SOP-TPC-GAS-O6-A

Allen Bradley Interlock System for the STAR TPC Gas System

Text Pages 1 through 12
Attachments 1 through 6

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Version 2.6 03/10/2001

Allen Bradley Interlock System for the STAR TPC Gas System

1.0 Purpose and Scope

An Allen Bradley interlock system has been developed in order to monitor the functioning of the STAR TPC gas system and to ensure that no ignition sources are operating while the system is in a potentially unsafe state. This document will outline the operation of the Allen Bradley interlock system, define the inputs and outputs, define the operating procedures for this interlock system, and describe a calibration, maintenance, and testing schedule and procedure.

The interlock system has expanded in scope since version 1.0 of this document was issued. The system includes all of the previous functionality, and operates in an essentially identical manner, but now the system also monitors the cooling water flow to the TPC and the Gas Mixing room. If any of these water systems fails, the interlock system sends an alarm to the STAR control room and signals Slow Controls to turn off the Front End Electronics (FEE) power. The interlock system also causes the inline water valves to the TPC and the Gas Room to close, thereby stopping the water flow, until the cooling water problem is understood and corrected.

2.0 AFFECTED SYSTEMS

TPC GAS SYSTEM, ANODE HV, FIELD CAGE HV, TPC GAS MONITOR CHAMBER, GATING GRID, LASER CALIBRATION SYSTEM, FEE ELECTRONICS, TPC WATER VALVES, GAS MIXING ROOM WATER VALVES.

3.0 Description of the Hardware

The Allen Bradley interlock system enables power to all systems that are potential sources of ignition on the TPC and in the gas room. These include the Anode High Voltage for the TPC multi-wire proportional chambers, the Gating Grid, the Field Cage High Voltage, the Monitor Chamber High Voltage, and the Laser Calibration System. In addition, the Allen Bradley interlock system controls power to the TPC gas system and shuts off the power if methane gas is detected in the Gas Mixing room. The AB interlock system also kills power to the gas system if requested to do so by the Global Interlock system. Killing power to the gas system automatically puts the TPC in purge mode. (A separate document describes the TPC gas system in more detail.)

The Allen Bradley interlock system also monitors the TPC cooling water system. If the system is operating normally, the AB computer merely opens and closes the water valves in the Gas Room and at the TPC upon request. But if the water systems has insufficient flow, a leak, or highly corrosive water (measured by pH and dissolved oxygen content), then the AB computer closes the valves and alerts the operators in the STAR control room.

The Allen Bradley interlock system uses two inputs from a Pioneer gas monitoring system located in the Gas Mixing Room to sense whether the gas system is leaking methane into the Gas Mixing Room. The alarm levels for the Pioneer are set within the Pioneer system and thus the signal to the Allen Bradley is either 24V (methane below alarm level) or 0V (methane above alarm level or input disabled).

The AB computer monitors inputs from the TPC gas system that reflect the operational status of the gas system, plus two sensors that measure the Oxygen content and Methane content of the TPC insulator gas gap, and a flow sensor that tells whether cooling air is being flushed through the TPC inner field cage. The signal from the insulator gas Methane sensor is a variable (4-20 mA) current loop. The other signals are +24V or 0V.

The new additions to the AB system include monitor signals to sense the flow of cooling water throughout the TPC systems and signals to report a leak in any of these systems.

The status of the inputs and outputs are shown on an LED light panel mounted in the gas room. (See attachment 1.) These signals are also reported to the STAR slow controls system. The Allen Bradley system also sends two signals to the STAR control room showing the status of the TPC gas system and the TPC cooling water system.

The Allen Bradley system itself is very robust. The AC power for the system is backed up by a UPS (duration ~20 minutes) and the AB computer is equipped with an EEPROM that ensures proper operation after a long term power failure.

4.0 **Operating Status**

The status of the Allen Bradley inputs is shown at all times by a series of red and green lights on an LED light panel in the Gas room. (See Attachment 1.) The top two rows of the display panel show the state of the various input channels. The first column shows the status of the Pioneer methane monitoring system. The second column shows whether the Global Interlock system is ready. The third column shows the status of the TPC gas system. This system is equipped with many internal sensors that monitor the status of the P10 gas. These signals are combined into a single output that is fed into the Allen Bradley system. Should there be a problem with the P10 gas system, an LED light panel at the top of the gas system (Rack 2) allows for a diagnosis of the problem independent of the Allen Bradley. The fourth column shows whether the Global Interlock system has given permission to apply HV to the TPC anodes and cathode. The fifth column represents the status of the insulator gas gap. It monitors the output of a methane and oxygen sensor sampling the return flow from the insulation gap gas and also monitors the inner field cage air flow. The sixth, seventh, and eighth columns show the status of the water systems at the TPC cooling water skid, at the face of the TPC, and in the gas room. In all cases, a green light indicates an “OK” state, while a red light indicates an alarmed state.

The Allen Bradley system controls a series of relays that enable the power to the subsystems. The status of the outputs is shown by a series of red and green lights in the third and fourth rows of the LED display system. Each output can be in one of four states:

ON: The system is enabled for normal operation. This requires that all inputs relevant to this system are OK and that the green output button has been depressed, manually, to unlatch the channel.

OFF: The system is disabled.

FORCED ON: The system is forced into an on state regardless of the state of the inputs. This state can only be achieved by inserting a key into the LED light panel and turning it. Access to the keys is restricted to experts, the keys are kept in a locked cabinet, and all keys must be logged in and out whenever they are used by a trained individual. The FORCED ON state is shown by a flashing green light and this information is relayed to STAR Slow Controls.

FORCED OFF: The inputs are ignored and the system is OFF. This state has highest priority. Any system can be immediately disabled by pressing the red FORCED OFF button. This is the default mode after Allen Bradley start-up.

Note that each output can only be put into the ON mode if a button on the Allen Bradley control panel is depressed. This means that each system must be actively enabled after a power failure or alarm. Should any relevant input fail, power to these systems is immediately cut or permission to operate is denied. All inputs are 'fail safe' by requiring active inputs.

The outputs require the following valid inputs to be in an ON state (see Attachment 2 for a logic diagram):

Gas System Power On: Pioneer methane sensors OK, Global interlocks OK

STAR Control Room and Global Interlocks Status Return Signal: Pioneer OK, Gas System OK

Gating Grid Enabled: Pioneer OK, Gas System OK, push button latch reset

Laser Calibration System Enabled: Pioneer OK, Gas System OK, push button latch reset

Anode HV Enabled: Pioneer OK, Gas System OK, push button latch reset

TPC Gas Monitor Chamber Enabled: Pioneer OK, Gas System OK, push button latch reset

Field Cage HV Enabled: Pioneer OK, Gas System OK, Insulator Gas Oxygen Sensor OK, Insulator Gas Methane OK, Inner Field Cage air flow OK, Global interlocks OK, push button latch reset

Water Systems OK Status: Sufficient water flow at four points near the TPC; pH, dissolved Oxygen, and cooling water flow OK on the TPC water skid, CTB cooling water flow OK, Inner Field Cage water flow OK, no water leaks on either end of the TPC, Gas Room cooling water flow OK, and no water leaks in the gas room

FEE Cooling Water OK: Sufficient water flow at four points near the TPC

TPC Water Valves Open: CTB cooling water flow OK, Inner Field Cage water flow OK, no water leaks on either end of the TPC

Gas Room Water Valves Open: Gas Room cooling water flow OK, and no water leaks in the gas room

5.0 Operating Procedures

5.1 **Normal Operation:** Starting up the entire system requires the assistance of a Global Interlocks system expert, a TPC water system expert, a TPC gas system expert, and an Allen Bradley system expert (see Attachment 6).

5.1.1 Upon start-up of the Allen Bradley system, Pioneer inputs 1 & 2 should be OK.

5.1.2 Global Interlock system expert should start the Global Interlock computer. Global interlocks must be in an OK state.

5.1.3 TPC water system expert should start the TPC cooling water system in the power supply room (aka. the Water Skid.). When the Water Skid flow is sufficient and stabilized, the Water Skid OK light will be illuminated. When the cooling water flow to the TPC is sufficient and stabilized, the TPC Water OK light will be illuminated. When the cooling water flow to the Gas Mixing Room is sufficient and stabilized, the Gas Room Water OK light will be illuminated. Finally, the Water Systems OK light will be illuminated.

5.1.4 Depress green Gas System button to enable power to TPC gas system.

5.1.5 Follow start-up procedures for TPC gas system and the insulation gas system:

5.1.5.1 SOP-TPC-GAS-02-A "Starting the STAR TPC Gas System and Purging the TPC With Dry Nitrogen."

5.1.5.2 SOP-TPC-GAS-03-A "Operating the STAR TPC Gas System with P10 Gas"

5.1.5.3 SOP-TPC-GAS-05-A "Operating the STAR TPC Insulating Gap Gas System"

5.1.6 After P10 is flowing in the TPC, the "**From Gas System & Computer**" status input should be OK.

5.1.7 When the insulation gas is good, the "gap gas" light will be green. (Methane less than 20% LEL, Oxygen less than 200 ppm, air flow OK.)

5.1.8 Check to see that no outputs are in **Forced On** mode (the green button will be blinking). If any outputs are in **Forced On** mode, find an expert for that sub-system.

5.1.9 To enable the TPC Anode HV, first use the Slow Controls Anode interface program to ensure that the "demand" voltage for ALL sectors is set to zero. (SOP-TPC-HV-01-A) Then push the "**Anode HV Enabled**" button on the interlock front panel.

5.1.10 To enable the Gating Grid power supply, first use the Slow Controls gating grid interface program to ensure that the "demand" voltage is set to zero. (SOP-TPC-HV-03-A) Then push the " **Gating Grid Enabled**" button on the interlock front panel.

5.1.11 To enable the Laser system, first turn the "LAMP POWER" potentiometer on the laser control box to zero (fully counterclockwise). (SOP-TPC-LASER-01-A) Then push the "**Laser System Enabled**" button on the interlock front panel.

5.1.12 To enable the Gas System Monitor Chamber, first confirm that the HV pots for the monitor chamber power supplies (NIM Bertan HV power supplies) are turned to zero (fully counterclockwise). The power supplies are in the NIM BIN in Rack 4 and are labeled "Anode", "Cathode" and "Drift". (See Attachment 6 of SOP-TPC-GAS-03-A "Operating the STAR TPC Gas System with P10 Gas.") Then push the "**Monitor Chamber Power**" button on the interlock front panel.

5.1.13 To enable the TPC Cathode HV, first use the Slow Controls Cathode interface program to ensure that the "demand" voltage for the cathode is set to zero. (SOP-TPC-HV-02-A "Operating the STAR TPC Field Cage") Then push the "**Cathode HV Enabled**" button on the interlock front panel.

5.2 After Pioneer Input Failure

5.2.1 Call a TPC gas system expert. (See Attachment #6)

5.2.2 With the assistance of the TPC gas system expert, use the slow controls display or Allen Bradley light panel to find the location of the tripped methane sensor.

5.2.3 Determine reason for tripped methane sensor with the assistance of the gas system expert.

5.2.4 Fix problem with assistance of an expert.

5.2.5 If all Pioneer inputs are OK, proceed with steps 5.1.1 to 5.1.13

5.3. After Gas System Failure

5.3.1. After a Gas System failure, the gas system will be in purge mode. In this mode, the TPC is flushed with an inert gas (Argon or Nitrogen).

5.3.2. Check status of Pioneer inputs. If they are **not** OK, proceed to step 5.2.

5.3.3. Contact TPC gas system expert (see Attachment #6) to diagnose problem.

5.4. After Insulator Gas Oxygen or Methane Sensor trip

5.4.1. Contact Insulator Gas expert (see Attachment #6).

5.5. **After a Water System Failure**

5.5.1. Contact Water System expert (see Attachment #6).

6. Methane Gas Sensor Calibration and Interlock Testing Procedure (See Attachment 5)

6.1. Methane Gas Sensor Calibration procedure

6.1.1. The Pioneer Methane Gas sensors must be calibrated yearly. This calibration involves setting the alarm levels on the Pioneer system so that the gas system is disabled when the methane level reaches ~18% LEL. In order to do this calibration, reference samples of methane in air are required. The procedure for setting the alarm levels is the following:

6.1.2. Place evacuated plastic bag around one sensor.

6.1.3. Fill bag with reference gas (20% LEL).

6.1.4. Refer to Pioneer manual for calibration procedure, if required.

6.1.5. Check to ensure that the corresponding Allen Bradley Pioneer input is in a failed state.

6.1.6. Repeat procedure with a second reference gas below the set point (10% LEL).

6.1.7. Check to ensure that the corresponding Allen Bradley Pioneer input is in an OK state.

6.2. Methane in Insulator Gap (N_2) Gas Calibration procedure

6.2.1. Repeat procedure 6.1 using 20% LEL methane in nitrogen reference mixture on the Matheson gas detector in the gap gas exhaust line.

6.3. Trigger Methane Alarm and Test Interlocks

6.3.1. Follow Normal operation procedure (section 5.1) to bring system into operational state.

6.3.2. All output systems should now be enabled.

6.3.3. Place evacuated plastic bag around one methane sensor.

6.3.4. Fill bag with reference gas (20% LEL)

6.3.5. All output systems should now be disabled by the Allen Bradley system. Check to ensure that this is the case:

6.3.6. For the gas system: Power to Rack 2 should be off and inert gas should be flowing in Flow Meters FI5 and FI6 (located in Rack 2) The methane mass flow controllers FM1 and FM2 (located in Rack 1) should read zero.

6.3.7. For the other systems: attempt to energize each system in turn following the steps outlined above (5.1.9 - 5.1.13). None of the systems should be operational.

6.3.8. During any maintenance to the Allen Bradley system, no interlocked systems should be used. The Allen Bradley is *required* for operation of these systems. Under no circumstances should the Allen Bradley be circumvented or bypassed. Note also that the oxygen sensors in the TPC and gap gas systems have a finite lifetime and should be replaced at regular maintenance intervals.

6.4. Power Off the Allen Bradley Computer

6.4.1. Disconnect the power cord to the Allen Bradley Computer

6.4.2. Check that all TPC electronics are disabled

6.4.3. Check that the water system shut down

6.4.4. Check that the gas system powered down and went into purge mode

6.4.5. Restart the AB system using the Normal operating procedures and verify that all systems recovered.

6.5. Global Interlock Alarms

6.5.1. Have global interlock personnel generate alarm condition #1

6.5.2. Check that the alarm disables the TPC electronics

6.5.3. Have global interlock personnel generate alarm condition #2

6.5.4. Check that the power to the gas system is off (rack 2). The gas system should be in purge mode.

6.5.5. Clear all alarms and restart all systems using normal operating procedures

6.6. Gas System Alarms

6.6.1. Have gas system personnel generate a “low level” alarm

6.6.2. Check that TPC gas system alarms ring in the control room

6.6.3. Check that no other action is taken

6.6.4. Have gas system personnel generate a “high level” alarm

6.6.5. Check that all TPC electronics are disabled

6.7. Inner Field Cage Air Flow

6.7.1. Disconnect power to the Inner Field Cage blower

6.7.2. Check that the TPC Cathode power supply is disabled

6.7.3. Power up the IFC blower

6.7.4. Check that TPC Cathode power supply can be re-enabled

6.8. TPC Leak Alarm

6.8.1. Have TPC or global interlock personnel generate a TPC leak signal

6.8.2. Check that the water flow valves located on the face of the TPC are closed when the alarms sounds

6.8.3. Check that the TPC water skid has stopped

6.8.4. Clear the leak condition and restart the water skid

6.9. Gas and Water System Alarms

6.9.1. Initiate any alarm condition that will trigger the gas system or water system alarms.

6.9.2. Check that the alarm lights light, and the bells sound in the STAR Trailer, in the STAR Control room, and in the Collision Hall.

6.9.3. Replace any burned out bulbs or failed horns & bells.

6.10. TPC Water Flow and FEE

6.10.1. Turn the TPC water skid on and off.

6.10.2. Observe the flow meters on the second floor platform

6.10.3. Check that the FEE low voltage power supplies are enabled when the flows are normal and that the FEE supplies are disabled when the flows are low.

6.10.4. Also check that the green indicator lamp located inside the back door of the TPC gas system rack is working and reports the proper FEE status.

6.11. UPS System Test

6.11.1. Unplug the power to the UPS system on the second floor platform. The Allen Bradley remote crate should remain on and the flow meters should continue operating.

6.11.2. Test for 2 minutes and reconnect the power.

6.11.3. Unplug the power to the UPS in the gas room. The Allen Bradley master crate should remain on and the gas system should continue operating.

6.11.4. Test for 2 minutes and reconnect the power.

7.0 Documentation

All readings, calibrations, and Allen Bradley control program changes should be recorded in the STAR TPC Gas System Interlock logbook.

8.0 References

1. TPC gas mixing room schematic - STAR Drawing # TPC584-E-1

2. TPC insulation gas schematic - STAR Drawing # TPC585-E-1

3. TPC gas pad schematic - STAR Drawing # TPC 586-E-1

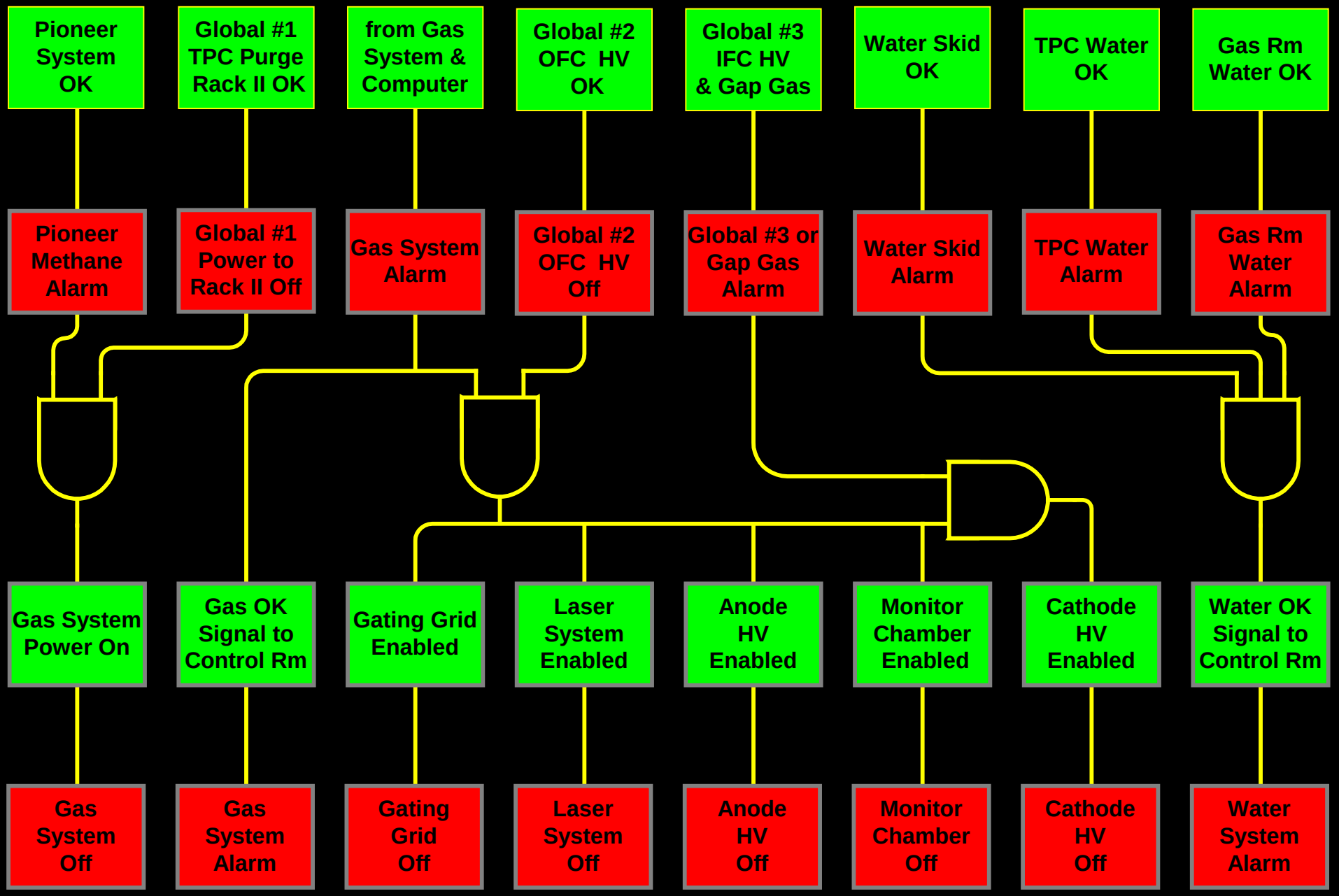
4. Pioneer Gas Monitor Operator's Manual

5. Allen Bradley SLC Operator's Manual

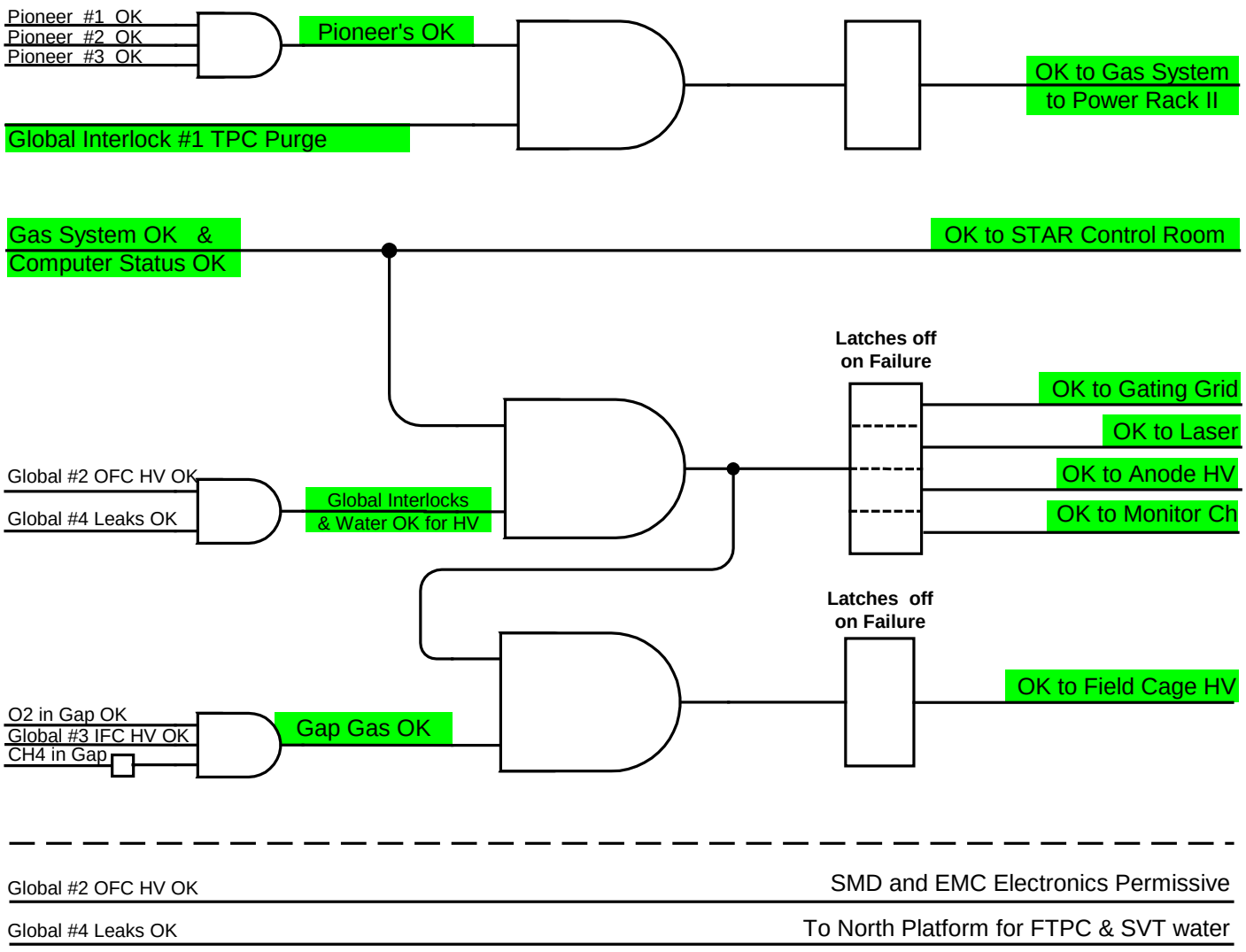
9.0 **Attachments**

1. Allen Bradley Interlock Front Panel
2. Allen Bradley Logic Diagram
3. Allen Bradley Crate & Module Map
4. Rules for Issuance of Allen Bradley override keys.
5. TPC Interlocks Certification Log
6. List of System Experts

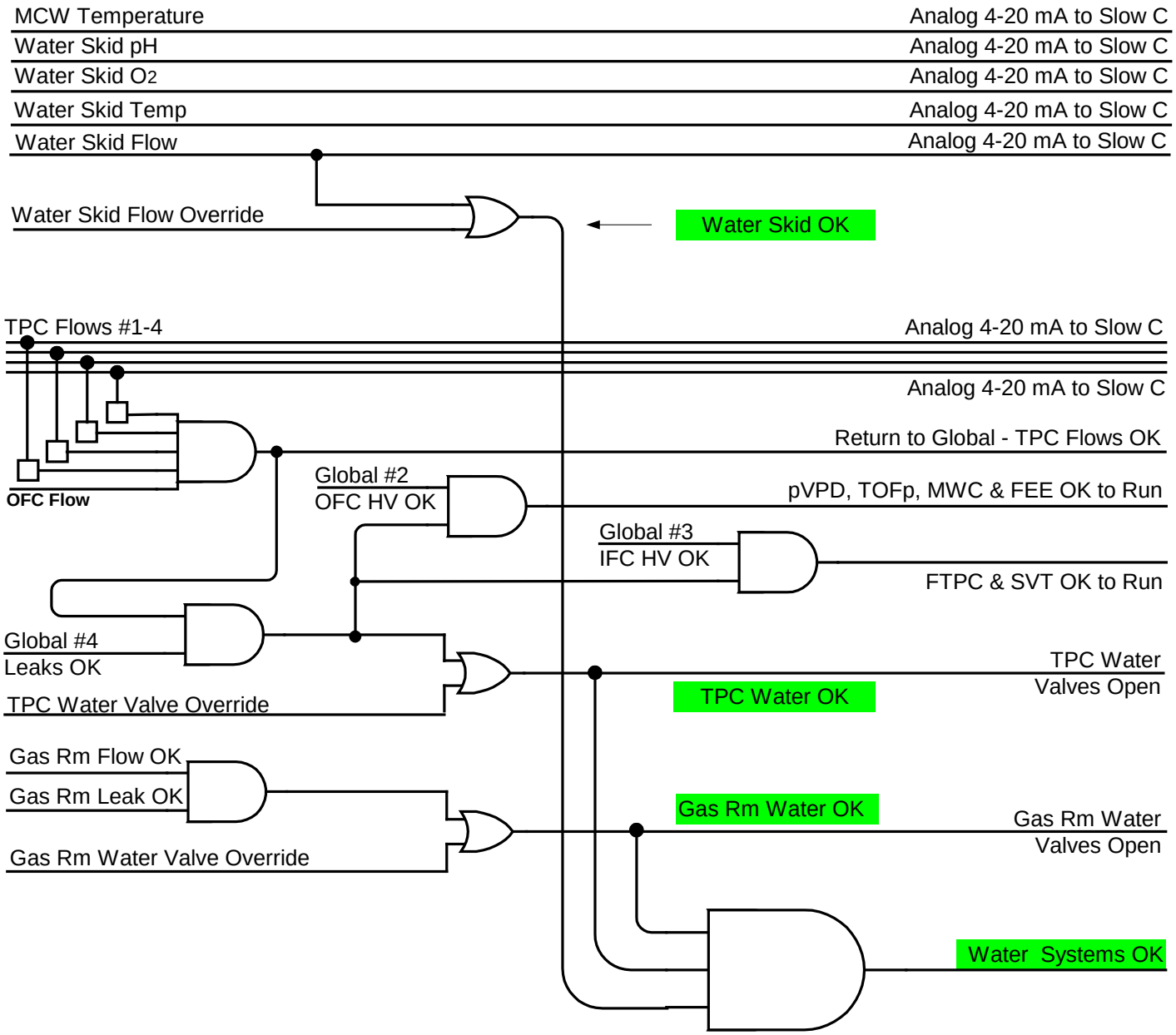
Allen Bradley Interlocks Front Panel - Attachment 1



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 16K Mem OS 302	1747-SN RIO Scanner to remote crate	1746-NI4 Analog Input 4 Ch. 4-20 mA or 0-10 V DC **Gap CH_4** **pH** **Flow** **O_2**	1746-IB16 24 V Input 16 Ch. **4- Pi** **Gas Flow** **Gas Leak** **Gas OK** **Gap O_2**	1746-NI4 Analog Input 4 Ch. 4-20 mA or 0-10 V DC **TPC Temp** **MCW Temp**	1746-OW16 24 V Output 16 Ch. Two groups of 8 **Eight Kybd Out** **OFC OK** **TPC Valves** **Gas Rm Valves**	1746-OX8 Relay Output 8 Ch. Indep ch's contact closure	1746-IB16 24 V Input 16 Ch. **Kbrd Ovrd 8 inp** **Water Skid Ovrd** **TPC Flow Ovrd** **Gas Flow Ovrd**	1746-IB32 24 V Input 32 Ch. Kbrd button input	1746-OB32 24 V Output 32 Ch. Kbrd lights output
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)

Platform Alarm & Reset (11)

Gas Alarm (1)
Pioneer Alarm (2)
Global #2 (3)
Global #1 (4)
Global #4 (5)
Gas OR Water (6)
Water Alarm (7)

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 IFC OK (11) Flows OK (12) Three Gas Rm Outputs (13) FTPC(14) MCW(15)	4, 5 4 TPC Flow Status (8-11) Three Platform Inputs (13-15)	6, 7	8, 9	10, 11

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)

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	X

Attachment 4: Rules for Issuance of Allen Bradley Override Keys

Override keys for the various subsystems protected by the Allen Bradley system will be kept in a cabinet in the STAR control room or the trailers outside Building 1006. To obtain a key for a certain subsystem the requestor must first contact the STAR shift supervisor. The shift supervisor will first determine if the requestor has the proper training for the subsystem by consulting the STAR training database. The shift supervisor must also obtain authorization from a STAR TPC gas system expert who will make a determination of the status and safety of the TPC gas. This authorization can be in writing or by phone. Once this has been done, the operator will take a key and sign the checkout sheet kept with the keys. The operator is responsible for checking the key back in when the work is completed.

Attachment 5: TPC Interlocks Certification Log

Procedure	Date checked	Certified by:	Frequency of Update
Calibrate Pioneer Methane heads			Annual
Calibrate Methane in N_2 monitor			Annual
Trigger Methane alarm to kill gas system, and disable electronics			Annual
Power Off/On to AB to kill gas sysem, disable electronics and close water valves			Annual
Global Interlock Alarm #1 kills enable for electronics			Annual
Global Interlock Alarm #2 kills power to gas system			Annual
Gas system low level alarm rings TPC gas alarms but takes no action			Annual
Gas system Hi level alarm kills enable for electronics			Annual
IFC Air flow alarm kills enable to cathode			Annual
TPC leak alarm closes water valves to TPC & shuts down water skid			Annual
Gas alarm rings in Control room			Annual
Gas alarm rings in collision hall			Annual
Gas alarm rings in STAR trailer			Annual
Water alarm rings in Control Room			Annual
Water alarm rings in collision hall			Annual
Water alarm rings in STAR trailer			Annual
TPC Water Flows OK enable FEE			Annual
UPS system test			Annual

Attachment 6: List of System Experts

TPC Gas System and Insulation Gas System:

Leonid Kotchenda	x7386 x7599 (BNL Dorm)
Blair Stringfellow	x7386 (BNL Office) x1042 (BNL Apartment) x8158 (BNL Beeper) 516-662-3466 (Cell Phone) 765-494-5391 (Purdue Office) 765-497-0161 (Home)
Howard Wieman	x7386, x7762 (BNL Office) 298-2195 (Home)

Allen Bradley System:

Jim Thomas	x3918 (Office) 928-8661 (Home)
Blair Stringfellow	see above
Howard Wieman	see above

Global Interlock System:

Bill Christie	x7137
Bill Edwards	x2923

TPC Water System:

Ed Dale	x7943
Jim Thomas	see above
Howard Wieman	see above