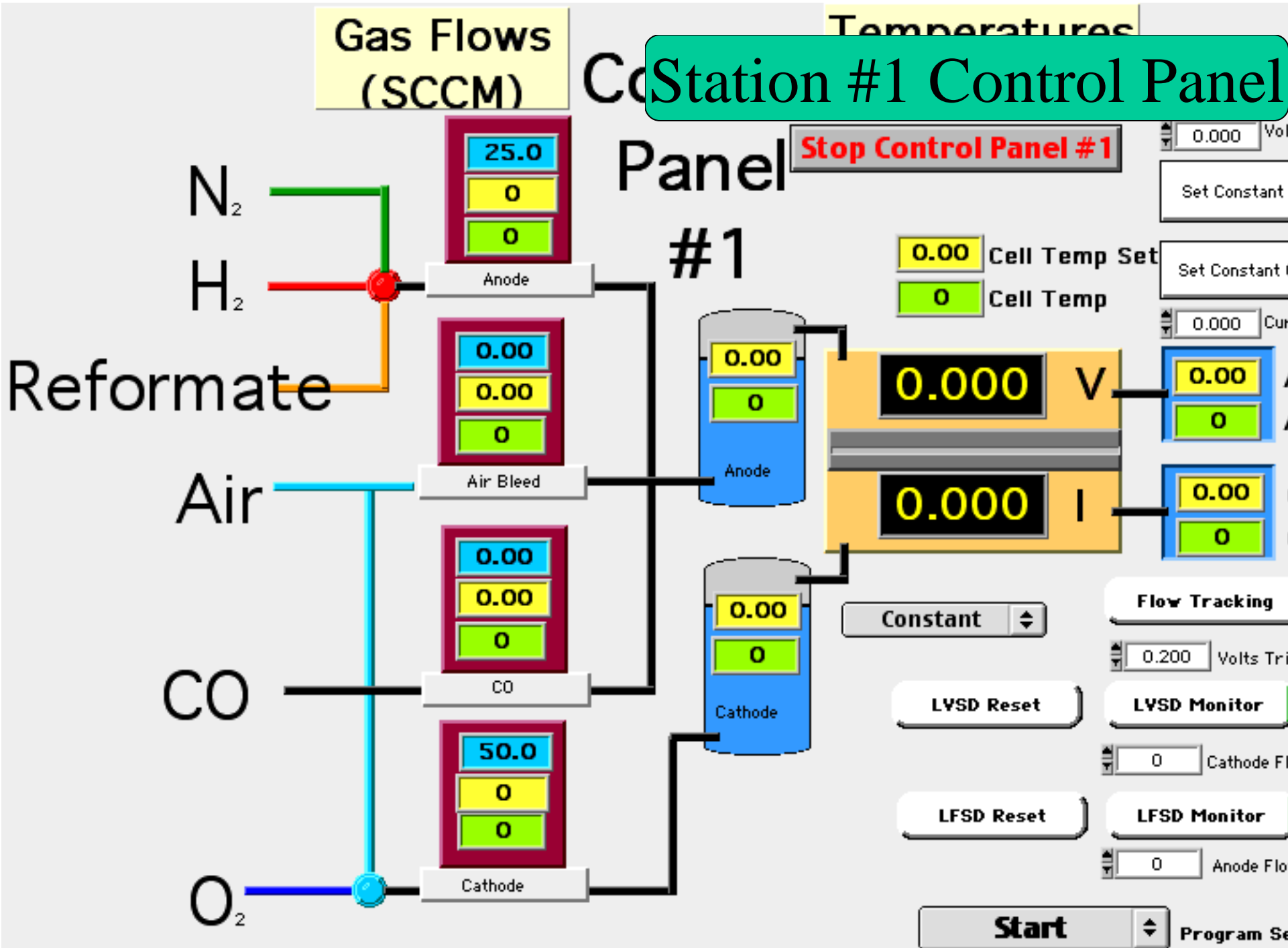


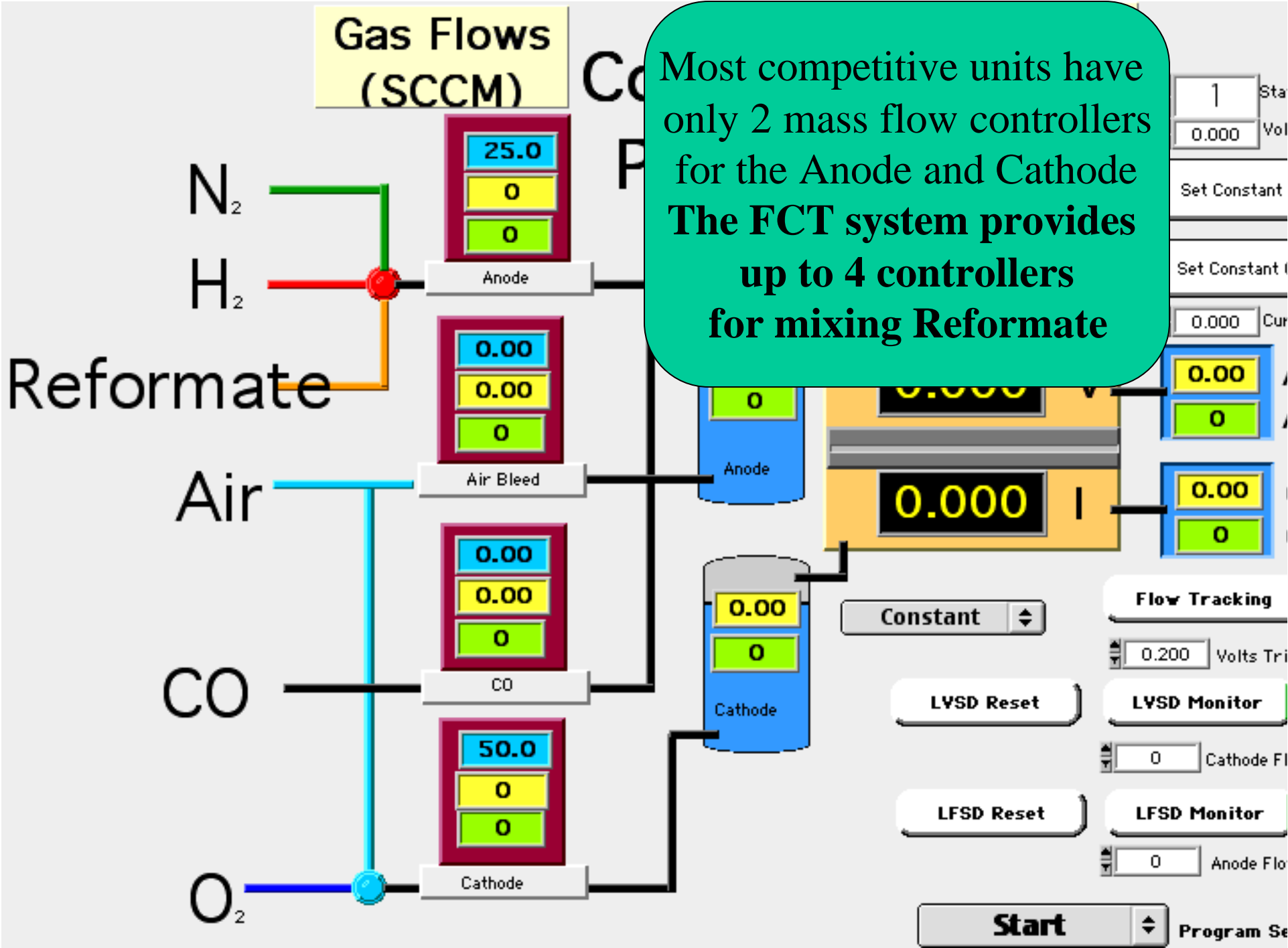


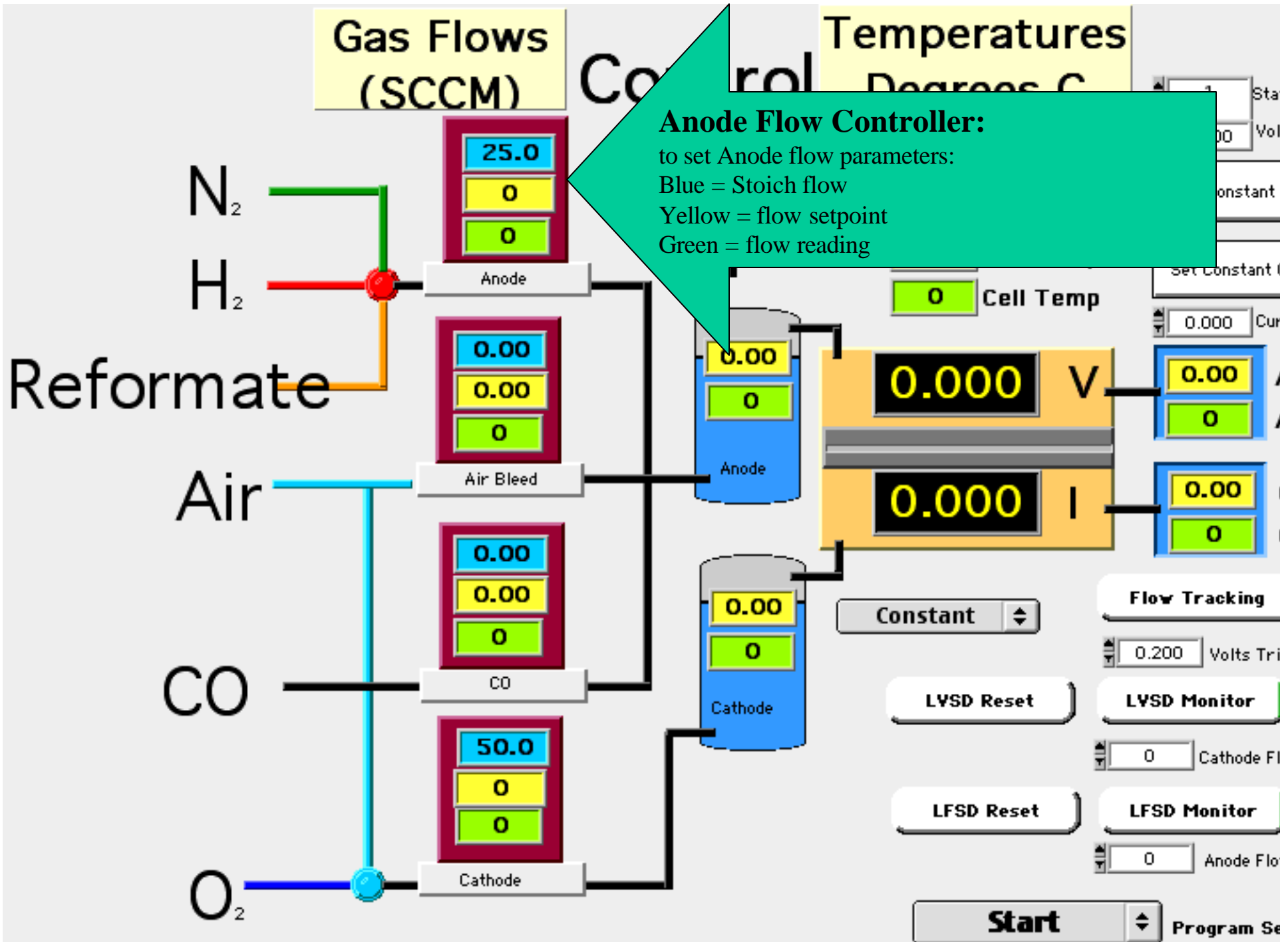
The following is a brief “tutorial” on the unique benefits and features of the LabView-based software used in the Fuel Cell Technologies Testing System. The presentation lasts approximately 17 minutes and is intended to demonstrate the ease-of-use, flexibility, and functionality of the software and how it can benefit the researcher for a wide range of fuel cell testing applications

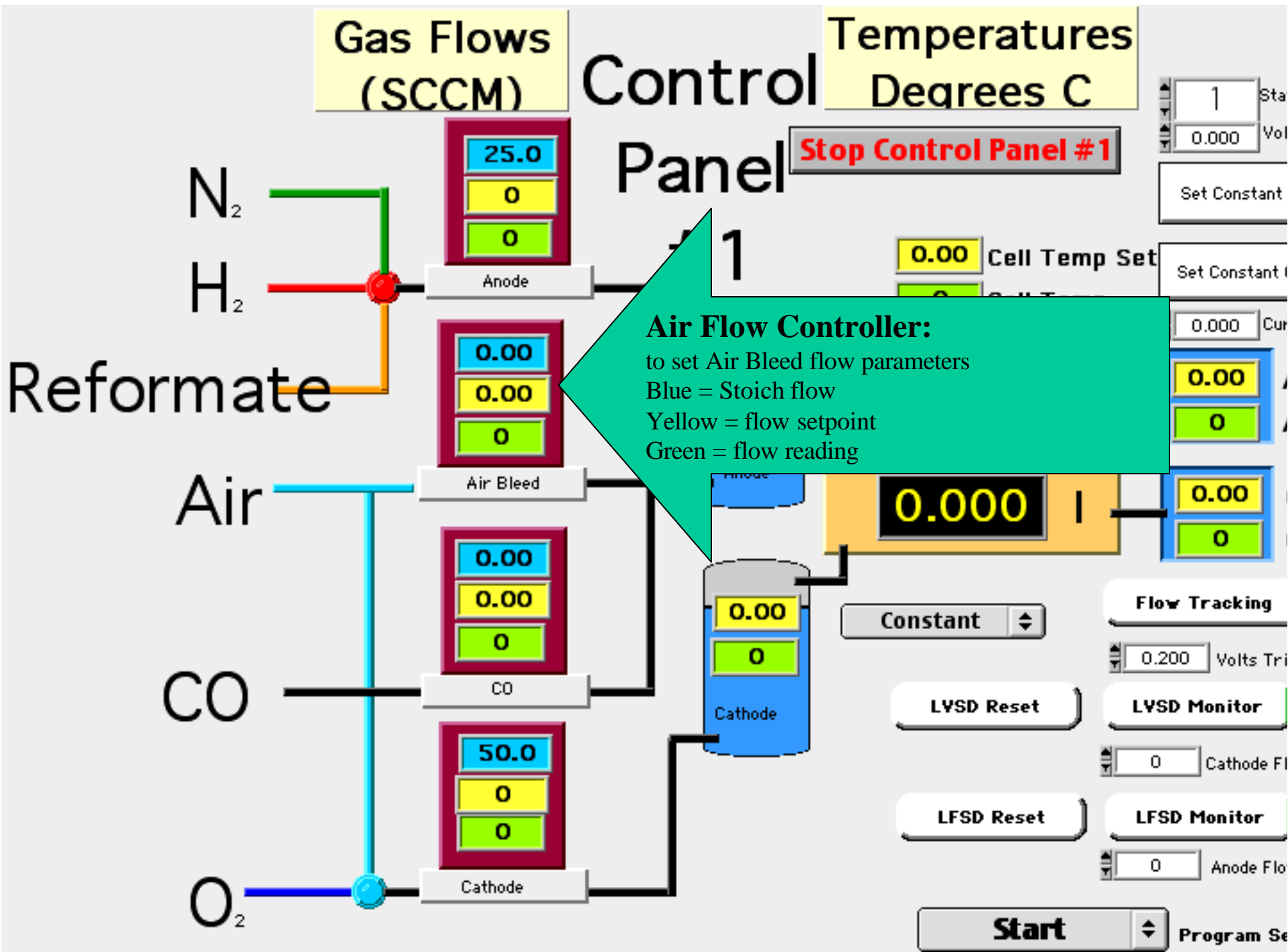
Station #1 Control Panel

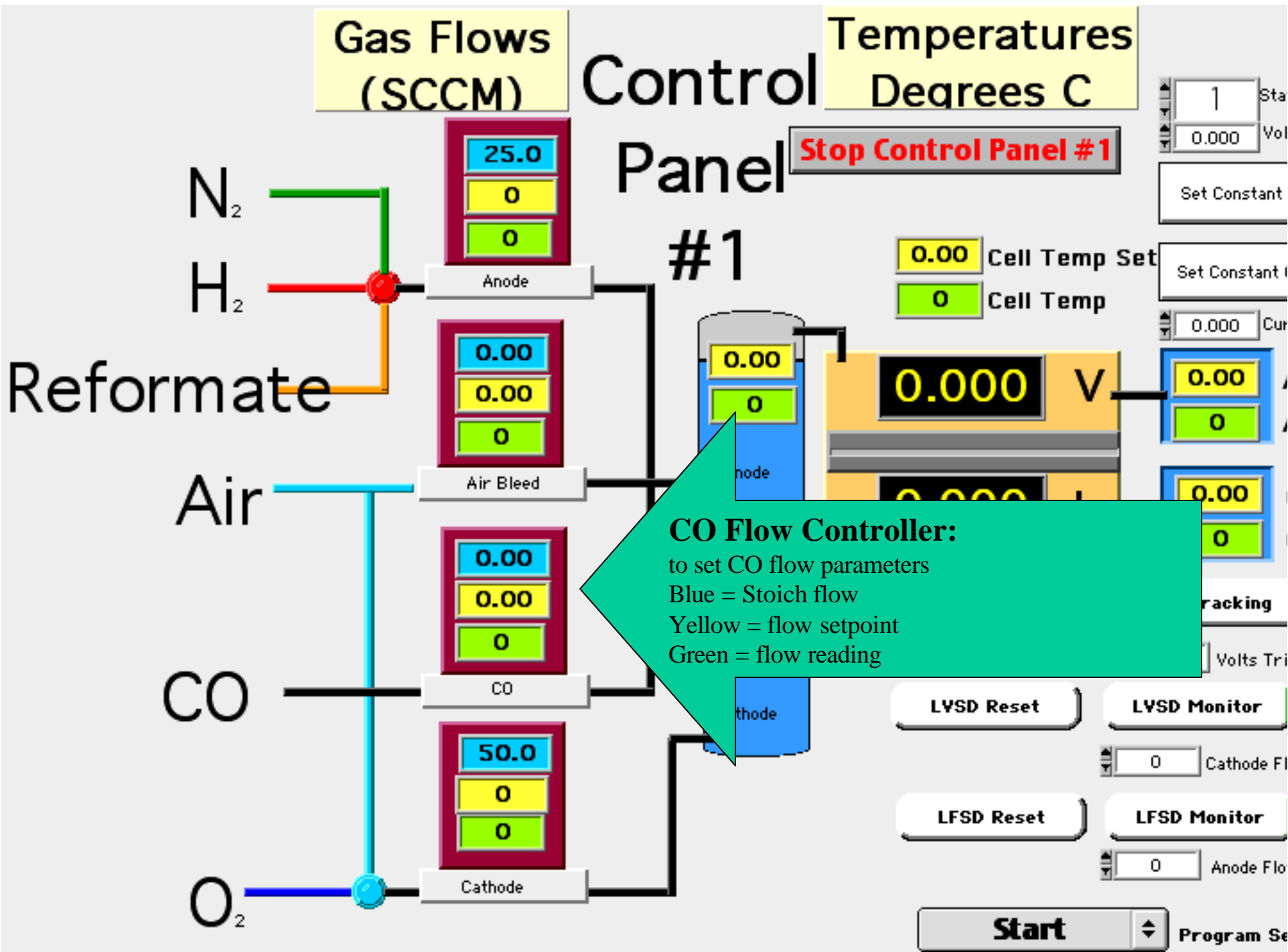


Most competitive units have only 2 mass flow controllers for the Anode and Cathode
The FCT system provides up to 4 controllers for mixing Reformat









Gas Flows (SCCM)

Temperatures Degrees C

Control Panel #1

Stop Control Panel #1

#1

Reformat

Air

CO

O₂

N₂

H₂

25.0
0
0

0.00
0.00
0

0.00
0.00
0

50.0
0
0

0.00
0

0.000 V

1 Sta
0.000 Vol

Set Constant

Set Constant

0.000 Cur

0.00
0

0.00
0

Tracking

Volts Tri

LVSD Reset

LVSD Monitor

0 Cathode Fl

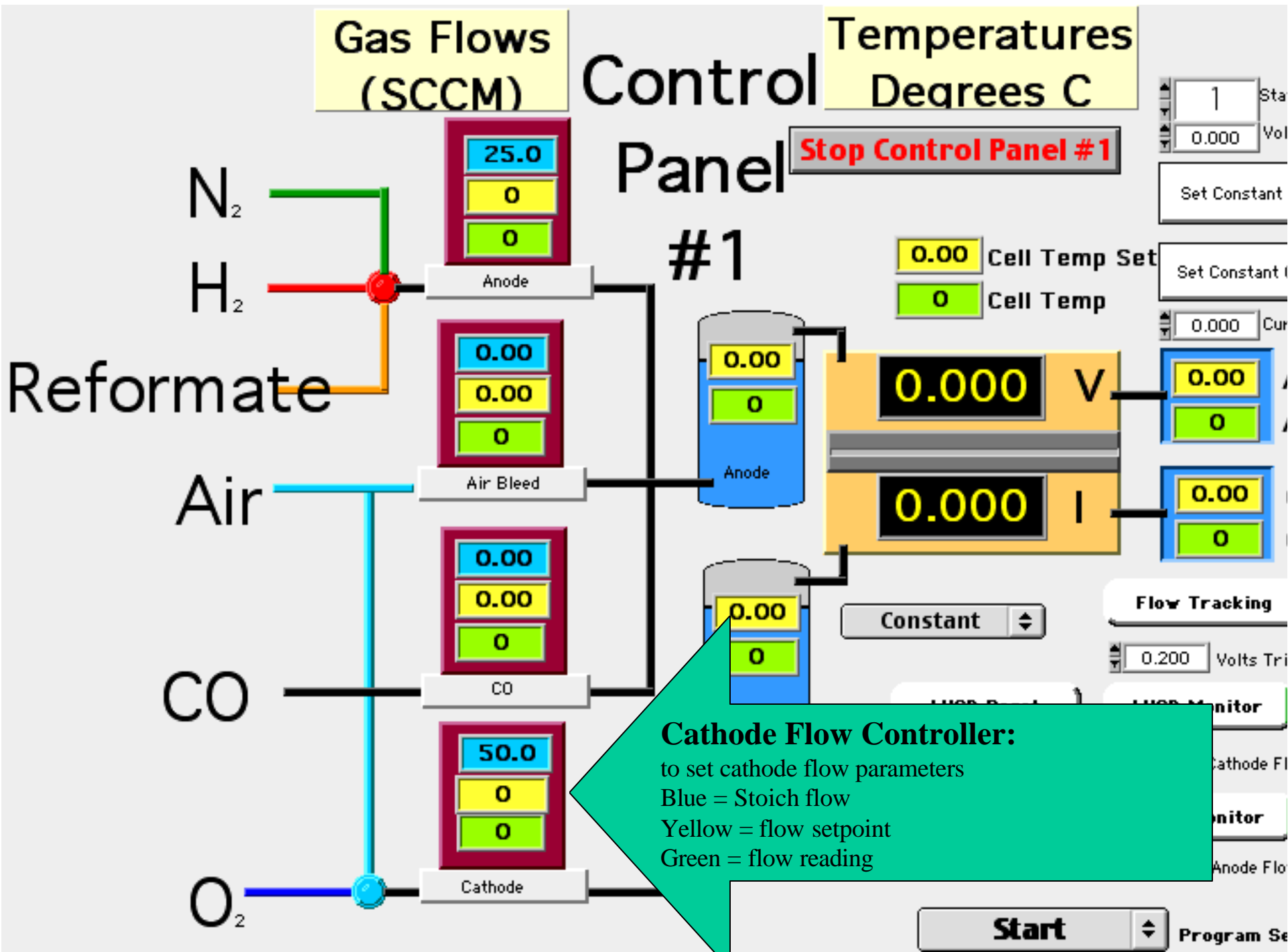
LFSD Reset

LFSD Monitor

0 Anode Flo

Start

Program Set



Cathode Flow Controller:
 to set cathode flow parameters
 Blue = Stoich flow
 Yellow = flow setpoint
 Green = flow reading

Gas Flows
(SCCM)

Control Panel #1

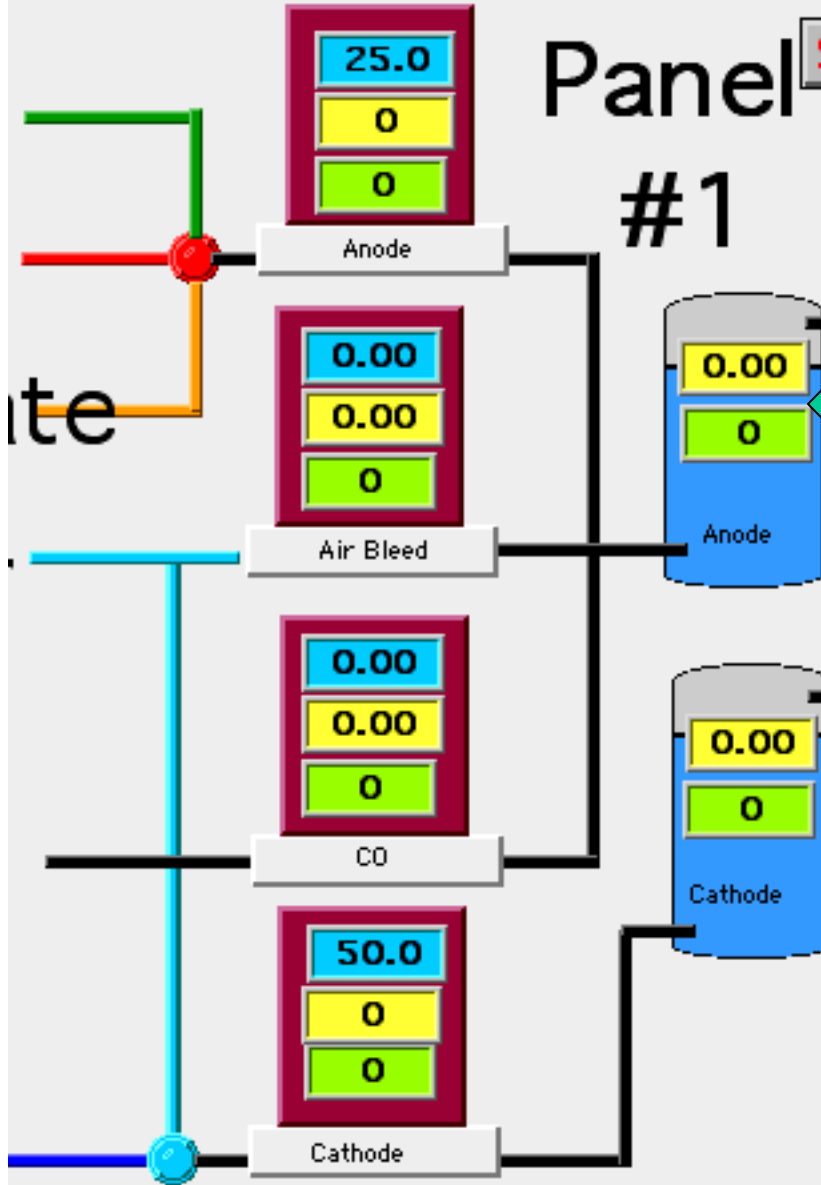
Temperatures
Degrees C

Stop Control Panel #1

1 Station
0.000 Volts Setpoint

Set Constant Voltage Mode

Set Constant Current Mode



Anode Humidity Temperature Controller:
 to set Anode Humidity Temperature (Degrees C)
 Yellow = Temperature setpoint
 Green = Temperature reading

0.00 | 0.00 | Cathode Backpressur
 0.00 | 0 | Cathode Backpressur

Constant

Flow Tracking

0.200 Volts Trip Setpoint

LVSD Reset

LVSD Monitor

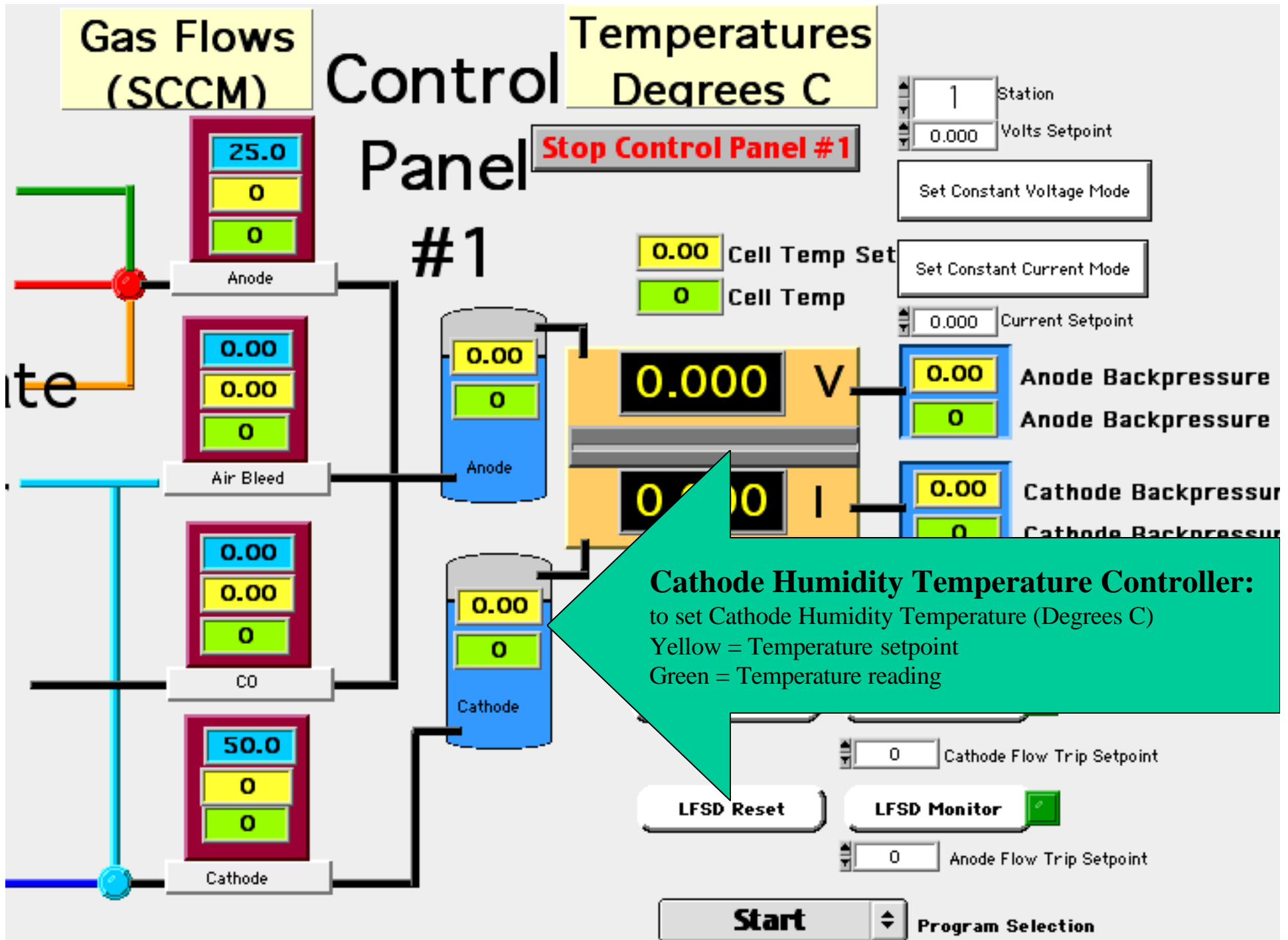
0 Cathode Flow Trip Setpoint

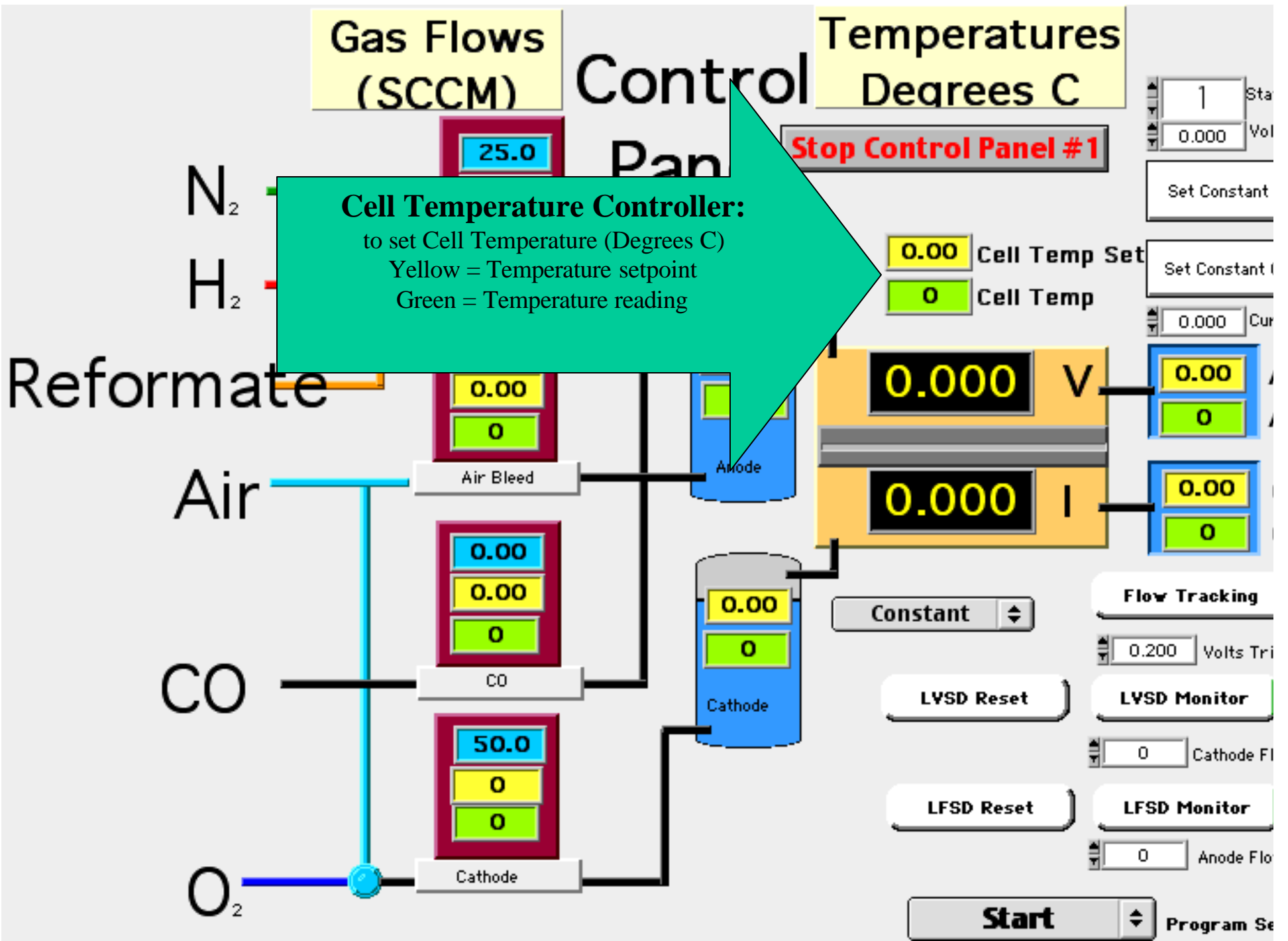
LFSD Reset

LFSD Monitor

0 Anode Flow Trip Setpoint

Start Program Selection





Gas Flows (SCCM)

Temperatures Degrees C

Control Panel #1

Cell Temperature Controller:
 to set Cell Temperature (Degrees C)
 Yellow = Temperature setpoint
 Green = Temperature reading

N₂

H₂

Reformat

Air

CO

O₂

25.0

0.00
0

0.00
0.00
0

50.0
0
0

Anode

Cathode

Stop Control Panel #1

0.00 Cell Temp Set
0 Cell Temp

0.000 V

0.000 I

1 Sta
0.000 Vol

Set Constant

Set Constant

0.000 Cur

0.00
0

0.00
0

Constant

Flow Tracking

0.200 Volts Tri

LVSD Reset

LVSD Monitor

0 Cathode Fl

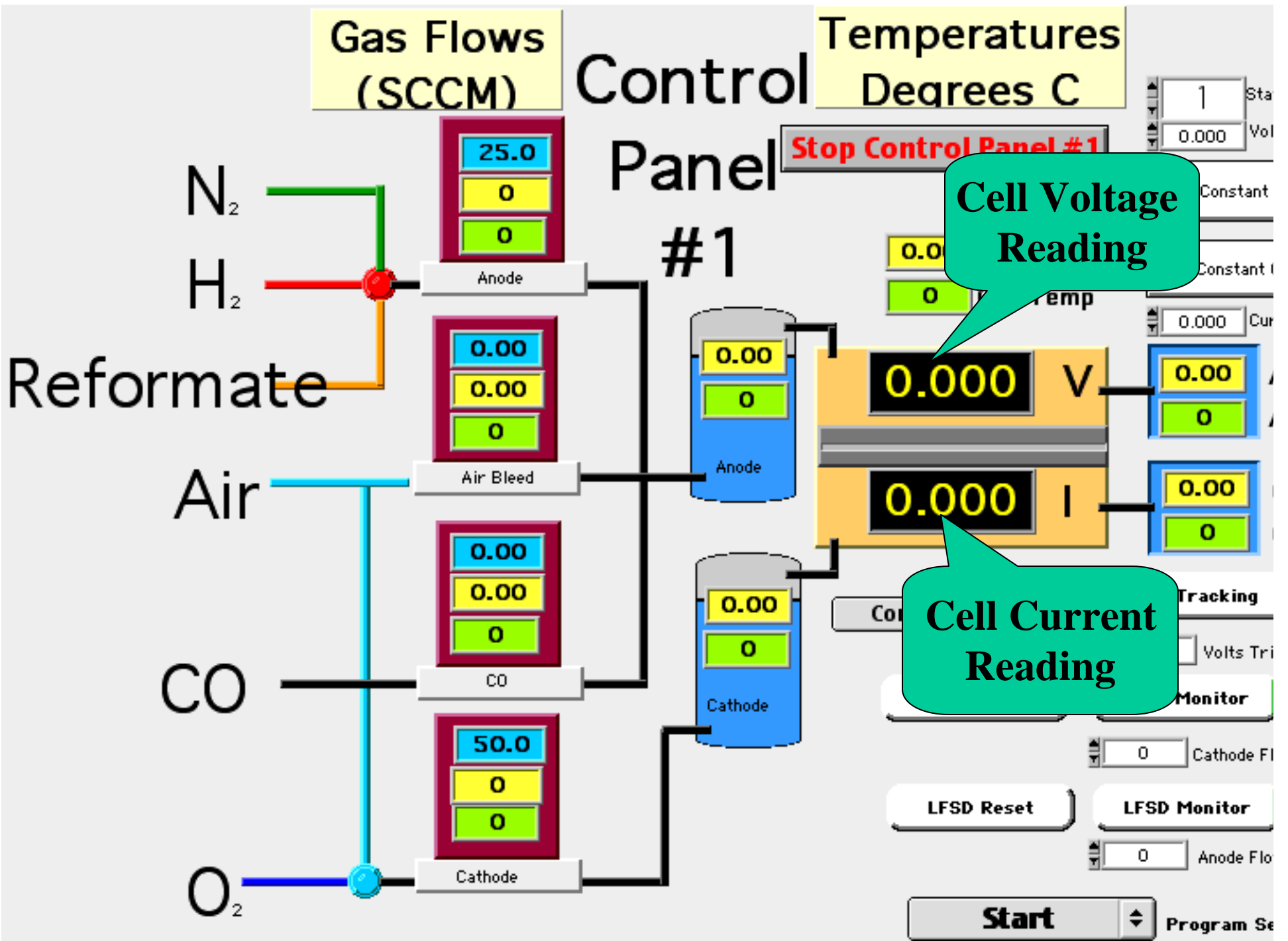
LFSD Reset

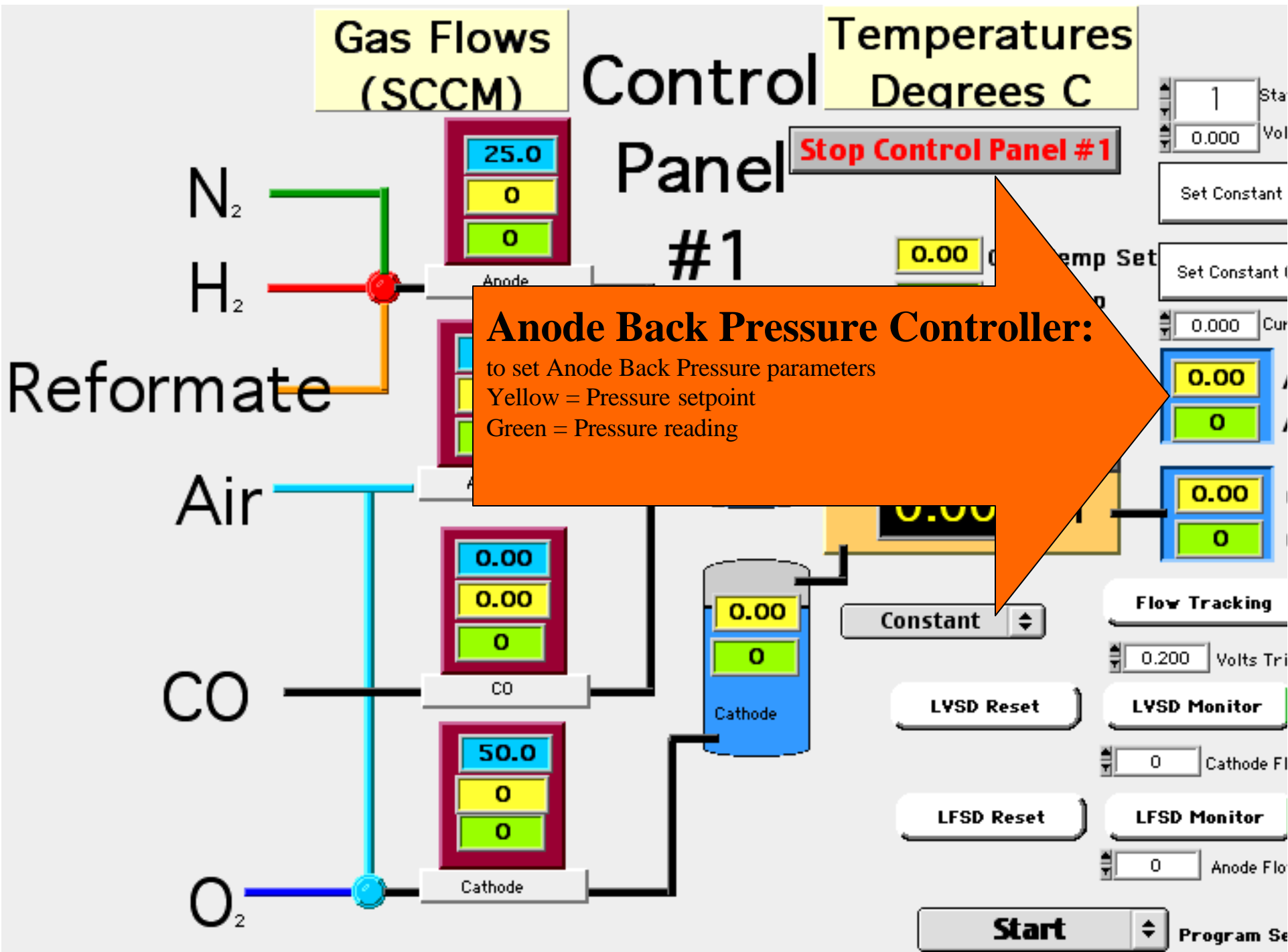
LFSD Monitor

0 Anode Flo

Start

Program Se





Gas Flows (SCCM)

Temperatures Degrees C

Control Panel #1

Stop Control Panel #1

Reformate

N₂

H₂

Air

CO

O₂

Anode Back Pressure Controller:

to set Anode Back Pressure parameters
 Yellow = Pressure setpoint
 Green = Pressure reading

25.0
0
0

0.00
0.00
0

0.00
0.00
0

50.0
0
0

0.00
0

0.00

Constant

LVSD Reset

LFSD Reset

Start

1 Sta
0.000 Vol

Set Constant

Set Constant

0.000 Cur

0.00
0

0.00
0

Flow Tracking

0.200 Volts Tri

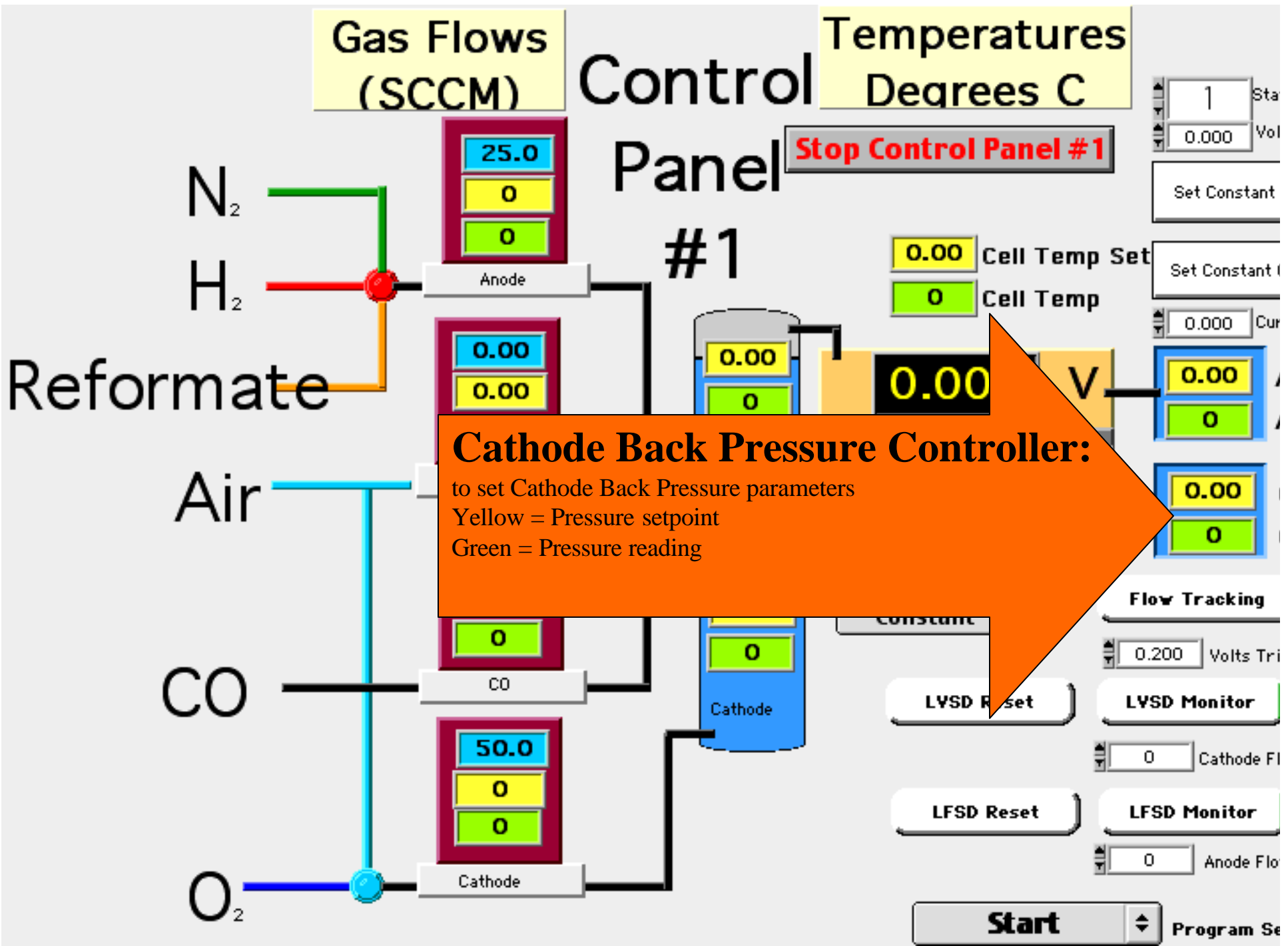
LVSD Monitor

0 Cathode Fl

LFSD Monitor

0 Anode Flo

Program Se



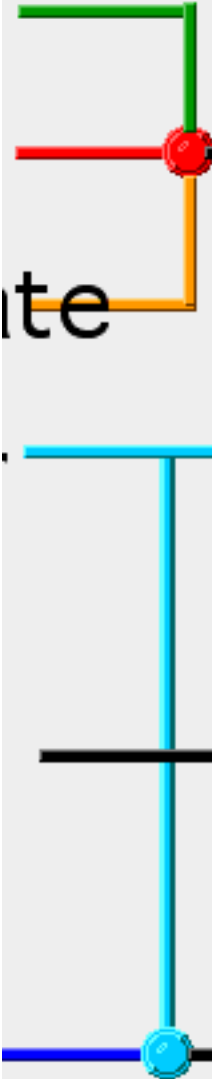
Gas Flows
(SCCM)

Control

Temperatures
Dear C

Voltage
Setpoint

Set Constant Voltage:
to change the HP Load-box to the
desired constant voltage



Air Bleed
0.00
0.00
0

CO
0.00
0.00
0

Cathode
50.0
0
0

Anode
0.00
0

Cathode
0.00
0

0.000 V
0.000 I

1
0.000 Volts Setpoint
Set Constant Voltage Mode
Set Constant Current Mode
0.000 Current Setpoint

0.00 Anode Backpressure
0 Anode Backpressure
0.00 Cathode Backpressure
0 Cathode Backpressure

Constant

LVSD Reset

Flow Tracking

0.200 Volts Trip Setpoint

LVSD Monitor

0 Cathode Flow Trip Setpoint

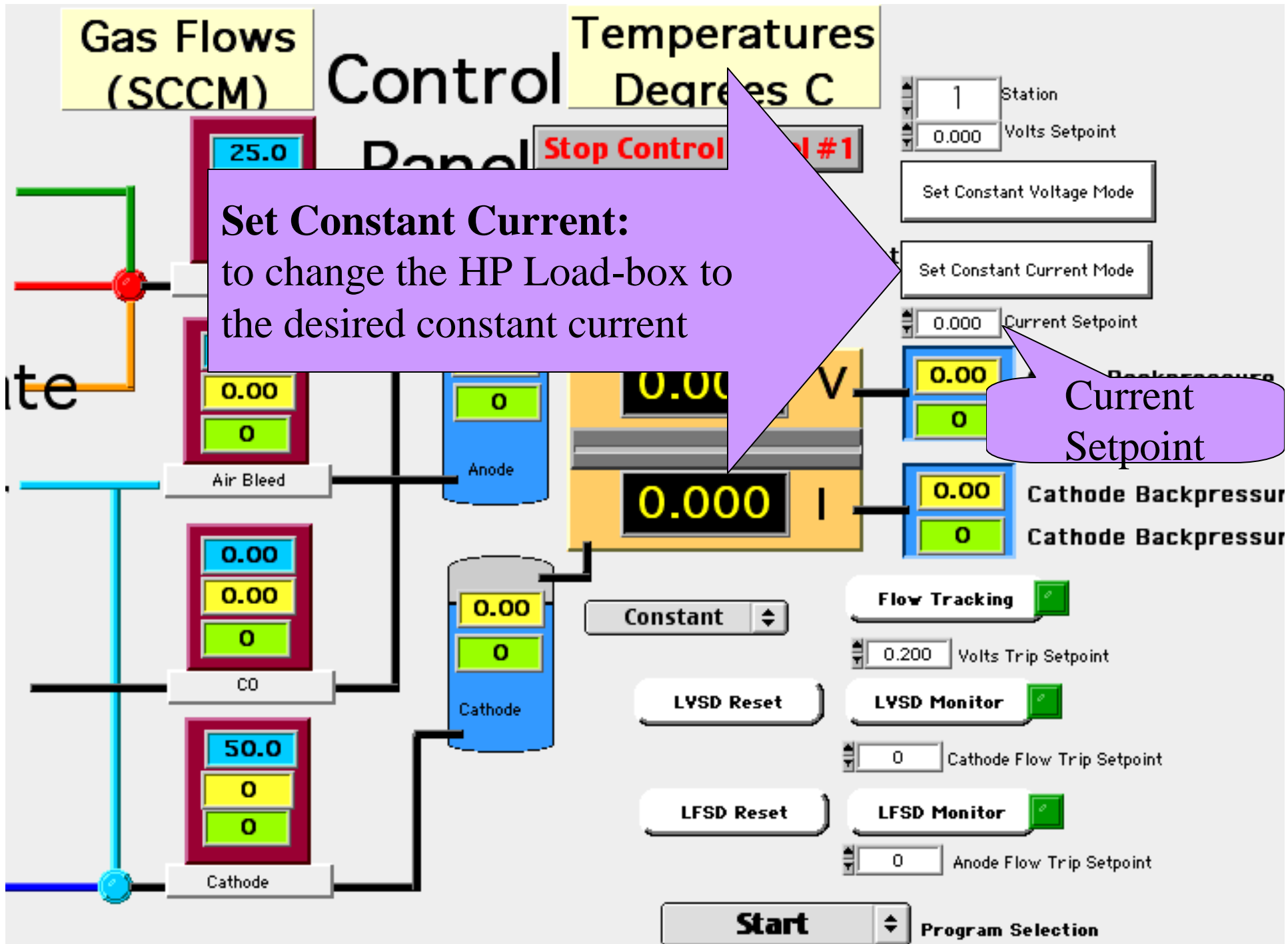
LFSD Reset

LFSD Monitor

0 Anode Flow Trip Setpoint

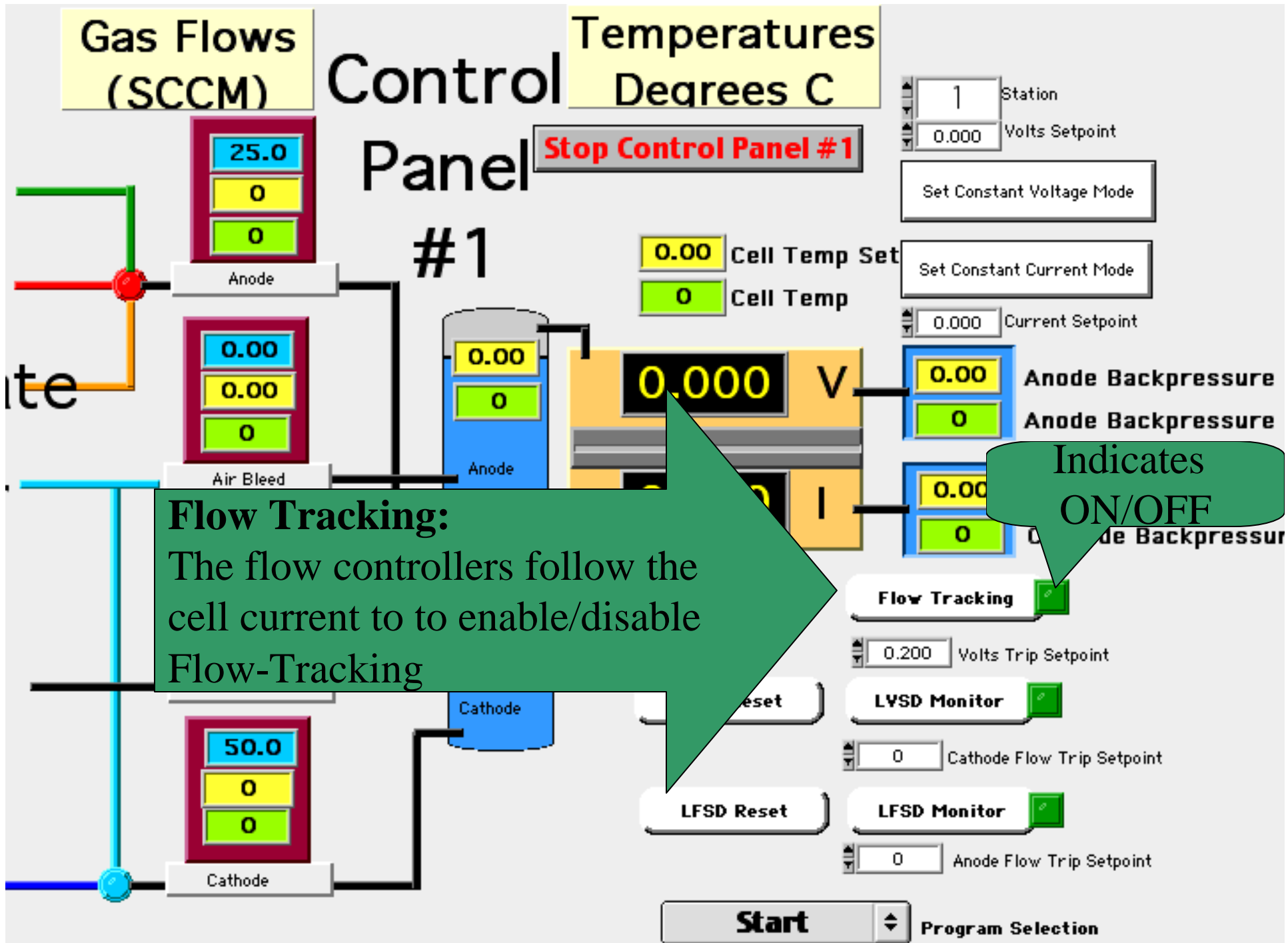
Start

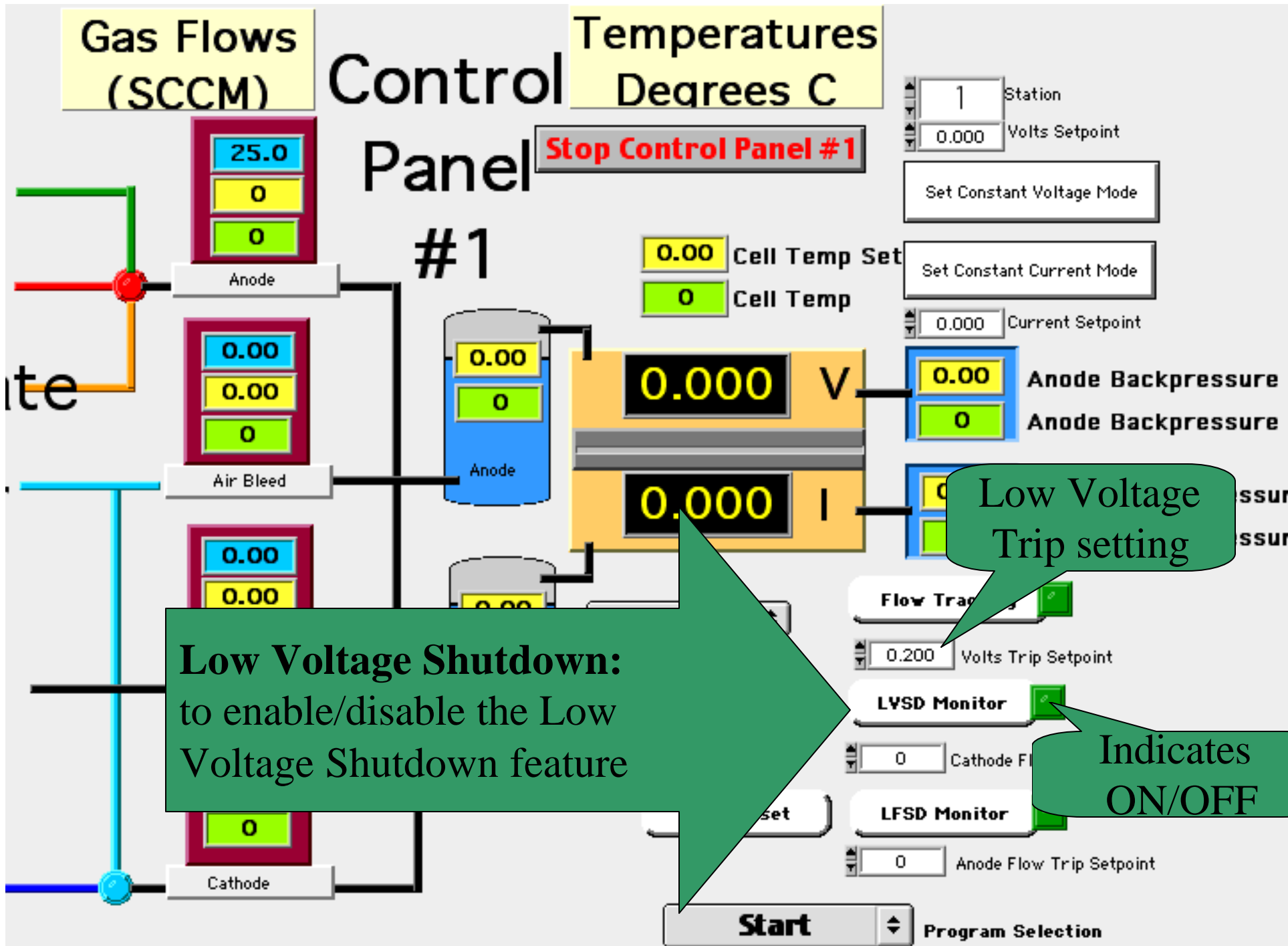
Program Selection

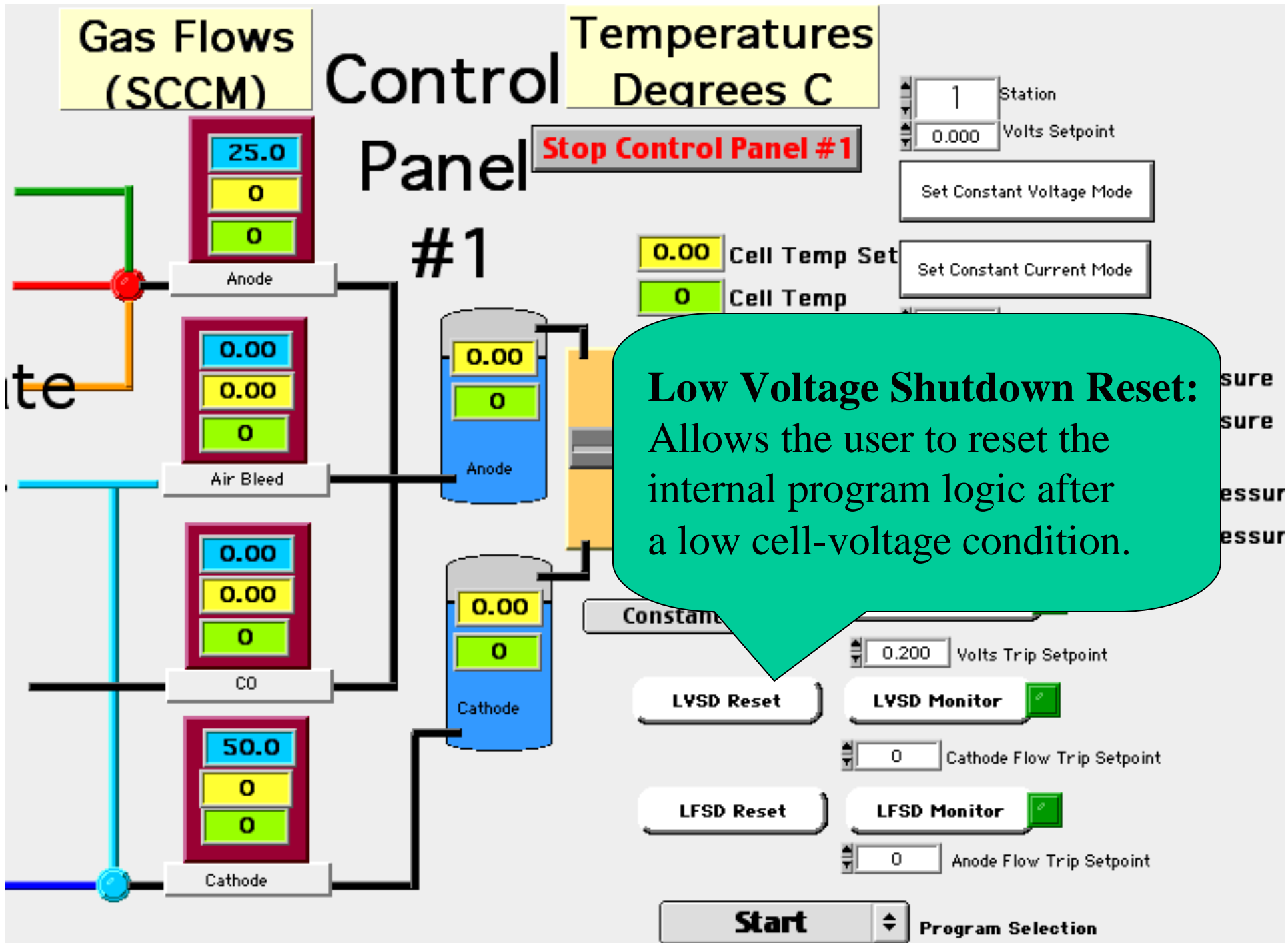


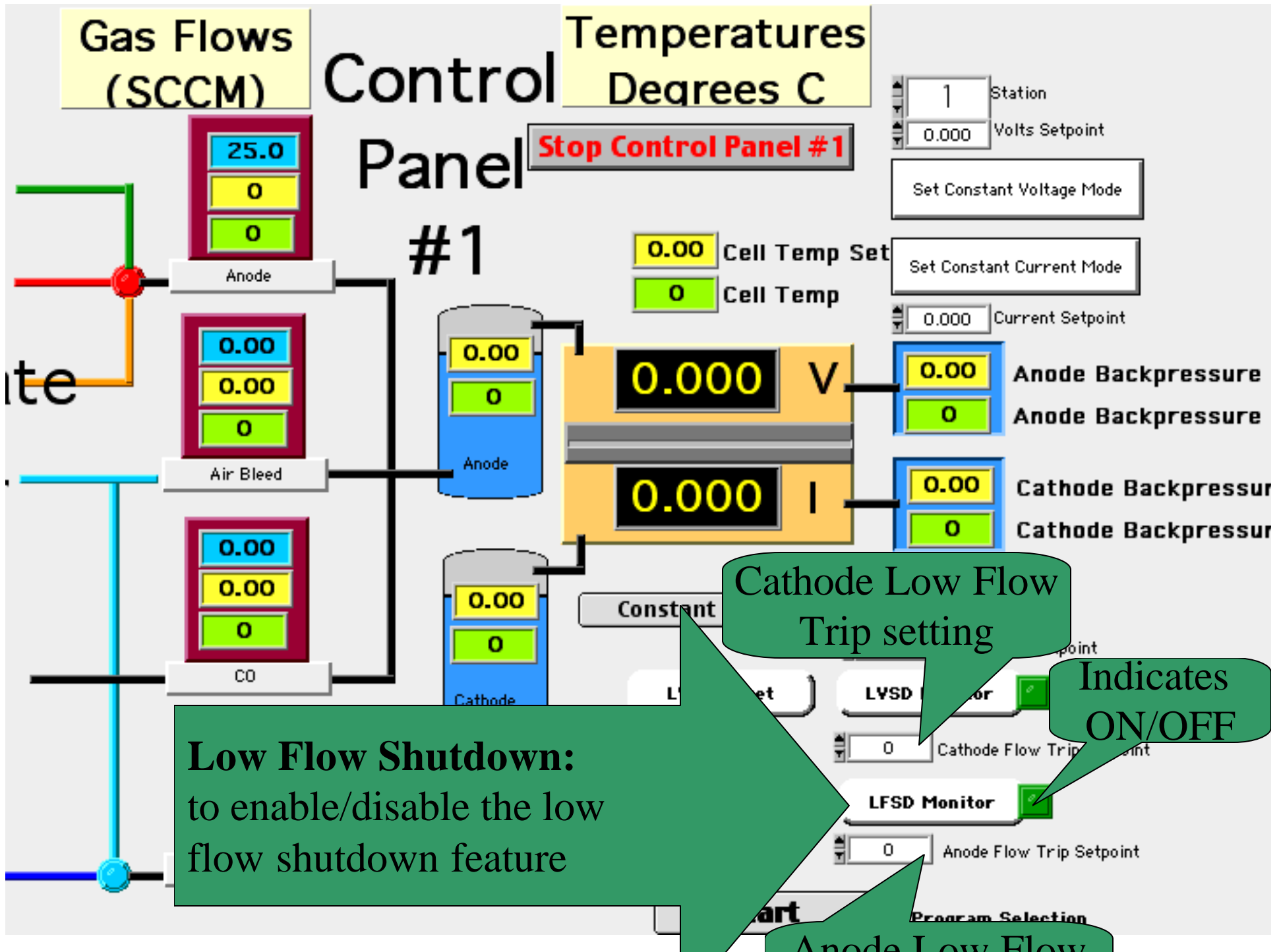
Set Constant Current:
to change the HP Load-box to
the desired constant current

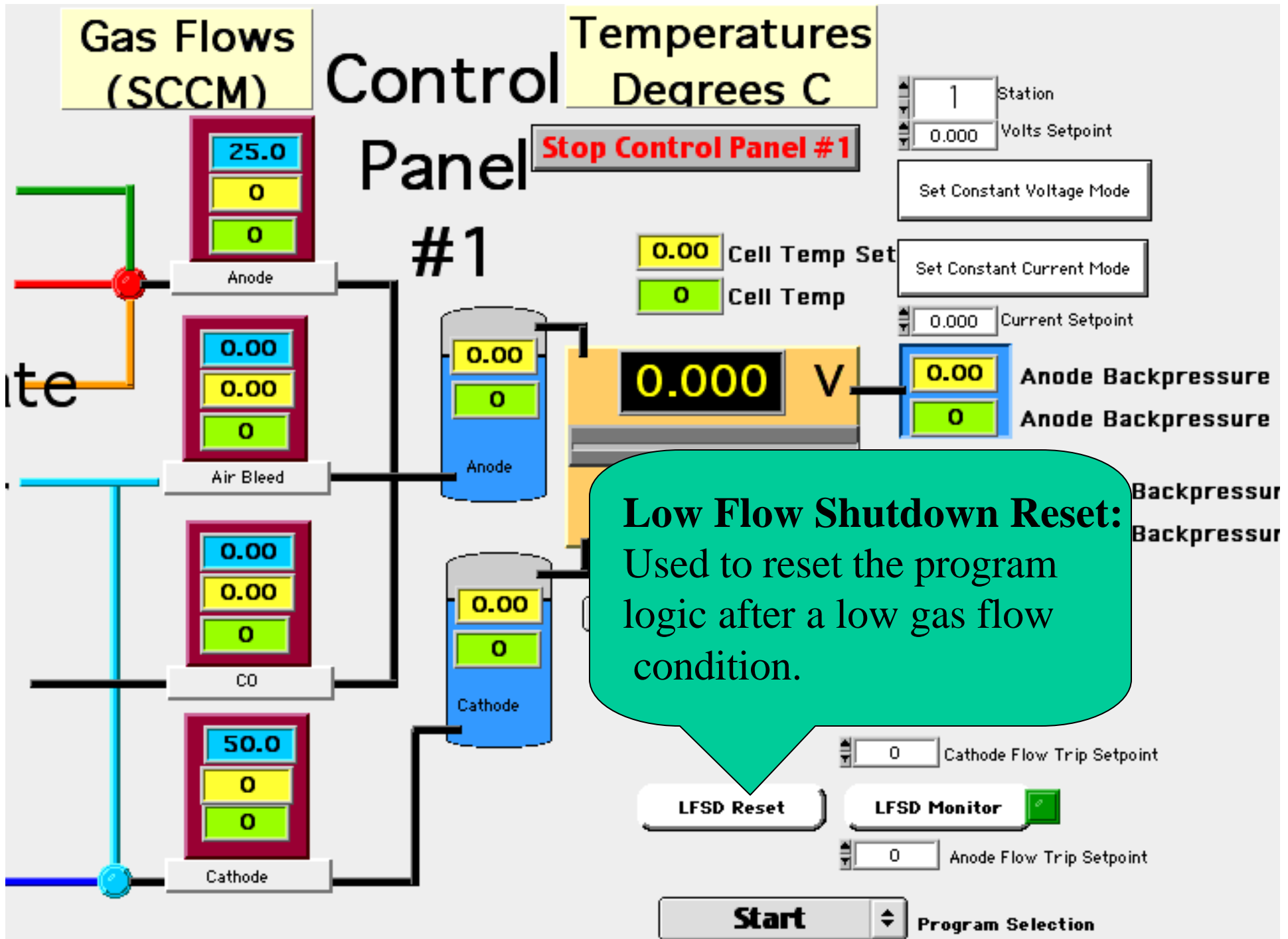
Current Setpoint



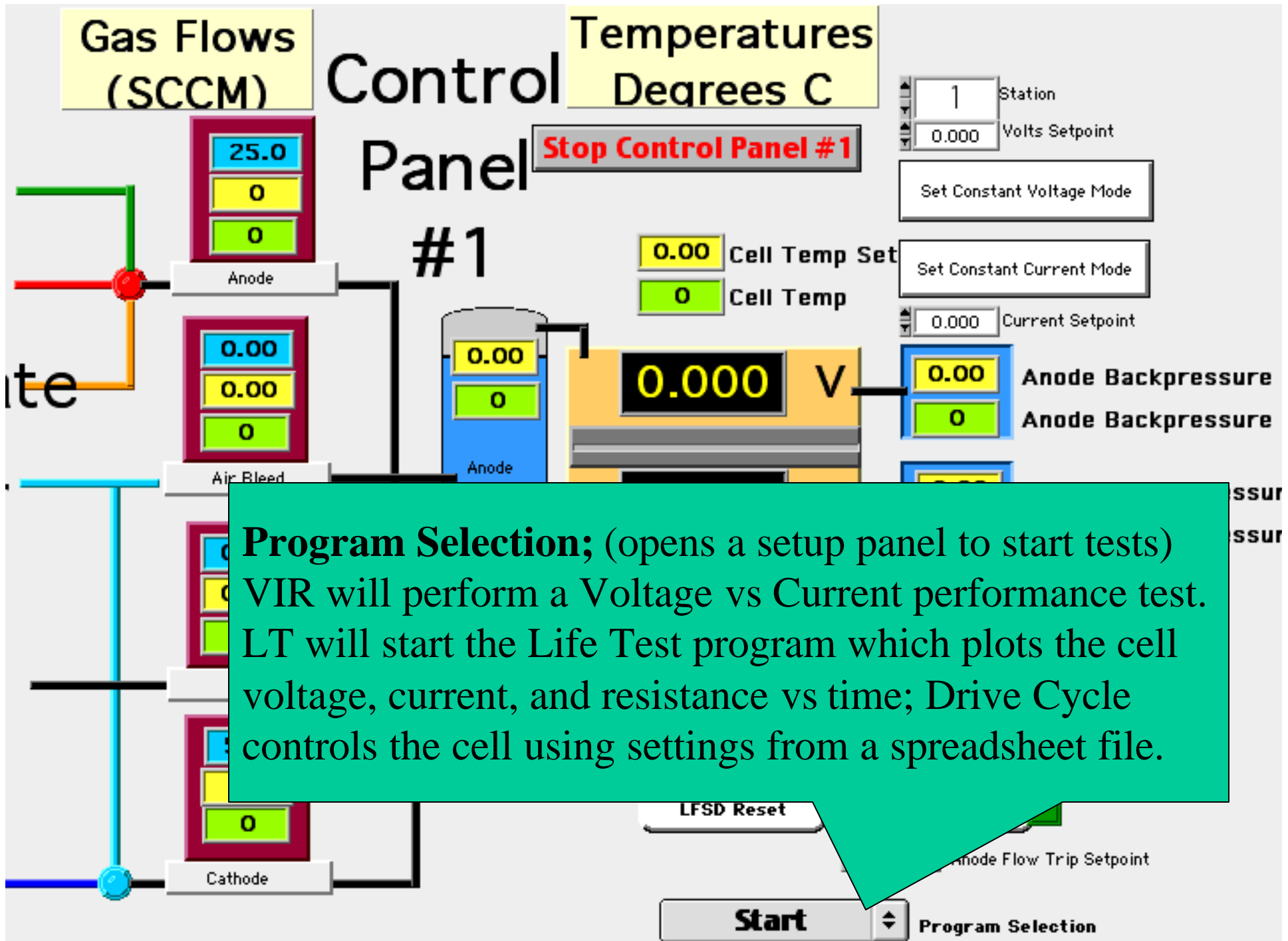








Low Flow Shutdown Reset:
Used to reset the program logic after a low gas flow condition.



Gas Flows SCCM - Temperatures

Anode Cathode Air Bleed CO

Stoich Flow

Flow

Measu

Volts Trip Setpoint Temperature

LVSD Monitor Measured Tem

Anode Flow Trip Setpoint Pressure

LFSD Monitor Measured

Cathode Flow Trip Setpoint

Set Flows Set Temperatures Set Pressures

Parameters In

V/I Start/Stop	V/I Min	V/I Increment	Final V/I	One Way	Delay Between Readings(Sec)
<input type="text" value="1.00"/>	<input type="text" value="0.20"/>	<input type="text" value="0.05"/>	<input type="text" value="1.00"/>	<input type="checkbox"/>	<input type="text" value="30"/>

File Name

Path

Reference OFF

Resistance OFF

Shunt Resistance (Ohms)

Cell Area (cm²)

Two Way

File label not entered

Calibrate Shunt

Fuel

Load Box Control Mode

Constant

Set Constant Voltage Mod

Set Constant Current Mod

VIR

Return St

Scan Interval (Hr.)

These buttons were described on the previous panels and have the same functionality

beginning and ending voltage. The measurement begins at a given cell Voltage or Current (V/I Min) controlled by the HP Electronic Load, and decreases by the “Voltage/Current (V/I) Increment” until “Volts/Current (V/I)” mid-value is reached; the process is reversed until the cell potential returns to the Volts “Start/Stop” potential. The “Final Volts/Current (Final V/I)” is set at the end of the test.

The screenshot displays a control interface with the following elements:

- Parameters In:**
 - V/I Start/Stop: 1.00
 - V/I Min: 0.20
 - V/I Increment: 0.05
 - Final V/I: 1.00
- Other Parameters:**
 - Cell Area (cm²): 30
 - Two Way: 5.00
 - Shunt Resistance (Ohms): 2.3800E-3
- Buttons:** Set Flows, Set Temperatures, Set Pressures, VIR, Return St, Calibrate Shunt
- Other UI Elements:** LFSD Monitor, Anode Flow Trip Setpoint, Cathode Flow Trip Setpoint, Load Box Control Mode (Constant), Scan Interval (Hr.) (1.00)

One Way/Two Way determines whether the VIR test goes uni-directionally or from start to mid-range, or to mid-range and back to the start point.

Cell Area in cm^2 is used to calculate the current density as shown on the data plot.

Delay between Readings (Sec.) Sets the time at each level (settling time)

The screenshot displays a control interface for a VIR test. At the top right, there are gauges for 'Air Bleed' (0.0), 'CO' (0.0), and 'Fuel' (0.00). Below these are 'LVSD Monitor' and 'LFSD Monitor' buttons, both with green status indicators. The interface includes several setpoint fields: 'Volts Trip Setpoint' (0.200), 'Anode Flow Trip Setpoint' (0), and 'Cathode Flow Trip Setpoint' (0). There are also 'Set Flow' and 'Set Temperature' buttons. A 'Parameters In' section contains a table with columns for 'V/I Start/Stop', 'V/I Min', 'V/I Increment', and 'Final V/I'. The 'One Way' and 'Two Way' radio buttons are selected. Other parameters include 'Cell Area (cm²)' (30), 'Delay between Readings (Sec.)' (5.00), 'File Name' (test), 'Path' (C:\FCell\Data:test), 'Reference OFF', 'Resistance OFF', and 'Shunt Resistance (Ohms)' (2.3800E-3). A 'Calibrate Shunt' button is at the bottom left. A 'VIR' button is at the bottom right. A 'File label not entered' message is visible near the 'Cell Area' field.

V/I Start/Stop	V/I Min	V/I Increment	Final V/I
1.00	0.20	0.05	1.00

Ascii Data Spreadsheet Filename

Ascii Data Spreadsheet File Path

Data File label containing information pertinent to this test

The screenshot shows a control interface for a fuel cell system. At the top, there are sections for "Temperatures", "Air Bleed", "CO", and "Fuel". The "Fuel" section features two digital displays showing "0.00". Below these are buttons for "Constant", "Set Constant Voltage Mod", "Set Constant Current Mod", "VIR", and "Return St".

The main control area includes several input fields and buttons:

- Parameters In:** V/I Start/Stop (1.00), V/I Increment (0.05), Final V/I (1.00), Delay Between Readings (Sec) (5.00), Cell Area (cm²) (30).
- File Name:** test
- Path:** C:\Cell\Data:test
- Buttons:** Reference OFF, Resistance OFF, Calibrate Shunt, Set Flows, Set Pressures.
- Shunt Resistance (Ohms):** 2.3800E-3

Three callout boxes highlight specific fields: "Ascii Data Spreadsheet Filename" points to the File Name field; "Ascii Data Spreadsheet File Path" points to the Path field; and "Data File label containing information pertinent to this test" points to a large empty text area labeled "File label not entered".

Turns Anode Reference measurement ON/OFF

Turns Cell Resistance measurement ON/OFF

Shunt Resistance use in Cell Resistance measurement. Obtained by calibrating Shunt.

Shunt Calibration routine reads the cell current from the load box and measures the voltage across the shunt induced by the Cell current. This voltage is read with the data acquisition card in the computer.

The image shows a control interface for a fuel cell system. At the top right, there is a 'Fuel' section with two digital displays showing '0.00'. Below this, there is a 'Return St' button. In the center, there is a 'Calibrate Shunt' button. To the left of this button, there are two buttons labeled 'Reference OFF' and 'Resistance OFF'. Above these buttons, there are several input fields and buttons. One input field shows '1.0', another shows '0.2', and another shows '0.05'. There is also a 'Set F' button. At the bottom right, there is a 'Scan Interval (Hr.)' field showing '1.00'. The interface is overlaid with several callout boxes containing text explaining the functions of the buttons and fields.

Gas Flows SCCM - Temperatures

Stoich Flow

Anode	Cathode	Air Bleed	CO
0.0	0.0	0.0	0.0
0	0	0	0
0	0	0	15

Measured

Anode	Cathode
85	85

Fuel

0.00
0.00

Parameters In

V/I Start/Stop	V/I Min	V/I Increment	Final V/I	Delay Between Readings
1.00	0.20	0.05	1.00	

Buttons: Flow Tracking, LVSD Monitor, LFSD Monitor, Set Flows, Set Temperatures, Set Pressures, Calibrate Shunt

Callout 1: This function opens a panel to set Anode, Cathode, Air Bleed, and CO Flow parameters

Callout 2: This function Opens a panel to set Anode, Cathode, and Cell Temperatures

Callout 3: This function Opens a panel to set Anode and Cathode back pressures

Flows SCCM - Temperatures

	Anode	Cathode	Air Bleed	CO
Stoich Flow	0.0	0.0	0.0	0.0
Flow SetPoint	0	0	0	0
Measured Flow	10	15	0	0
Temperature SetPoint	10	12	0	0
Measured Temperature	85	85	85	85
Pressure SetPoint	10	0	0	0
Measured Pressure	85	0	0	0

Fuel

V

I

Station: 1

Volts Setpoint: 0.600

Current Setpoint: 0.000

Program Selection: **VIR**

Delay Between Readings(Sec): 30

Area (cm²): 30

Scan Interval (Hr.): 1.00

Resistance (Ohms): 2.3800E-3

librate Shunt

Return Start Test

Set Flows **Set T**

Starts the selected test

Selects the test, and Shows the parameters for the test selected

Returns to the Station Control Panel



Contact Information

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