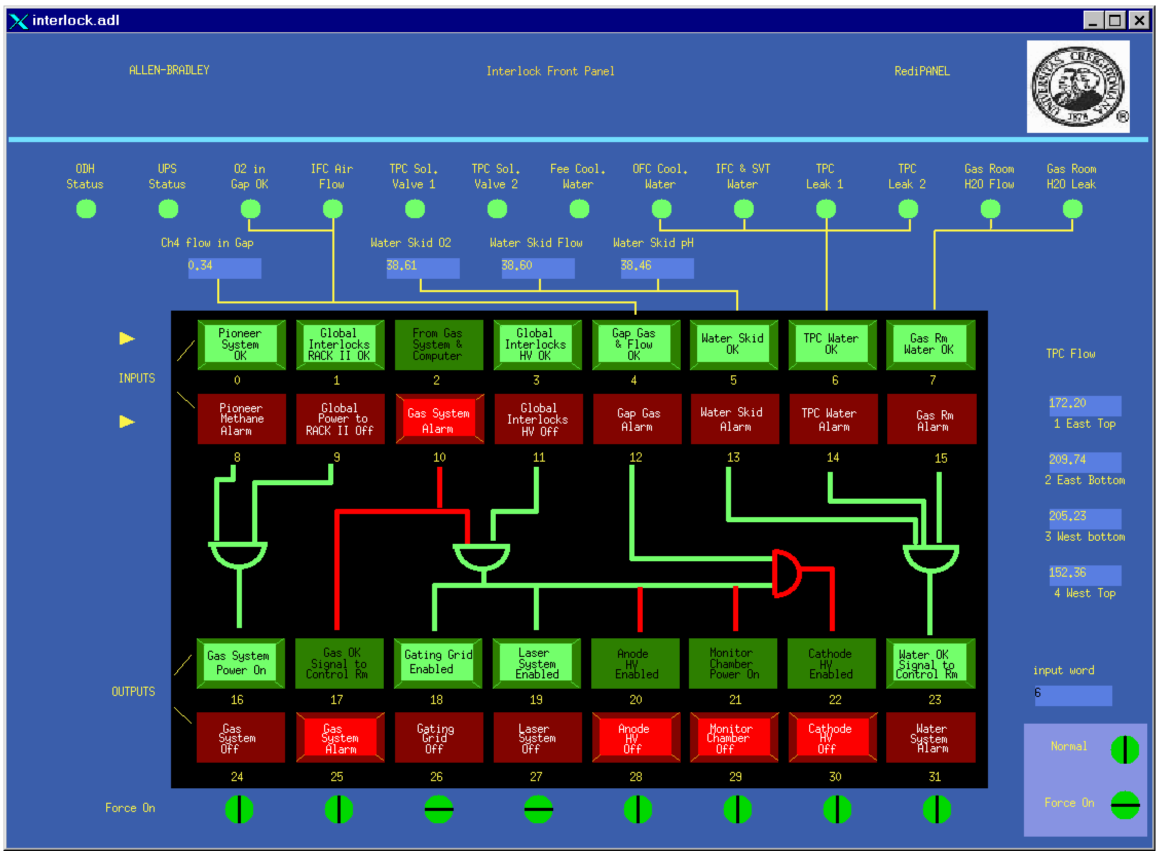
TPC INTERLOCKS MANUAL

Blair Stringfellow
5/2/00



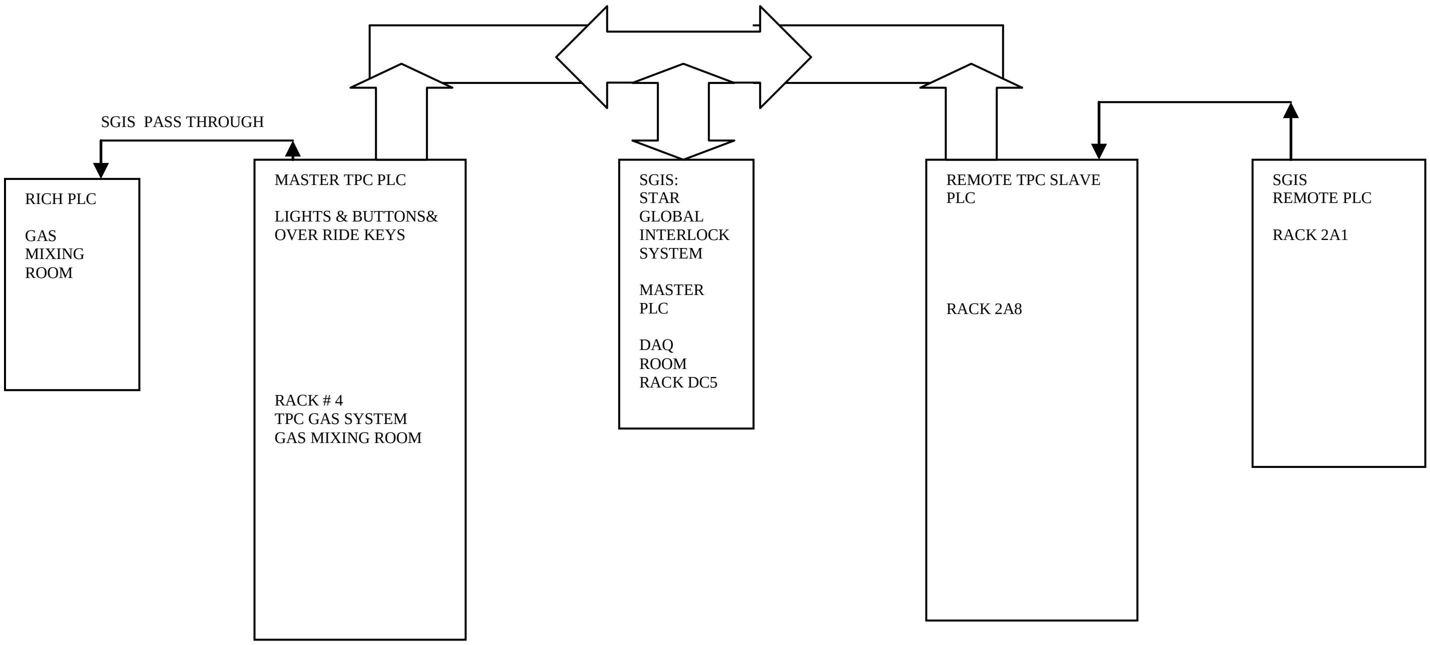
INTRODUCTION

The STAR TPC interlock system is a stand-alone Allen-Bradley PLC that is primarily used to automatically protect the TPC and sub-systems. It receives inputs from various sources and takes actions according to programmed logic. This document is intended to be a guide for dealing with the interlock trips that may arise and getting the TPC safely running again. See also the document SOP-TPC-GAS-06-A, “Allen Bradley Interlock system for the STAR TPC Gas System” by Jim Thomas.

NOTE: The PLC takes actions AUTOMATICALLY without operator intervention if unsafe conditions arise. This document is meant as a guide for the operator to figure out what happened, how to correct the problem, and get running again. Even though there is some override capability built into the system, YOU do not have authority to implement these overrides! Running with a bypassed safety system can only be attempted for debug purposes and only with the permission of Blair Stringfellow or Howard Wieman (in consultation with STAR and RHIC safety officers.) Ignoring these guidelines can result in severe damage to the TPC and/or denying STAR permission to run.

The TPC interlock system was implemented and is maintained by Jim Thomas (LBNL). Operational questions should be addressed to him or to Blair Stringfellow.

BLOCK SCHEMATIC



The master TPC PLC is in the gas mixing room in Rack #4 of the TPC gas system. This is the main indicator/input/override panel. A representation of this panel (and additional inputs) is available in the control room via slow controls. On the top level TPC GUI, click on the “Interlocks” button.

The master TPC PLC communicates over fiber optics with the main STAR GLOBAL INTERLOCK SYSTEM (SGIS) PLC located in the DAQ room. It also uses a remote (slave) PLC on the platform (back of RACK 2A8) to collect sensor inputs and send out permissives to various HV power supplies etc.

ALARM ANNUNCIATION

TPC interlock alarms (also called gas alarms) are indicated in four separate places simultaneously in the STAR complex:

1. Control room – a box is mounted on the wall containing two sets of red/green lights, a beeper and an acknowledge (silence) button. One set of lights is for gas alarms, the other for TPC cooling water skid problems. For normal running, both lights will be green. For an alarm, one or both lights will be red and the beeper will sound.

2. Counting house – a similar box is mounted in the counting house.

3. Gas Mixing Room – There is a large mechanical bell mounted on the wall of the Assembly Building (AB) just outside the gas mixing room. For any type of TPC alarm this bell will sound. There is also a flashing red light mounted on the top of Gas Rack #3 in the mixing room.

4. Detector – There is a loud horn and flashing red light mounted on the second level of the south platform. This will go off for any TPC alarm.

The global interlock system (SGIS) can also sound alarms. In the control room and counting house there is a separate box (2 red lights and beeper) for SGIS. In addition, SGIS can INDEPENDENTLY sound the horn on the detector for a global alarm. Note that for a major detector problem it is entirely possible for ALL alarms to go off simultaneously since the TPC system and SGIS have a significant degree of overlap.

TURNING OFF THE ALARM

For some alarms up to five bells or beepers will be sounding. The first job is to acknowledge (and silence) the alarms:

1. Control room and counting house – for a TPC gas or water alarm, push the acknowledge button on the beeper box and then go to the gas mixing room.

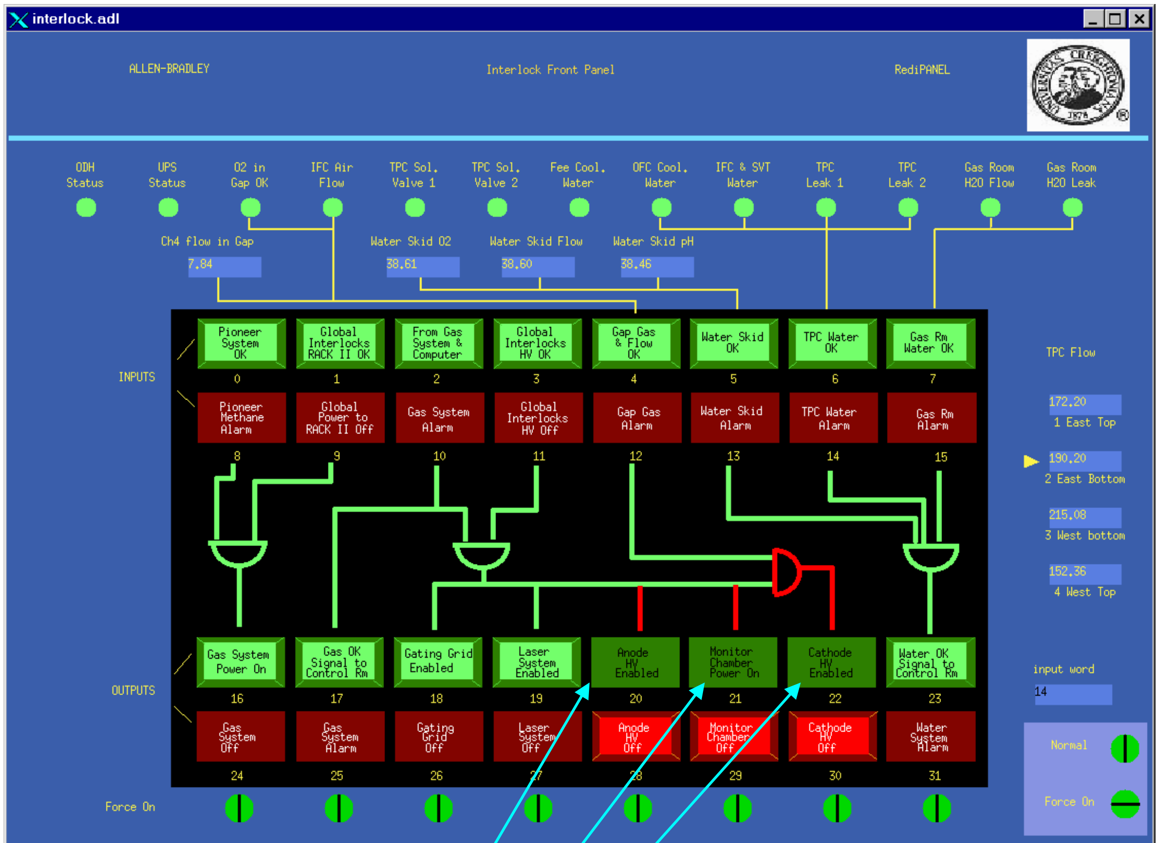
2. Gas mixing room and detector – The alarm silence pushbutton is located in TPC Gas Rack #4 near the PLC panel Pushing this button silences the alarm in both places.

3. SGIS Alarm – go to the DAQ room, Rack DC5 and push F3 on the touch panel (Alarm Silence)

Note that silencing the alarm has in NO WAY solved the problem – it just gives you peace and quiet to get on with finding out what went wrong.

TPC INTERLOCK PANEL & SCHEMATIC

The TPC interlock front panel in the gas mixing room has lights and push buttons that reflect the status of the inputs (sensors) and condition of the output permissives. As shown in slow controls, the panel looks like:



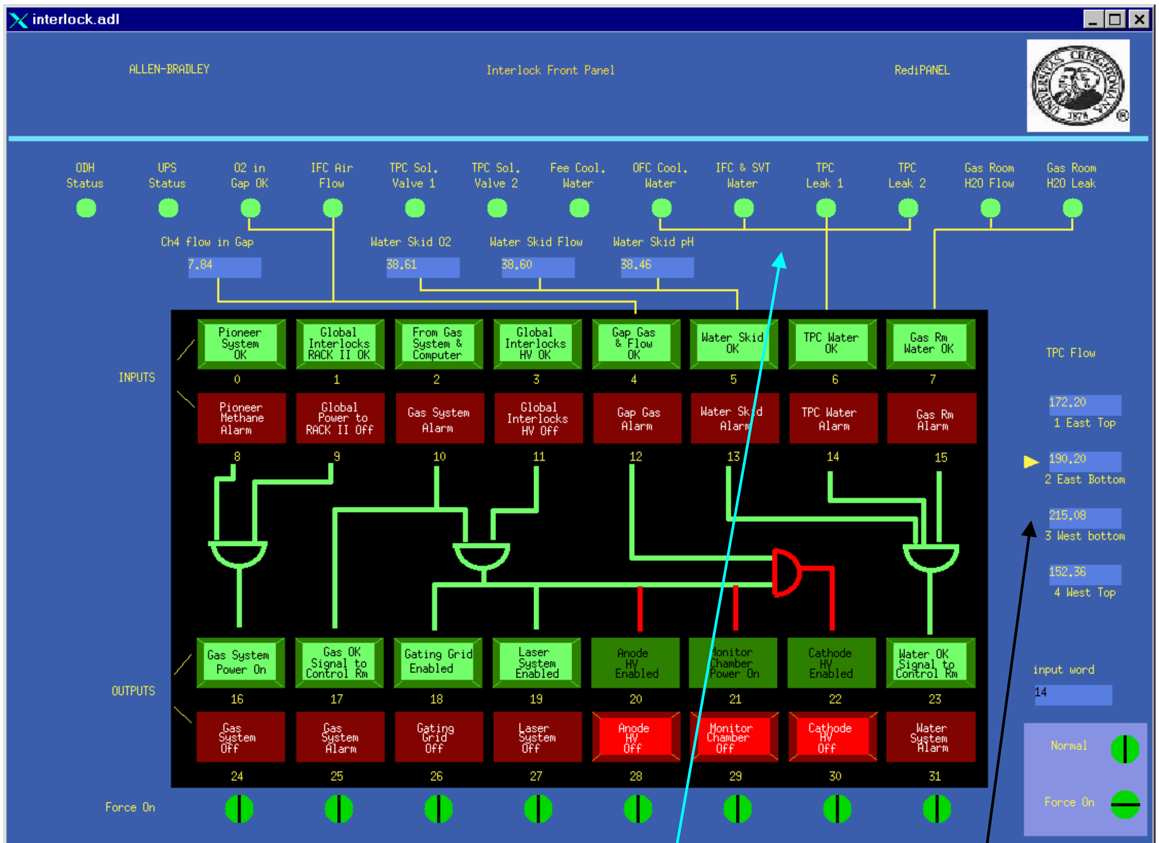
The top two rows of lights are indicators only, reflecting the status of the various safety system inputs. As shown, all inputs are green (= OK to run). If one of the inputs goes to red (= not OK) the affected subsystem will lose its permissive and the alarm will sound.

The bottom two rows of lights are both indicators and buttons. As shown, three subsystems currently do not have permission to turn on (Anode HV, Monitor Chamber and Cathode). Since the inputs for these systems are OK (i.e. all the inputs in the top row are green) their permissive can be enabled by pushing the corresponding green output buttons.

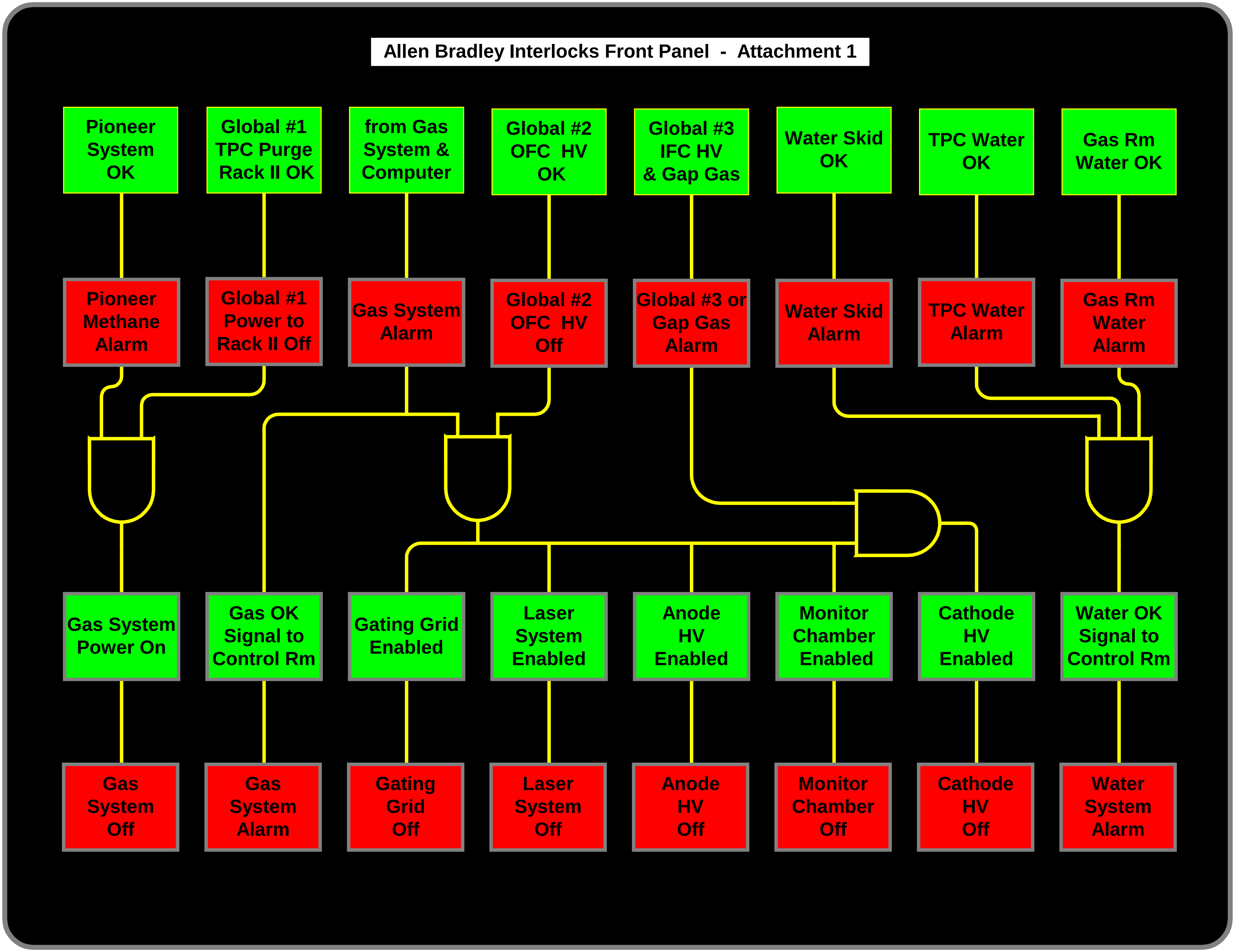
NOTE: After an alarm that drops a permissive the output will stay in a not OK state (latched off) even after the problem has been fixed. You must go to the gas mixing room to re-enable each output after an alarm.

The output lights/buttons have two additional states. A permissive can be FORCED OFF at any time by pushing the corresponding red button. The light will then flash. A flashing red light means someone wants the system to stay OFF, so you need to find the reason for this. An output can also be FORCED ON by using an override key – this can only be done by the TPC subsystem manager or his designate. Note that OUTPUT permissives can be over ridden – inputs can not be.

The slow controls GUI for the interlock system contains additional information that is not shown in the gas mixing room.



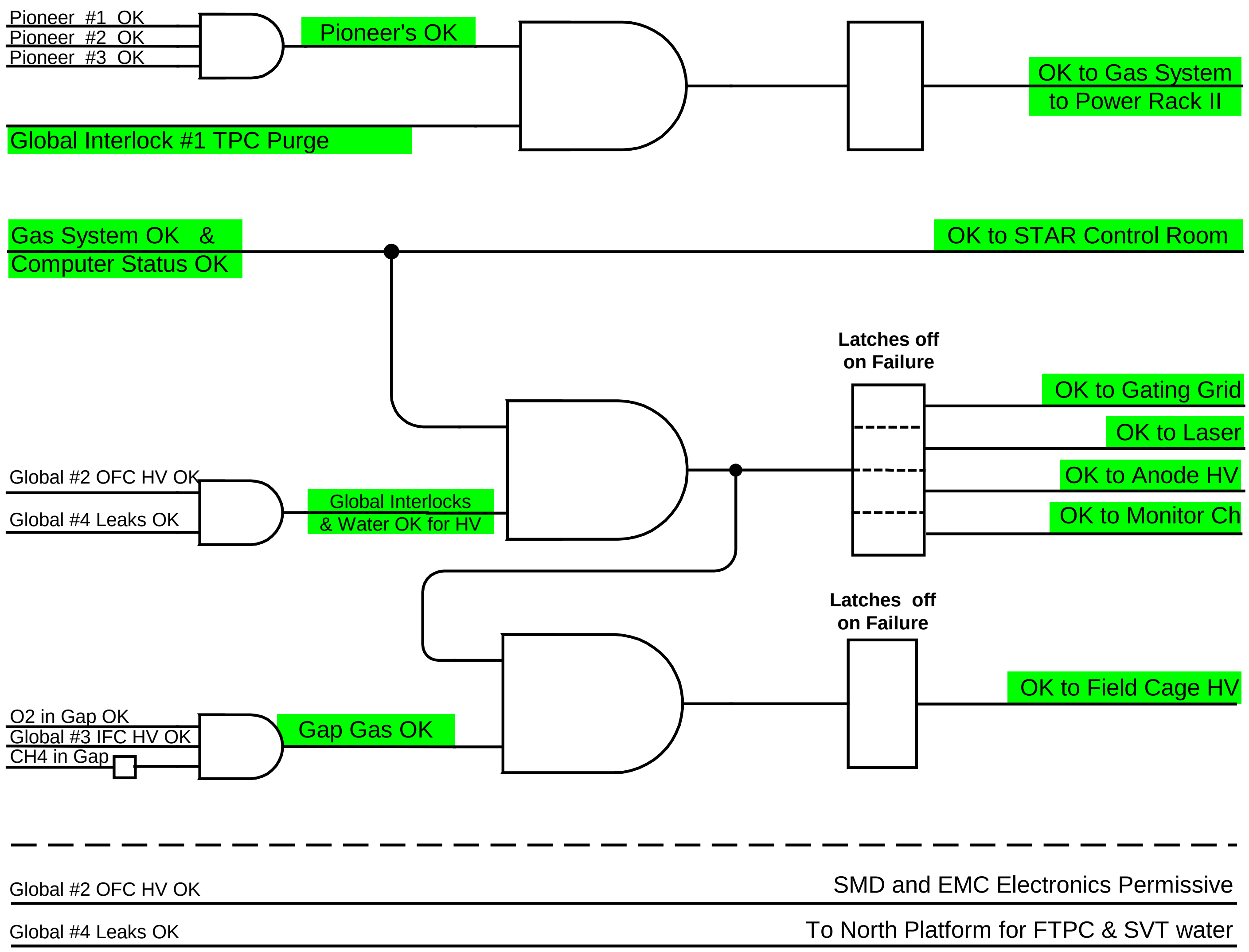
The row of round status lights across the top show various sensor inputs to the system. Also, the four TPC cooling water flow rates are shown on the right.. A more complete logic schematic for the interlock system is shown on the next several pages:



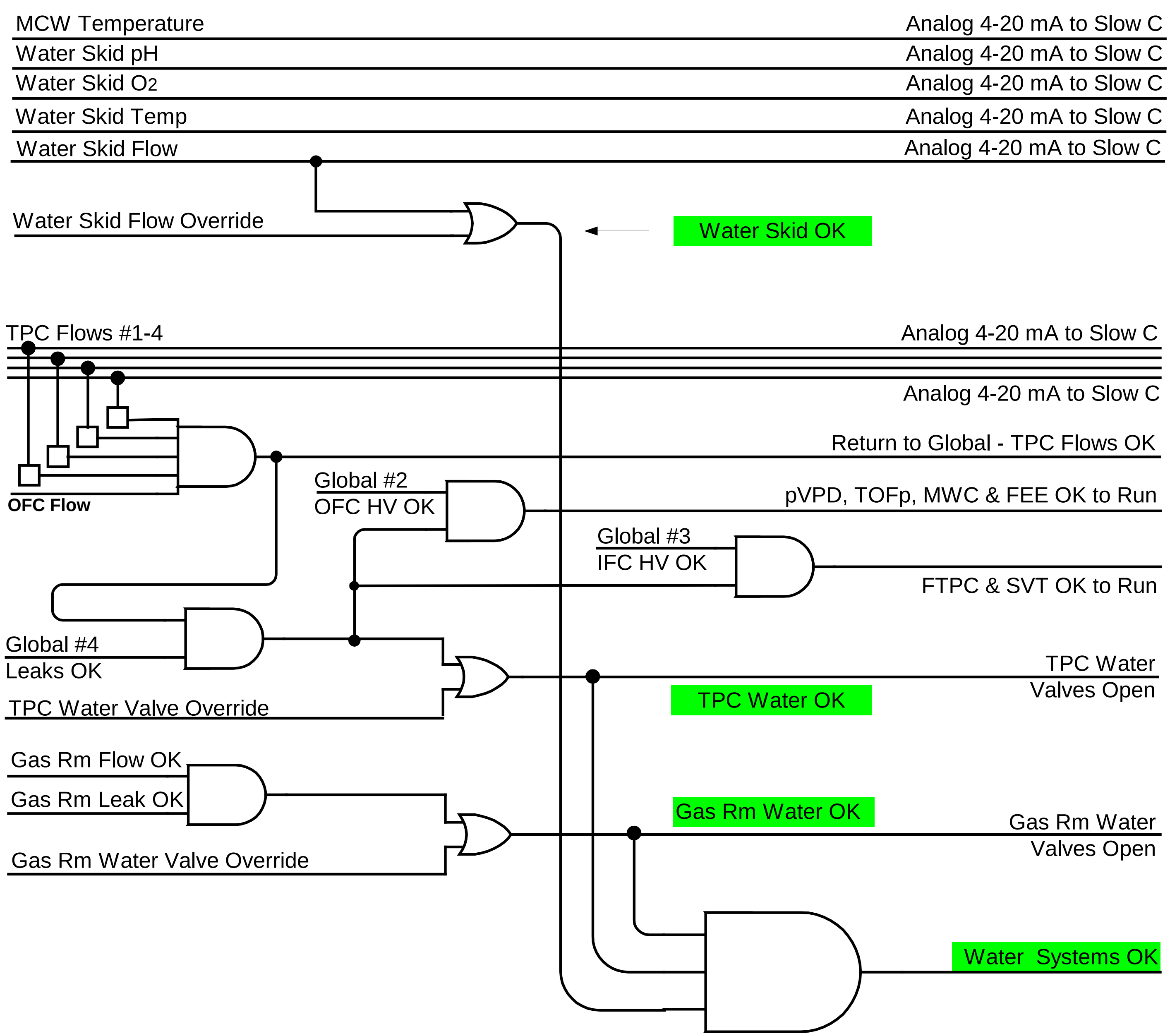
Allen Bradley Interlocks Front Panel - Attachment 1
Pioneer System OK
Global #1 TPC Purge Rack II OK
from Gas System & Computer
Global #2 OFC HV OK
Global #3 IFC HV & Gap Gas
Water Skid OK
TPC Water OK
Gas Rm Water OK
Pioneer Methane Alarm
Global #1 Power to Rack II Off
Gas System Alarm
Global #2 OFC HV Off
Global #3 or Gap Gas Alarm
Water Skid Alarm
TPC Water Alarm
Gas Rm Water Alarm
Gas System Power On
Gas OK Signal to Control Rm
Gating Grid Enabled
Laser System Enabled
Anode HV Enabled
Monitor Chamber Enabled
Cathode HV Enabled
Water OK Signal to Control Rm
Gas System Off
Gas System Alarm
Gating Grid Off
Laser System Off
Anode HV Off
Monitor Chamber Off
Cathode HV Off
Water System Alarm

Sub-System	Global Interlocks #1 TPC Purge	High Level Methane	High Level Smoke (Delayed)	Global Interlocks #2 OFC OK to Run	High Level Methane	High Level Smoke (Prompt)	Detector Water Leaks	Global Interlocks #3 IFC OK to Run	High Level Methane	High Level Smoke (Prompt)	Detector Water Leaks	IFC Air Flow	Global Interlocks #4 Detector Water Leaks	Pioneer Gas Alarm - Methane in Gas Rm	Gas System Fault & Computer Status	Gas Room Water Leak	Gas Room Water Flow	TPC E&W Face Water Flow	OFC Water Flow	Methane in TPC Insulator Gap	Oxygen in TPC Insulator Gap	Water Skid Flow	Water Skid pH	Water Skid Oxygen Level	Water Skid Temperature	ODH Status	UPS Status	MCW Temperature
STAR Control Room - Water Alarm							X				X		X			X	X	X	X			X						
STAR Control Room - Gas Alarm		X	X		X	X			X	X				X	X													
TPC Water Valves Close							X				X		X					X	X			X						
Gas Rm Water Valves Close																X	X											
Power to TPC Gas System		X	X		X	X			X	X				X														
TPC Gating Grid		X	X		X	X	X		X	X	X		X	X	X													
TPC Anode		X	X		X	X	X		X	X	X		X	X	X													
TPC Cathode		X	X		X	X	X		X	X	X	X	X	X	X					X	X							
TPC Monitor Chamber		X	X		X	X	X		X	X	X		X	X	X													
Laser		X	X		X	X	X		X	X	X		X	X	X													
RICH		X	X		X	X	X		X	X	X		X	X														
FEE, MWC, TOFp & pVPD Electronics		X	X		X	X	X		X	X	X		X					X	X			X						
SVT & FTPC Electronics		X	X		X	X	X		X	X	X	X	X					X	X			X						
EMC & SMD Electronics		X	X		X	X	X		X	X	X		X															
SVT & FTPC Water							X				X		X															
Slow Controls		X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X

Attachment 2: Allen Bradley Logic Diagram



Attachment 2: Allen Bradley Logic Diagram (continued)



Attachment 3: Allen Bradley Crate & Module Map

Master Crate in Gas Room

P2 Power Supply	CPU 5/03	1747-SN	1746-NI4	1746-IB16	1746-NI4	1746-OW16	1746-OX8	1746-IB16	1746-IB32	1746-OB32
	16K Mem	RIO Scanner	Analog Input	24 V Input	Analog Input	24 V Output	Relay Output	24 V Input	24 V Input	24 V Output
	OS 302	to remote crate	4 Ch.	16 Ch.	4 Ch.	16 Ch.	8 Ch.	16 Ch.	32 Ch.	32 Ch.
			4-20 mA or 0-10 V DC		4-20 mA or 0-10 V DC	Two groups of 8	Indep ch's contact closure		Kbrd button input	Kbrd lights output
			Gap CH_4 **pH Flow O_2**	**4- Pi** **Gas Flow** **Gas Leak** **Gas OK** **Gap O_2**	**TPC Temp** **MCW Temp**	**Eight Kybd Out** **OFC OK** **TPC Valves** **Gas Rm Valves**		**Kbrd Ovrd 8 inp** **Water Skid Ovrd** **TPC Flow Ovrd** **Gas Flow Ovrd**		
Full Slot Addressing	0	1	2	3	4	5	6	7	8	9
				ODH (8) Gas Lo Lv Alarm (9) UPS (11) Three Gas Rm Inputs (13) FTPC(14) MCW(15)		IFC OK (11) Three Platform Outputs (13-15)	Gas Alarm (1) Pioneer Alarm (2) Global #2 (3) Global #1 (4) Global #4 (5) Gas OR Water (6) Water Alarm (7)	Platform Alarm & Reset (11)		

Attachment 3: Allen Bradley Crate & Module Map (continued)

Slave Crate on Platform

		0	32	64	96	128	160
P2 Power Supply	1747-ASB RIO Adapter from master crate	1746-NI4 Analog Input 4 Ch. 4-20 mA or 0-10 V DC **4 - TPC Flow**	1746-OW16 Relay Output 16 Ch. Two groups of 8 **Eight Kybd Out** **OFC OK** **TPC Valves** **Gas Rm Valves**	1746-IB16 24 V Input 16 Ch. **Glob #1** **Glob #2** **OFC Flow** **Glob #3** **Glob #4**	1746-OX8 Relay Output 8 Ch. Indep ch's contact closure **MWC (0)** **Flows OK (5)** **Kybd Out (1-4,6,7)**	1746-IG16 TTL Input 16 Ch. from Slow Control	1746-OG16 TTL Output 16 Ch. to Slow Control
1/2 Slot Addressing		0, 1	2, 3	4, 5	6, 7	8, 9	10, 11
			IFC OK (11) Flows OK (12) Three Gas Rm Outputs (13) FTPC(14) MCW(15)	4 TPC Flow Status (8-11) Three Platform Inputs (13-15)			

TTL 1 = B3:0
TTL 2 = B3:1
TTL 3 = B3:2
TTL 4 = B3:3
TTL 5 = B3:4
TTL 6 = Kpad 1&2
TTL 7 = Kpad 3&4
TTL 8 = Local Analog 1
TTL 9 = Local Analog 2
TTL 10 = Local Analog 3
TTL 11 = Local Analog 4
TTL 12 = Rmt Analog 1
TTL 13 = Rmt Analog 2
TTL 14 = Rmt Analog 3
TTL 15 = Rmt Analog 4
TTL 16 = Local Input
TTL 17 = Rmt Input
TTL 18 = Local Analog 5
TTL 19 = Local Analog 6
TTL 20 = Local Analog 7
TTL 21 = Local Analog 8

B3:0 = Logical inputs (0-11) [First level logic] (8 == OFC OK to run, 9 == TPC Flows OK, 10 == TPC Leaks OK, 11 == IFC OK to run)
B3:1 = Temp outputs (0-11) [Second level logic] (same map as B3:4)
B3:2 = Forced On Reg (0-10) (8 == Water Skid, 9 == TPC Water Valves, 10 == Gas Rm Water Valves)
B3:3 = Forced Off Reg (0-7)
B3:4 = Enable Output (0-11) (8 == OFC OK to run, 9 == TPC Water Valves, 10 == Gas Rm Water Valves, 11 == IFC OK to run)

ALARM RESPONSE FOR OPERATORS

In the following pages, each type of alarm will be explained. Specifically, for each input to the interlock system, the following information will be given:

1. INPUT: Where the sensors are located, what they are measuring, and what the alarm threshold is.

2. ACTIONS TAKEN BY PLC: What actions are taken by the PLC and what subsystems are affected.

3. RESET: What needs to be done to reset the interlock, including who to call if it is not solely STAR’s responsibility.

PIONEER METHANE DETECTOR

The Pioneer methane detector checks for leaks in the gas mixing room. The controller is mounted on the south wall between TPC Racks 1 & 2.

INPUTS: There are three sensor heads in the mixing room. One is mounted on top of TPC Rack 2, another is mounted inside TPC Rack 3 and the third is located at the bottom of the RICH gas rack. The sensors are sniffing the room air for the presence of methane and will alarm for a concentration of 18% LEL Methane in air. (LEL = Lower Explosive Limit = ~ 5% in air).

ACTIONS TAKEN BY PLC: For any ONE of the three sensors above threshold, the following actions are taken:

1. AC Power to Rack 2 of the TPC gas system is cut. This puts the TPC gas system into purge mode (Argon) and closes the methane inlet solenoid valves.

The power to Rack 2 comes from a three phase solid state relay mounted in a box on the south wall of the gas mixing room between racks 2 & 3. The power is held on by the 24 volts control voltage supplied by the interlock system. Absence of this control voltage drops the power to Rack 2.

2. ALL permissives for the TPC HV are dropped (Gating Grid, Laser, Anode, Monitor Chamber, & Cathode)

3. The RICH gas system goes into safe mode.

RESET: This is a MAJOR alarm and recovery can not be attempted by shift leaders alone! CALL:

TPC Expert
TPC Gas Expert
RICH Expert

GLOBAL INTERLOCKS RACK II OK

This is an input from the STAR Global Interlock System (SGIS) that permits the TPC gas system to run with P10.

INPUTS: There are two conditions that cause the permissive to be removed:

1. High Level Alarm: High Sensitivity Smoke Detector.(HSSD) This is a system that senses smoke around the detector in the WAH.

2. High level gas alarm. There is a sniffer system located in Rack 2A2 that draws air samples from the TPC face through 8 separate tubes. If methane is detected at the level of ~ 12% LEL, the unit generates a high level alarm.

ACTIONS TAKEN BY PLC: For a HSSD High Alarm:

1. After a 10 minute delay, drop the permissive for the gas system.

For a High Level Gas Alarm:

1. Immediately drop the permissive for the gas system.

Upon removal of the permissive, the power to Rack 2 of the TPC gas system goes off, the TPC is purged with Ar and the methane inlet valves are closed.

NOTE: The TPC volume is 50,000 liters of P10. The Argon purge is at the rate of ~ 120 lpm. To purge the TPC to a level that is considered safe by CAD (i.e. P8) takes ~ 1 hour.

Both these alarms are major STAR alarms and the SGIS will take further action, such as tripping platform power. See the SGIS manual.

RESET: These are major STAR alarms that result in complete shutdown of the STAR detector. For HSSD, the fire department will be on the way.

Call: MCR X4662
STAR Global Interlock Expert
TPC expert
TPC gas expert

FROM GAS SYSTEM & COMPUTER

This is the input from the TPC gas system. The gas system has its own system of interlocks and alarms, which can come from the hardware alarm box (top of Rack 2) or from the control computer (Rack 1). These alarms can be of varying degrees of severity, but they are ALL annunciated through the Allen-Bradley system.

INPUTS: The gas system alarms can be split into two broad categories:

1. High level alarm – usually indicates something wrong with the TPC pressure, methane content etc. Various actions are taken by both the gas system itself (compressor turned off, vent opened) and by the Allen-Bradley PLC (see below)

2. Low level (informational alarms). Usually indicates a non-emergency problem (gas bottle low, delivery pressure not adjusted etc)

ACTIONS TAKEN BY PLC:

High level alarms that turn off the permissives for the TPC HV (Gating grid, laser, anode, monitor chamber and cathode.)

From the computer:

- TPC pressure too high (PT8)
- TPC pressure too low (PT8)
- Oxygen too high (M1)
- Water too high (M2)
- Ar-Methane flowmeter ratio too high
- Ar-Methane flowmeter ratio too low

From the hardware alarm box:

- Return Pressure from TPC too high (PT5)
- Return pressure fromTPC too low (PT5)
- Oxygen too high (M1)
- Water too high (M2)

Truth tables for the gas systems (with alarm limits) are posted in the gas mixing room.

For low level alarms, the PLC merely sounds the alarm (“gas alarm” in control room, counting house, AB and WAH). No other action is taken.

RESET: ANY gas alarm needs attention from a gas system expert – call.

GLOBAL INTERLOCKS HV OK

This is a separate input from the global system (SGIS) which permits the TPC HV to be turned on. There is a significant overlap between this input and the “Global Interlocks RACK II OK” (see above), since putting the gas system into purge mode will independently turn off all HV. However, this input adds one more condition dealing with water leaks.

INPUTS: There are three conditions that cause the HV permissive to be dropped:

1. High Sensitivity Smoke Detector (HSSD) High Alarm.

2. High level gas alarm – from the methane sniffer in Rack 2A2.

3. Cooling water leak – east TPC face, west TPC face or RICH. There are three “Tracetek” water detection cable circuits that loop through the water cooling manifolds of the TPC and RICH. Any alarm from these circuits causes the HV to trip and the TPC water skid to shut down (see below).

ACTIONS TAKEN BY PLC: For a HSSD High Alarm:

1. Causes an immediate trip of the HV (but a 10 min delay before causing a gas system purge – see above). Note also that this alarm turns off ALL power on the platform, so it is triply redundant.)

For a High Level Gas Alarm:

1. Trips all TPC HV (and power to the platform)

For a Water Alarm:

1. Trips all TPC HV (Gating Grid, Laser, Anode, Monitor Chamber & Cathode) and shuts down the water skid (see below under “TPC Water OK”).

RESET: Again, the smoke and gas alarms are major STAR alarms that shutdown the whole detector. Call MCR, SGIS expert, TPC gas expert.

A water alarm will require an access to investigate the cause and to reset the Tracetek controller (Rack 2A1). See below under “TPC Water OK”.

GAP GAS & FLOW OK

Between the TPC outer field cage and the outer gas containment vessel is a 5 inch gas insulating gap. This volume is continuously purged with dry nitrogen, which acts as the insulator. The return gas is sampled to test for oxygen, water and methane. The controls and meters for the insulation gas system are in Rack 4 in the gas mixing room. In addition, to prevent a possible buildup of Methane in the inner field cage region (where the SVT is mounted), a continuous flow of conditioned air is maintained. The air blower is maintained by the SVT group and sits in the WAH on the floor (east end of the magnet). This are is not sampled, but there is a flow switch in the exhaust line.

INPUTS: 1. Oxygen in gap is < 200 ppm. The Oxygen meter (M6) is mounted in Rack 4 in the gas mixing room.

2. Methane in gap < 18% LEL. The methane meter is in Rack 4 in the gas mixing room (M8).

3. IFC air flow ok. The flow switch is mounted in a grey PVC tube which comes from the SVT cover plate on the west side. The end of the tube (and the switch) is mounted on the magnet face.

ACTIONS TAKEN BY PLC: 1. For high oxygen, high methane, or no IFC flow the permissive for the **cathode** only is dropped, since it is the only ignition source in these regions.

RESET: 1. For a high oxygen or high methane, contact a TPC gas system expert.

2. For the IFC air flow, request an access and check the SVT air blower. If ok, check the flow switch – it has a red LED that should be OFF if the flow is ok. If the interlock still won't clear, contact a TPC expert or Jim Thomas (interlock expert.)

Note: The only place to check the status bit of the IFC air flow is on the slow controls Interlock GUI accessible from the top level TPC GUI. The status is indicated by the "IFC Air Flow" light (green = ok).

<u>WATER SKID OK</u>

This input has not been implemented yet and should always be OK (= green). It will eventually have inputs from the TPC water skid (located in AB second floor utility room) indicating total water flow, dissolved oxygen and pH.

TPC WATER OK

The TPC water skid (located in the second floor utility room) supplies water for the TPC FEE and read-out boards (RDO), SVT RDO boxes, RICH safety box and the gas mixing room. The skid exchanges heat with the STAR Modified Chilled Water (MCW) that is also cooling the racks on the platform and in the DAQ room. In general, the interlock system is checking for minimum flow rates in all branches and for leaks.

INPUTS: 1. Flow rates from the four main cooling branches:
East top, East bottom, West Top, West Bottom
The flow meters are mounted on the magnet face, shielded by mu metal.
2. Global HV OK (see above)
3. Flow rate from the branch that circulates water along the outer containment vessel (called CTB flow on the schematic).
4. IFC & SVT Flow – a dummy input always OK.
5. TPC leak #1 & #2 – from the east and west Tractek leak detection circuits threaded through the cooling manifolds.
6. RICH leak – independent Tracetek circuit for the RICH loop.

ACTIONS TAKEN BY PLC: For any alarm (low flow, Global HV or leak) the platform slave PLC for the TPC will close the main supply and return valves for the cooling water. This will cause the skid to shut down.

The TPC water alarm will sound (second red/green light in the control room and counting house) and if there is a leak there will also be a global alarm.

The valves are located in the water lines just after they cross from the west wall to the magnet. They are driven open or closed by 110 VAC. There is an indicator on the backs of the valves which shows if they are open or closed.

RESET: For a leak:

An access will be needed to check for the source of the leak. With the pole tips in this may be non-trivial! Also, the Tracetek control units, mounted in Rack 2A1 have a reset button that has to be pushed before the alarm can be cleared. For a real leak, the control box will have a red LED status light on. Once the source of the leak alarm has been determined, the skid can be restarted. Note that the leak indication MUST be cleared both at the controller and at the Global PLC.

Restarting the skid:

The skid will be shutdown for an alarm, but it can also trip off during a power dip etc. To restart:

Call the CAS watch (X2024) or MCR (4662) and request that they send a pump room person over. The skid is the responsibility of CAD but the interlocks and permission to restart are STAR's responsibility. DON'T restart the skid unless you are satisfied that there are no leaks in the WAH!

Before restarting the skid it is necessary to over ride and open the main supply and return valves. Go to the back of Rack 4 in the gas mixing room and locate the two keys labeled "TPC H2O OVRD" and "GAS RM H2O OVRD". Turn both keys to the over ride position (horizontal). This will force the supply and return valves open. On the front PLC panel (Rack 4) the top green lights labeled "TPC Water OK" and "Gas Rm Water OK" should be flashing green.

Tell the pump room tech to start the skid. When the skid comes up to full flow, a green ok light will come on (near the start pushbutton). Check that the skid flow is ~ 270 GPM or greater (flow meter on the skid front panel.) If skid flow looks ok, return to the gas mixing room and return both keys to the normal (vertical) position. The green light near the keys (labeled "FEE cooling water ok" should be green and the two lights on the PLC panel should be green and not flashing.

If the alarm goes off again when you turn the keys to normal, then there is still a problem and the skid will shutdown again.

NOTE: NEVER run the TPC skid with the keys in over ride for longer than it takes to restart the skid. In override there is NO leak protection and the entire contents of the reserve tank could be dumped on the experiment.

GAS ROOM WATER OK

A branch of the TPC water line is used to cool equipment in the gas mixing room. The lines are located on the south wall of the AB just outside the gas mixing room. A manifold with visual flowmeter, flow switch and solenoid valves is also located there. The water is used in three of the TPC gas system racks:

1. Rack 1 for the Rosemount methane analyzer water jacket.
2. Rack 2 for the heat exchanger after the compressor and for the mass flowmeters.
3. Rack 3 for the cooling jackets of the two Rosemounts.

Leak detection is provided by a local Tracetek circuit with the controller mounted in back of Rack 4.

INPUTS: 1. Flow switch ok – mounted on the manifold outside the mixing room. Flow >` 1 GPM = OK.

2. Tracetek leak detector ok.

ACTIONS TAKEN BY PLC: For lack of flow or leak indication:

1. Close the local supply and return solenoid valves mounted on the manifold. The solenoids are powered open (110 VAC) by supplying a 24 V control signal to a solid state relay mounted in a box on the south wall of the AB.

2. Sound the TPC water alarm in the control room, counting house, WAH and AB.

Closing the gas room water solenoids will NOT affect the water skid – it will keep running. Lack of cooling water to the gas system is not necessarily a major alarm. However, the Rosemount methane analyzers will quickly lose calibration and the gas being sent to the TPC will not be constant temperature.

RESET: For a leak, find the source and fix it. After the leak has been repaired, allow the Tracetek cable to dry out and then push the reset button on the Tracetek controller (back of Rack 4). Then turn the over ride key labeled “Gas Rm H2O OVRD” – this should open the solenoid valves. Go to the water manifold outside the mixing room and check that the visual flowmeter shows ~ 2 GPM and that the LED on the flow switch is out.

Return the over ride key to the normal position.

HARDWARE CONNECTIONS

The following is a brief description of how the PLC controls each system:

1. Gas system:

   The power to Rack 2 comes from a three phase solid state relay mounted in a box on the south wall of the gas mixing room between racks 2 & 3. The power is held on by the 24 volts control voltage supplied by the interlock system. Absence of this control voltage drops the power to Rack 2 . This will cause the gas system to close the methane inlet valves, open the vent valve, and start an Argon purge (~75 lpm).

2. Gas system alarm:

   1. The alarm boxes in the control room and counting house are home built devices containing lights, relays and a reset switch. They get power from local AC to DC converters. The signals from the PLC get to the alarm boxes using phone lines.

   2. The alarm bell in the AB (mounted on the wall outside the gas mixing room) is a 110 VAC bell controlled by a solid state relay mounted in a box nearby. The PLC supplies the control voltage (24 V) for the relay.

   3. The alarm horn and light mounted on the platform in the WAH are controlled from the remote TPC PLC.

3. Gating Grid – the VME crate for the gating grid driver modules (Rack 2A6) has an inhibit input at the front of the crate (DB15 connector). The remote PLC on the platform supplies 24 volts for this input, which is dropped to 12 volts by a Zener diode in the connector hood. A voltage < 12 volts = inhibit.

   Note: The pulser VME crate (Rack 2A5) has a similar inhibit input (for historical reasons.) Thus, even though the pulser is not an ignition source, it has the same interlock as the gated grid, also supplied from the remote PLC via a DB 15 connctor.

4. Laser System – the laser system is interlocked by a contact closure from the remote PLC. (Contact closed = OK to run.) The cable goes into the laser interlock box mounted in back of Rack 1A9. (Burndy twist lock connector).

5. Anode HV off – the interlock for each Lecroy HV crate is supplied by the remote TPC PLC. The permissive to run is a contact closure supplied on a BNC cable which plugs into the “Macro” input on the front of the Lecroy crates (Rack 2A7). We use the macro input in place of the normal interlock input since it is remotely resettable.

6. Monitor Chamber – the monitor chamber is located inside Rack 3 in the gas

mixing room. It can be used to measure electron transmission in the TPC gas (in case of questions about gas quality). Under normal condirtions the chamber is OFF and is of no concern. It is interlocked by turning off the Nim Bin which contains the HV modules. The Nim Bin is mounted in Rack 4 of the gas system.

7. Cathode HV – the Glassman HV power supply (mounted in Rack 2A3) is interlocked by a contact closure from the remote TPC PLC.. The cable attaches to the TB1 terminal strip on the back of the Glassman. (See the Glassman manual and documentation supplied by Greg Harper from U of Wash.)

8. Water System Alarm – the water skid is shut down by powering closed the supply and return valves located in the WAH. This slows the flow enough that the flow switch on the skid interupts the pump power. The AC power to drive the valves is controlled by the remote PLC, with the AC coming from the UPS at the top of Rack 2A9. The power for the five water flowmeters also plugs into this UPS, as does the PLC itself.