Some thoughts on RPC gas system slow control

(Dongguan, 7/15/2008)

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Overview

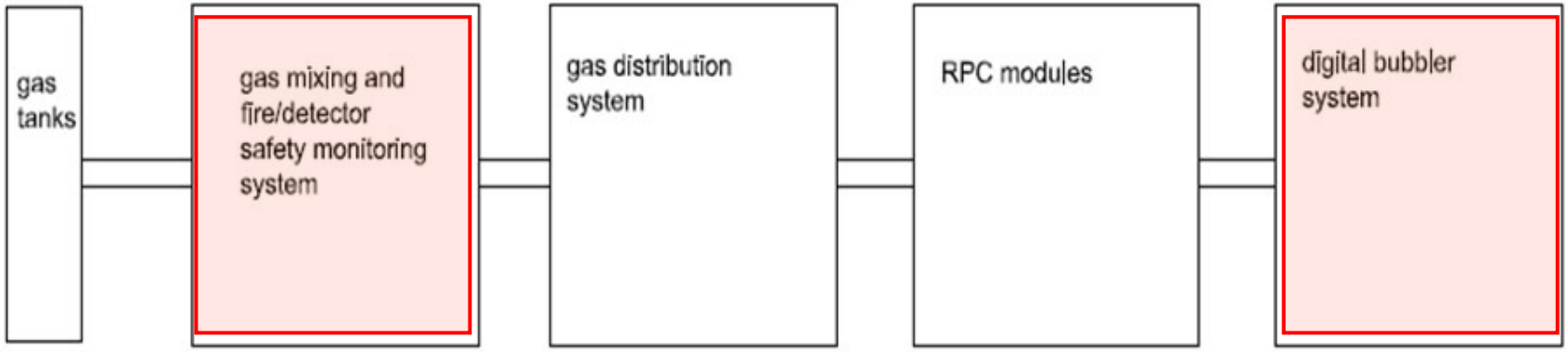
- Brief description of the Daya Bay Experiment RPC gas system;
- Signals exchanged between gas system and slow control system:

  Gas system running parameters;

  Warning sign;

  Emergency response;
- Main building blocks of the slow control screen (just for your reference);
- On-line operation instruction.

RPC Gas System



The RPC gas system has five major components:

1. The gas storage bottles, including the bottle changeover system
2. The gas mixing and fire/detector safety monitoring system
3. The gas distribution system
4. The RPCs
5. The gas exhaust system, including the output bubbler system.

2. and 5. will interact with slow control system.

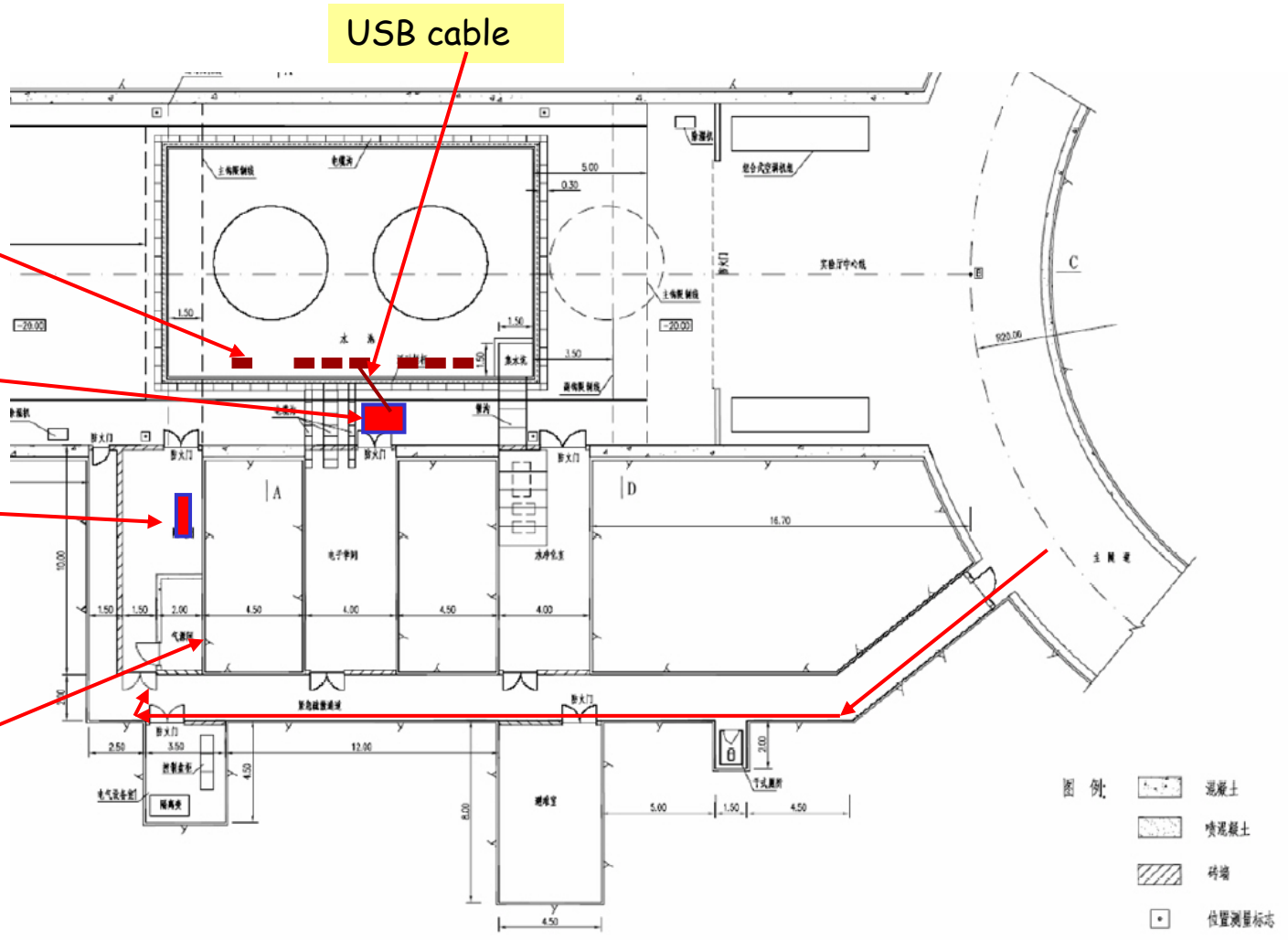
Location of the Gas System in the Daya Bay Near Hall (#1)

Gas distribution /digital bubbler system crates (total 7) on RPC support frame.

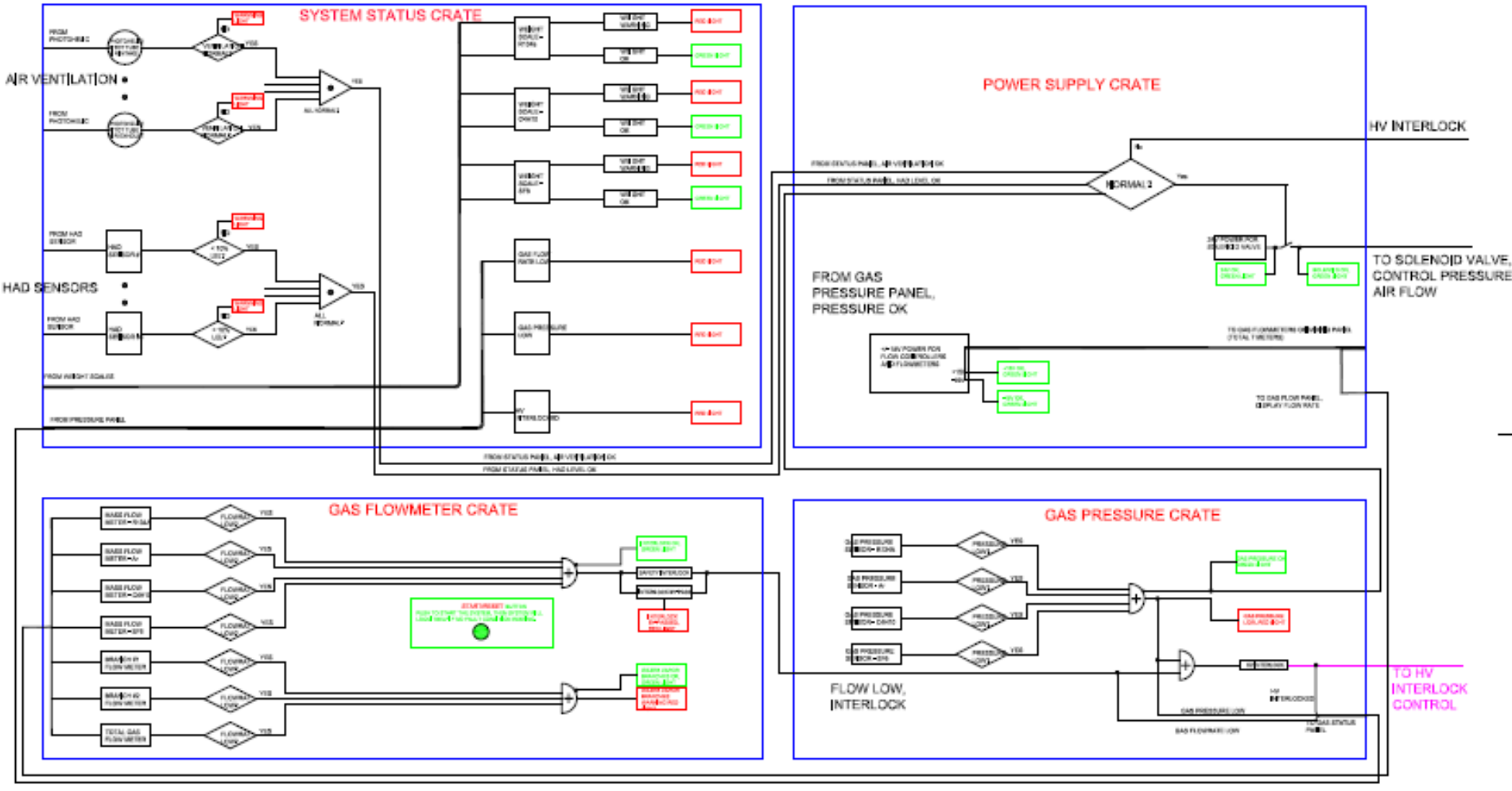
Host PC for the digital bubbler system

Gas mixing system

Gas cylinders, ODH & HAD sensors



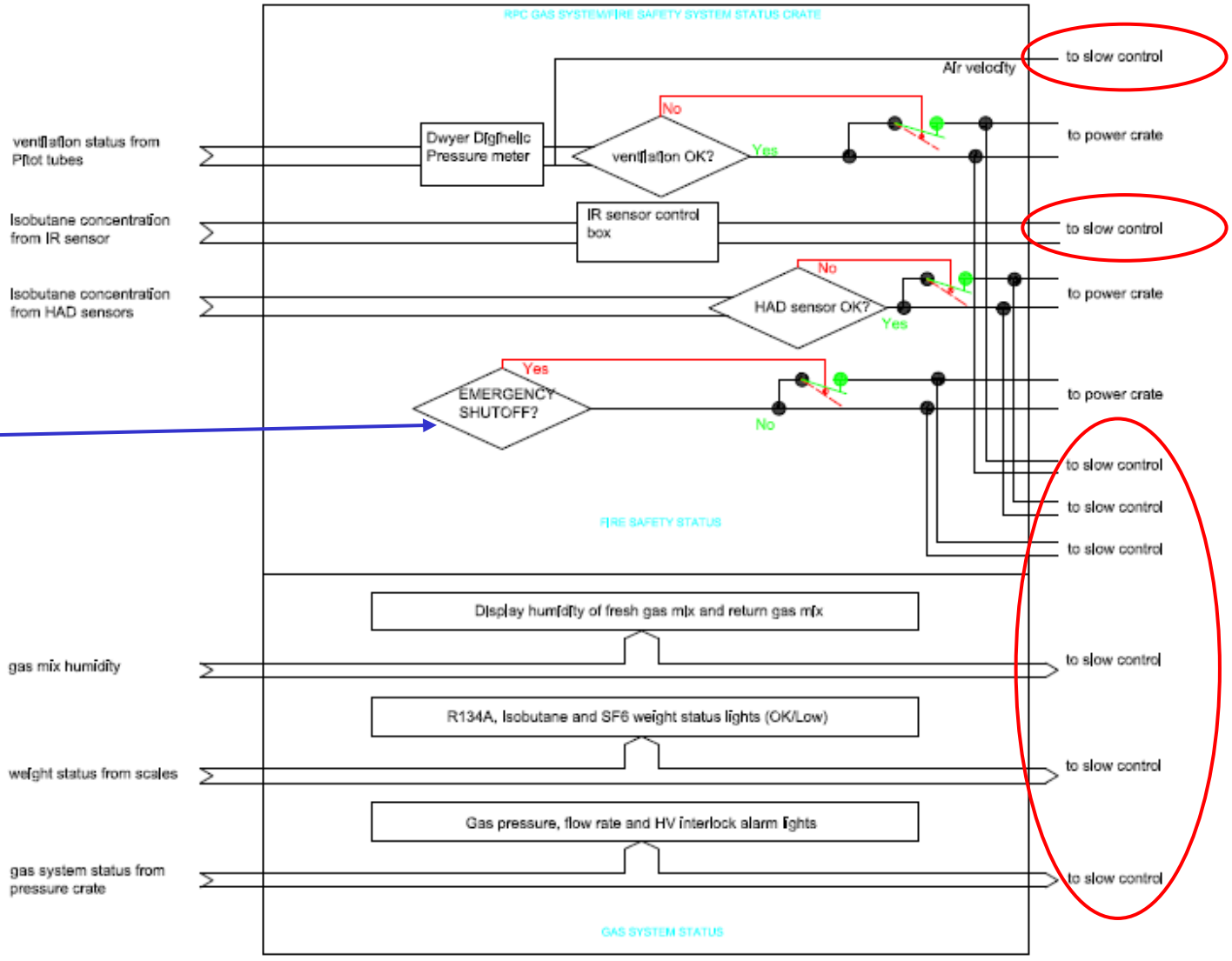
Block Diagram of Gas Control and Fire Safety Systems



Logic Diagram of the System Status Crate

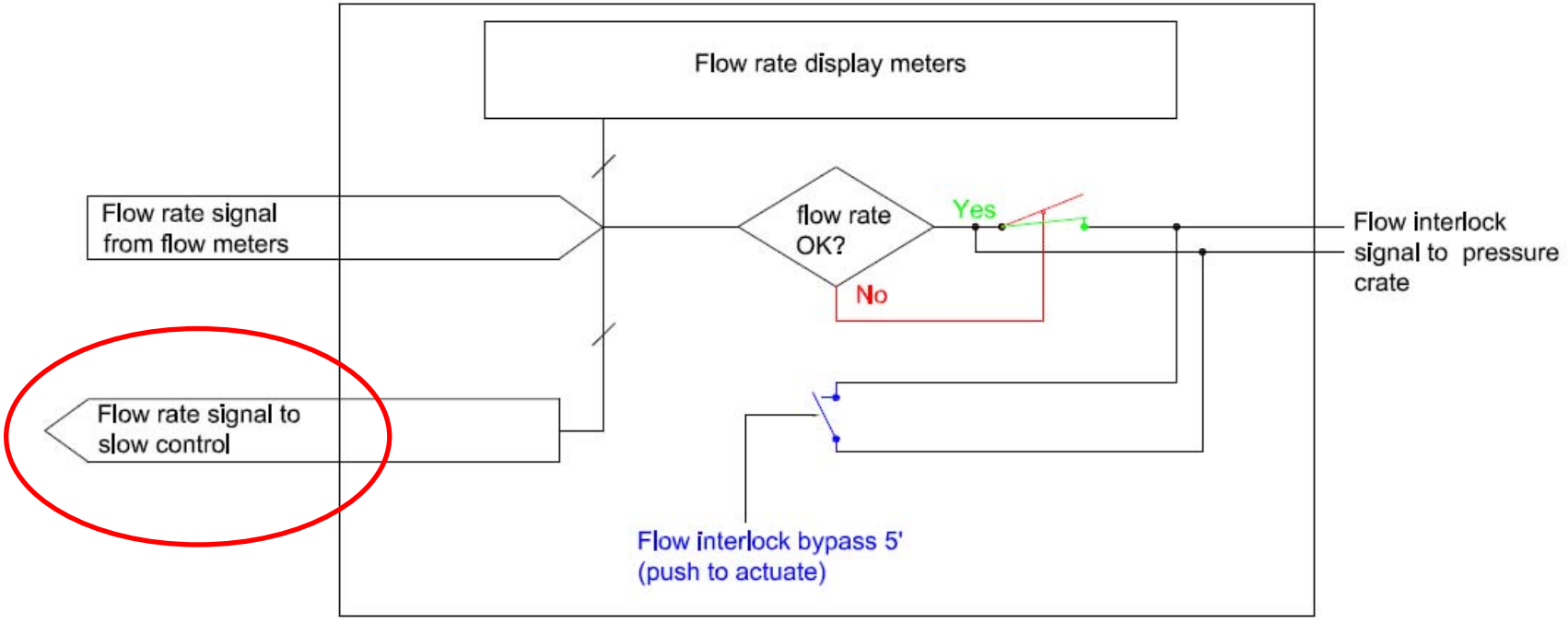
Fire safety interlock function:

If the Emergency Shutoff button is pushed, all four gases will be shut off simultaneously.



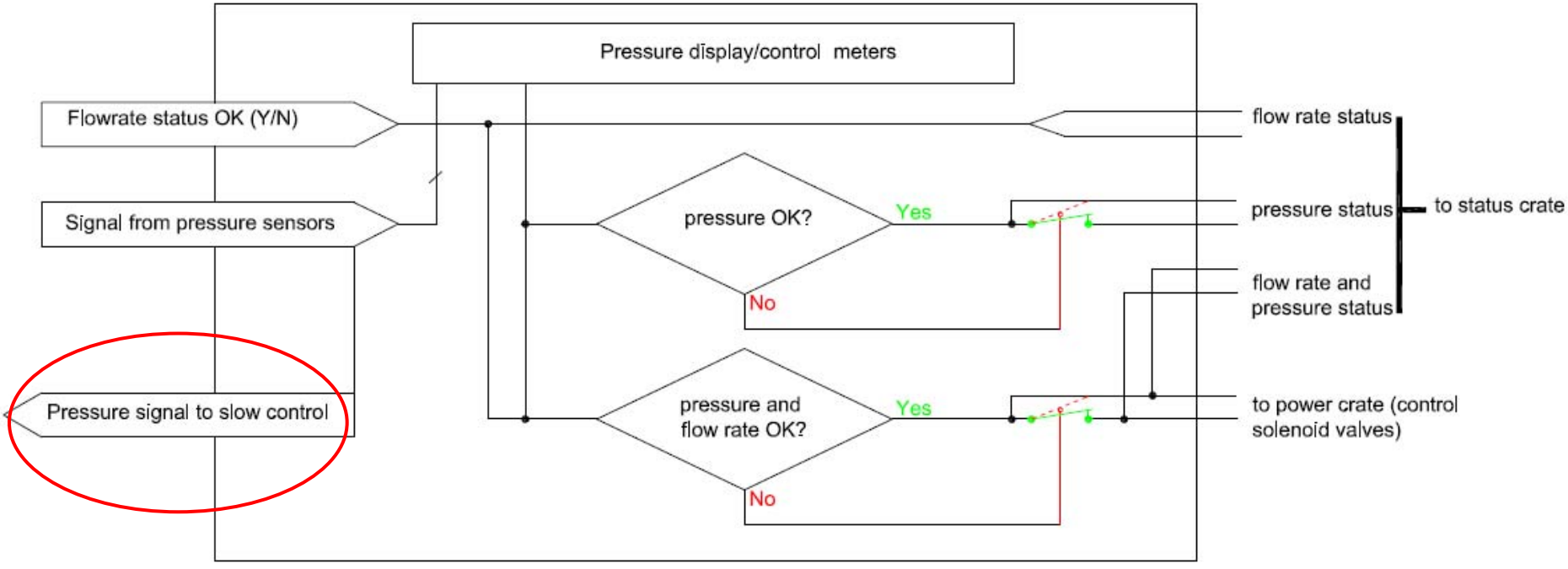
Logic Diagram of the Gas Flowmeter Crate

The gas flowmeter crate displays the gas flow rate from seven mass flow meters: one for each of the four gases, one for each of the three water-vapor-control branches.



Logic Diagram of the Gas Pressure Crate

The gas pressure crate displays the gas pressure at the upper stream of the flow controller for each gas.



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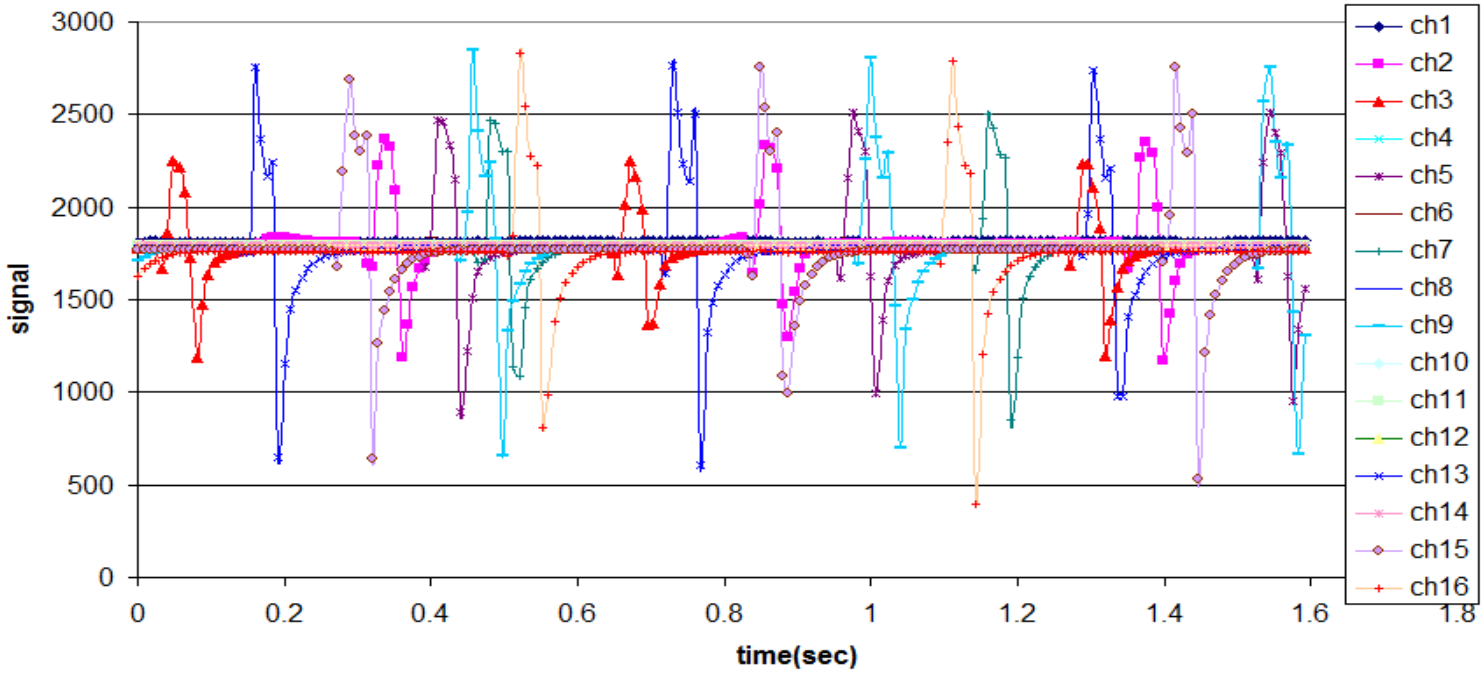
Digital Bubbler



Microprocessor ADC can reconstruct the bubble shape, the digital bubbler system can count the pulse rate and store the data file in a database.

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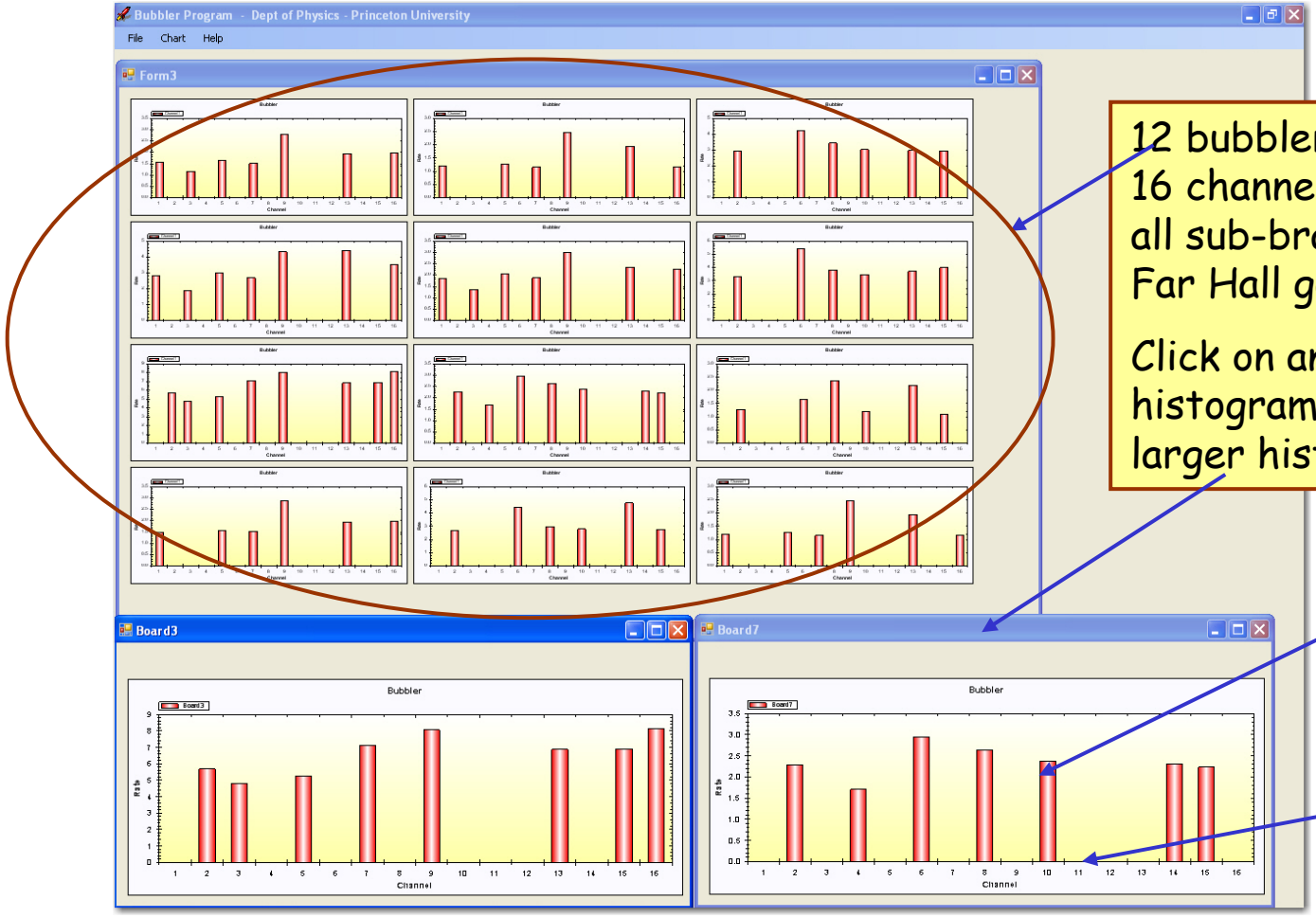
Digital Bubbler – Graphics User Interface (Far Hall)

On the host PC, the following GUI will be displayed:



12 bubbler boards, 16 channels/each, display all sub-branches for the Far Hall gas system.

Click on any one of the histograms will pop-up a larger histogram window.

Bubbling channel

Non-bubbling channel

RPC Gas System Signals for the Slow Control System

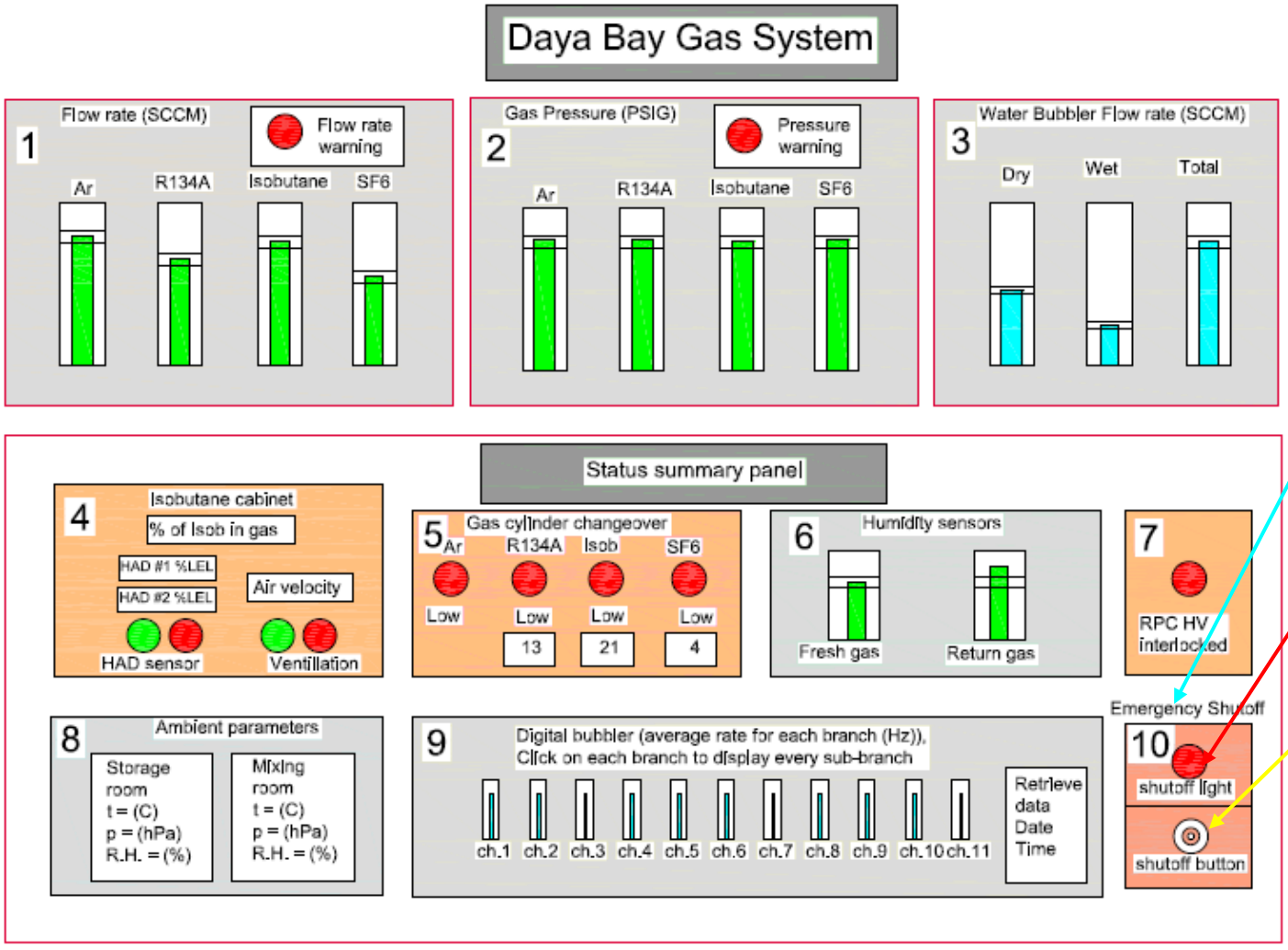
The RPC gas system will send signals to the slow control system for on-line monitor and emergency control.

- Gas flow rate for all four components, the total flow rate, and dry/wet branch flow rates for the gas mixture – Analog signal 0 – 10V and a warning signal on/off.
- Gas pressure upstream of the mass flow controllers - Analog signal 0 – 10V and a warning signal on/off.
- Gas mixture humidity – Analog signal 0 – 10V.
- Ventilation air flow rate – warning signal on/off.
- HAD sensors – warning signal on/off.
- Gas cylinder storage room/mixing room temperature/air pressure. (a stand-alone Weather Station device in the gas room).
- Gas cylinder weights – Warning signal from digital scales (analog signal also available).
- Emergency shutoff status.
- RPC HV interlock status, through slow control it should be able to control RPC HV on/standby/off.
- Gas bubbling rate for every sub-branch – Database file.

RPC Gas System Signals for the Slow Control System (cont'd)

Source Crate	Connector	Name	Signal Type	Signal Range	Slow Control
Flowmeter crate	J3	Flow rate(Isobutane)	DC level	0 - 10V	1
	J3	Flowr rate(Argon)	DC level	0 - 10V	1
	J3	Flow rate(R134A)	DC level	0 - 10V	1
	J3	Flow rate(SF6)	DC level	0 - 10V	1
	J3	Total flow rate	DC level	0 - 10V	3
	J3	Branch #1 flow rate	DC level	0 - 10V	3
	J3	Branch #2 flow rate	DC level	0 - 10V	3
Pressure crate	J6	Pressure(Isobutane)	DC level	0 - 10V	2
	J6	Pressure(Argon)	DC level	0 - 10V	2
	J6	Pressure(R134A)	DC level	0 - 10V	2
	J6	Pressure(SF6)	DC level	0 - 10V	2
Gas status crate	J7	HAD sensor status	switch	O(alarm)/C(normal)	4
	J7	HAD #1 analog out	DC current	4 - 20mA	4
	J7	HAD #2 analog out	DC current	4 - 20mA	4
	J7	IR sensor analog out	DC current	4 - 20mA	4
	J7	Ventillation status	switch	O(alarm)/C(normal)	4
	J7	Ventillation status	DC current	4 - 20mA	4
	J7	Emergency shutoff(out)	switch	click set/reset	10
	J6	Flow rate status	switch	O(alarm)/C(normal)	1
	J6	Pressure status	switch	O(alarm)/C(normal)	2
	J6	HV interlock	switch	O(alarm)/C(normal)	7
	J5	R134A weight	DC current	4 - 20mA	5
	J5	Isobutane weight	DC current	4 - 20mA	5
	J5	SF6 weight	DC current	4 - 20mA	5
	J10	Humidity(fresh)	DC level	0 - 10V	6
	J10	Humidity(return)	DC level	0 - 10V	6
Weather information	Tong Guan U.	Temperature(storage)			8
	Tong Guan U.	Humidity(storage)			8
	Tong Guan U.	Atm. pres.(storage)			8
	Tong Guan U.	Temperature(mix)			8
	Tong Guan U.	Humidity(mix)			8
	Tong Guan U.	Atm. pres.(mix)			8
Digital bubbler	Ethernet	bubble rate	Data file	PC Data file/Database	9
			Database	One PC/each hall	

What the main building blocks on the GUI may look like



All meters and indicators on screen are passive but this Emergency Shutoff Block.

If this red light is on, it means the hardware shutoff button has been pushed manually.

If for some reason the shift taker needs to push this software button, a warning sign must appear to remind the user the consequence of this action, upon receipt of the confirmation the relevant hardware action takes place.

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On-line operation instruction

Gas system has many manual knobs and buttons can be touched, unexpected modification of the setting might cause a lot of confusing to the diagnostic in case of the system warning, it also can interrupt the entire experiment because the gas mix in the RPC system needs long time to be re-stabilized. When the warning sign shows up on the on-line monitoring screen it may cause some panic reaction, thus the on-line instruction to deal with the specific warning could be very helpful. We'll provide these instructions later, so when slow control group design the system, please make such options available.

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