volts
Temperature Read Out 1.51 Volts
RF Setpoint 0.00 Volts
RF Forward 0.00 Volts
RF Reflected 0.00 Volts
STOP