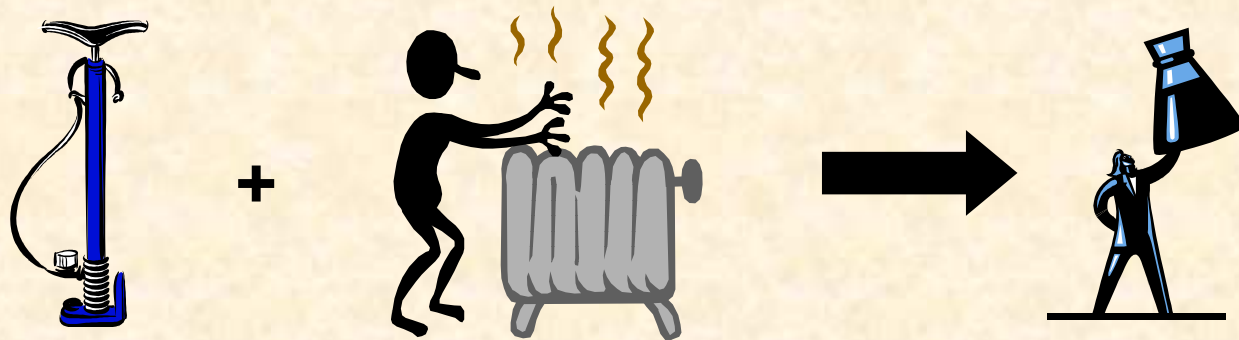# Portable Automated Pressure and Temperature Control System

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OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

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Overview

- **Purpose**
  - **Control the environment of fluid confinement cells used for neutron scattering research**

- **Construction**
  - **Reference volume inside**
  - **Commercially available parts**
  - **Mobile**

- **Operating Range**
  - **Pressure Withstand: 0–87 bar (1264PSIA)**
  - **Pressure Measurement: 0–100 bar (1450PSIA)**
  - **Valve Control: Automatic or Manual**
  - **Voltage: 120VAC / 60Hz or 240VAC / 50Hz**

System View

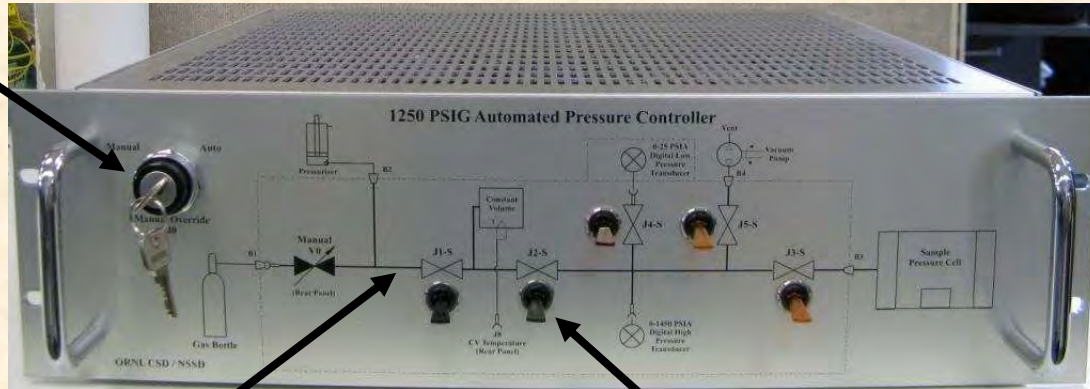High Current Power Supply

Temperature Controller

Pressure Controller

Portable Rack on Wheels
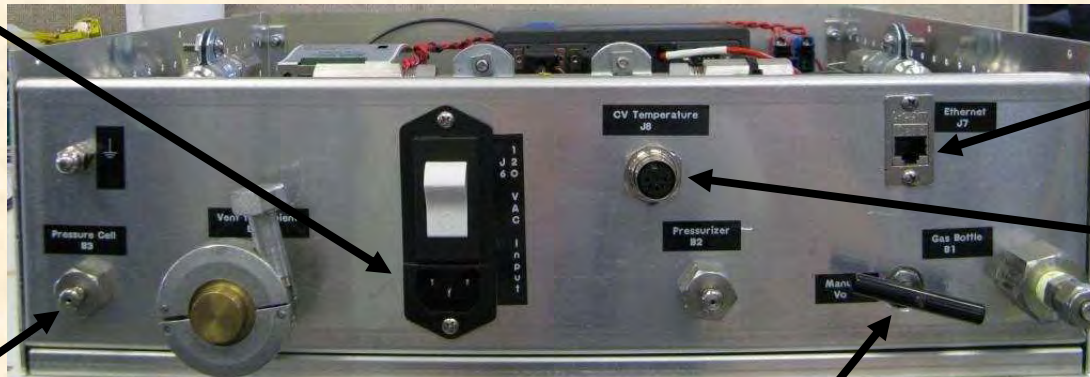
Pressure Controller
Front and Rear View

Keyswitch

1250 PSIG Automated Pressure Controller

Gas Flow Diagram

Manual Valve Controls

Power

Network

Gas Ports
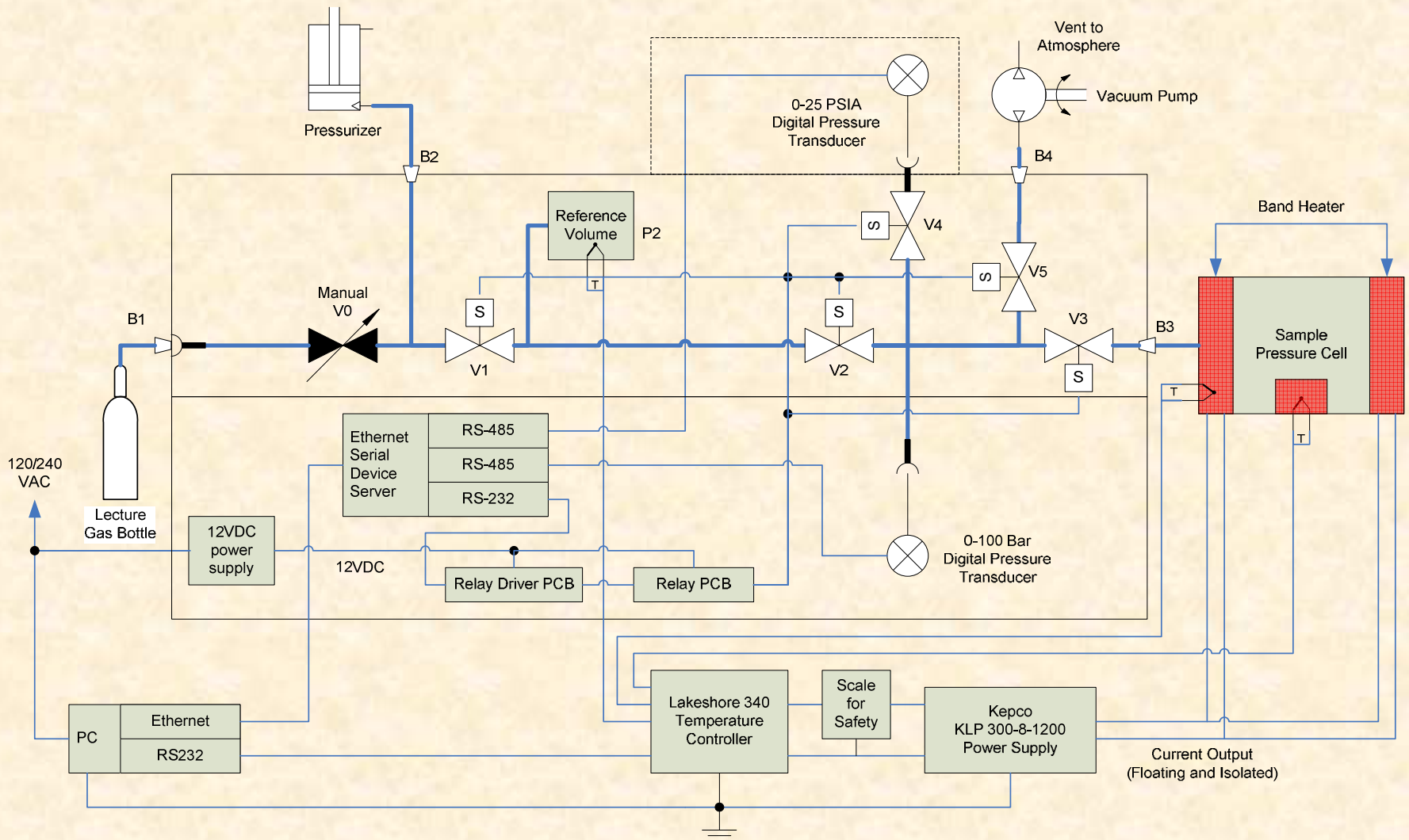
Ref. Volume Temperature

Gas Bottle Isolation

Block Diagram

Software State Diagram
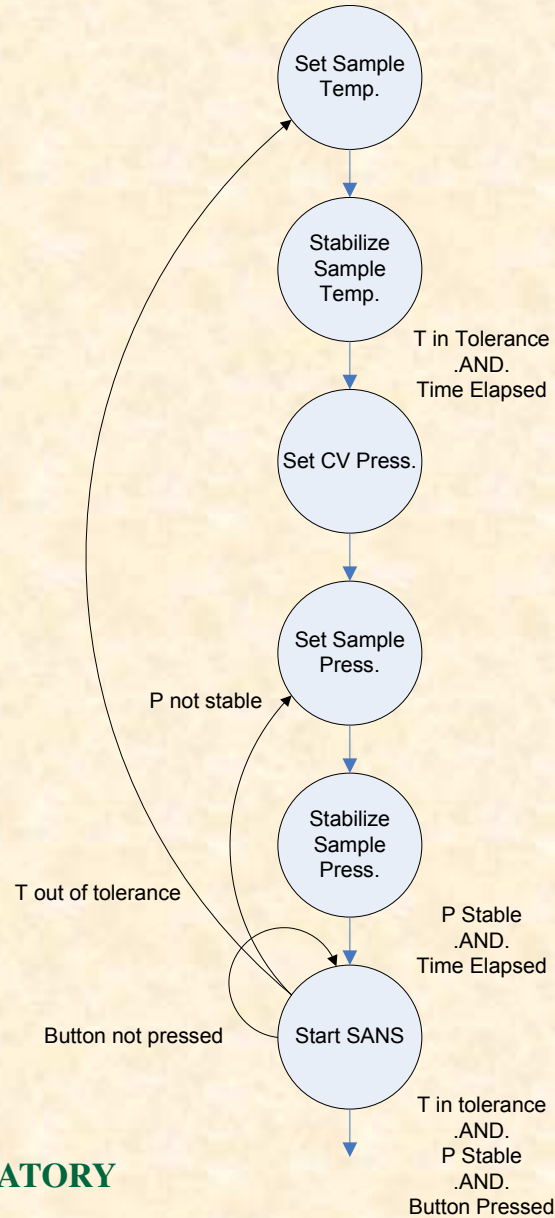
Software State Diagram (Continued)

T in tolerance
.AND.
P Stable
.AND.
Button Pressed

T Not in Tolerance
.OR.
P Not Stable
.OR.
Button Not pressed

Monitor P&T

T in Tolerance
.AND.
P Stable
.AND.
Button Pressed

Goto Set CV
Pressure State

Goto Next
Press.

Last P in Series

Goto Set Sample
Temperature State

Goto Next
Temp.

Last T

Close All
Valves
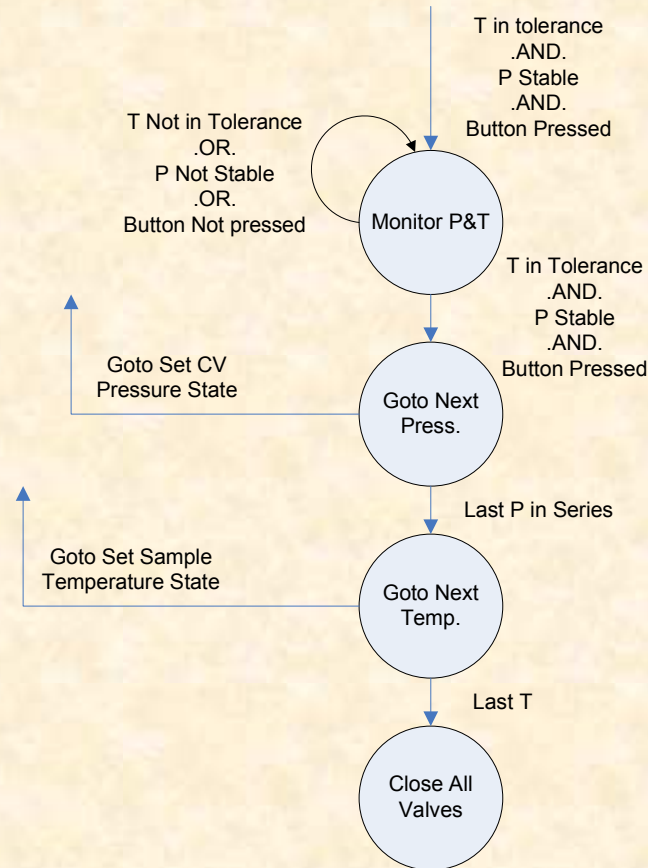
Temperature Control

- **Lakeshore LS340**
  - **Closed loop PID Temperature Controller**
  - **Loop #2 controls Analog Output #2**

- **Kepco KLP 300-8-1200**
  - **DC Power Supply**
  - **300V, 8A, 1200W hyperbolic**
  - **Cable scales control signal to protect band heater**

- **Temperature sensors**
  - **PT-100 Platinum RTD**
  - **Accuracy of +/- 51mK for calibrated sensor**

- **Stability Criteria**
  - $| T_{setpoint} - T_{measured} | < dT$; **dT = Stability Temperature**
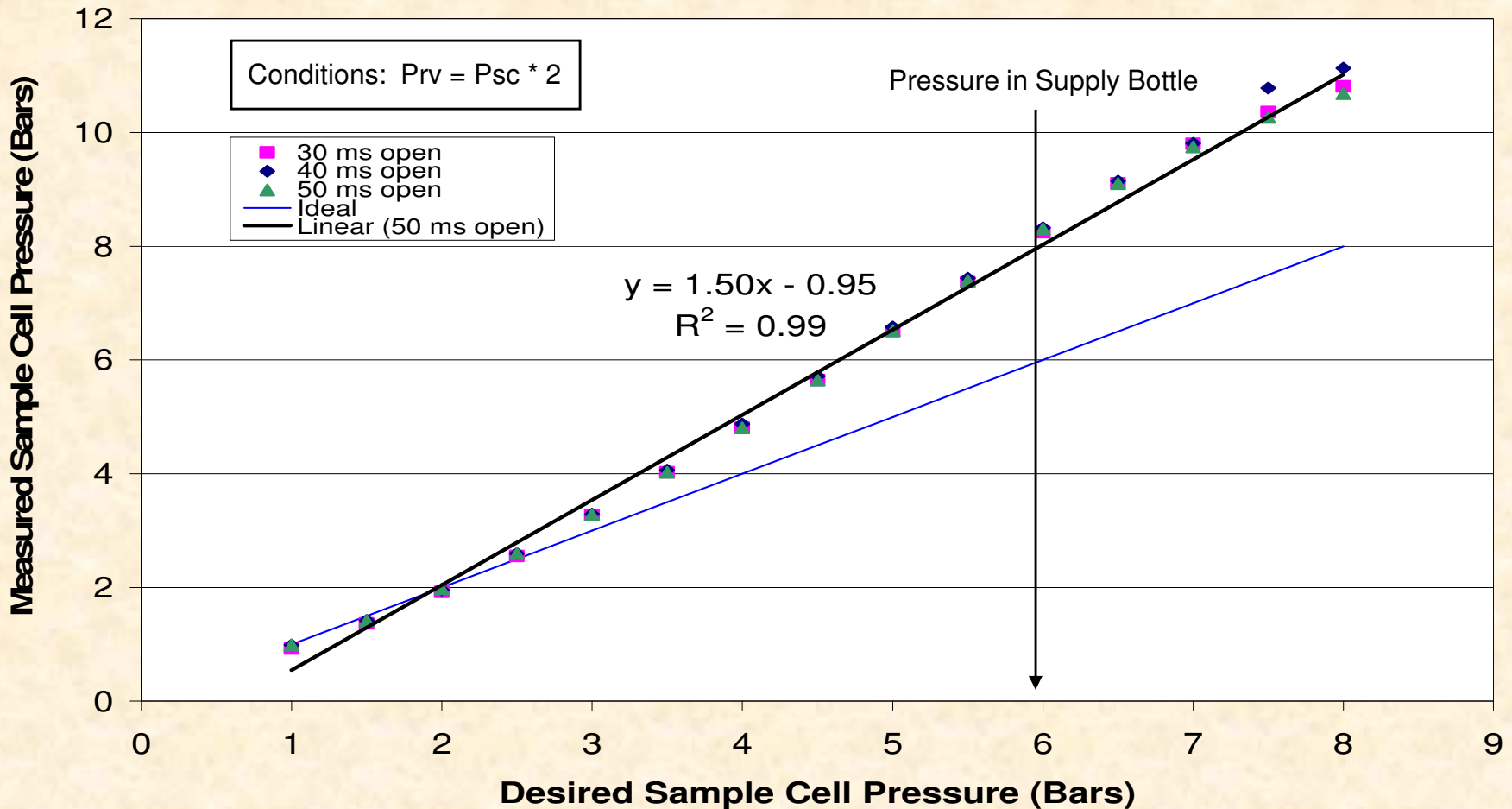 - **Meet this criteria for a specified time**

Pressure Control

- **Solenoid Valves**
  - **Move parcels of gas through system**
  - **Fast response (5 ms)**
  - **Control: Auto or Manual**

- **Pressure Measurement**
  - **Reference volume allows volumetric sorption**
  - **2 pressure transducers with digital output**
  - **High Pressure: 0.0031% full-scale accuracy [$\pm$ 0.003 bar ($\pm$0.039PSI) at 100 bar (1450PSIA)]**
  - **Low Pressure: 0.0362% full-scale accuracy [$\pm$0.009PSI ($\pm$0.0006 bar) at 25 PSIA (1.72 bar)]**

- **Stability Criteria**
  - **$P_{measured} = P_{setpoint}$ +/- dP1; dP1 = Dosage Accuracy**
  - **| P_n – P_{n-1} | < dP2; dP2 = Equilibrium Accuracy**
  - **Meets this criteria for a specified time**

Cost Summary

Component	Function	Cost
Temperature Controller	Measure and Control Temperature	$5339
High Current Power Supply	Control Temperature	$1826
5 - Solenoid Valves	Control Pressure	$1425
2 - Pressure Transducers	Measure Pressure	$1075
Serial Device Server	Control APC	$530
Etched Front Panel	User Interface	$300
Powered Roller Rack	Portability	$270
Total		$12400 (~€8000)

Measured Sample Cell Pressure versus Setpoint Sample Cell Pressure

Conditions: Prv = Psc * 2

- ■ 30 ms open
- ◆ 40 ms open
- ▲ 50 ms open
- — Ideal
- — Linear (50 ms open)

Pressure in Supply Bottle

$$y = 1.50x - 0.95$$
$$R^2 = 0.99$$

Measured Sample Cell Pressure (Bars)

Desired Sample Cell Pressure (Bars)

Future Plans

- **Convert algorithm to be controlled by HFIR SpICE and SNS DAS**

- **Add heater to reference volume**

- **Scale design up to 1034 bar (15000 PSIA)**

- **Fill Pressure Controller with a shock absorbing epoxy**

- **Test proportional valve at Sample Cell to see if it will give better accuracy**

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  - **Mariano Ruiz-Rodriquez, Data Acquisition**
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  - **Chris Redmon, Sample Environment**

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