PHENIX TEC-TRD GAS SYSTEM
OPERATION PROCEDURE

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REVISION CONTROL SHEET

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1. Purpose

The purpose of this document is to define the local emergency plan for operation of the Gas Systems for the PHENIX Time Expansion Chamber/ Transition Radiation Detector (TEC-TRD). In addition to the Local Emergency Plan this document specifies the Operating Procedures of the TEC-TRD. This Local Emergency Plan will ensure:

1.1 The safety of all personnel from risks associated with the operation of the TEC-TRD gas system

1.2 The implementation of the appropriate emergency procedures

1.3 Prompt notification of the appropriate C-A and S&EP specialists

1.4 The maintenance of appropriate C-A emergency status

1.5 The preservation and protection of the environment

1.6 The preservation of BNL facilities and equipment

2. Responsibilities

During PHENIX operations, there will be two levels of responsibility for the oversight of the TEC-TRD gas systems: the PHENIX shift crew and the TEC-TRD GAS experts.

The first level of responsibility resides with the PHENIX Shift Crew. During any period when the TEC-TRD has flammable gas flowing or HV on, there will be a minimum of two people on continuous shift in the PHENIX counting house. Once data taking starts, the number of people on shift at PHENIX will increase to five. The second level of responsibility resides with the TEC-TRD gas experts. The TEC-TRD gas experts will be on-call to respond to any alarm or unusual occurrence detected by the PHENIX shift crew. A record of the performance of the TEC-TRD gas system will be maintained and monitored by the TEC-TRD experts and shift crew.

During watch shifts or data taking, it will be the responsibility of the PHENIX Shift Crew to:

2.1 Monitor the status and alarms for the gas system.

2.2 **In the event of an alarm or unusual occurrence, contact an expert from the Expert Call List.**

The second level of responsibility is the TEC-TRD gas experts. It is the responsibility of the TEC-TRD Gas experts to:

2.3 Maintain the TEC-TRD Gas System in a safe operating condition. This includes:

2.3.1 Changing gas cylinders and dewars when required

2.3.2 Setting, adjusting, and checking the gas mixture, flow rates and pressures.

2.3.3 Checking the certification of the operating gas (see details in Precautions, Section 4)

2.3.4 Posting any special instructions or notifications as required

2.3.5 Carrying out any emergency actions, as prescribed in the Procedures section of this document.

3 Prerequisites

The TEC-TRD Gas Expert shall have read or have training in the following areas:

3.1 PHENIX Local Emergency Plan, RHIC-OPM 3.16,

3.2 BNL Compressed Gas Safety Training Course,

3.3 BNL Electrical Safety I

3.4 RHIC/PHENIX access training

3.5 BNL Haz-com

3.6 BNL General Employee Training

4 Precautions

The safety of personnel is of primary importance. The TEC-TRD Gas experts shall take great care to ensure that the TEC-TRD Gas Systems will be operated in a way that does not place personnel or equipment at risk of physical harm.

4.1 Gas System Precautions:

4.1.1 All gas cylinder storage is on the PHENIX Gas pad located just south and east of Building 1008 F, the PHENIX Gas Mixing Hut. All gas cylinders and dewars are to be changed by ***authorized*** PHENIX personnel with current BNL Compressed Gas Safety Training.

4.1.2 All valves and controls associated with the TEC-TRD Gas system are to be operated ONLY by ***authorized*** TEC-TRD gas system experts with current training.

4.1.3 Primary care should be given to monitoring the internal pressure of the TEC-TRD throughout the duration of the start-up procedure, especially when adjusting flow rates. Over-pressurization of the TEC-TRD (above 7.0 mm WC) can result in structural damage to the detector.

4.1.4 **Before any HV can be turned on, sufficient operating gas must have flowed through each of the detectors for 4 volume exchanges. The total gas volume of all TEC-TRD planes on the East carriage is 6000 liters. The TEC-TRD HV is to be turned on only by a TEC-TRD HV expert with current training**.

4.1.5 Any reconfiguration or adjustment to the TEC-TRD Gas System in the PHENIX IR or mixing house is to be performed ONLY by an ***authorized*** TEC-TRD Gas System expert with current training.

5 Emergency Procedures

5.1 In the event of a fire or emergency in Building 1008, members of the PHENIX Shift Crew shall (in order of priority)

5.1.1 Follow emergency procedures described in C-A OPM 3.16 for the PHENIX area.

5.1.2 All TEC-TRD HV should be turned -off by the PHENIX shift crew or TEC-TRD experts.

5.1.3 Confirm that the TEC-TRD Gas System is in safe/purge mode. The shift leader (under authority of a Gas expert) or TEC-TRD Gas system expert can confirm that the alarm/safety system has functioned properly by going to the PHENIX Gas Mixing Hut 1008F, and observing that the AC power to the TEC-TRD Gas system is off , the argon flow meter shows flow and that the CH4 flow meter has no flow. This action should be taken once it has been determined that no hazard exists in 1008F.

5.2 In the event that a TEC-TRD gas line ruptures, the Shift Leader (under an experts authority) or TEC-TRD Gas System expert shall:

5.2.1 Turn off all gas flowing to the TEC-TRD at either the TEC-TRD Gas system computer control in the Gas Mixing Hut, the gas distribution values in the Mixing Hut or the cylinders and dewars on the PHENIX gas pad.

5.2.2 Turn off the power to all TEC-TRD high voltage (HV).

5.2.3 Contact a TEC-TRD Expert

6 Standard Operating Procedures

This procedure covers running gas to the Phenix TEC-TRD. These Procedures shall be carried out by TEC-TRD Gas System experts only.

The procedures for operating the TEC-TRD Gas systems are described in general terms in this OPM. A more detailed description of the TEC-TRD Gas system and its operation can be found in the *PHENIX Central Tracking Gas System Design and Specification Manual (March 2000)*. In addition, the TEC-TRD gas system expert should read procedures PP-2.5.2.6-04 (Xenon gas compression system operation procedures) and PP-2.5.2.5-05 (Regeneration of TEC-TRD gas system Purifiers). The TEC-TRD Gas system experts will have familiarized themselves with all these documents before performing any work.

The Gas system for the TEC-TRD is composed of a number of components.

1. Gas cylinders and dewars located on the PHENIX Gas Pad and Isobutane shed (Xenon cylinders only).
2. Gas distribution manifolds located in the PHENIX Mixing Hut 1008F south wall.
3. TEC-TRD Gas rack located in the Gas room in 1008F (north west corner)
4. TEC-TRD Gas Electronics Rack located in the Electronics room of 1008F
5. TEC-TRD carriage gas rack located underneath the East carriage in the PHENIX IR.
6. TEC-TRD flow meters, bubblers and flow direction indicators mounted on the TEC-TRD sectors in the PHENIX East carriage.
7. TEC-TRD Xenon Compression system located on the south west corner of the Phenix Mixing Hut 1008F

When the PHENIX IR is closed, the status of the TEC-TRD Gas system can be monitored in a number of places.

1. TEC-TRD Gas Control computer located in the electronics room of 1008F shows the status of all electronic readout flow meters, flow direction indicators, pressure transmitters/indicators, solenoid valves and temperature transmitters.

2. TEC-TRD Gas Control rack located in the Gas room of 1008F shows status of all manually controlled flow meters and pressure gauges.

3. PC located in PHENIX Counting House allows monitoring of TEC-TRD Gas system logging file created by the TEC-TRD Gas Control computer.

4. PHENIX web camera (pcam2.phenix.bnl.gov) allows one to use cameras in the IR to view status of flow meters and pressure gauges located in TEC-TRD carriage gas rack underneath the East carriage.

5. Programs on the LV PC in the PHENIX counting house can be used to monitor the output pressures of each individual TEC-TRD chamber.

For details of the gas system, please refer to the TEC-TRD Gas System drawing 002-0206-911 rev C and the *PHENIX Central Tracking Gas System Design and Specification Manual, March 2000*. The labels of valves and meters in the operation instructions below refer to parts identified in the figures in this drawing.

Note: All the flow rate settings specified in the procedures below are nominal and can be adjusted by the TEC-TRD gas system experts in accordance with the requirements of the TEC-TRD detector or gas system.

6.1 Gas System start up Procedures

This part of the procedure describes how to start gas flow to the TEC-TRD after a long shutdown. This assumes no gas is currently flowing, no flow meters are adjusted and the PHENIX IR is open. If the PHENIX IR is closed, it is necessary that the TEC-TRD carriage rack and sector flow meters have been previously adjusted prior to any gas flow. Check that PP-2.5.3.4-09 *Check-off List for Ending Access to the PHENIX IR* has been completed. If no gas has been flowing in the TEC-TRD for 24 hours, one must start flowing inert gas first.

6.1.1 Turning the Power to the TEC-TRD Gas System ON

Note: If system is powered on, skip to step 6.1.2

6.1.1.1 Turn on AC power for Electronic Rack (Receptacles Breaker)

6.1.1.2 Turn on mass flow controller power supplies (Electronic Rack)

6.1.1.3 Turn on Keithley Digital Multi-meter and High Density Switch System

6.1.1.4 Turn on Alarm/Interlock box

6.1.1.5 Turn on and boot the TEC-TRD gas system PC.

6.1.1.6 Start the gas system control program.

6.1.1.7 Turn on Power Supplies Breaker

6.1.1.8 Turn on AC power for Gas Rack

6.1.2 Prepare for Inert Gas Flow (either argon or nitrogen)

Note: All solenoid valves and compressors are controlled with the gas system PC. Green light means SV is open and red light means SV is closed.

Caution: When purging with inert gas, make sure the PID controller bypass valve is turned OFF (Nitrogen supply line to PID controller should be shut off with manual valve MV5 in Gas rack). This is only used for gas re-circulation mode.

6.1.2.1 Close SV6 (N/O) (red light) and SV7 (N/O) (red light). This closes off the manual flow indicator FI3 and flow meter FM1 (see attached schematic)

6.1.2.2 Close FI3, FI4 (Gas Rack)

6.1.2.3 Open FI12 (East Carriage Gas Rack).

6.1.2.4 On the gas pad, supply Argon gas to Argon supply line at 20PSIG.

6.1.2.5 In the mixing room, purge the Argon supply line to the vent line for a few seconds .

6.1.2.6 On the TEC-TRD Gas Rack, confirm gas delivery pressure of 20PSIG indicated on PI6.

6.1.2.7 Confirm that MV5 (Compressor Bypass, Gas Rack) is closed.

6.1.2.8 Check SV21 (N/O) status (Vent, East Carriage Rack). It should be open (no light is open / red light is closed).

6.1.2.9 Check that SV16 (N/O) (no light) (GMH Input, East Carriage Gas Rack)), SV17 (N/O)(no light)(GMH Return, East Carriage Rack) are open .

6.1.2.10 Confirm that MV10 is turned to vent line

6.1.2.11 Confirm that MV9 is turned to vent line.

6.1.2.12 Confirm that MV5a is open to vent line (inside gas rack above compressor)

6.1.2.13 Confirm that CMV1 is open (Inside Gas Rack)

6.1.3 Begin inert gas flow

6.1.3.1 Open SV6 (green light).

6.1.3.2 Slowly open FI3 and set flow rate to 15 SCFH (~ 6 lpm) (nominal rate).

Caution: After starting or changing flow, wait and observe the pressure rise on PI1, PI2, PI3, PI8, PT5,and PT9. To maintain a margin of safety, pressure for this procedure should not exceed 6 mm WC on PT9. Structural damage to the East TEC-TRD can result for a pressure >7.0mm WC. If the pressure becomes too high, reduce the flow or close FI3.

6.1.3.3 Using PCV1 and BPCV1, adjust pressure of PI2 to 90”WC.

6.1.3.4 Using PCV1 and BPCV2, adjust pressure of PI3 to 2”WC.

6.1.3.5 Confirm that FI8 flow rate is 0 and FI12 = 15 SCFH (on East Carriage gas Rack) nominal flow rate.

6.1.3.6 Adjust TEC-TRD sector flow meters until the flow is equalized between each of the 4 TEC-TRD sectors

6.1.3.7 Adjust TEC-TRD flow meters on each sector to balance flows between each of the 6 planes. (do this on all 4 sectors)

6.1.3.8 Slowly open FI3, watch PI3 and set flow 30SCFH (12 LPM) nominal or prescribed flow rate.

6.1.3.9 Turn ON Oxygen and Water Analyzers

6.1.3.10 Open SV12,SV13, and SV4

6.1.3.11 Adjust FI5 and FI6 flow to 0.5LPM

6.1.3.12 Record the start time, flow rates and TEC-TRD pressure in the data sheet (Attachment E).

6.1.4 Initial Set-up for P10 Flowing

Note: If you have been flowing nitrogen through the TEC-TRD this is the point where you switch to argon. Valve MV AR/HE should be turned to Argon. If you have been flowing argon through the TEC-TRD these steps are necessary prior to mixing with methane.

6.1.4.1 Close SV6(red light)

6.1.4.2 Close FI3

6.1.4.3 On the Gas Pad, connect Argon to Argon Supply Line

6.1.4.4 Confirm that MV Ar/He is turned to Argon

6.1.4.5 In the Mixing House, confirm that delivery pressure is 20 PSIG on PI6

6.1.4.6 Confirm that SV16(n/o)(no light), SV17(n/o)(no light) are open

6.1.4.7 Check SV21 (N/O) status (Vent, East Carriage Rack). It should be open (no light is open/red light is closed).

6.1.4.8 Confirm that MV10 is turned to vent line

6.1.4.9 Confirm that MV9 is turned to vent line

6.1.4.10 Confirm that MV5 is closed

6.1.4.11 Confirm that MV5a is opened to vent line

6.1.4.12 Confirm that FI9(gas rack) is closed

6.1.4.13 Using Attachment 6, set/confirm all SV, MV and FI's to their initial states.

6.1.4.14 Open SV7(green light)

6.1.4.15 Set FI3 flow to 10SCFH

6.1.4.16 Set FM1 flow to 3LPM(Electronic Rack)

6.1.4.17 Close SV6(red light)

CAUTION: Structural damage to the TEC-TRD can result for a pressure > 7.0mmWC. If the pressure becomes too high, reduce the flow rate. After starting or changing flow rates, wait and observe the pressure rise on PT9 (TEC-TRD pressure).

6.1.4.18 Confirm that the flow through FM1 = 3 LPM(Electronic Rack)

6.1.4.19 Confirm that PI2 pressure is not above 90"WC and PI3 does not above 2"WC

6.1.4.20 Confirm FI8 Zero flow

6.1.4.21 Slowly increase flow through FM1 to 10 LPM, argon flow.

6.1.4.22 If you have been flowing nitrogen, exchange 3 East TEC-TRD volumes (East TEC-TRD volume = 6,000 liters). If you have been flowing argon go to the next step. Time in hours for 3 volume exchanges = 18,000 liters/flow*60. For 10 LPM, time = 30 hours.

6.1.4.23 Open MV5

6.1.4.24 Block the compressors moving the PIS1 low pressure setpoint arrow

6.1.4.25 Set PSI1 low pressure setpoint to 1mmWC

6.1.4.26 Open SV2 (SV2a)(green light) on PC

6.1.4.27 Start Compressor 1 on PC

6.1.4.28 Start Compressor 1 using Reset button (Gas Rack Front Panel). Wait until Compressor 1 stops itself at 1mmWC

6.1.4.29 Stop Compressor 1 and Start Compressor 2 on PC.

6.1.4.30 Start Compressor 2 using Reset button (Gas Rack Front Panel). Wait until Compressor 2 stops itself at 1mmWC.

6.1.4.31 Stop Compressor 2 on PC

6.1.4.32 Close SV2(SV2a)(red light) on PC

6.1.4.33 Close MV5

6.1.5 Prepare for P10 flow

6.1.5.1 Notify the MCR that flammable gas is being put into PHENIX so that they will heed the flammable gas alarms.

6.1.5.2 Open SV8(green light)

6.1.5.3 Set 1LPM flow through FM2. Purge for 10 seconds.

6.1.5.4 Set 0LPM flow through FM2.

6.1.5.5 Close SV8 (red light).

6.1.6 Start P10 flow

6.1.6.1 Confirm the PHENIX **SMCS** is operating.

6.1.6.2 Confirm that the control pots (labeled "command") for FM2 (Electronic Rack) are turned fully counterclockwise.

CAUTION: The mass flow controller pot used in the following step is very sensitive. The pot should be turned in very small increments.

6.1.6.3 Confirm that the Methane Bank is connected to Methane supply line on Gas Pad

6.1.6.4 Set the Methane pressure to 15PSIG with pressure regulator in the Mixing house. Open MV-M10A on Methane Distribution panel.

6.1.6.5 Confirm that Methane Supply pressure(PI7) is 15PSIG (Gas Rack)

6.1.6.6 Confirm than the Nitrogen Purging Line is at 15PSIG min pressure on PR/N2 on distribution wall

6.1.6.7 Set FI15 flow (on side of Gas Rack) to purge PIS1 case to 1.0LPM (nitrogen flow to photohelic)

6.1.6.8 Open SV8(green light)

6.1.6.9 Set FM2 flow to 1.0 LPM nominal to obtain 90:10 mixture of argon/methane gas mixture.

NOTE: At this point, the methane mass flow controller (FM2) is slaved to the argon mass flow controller (FM1). Increasing the argon flow will automatically increase the methane flow, maintaining the 90:10 ratio.

6.1.6.10 Slowly raise FM1 argon flow to 20LPM

6.1.6.11 Set FM1 flow to appropriate value, 10LPM nominal for long term operation.

6.1.6.12 Enable Alarms for PC and Alarm Box

6.1.6.13 Record the time and date that gas flow was started for each chamber in the Phenix Run logbook

6.1.6.14 Allow the chamber to flow Mixed Gas until there has been at least four exchanges of gas inside the chamber**. DO NOT TURN ON HV UNTIL FOUR VOLUME EXCHANGES OF P10 GAS HAVE TAKEN PLACE IN THE TEC-TRD**. The TEC-TRD volume is 6.0 cu meters, 6000 liters

6.1.6.15 After 4 volume changes, 24,000 liters of P10, it is safe to turn on the high voltage of the TEC-TRD. **HV to be turned on by an TEC-TRD expert.**

6.1.7 Recirculation Mode—After the system has stabilized and the TEC-TRD has had at least 2 days if regular flow, the TEC-TRD gas system can be switched into recirculation mode

NOTE: Both Purifiers should be regenerated before switching to

Recirculating Mode in accords with Procedure PP-2.5.2.6-05 (Regeneration of TEC-TRD-TRD Gas System Purifiers)

6.1.7.1 Turn MV6 to Purifier 1
6.1.7.2 Open MV7 and MV8
6.1.7.3 Turn on purifier's TIC1 on PC and let it warm up to 220 C before proceeding to next step
6.1.7.4 Disable alarms
6.1.7.5 Open N2 supply to TEC-TRD on north wall
6.1.7.6 Open vent ball valve MV6d on west wall exhaust manifold
6.1.7.7 Open BPCV1 until ball on FI8 moves, then close it until flow goes to 0 scfh at 90"WC on PI2
6.1.7.8 Block the Compressors using PSI1 low pressure arrow
6.1.7.9 Start PID Controller program
6.1.7.10 Set FM1 flow to 3LPM
6.1.7.11 Close SV21(red light) on PC
6.1.7.12 Open SV1 and SV2(SV2a)
6.1.7.13 Start Compressor 1(green light) on PC
6.1.7.14 Confirm that PID Controller shut off valve(inside Gas Rack) is set to the ON position
6.1.7.15 Open MV5 about 1 turn.
6.1.7.16 Turn MV9 to the Rack.
6.1.7.17 Start the Compressor using Reset push button(Gas Rack Front panel) at 4mmWC on PIS1
6.1.7.18 Close MV5a(inside Gas Rack)
6.1.7.19 Adjust MV5 to have PID Controller stable operation at its setpoint pressure of 1.2mmWC

- FI8 should be about 3scfh,
- PI3 should be about 2" wc,
- PI2 should be 90-95" wc,
- PIS1 should be about 1.3mm wc

6.1.7.20 Set FI9 flow to 5SCFH
6.1.7.21 Set FI16 flow to 1-2 LPM (Heat Exchanger purging)
6.1.7.22 Close MV7 Purifier II output
6.1.7.23 Set PIS1 low setpoint arrow to 0.2mmWC and high pressure setpoint arrow to 4mmWC
6.1.7.24 Enable alarms when system is stable

6.1.8 Returning to non-recirculation mode—This is necessary to purge the detector of flammable gas

6.1.8.1 At the TEC-TRD PC in the mixing house

6.1.8.1.1 Turn off alarms
6.1.8.1.2 Set FI16 flow to Zero(Heat Exchanger purging)
6.1.8.1.3 Set PIS1 low pressure setpoint arrow to 0.5mmWC
6.1.8.1.4 Open SV5a, close MV5 (compressors bypass). Compressor stops itself at the pressure below 0.5mmWC.
6.1.8.1.5 Turn MV9 to vent line
6.1.8.1.6 Turn off purifiers TIC 1
6.1.8.1.7 Close SV1, SV2
6.1.8.1.8 Open SV21 on PC
6.1.8.1.9 Increase flow at mass flow controller to straight thru level (about 10 lpm argon)
6.1.8.1.10 Check PI2 and PI3 readings. PI2 should be below 90"WC, PI3 about 2"WC
6.1.8.1.11 Stop PID controller program and close window
6.1.8.1.12 Close MV8 Purifier I output
6.1.8.1.13 Enable Alarms

6.2 Setting-up for Xenon Mixture(45%Xe+45%He+10%CH4) Flow

6.2.1 Prepare for Xenon mixture flow

NOTE: At this point the feed to FI3 and FM4 should be switched from Argon to HE using the valve labels MV Ar/He on top of the TEC-TRD rack. Xenon cylinder should be connected to Xenon line. FM3, FM4 and FM5 should be set to Zero flow

6.2.1.1 Confirm that the delivery pressure is 15PSIG on PI6

6.2.1.2 Close SV6 (red light)

6.2.1.3 Open SV7 (green light).

6.2.1.4 Set FM4 flow to 3LPM

Caution: After starting or changing flow, wait and observe the pressure rise on PI2, PI3, PI8, PT5 and PT9. To maintain a margin of safety, pressure for this procedure should not exceed 6 mm WC on PT9. Structural damage to the East TEC-TRD can result for a pressure >7.0mm WC. If the pressure becomes too high, reduce the flow or close SV7.

6.2.1.5 Using PCV1 and BPCV1, adjust pressure of PI2 to 90”WC and PI3 to 2”WC

Note: At this point, the compression system should be prepared for the operation in the accord with PHENIX Procedure. PP-2.5.2.6-04

6.2.2 Prepare for Flammable mixture flow

6.2.2.1 Notify the MCR that flammable gas is being put into PHENIX so that they will heed the flammable gas alarms.

6.2.2.2 Supply Xenon to Xenon supply line at 15PSIG

6.2.2.3 In the Mixing House, confirm that delivery pressure is 15 PSIG on PI5

6.2.2.4 Confirm that the Methane Bank was connected to Methane supply line on Gas Pad

6.2.2.5 Set Methane pressure to 15PSIG with the pressure regulator in the Mixing house. Open MV-M10A on Methane Distribution panel.

6.2.2.6 Confirm that Methane Supply pressure(PI7) is 15PSIG (Gas Rack)

6.2.2.7 Confirm that the Nitrogen Purging Line is at 15PSIG on PR/N2 on distribution wall

6.2.2.8 Confirm MV Ar/He on top of rack is turned to Helium

6.2.2.9 Open MV14(Gas Rack)

6.2.2.10 Set FI15 flow to purge PIS1 case to 1.0LPM, nitrogen flow to photohelic.

6.2.3 Start Flammable Mixture flow

6.2.3.1 Confirm the PHENIX **SMCS** is operating.

6.2.3.2 Confirm that the control pots (labeled "command") for FM5 (Electronic Rack) are turned fully counterclockwise.

CAUTION: The mass flow controller pot used in the following step is very sensitive. The pot should be turned in very small increments.

6.2.3.3 Set FM4 flow to 2.5LPM

6.2.3.4 Open SV2(SV2a)

6.2.3.5 Confirm that PI2 pressure is below 90”WC , FI8 flow is Zero and PI3 does not exceed 2”WC

6.2.3.6 Close CMV1(inside Gas Rack)

6.2.3.7 Block Compressors using PIS1 low pressure setpoint arrow
6.2.3.8 Start PID Controller program
6.2.3.9 Start Compressor 1(green light) on PC
6.2.3.10 Close SV21(Green Light)
6.2.3.11 Confirm that PID Controller shut off valve MV5b (inside Gas Rack) set to OPEN position
6.2.3.12 Open MV5 about 1 turn.
6.2.3.13 Turn MV9 to Rack
6.2.3.14 Start Compressor using Reset push button(Gas Rack Front panel) at 4mmWC on PIS1
6.2.3.15 Close MV5a(inside Gas Rack)
6.2.3.16 Adjust MV5 to have PID Controller stable operation at its setpoint pressure of 1.2mmWC

- FI8 should be about 2- 3SCFH,
- PI2 should be 90-95” wc,
- PIS1 should be about 1.3mm WC

6.2.3.17 Open SV15 and close SV4

6.2.3.18 Set FM4 flow to 1LPM

6.2.3.19 Open SV10(green light)

6.2.3.20 Set FM3 flow to 1LPM

6.2.3.21 Open SV8(green light)

6.2.3.22 Set FM5 flow to 0.222 LPM nominal to obtain 45:45:10 mixture of Xenon/Helium/Methane gas mixture.

NOTE: At this point, the methane mass flow controller (FM5) and Xenon mass flow controller (FM3) are slaved to the helium mass flow controller (FM4). Increasing the helium flow will automatically increase the methane/ xenon flow, maintaining the 45:45:10 ratio.

6.2.3.23 Enable Alarms for PC and Alarm Box

6.2.3.24 Record the time and date that gas flow was started for each chamber in the PHENIX Run logbook

6.2.3.25 Allow the chambers to flow Mixed Gas until there has been at least ONE exchange of gas inside the chambers**.** The TEC-TRD volume is 6.0 cu meters, 6000 liters. At a total input of **2.22 LPM** it should take about **44hours.**

NOTE: After ONE volume change, go to the compression system operation.

6.3 Compression system –refer to Phenix procedure PP-2.5.2.6-04

6.3.1 Turn MV6 to Purifier I

6.3.2 Open MV8 and MV7(purifiers OUT)

6.3.3 Turn on purifiers TIC1 on PC and let warm up to 220 C. before proceeding to next step.

6.3.4 Disable Alarms

6.3.5 Open SV1 and close SV2(SV2a)

6.3.6 Enable Alarms

Allow the chamber to flow Mixed Gas until there has been at least 3 volume exchanges of gas inside the chamber. The TRD volume is 6.0 cu meters, 6000 liters. At a total input of 2.22 LPM it should take 5.5 days. After that, go to Recirculation Mode. (step 6.4)

6.4 Recirculating Mode

6.4.1 Disable Alarms

6.4.2 Open CMV1(inside Gas Rack)

6.4.3 Adjust MV5 to make the PID Controller stable at its setpoint pressure of 1.2mmWC. FI8 should be about 2- 3 SCFH, PI2 should be 90-95" WC and PI3 should be 2"WC.

6.4.4 Set FM16 flow to 3LPM(Heat Exchanger Purging)

6.4.5 Set FM4 flow to 0.5LPM for long term operation

6.4.6 Enable Alarms

6.5 Removing Xenon Mixture from TRD and returning to non–recirculating Mode

6.5.1 Disable Alarms

6.5.2 Close SV8 and SV10

6.5.3 Set FM4 flow to 2.5LPM

6.5.4 Switch to MV Ar/He to Argon instead of Helium

6.5.5 Turn MV3 to FM1 (High flow argon FM)

6.5.6 Close CMV1(inside Gas Rack)

6.5.7 Set FM1 flow to 2.5LPM

6.5.8 Enable Alarms

NOTE: Allow the chambers to flow pure gas until there has been at least 3 volume exchanges of gas inside the chamber. The TRD volume is 6.0 cu meters, 6000 liters. At a total input flow of 2.5 LPM, this should take 5 days.

6.5.9 Turn MV10 to vent line

6.5.10 Stop Compression system in the accord with PHENIX Procedure PP-2.5.2.6-04

6.5.11 Turn off alarms

6.5.12 Open SV4 and close SV15

6.5.13 Set FI16 flow to Zero(Heat exchanger purging)

6.5.14 Set PIS1 low pressure setpoint arrow to 0.5mmWC

6.5.15 Open SV5a, close MV5 (compressors bypass). Compressor will stop itself when the pressure falls below 0.5mmWC

6.5.16 Turn MV9 to vent line

6.5.17 Turn off purifiers TIC 1

6.5.18 Close SV1

6.5.19 Increase flow at the mass flow controller to straight thru level (about 10 lpm argon)

6.5.20 Check PI2 and PI3 readings. PI2 should be below 90”WC, PI3 about 2”WC

6.5.21 Stop the PID controller program and close the window

6.5.22 Close MV8 Purifier I output

6.5.23 Open CMV1(inside Gas Rack)

6.6 Gas System Procedures: In order to change a six-pack of gas cylinders:

6.6.1 Close the valve on the six-pack in use, either MV-E1A, MV-E1C, MV-E1E, MV-E1G, MV-E1J or MV-E1L.

6.6.2 Open the valve to the full six-pack.

6.6.3 Verify that the regulator is set to 40 psig.

6.6.4 Record the starting cylinder pressure and the time and date in the gas logbook.

6.7 Shut off flammable gas flow

6.7.1 Disable the hardware and PC alarms

6.7.2 Make sure HV supplies are off

6.7.3 Set FM2 flow to Zero.

6.7.4 Close SV8(red light)

6.7.5 Close the Manual Valve MV-M10A on the Methane Gas Distribution Panel

6.7.6 Open Methane Supply Line Purging Valve to Vent Line

6.7.7 Confirm that PI7 pressure is Zero(Gas Rack)

6.7.8 Close Methane Supply Line Purging Valve to Vent Line

6.7.9 Set FM1 flow to 10LPM

6.7.10 Exchange 1 East TEC-TRD volume(10 hrs duration)

6.7.11 Close FI15(Gas Rack)

6.7.12 Close MV6(Gas Rack)

6.7.13 Record the pressure remaining in the cylinders, and the time and date in the gas logbook.

6.7.14 Notify the PHENIX shift leader that the TEC-TRD flammable gas has been purged. If PHENIX has purged all flammable gas the shift leader should notify the MCR of this fact.

6.8 Switch from argon purge to nitrogen purge. This is an option depending on inert gas supply.

6.8.1 Set FM1 flow to 6LPM

6.8.2 On Gas Pad connect Nitrogen to Argon Supply line

6.8.3 Close Argon

6.8.4 Open Nitrogen

6.8.5 Confirm that PI6 pressure is 20PSIG(Gas Rack)

6.8.6 Set FM1 flow to 10LPM(Electronic Rack)

6.8.7 Exchange 3 TEC gas volumes, 18000 liters prior to any long term Gas Shutdown.

6.8.8 Set FM1 flow to 6LPM(Electronic Rack)

6.9 Gas Shutdown

6.9.1 Set FM1 flow to Zero

6.9.2 Close Supply Line manual valve in Mixing House

6.9.3 Close inert gas supply on Gas Pad

6.9.4 Stop the gas system control program on the PC.

6.9.5 Log off the PC

6.9.6 Turn off the AC power for the PC.

6.9.7 Turn off the AC power for the alarm/interlock box

6.9.8 Turn off the AC power for Power supplies and Gas Rack

7 References

8.1 RHIC-OPM 3.0, "Local Emergency Plan for the Relativistic Heavy Ion Collider Project."

8.2 BNL ES&H Health Standard, Section 1.4.0, "Compressed Gas Cylinder Safety", December 18, 1991.

8.3 BNL Occupational Health and Safety Guide (Interim), Section 4.11.0, "Installation of Flammable Gas Systems (Experimental & Temporary Installations)", June 21, 1989.

8 Appendix A

9.1 Attachment A - Call list for the TEC-TRD Gas System experts.

9.2 Attachment B –TEC-TRD Gas system diagram. 002-0206-911 rev C

9.3 Attachment C --TEC Gas System Acronym Glossary

9.4 Attachment D --Log Sheet for Inert Gas Purge

9.5 Attachment E– TEC-TRD Gas System Check List

9.6 Attachment F – TEC-TRD Gas System Computer Alarm Conditions

9.7 Attachment G –TEC-TRD Gas System Hardware Alarm Conditions

9.8 Attachment H –TEC-TRD Operations Initial Checklist

Attachment A:TEC-TRD Gas System Experts

The following people have been trained to operate the PHENIX TEC-TRD gas system within the scope described in section 1.0 above. They have completed the prerequisite BNL training courses (see 3.1).

Leonid Kotchenda x5795

Peter Kravtsov x5795

Robert Pisani x5301 beeper 8539

Carter Biggs x7515 beeper 8535

Additional qualified users are to be listed below and posted in the

TEC-TRD gas system mixing house:

Name	Phone	Approved by	Date

Attachment A continued:TEC-TRDHV and LV System Experts

The following people have been trained to operate the PHENIX HV and LV system. They have current training in the required BNL courses.

Robert Pisani x5301

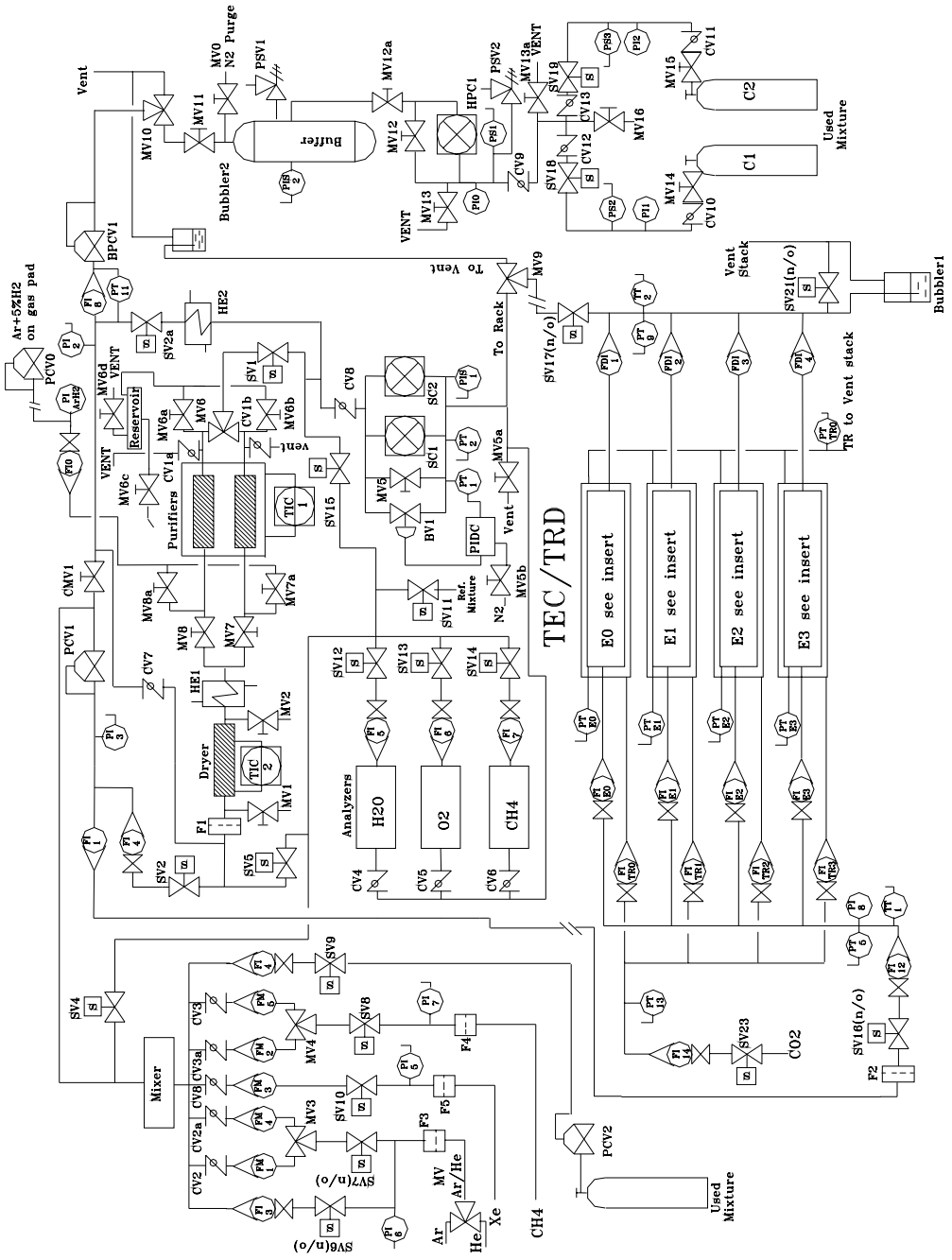
Achim Franz x4750

Additional qualified users are to be listed below and posted in the

TEC-TRDgas system mixing house:

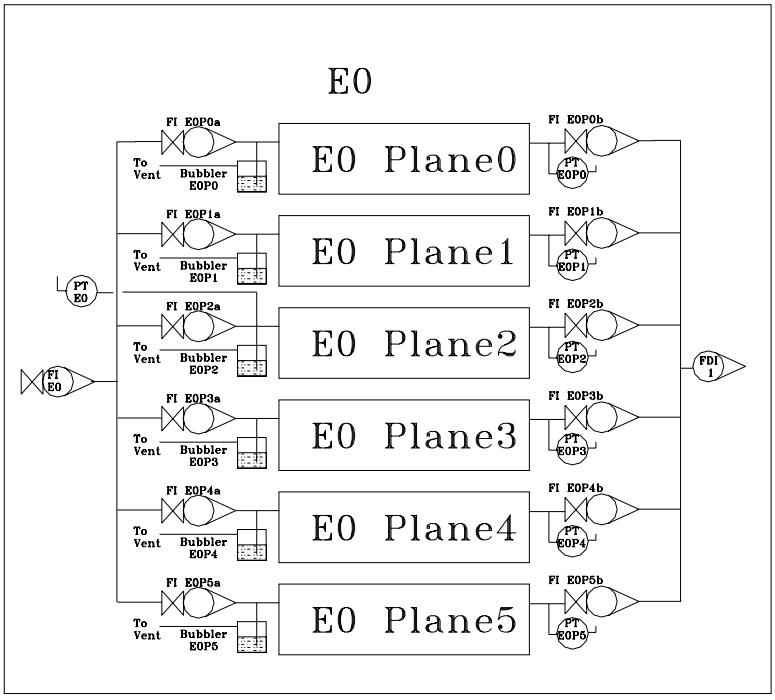
Name	Phone	Approved by	Date

Attachment B: TEC Gas System Diagrams From drawing 002-0206-911 revC



Attachment B: TEC Gas System Diagrams

Blowup of Sector E0



For E1, E2, and E3
Replace E0 with E1,E2 or E3

Attachment C . TEC-TRDGAS SYSTEM ACRONYM GLOSSARY

BPCV	Back pressure control valve
CV	Check valve
F	Filter
FI	Flow indicator
FM	Mass flow controller
MV	Manual valve
PCV	Pressure control valve
PI	Pressure indicator
PS	Pressure switch
PSV	Pressure safety valve
PT	Pressure transmitter
SV	Solenoid valve
TT	Temperature transmitter

Attachment D : **Log Sheet for Inert Gas Purge**

Fill out and affix to TEC-TRD Gas Logbook

1._____ AllTEC-TRDviewing windows in place

2.____ Gas supply lines intact from mixing rack to small racks andTEC-TRD (both ends)

3.____ Gas Return lines intact from small racks to vent line and to Mixing house Gas Rack.

Time/Date	Gas Flow Rate(FI3)	EastTEC-TRDPressure (PI8)	EastTEC-TRDPressure (PT9)	Supply Pressure (PI2)	Bypass Pressure (PT11)

Operator _____

Attachment E: PHENIXTEC-TRDGAS SYSTEM CHECK LIST

Computer Monitored Sensors

Sensor	Function	Value	Range	Comments
PT1	Leakage Pressure		0 – 20mmWC	
PT2	Input of Compressors		0.5 - 2.5mmWC	
PT5	Input of EastTEC-TRDpressure		0.5 – 2”WC	
FM3	Xenon Flow		0-0.3LPM	
FM4	Helium Flow		0-4LPM	
FM5	Methane Flow		0-2LPM	
PT9	Output of East TEC		0.5-6.0mmWC	
PI5	Xenon Delivery pressure		10-18PSIG	
PT13	East CO2 pressure		0.0mmWC	
PI2	Output of Compressors		45-100”WC	
PI3	Supply pressure		1.2-2.5”WC	
PI6	Argon Delivery pressure		15-21PSIG	
PI7	Methane Delivery pressure		12-16PSIG	
FI1	Flow indicator		9-11LPM	
FM1	Argon mass flow controller		9.8-10.1LPM	
FM2	Methane mass flow controller		0.98-1.1 LPM	
H20	Water analyzer		0.0-50ppm	
CH4	Methane analyzer		0.0%	
O2	Oxygen analyzer		0.0-300ppm	
FDI1	Flow direction indicator East			
FDI2	Flow direction indicator East			
FDI3	Flow direction indicator East			
FDI4	Flow direction indicator East			
TT1	Temperature Sensor Input		290-310K	
TT2	Temperature Sensor Output East		290-310K	

CH4/FM	Methane content		9.8-10.1%	
LEAK	Leakage		0.0LPM	

Gas Rack

PI1	Input of Compressors		0.5-2.5mmWC	
PI2	Output of Compressors		45-100”WC	
PI3	Supply pressure		1.2-2.5”WC	
PI6	Argon Delivery pressure		15-21PSIG	
PI7	Methane Delivery pressure		12-16PSIG	
FI15	Purging flow for PI1 case		1.0LPM	

Gas Pad

Methane Bank			1 or 2	
Argon Bank			0 - 2000 PSIG	

Electronic Rack

Sensor	Function	Value	Range	Comments
FM1	Argon mass flow controller		9.8-10.1LPM	
FM2	Methane mass flow controller		0.98-1.1 LPM	
FI1	Flow indicator		9-11LPM	

Mixing Room Manifold

Sensor	Function	Value	Range	Comments
	Nitrogen Supply Pressure		15 PSIG	
	Argon Delivery Pressure		20 PSIG	
	Methane Delivery Pressure		15 PSIG	

Operator_____ Date & Time_____

Attachment F: Computer Alarm Conditions

Alarm Event	Problem	Level	Computer Action	Possible Causes
CH4 /FM Low Alarm	Fresh gas methane content low	< 9.0%	Sound, Light	Methane bottle empty; FM2 set wrong
CH4 /FM High Alarm	Fresh gas methane content high	> 12.0 %	Off HV,SV6,SV8	FM2 set wrong.
PT9 High Alarm	EastTEC-TRDpressure too high	> 6 mmWC	Sound, Light	Makeup flow too high; No outlet flow
PT9 Low alarm	EastTEC-TRDPressure too low	< 1.0 mmWC	Sound, Light	Makeup flow stopped; Argon empty, Leak
PT2 Low alarm	Return line pressure too low	< 0.3mmWC	Off HV,SV6, Sound, Light	Big leak, Makeup flow stopped
PT2 Low Warning Alarm	Return line pressure low	<0.5mmWC	Sound, Light	Leak; Makeup gas flow low;
PT2 High Warning Alarm	Return line pressure high	>1.8mmWC	Sound, Light	Makeup gas flow high, Restricted outlet flow
PT2 High Alarm	Return line pressure too high	> 2.5mmWC	Off HV,SV8 On SV7 Sound, Light	Makeup gas flow too high, PCV1 fails
PT5 High alarm	EastTEC-TRDinput pressure high	> 1.8”WC	Sound, Light	Input restriction to flow
PI2 Low Alarm	Makeup pressure low	< 20”WC	Sound, Light	PCV1 fails, Argon Bank empty
PI6 Low Alarm	Argon supply pressure low	<10PSIG	Sound, Light	Argon Bank empty, leak
PI7 Low Alarm	Methane supply pressure low	<7PSIG	Sound, Light	Methane Bank empty, leak

Note: High Warning = alert by the computer before alarm condition

High Warning Return = alarm flag resets when sensor value returns to this number

Attachment G: Hardware Alarm Conditions

Alarm Event	Problem	Level	Action	Possible Causes
PT9 High Alarm	EastTEC-TRDpressure too high	> 6 mmWC	Sound, Light	Makeup flow too high; No outlet flow
PT9 Low alarm	EastTEC-TRDPressure too low	< 1.0 mmWC	Sound, Light	Makeup flow stopped; Argon bank empty, Leak
PT2 Low alarm	Return line pressure too low	< 0.3mmWC	Off HV,SV6, Sound, Light	Big leak, Makeup flow stopped
PT2 Low Warning Alarm	Return line pressure low	<0.5mmWC	Sound, Light	Leak; Makeup gas flow low;
PT2 High Warning Alarm	Return line pressure high	>1.8mmWC	Sound, Light	Makeup gas flow high, Restricted outlet flow
PT2 High Alarm	Return line pressure too high	> 2.5mmWC	Off HV,SV8 On SV7 Sound, Light	Makeup gas flow too high, PCV1 fails
PI2 Low Alarm	Makeup pressure low	< 20”WC	Sound, Light	PCV1 fails, Argon Bank empty

Alarm = Bell and red flashing light in mixing house. There is also an alarm condition notification through slow controls (EPICS) to run control.

Attachment H. Operations Initial Checklist

MV1-closed(Dryer In)

MV2-closed(Dryer Out)

MV3-open to FM1(P10 operation) or to FM4(Xenon Mixture operation) (Mixing Block 3-way valve)

MV4-open to FM2(P10 operation) or to FM5(Xenon Mixture operation) (Mixing Block 3-way valve)

MV5-closed(Compressors Bypass)

MV6-open(Purifiers 3-way Input valve) to Purifier I

MV6a-closed(Purifier I Input)

MV7-closed(Purifier II Output)

MV7a-closed(Purifier II Output)

MV8-closed(Purifier I Output)

MV8a-closed(Purifier I Output)

MV9-open to vent line (Return manifold 3-way valve)

MV10-open to vent line(BPCV1 output 3-way valve)

MV11-closed(Buffer Input)

MV12-closed(High pressure compressor Bypass)

MV12a-closed(High pressure compressor Input)

MV13-closed(compression system purge valve)

MV13-closed(compression system purge valve)

MV14-closed(N2 purging valve)

MV15-open(PID Controller N2 supply valve)

CMV1-open(recirculating flow shut off valve)

SV1-closed(Purifier In)

SV2-closed(Dryer Out)

SV2a-closed(Compressors shut off valve)

SV4-closed(Mixer Out)

SV5-closed(Dryer Out)

SV6-open(Ar(He) supply line)

SV7-open(Ar(He) In)

SV14-closed(CH4 analyzer In)

SV15-closed(Compressors Out)

SV16-open(EastTEC-TRDIn)

SV17-open(EastTEC-TRDOut)

SV18-closed(Compression System)

SV19-closed(Compression System)

SV8-closed(Methane In)

SV9-closed(Used Mixture Supply line)

SV10-closed(Xenon Supply Line)

SV11-closed(Reference Mixture Line)

SV12-closed(O2 analyzer In)

SV13-closed(H2O analyzer In)

FI3-closed(Ar(He) In)

FI4-closed(Used Mixture In)

FI5- closed(H2O Analyzer In)

FI6- closed(O2 Analyzer In)

FI7-closed(CH4 Analyzer In)

FI9-closed(Dryer Out)

SV21-status(EastTEC-TRDVent)

SV23-closed(East CO2 Line)

FI12-closed(EastTEC-TRDIn)

FI14-closed(EastTEC-TRDCO2 Line)

FI15-closed(PIS1 case)

FI16-Closed(Heat Exchanger line)