Operating Procedures for the Engineering Run Gas and High Voltage Systems of the PHENIX Central Tracking Detectors

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REVISION CONTROL SHEET

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1. Purpose

The purpose of this document is to define the operation of the Gas and High Voltage Systems for the PHENIX Central Tracking Detectors during the Engineering Run (ER). This document specifies the Operating Procedures for the Drift Chamber prototype (DC), the Pad Chamber prototype (PC), and the sector of the Time Expansion Chamber (TEC). Where possible the Operating Procedures for the three subsystems involved have been made uniform so that a single procedure would suffice for all three.

2. Responsibilities

During the ER, there will be two levels of responsibility for the oversight of the Central Tracking Gas System.

The first level of responsibility will be the PHENIX Shift Crew. During any data taking period there will be at least four people on shift in the PHENIX counting house. Prior to data taking, there will be a period of chamber commissioning when the chambers are flushed with operating gas and tested at high voltage before the IR is closed and the chambers are inaccessible. During this commissioning phase the gas system will be monitored by the team of Gas Experts every eight hours, at 8:00, 16:00 and 24:00. A record of the performance of the gas system will be kept by the Gas Experts.

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

2.1 monitor the status and alarms for the gas system according to a prescribed check off list at least once a shift (eight hours).

2.2 In the event of an alarm or irregularity, contact an expert from the Expert Call List given in Appendix A.

The second level of responsibility is the Central Tracking System Gas Experts. It is the responsibility of the Gas Experts to:

2.3 maintain the Central Tracking Gas Systems in a safe operating condition. This includes:

2.3.1 changing gas cylinders when required,

2.3.2 setting, adjusting, and checking the gas mixture,

2.3.3 setting, adjusting, and checking the flow rates of gas,

2.3.4 checking the certification of the operating gas, (see details in Precautions, Section 4)

2.3.5 posting any special instructions or notifications as required, and

2.3.6 carrying out any emergency actions, as prescribed in the Procedures section of this document.

2.4 maintain the Central Tracking HV Systems in a safe operating condition. This includes

2.4.1 verifying the readiness of the chamber for HV,

2.4.2 turning on the HV according to the operating procedures described below,

2.4.3 posting any special instructions or notifications as required, and

2.4.4 carrying out any emergency actions, as prescribed in the Procedures section of this document.

3. Prerequisites

The Central Tracking Gas Experts shall have read or have training in the following areas:

3.1 RHIC Project Local Emergency Plan, RHIC-OPM 3.0,

3.2 BNL Compressed Gas Safety Training Course,

3.3 BNL Electrical Safety I,

3.4 BNL Lock Out/Tag Out Authorized Training,

3.5 PHENIX Central Tracking Gas and High Voltage System Training,

3.6 geographical layout of the experimental area (routes of egress, location of emergency equipment, phones and controls)

Before any HV can be turned on, sufficient gas must have flowed through each of the detectors for 4 volume exchanges.

4. Precautions

The safety of personnel is of primary importance. The Gas Experts shall take great care to ensure that the Central Tracking Gas and High Voltage 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 outside of the building in a gas rack. Only non-flammable gas will be brought into the building.

4.1.2 The operating pressure of gas lines inside the building will not exceed 5 psig thereby eliminating the hazard of high pressure compressed gas lines.

4.1.3 In order to ensure that the operating gas always remains non-flammable, a system of control valves has been designed into the system. As shown in Attachment 2, Figure 9.3.2, the P-10 and Argon each pass through a two-stage high pressure regulator and an in-line regulator before arriving at a flowmeter panel. The P-10 uses a single flowmeter and the Argon uses a single flowmeter. The ratio of flow rates is 4 to 1 by volume. The flowmeters were individually calibrated by Leigh Hawkins. Following the flowmeters, the gases pass through pneumatic shut-off valves before they are mixed in a common tube. After the mixing tube, the gas passes through a back-pressure regulator. Flowmeters perform best when they function in a constant pressure environment, so keeping an in-line regulator just upstream of the flowmeters and a back-pressure regulator immediately downstream of the flowmeters makes for more stable operation. Each of the gases has a photohelic pressure gauge monitoring the pressure in the flowmeter volume. It is the Argon photohelic that ensures the certification of the gas mixture, and keeps the gas in the experimental hall from becoming flammable. Should the Argon cylinder run low, or for any other reason reduce the flow to the Argon flowmeter, a signal from the Argon photohelic will shut of all gas flow. Normal operation of the system is calibrated to produce a gas mixture that is 92% Argon and 8% Ethane. Tests of the system have been conducted by Leigh Hawkins. These tests show that all gas flow will be stopped if the Argon flow is reduced enough to produce a mixture that is 8.25% Ethane. At the same time that the gas flow is stopped, an alarm will sound in the PHENIX Counting Room to alert the people on shift that the Central Tracking Gas System needs attention. Since P-8.5 is considered non-flammable, this control system will protect us from operating with flammable gas in the chambers.

4.2 High Voltage System Precautions:

4.2.1 The total stored electrical energy in the high voltage systems is low. The HV power supplies are current limited at less than 1 microamp per channel. All HV points are covered by an insulating layer in order to eliminate the danger to personnel. When the DC and PC-1 prototypes are mounted on the carriage the HV points are inaccessible to personnel. The TEC section will be mounted on the floor of the experimental hall. When TEC testing is being conducted and HV is on the TEC, there will be a yellow tape barrier and an HV warning sign posted around the TEC to indicate to personnel that they need to keep their distance. When the IR is closed no barriers or warnings will be required.

5. Standard Operating Procedures

There are two elements to these Operating Procedures. The first element covers running gas to the chambers. The second covers the high voltage system for the chambers. These Procedures shall be carried out by Central Tracking Gas Experts only.

The three PHENIX subsystems that make use of this gas system are the TEC, PC, and DC. All three subsystems use the same operating gas for the ER. This gas, called P-8, is a mixture of 8% Methane and 92% Argon. Since this gas is not a standard gas mixture we will be producing our own gas mixture from P-10 cylinders and Argon cylinders. The gas cylinders will be located in a gas rack outside of the South door of the Assembly Hall. All mixing will take place outside of the building in order to ensure that no flammable gas will enter building 1008.

For details of the gas system, please refer to Attachment 2. The labels of valves and meters in the operation instructions below refer to parts identified in the figures in Attachment 2.

5.1 Gas System Procedures: In order to start the flow of operating gas through a chamber when the chambers are first brought in to the experimental hall, it is assumed that the chambers are filled with air or dry nitrogen. The chambers will be flushed with nitrogen in storage, or will be kept sealed. This is the procedure for bringing on a chamber for the first time.

5.1.1 Open the cylinder valve on the Nitrogen bottle (V26) in order to provide compressed gas to operate the pneumatic shut-off valves V23 and V24.

5.1.2 Verify that the Nitrogen regulator (V27) is set to 60 psi.

5.1.3 Disable the Low Flow Shut-off switches S1 and S2.

5.1.4 Verify that the pneumatic shut-off valves (V23 and V24) are open.

5.1.5 Verify that the cylinder valves on the Argon and P-10 cylinders are closed (V1, V2, V3 and V4).

5.1.6 Verify that the pressure regulators on the Argon and P-10 cylinders are closed (V5, V6, V7, V8).

5.1.7 Verify that the manual shut-off valve V18 is closed.

5.1.8 Verify that the in-line regulators V19 and V20 are closed.

5.1.9 Verify that the needle valves on the flowmeters are closed (V21 and V22).

5.1.10 Verify that the needle valves for the input flowmeters on the Central Tracking Gas Panel are closed (V29, V30, V31).

5.1.11 Verify that the Argon blow-down valves V9, V10, and the P-10 blow-down valves V11, V12 are closed.

5.1.12 Slowly open the valve on top of the first Argon gas cylinder (V1). Record the pressure remaining in the cylinder.

5.1.13 Adjust the Argon regulator (V5) output to 20 psig. (Note: If you overshoot in setting the regulator output pressure you may need to briefly open the blow-down valve V9 in order to vent the regulator.)

5.1.14 Adjust the P-10 regulator (V8) output to 15 psig. (Note: If you overshoot in setting the regulator output pressure you may need to briefly open the blow-down valve V12 in order to vent the regulator.)

5.1.15 Verify that the P-10 Inline regulator V20 output pressure is set to 5 psi.

5.1.16 Verify that the P-10 flowmeter V22 is set so that the steel ball is at the level indicated on the flowmeter by an arrow. (Note: the darker nylon ball should rise to the top of the flow tube in normal operation.)

5.1.17 Verify that the Back Pressure regulator V25 is set to 3 psi.

5.1.18 Close the System Blow Down Valve V17.

5.1.19 Verify the Argon pressure reading PT1 is set to 5 psi.

5.1.20 Verify the P-10 pressure reading PT2 is set to 5 psi.

5.1.21 Enable the Low Flow Shut-off Switches S1 and S2.

5.1.22 Open the System manual valve V18.

5.1.23 Verify that the Low pressure regulator V28 is set to 2" H2O.

5.1.24 Open the DC flowmeter V29 and set it to 1 Liter Per Minute (LPM).

5.1.25 Verify that the DC bubbler B1 is not bubbling.

5.1.26 Open the PC flowmeter V30 and set it to 0.1 LPM.

5.1.27 Verify that the PC bubbler B2 is not bubbling.

5.1.28 Open the TEC flowmeter V31 and set it to 2 LPM.

5.1.29 Verify that the TEC bubbler is not bubbling.

5.1.30 After sufficient time has passed to pressurize the chambers, verify that the exhaust flowmeters V32, V33, V34, indicate flow. Check that the exhaust flow from each of the tracking chambers is reading their nominal values; 2 LPM for the TEC, 1 LPM for the DC prototype and 0.1 LPM for the PC prototype. (Markers attached to the three flow meters indicate the nominal values.) It may take some time after starting flow before the exhaust flow rate is stabilized. If the exhaust flow is not normal, shut off the input flow by closing the appropriate needle valve (V29, V30 or V31).

5.1.31 Look at the three bubblers to see if there is any venting of over-pressure gas. Under normal operating conditions the bubblers should not be bubbling. If bubbling continues, close the input flowmeter (V29, V30, or V31).

5.1.32 Record the time and date that gas flow was started for each chamber.

5.1.33 Allow the chamber to flow Mixed Gas until there has been at least four exchanges of gas inside the chamber. This represents about 4 hours for the PC-1 prototype. For the DC

prototype and the TEC this represents nearly two days of flow at the nominal flow rates.

5.1.34 It is now safe to turn on the high voltage on the chamber.

5.2 Gas System Procedures: In order to change a gas cylinder:

5.2.2 In normal operation, only one of the two gas cylinders will be flowing gas at any one time. Begin by locating the empty cylinder, and closing the valve on top of the empty gas cylinder (V1 or V2 for Argon, V3 or V4 for P-10).

5.2.3 Adjust the regulator on the cylinder flowing gas to 20 psi. (V5 or V6 for Argon, V7 or V8 for P-10).

5.2.4 Open the Blow Down Valve for the empty cylinder (V9 or V10 for Argon, V11 or V12 for P-10).

5.2.5 Unscrew the regulator connection from the empty gas cylinder.

5.2.6 Replace empty cylinder with a full cylinder.

5.2.7 Ensure that the full cylinder is chained securely in the gas rack.

5.2.8 Verify that the cylinder valve is clean and dry.

5.2.9 Secure the regulator to the full cylinder.

5.2.10 Open the cylinder valve (V1 or V2 for Argon, V3 or V4 for P-10).

5.2.11 Close the Blow Down Valve (V9 or V10 for Argon, V11 or V12 for P-10).

5.2.12 Verify that the regulator is set to 15 psi.

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

5.3 Gas System Procedures: In order to shut off gas flow to a chamber:

5.3.2 Close the needle valve for the chamber that you want to stop gas flowing to (V29, V30 or V31).

5.3.3 Record the time and date in the gas logbook.

5.4 Gas System Procedures: In order to shut off all gas flow:

5.4.2 Close the System Manual Valve V18.

5.4.3 Close the valves on top of the Argon and P-10 gas cylinders (V1, V2, V3 and V4).

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

5.5 HV System Procedures: In normal operations the experimental hall will be closed to personnel making access to any HV point impossible. Under such conditions, follow this procedure for turning on the HV:

5.5.2 Check that the appropriate current limits are in place for the power supply. Each subsystem shall maintain a HV logbook where the operating parameters of the HV settings are recorded. This shall include the current limits, target voltages, ramp rates, operating voltages and currents, and trip tolerances.

5.5.3 Check that the target voltage for each HV output line is appropriate (50 volts). The first stage

of bringing on the HV shall be a single increment in the ramp up. This is because the current trips are disabled during ramping, and in order to locate a short in the system, it is necessary to halt the ramping and check the current at the earliest possible stage.

5.5.4 Check that the ramp up rate for each HV supply is appropriate (50 volts per step).

5.5.5 Begin ramping up the HV.

5.5.6 If any of the HV supplies trips, disable all HV supplies for that chamber until the reason for the trip is understood. Then begin the procedure again from 6.5.1

5.5.7 If there are no HV trips, verify that the operating currents are appropriate.

5.5.8 Change the target voltage to the correct operating voltage for each chamber, as given in the operating log for each chamber.

5.5.9 Continue ramping up the HV.

5.5.10 When ramping is complete, verify that the operating currents are appropriate, as given in the operating log for each chamber.

5.5.11 HV is ready for chamber testing.

5.6 HV System Procedures: Turning off high voltage to a chamber:

5.6.2 Begin ramping down the HV.

5.6.3 Verify by the read back that the HV is off the system.

5.7 HV System Procedures: If there is access to the IR and personnel are working in the area around the TEC, then it is necessary to take extra precautions when turning on the HV for the TEC. In this case, follow this procedure for turning on the TEC HV.:

5.7.2 Verify that the yellow isolation chains surrounds the subsystem to be energized in order to ensure the appropriate working clearance for personnel.

5.7.3 Verify that chamber gas is flowing, and that sufficient time has been allowed for adequate purging of the chamber. Each subsystem shall maintain a gas log book where the gas flow history is recorded.

5.7.4 Place the "HV ON" sign in a prominent position.

5.7.5 Check that the appropriate current limits are in place for the power supply. Each subsystem shall maintain a HV logbook where the operating parameters of the HV settings are recorded. This shall include the current limits, target voltages, ramp rates, operating voltages and currents, and trip tolerances.

5.7.6 Check that the target voltage for each HV output line is appropriate (50 volts). The first stage of bringing on the HV shall be a single increment in the ramp up. This is because the current trips are disabled during ramping, and in order to locate a short in the system, it is necessary to halt the ramping and check the current at the earliest possible stage.

5.7.7 Check that the ramp up rate for each HV supply is appropriate (50 volts per step).

5.7.8 Begin ramping up the HV.

5.7.9 If any of the HV supplies trips, disable all HV supplies for that chamber until the reason for the trip is understood. Then begin the procedure again from 6.5.1

5.7.10 If there are no HV trips, verify that the operating currents are appropriate.

5.7.11 Change the target voltage to the correct operating voltage for each chamber, as given in the operating log for each chamber.

5.7.12 Continue ramping up the HV.

5.7.13 When ramping is complete, verify that the operating currents are appropriate, as given in the operating log for each chamber.

5.7.14 HV is ready for chamber testing.

5.8 HV System Procedures: Turning off high voltage to a chamber:

5.8.2 Begin ramping down the HV.

5.8.3 Verify by read back that the HV is off the system.

5.8.4 Remove the "HV ON" sign.

6. Documentation

Each subsystem is responsible for maintaining its own logbooks for their gas system and their HV system.

7. References

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

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

7.3 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

8.1 Attachment 1: - Call list for the Central Tracking Gas System Experts.

8.2 Attachment 2 – Layout of the building showing:

- 8.2.1 Central Tracking Detector locations,
- 8.2.2 Gas cylinder location,
- 8.2.3 Fire alarm pull boxes and fire extinguishers,
- 8.2.4 Telephones

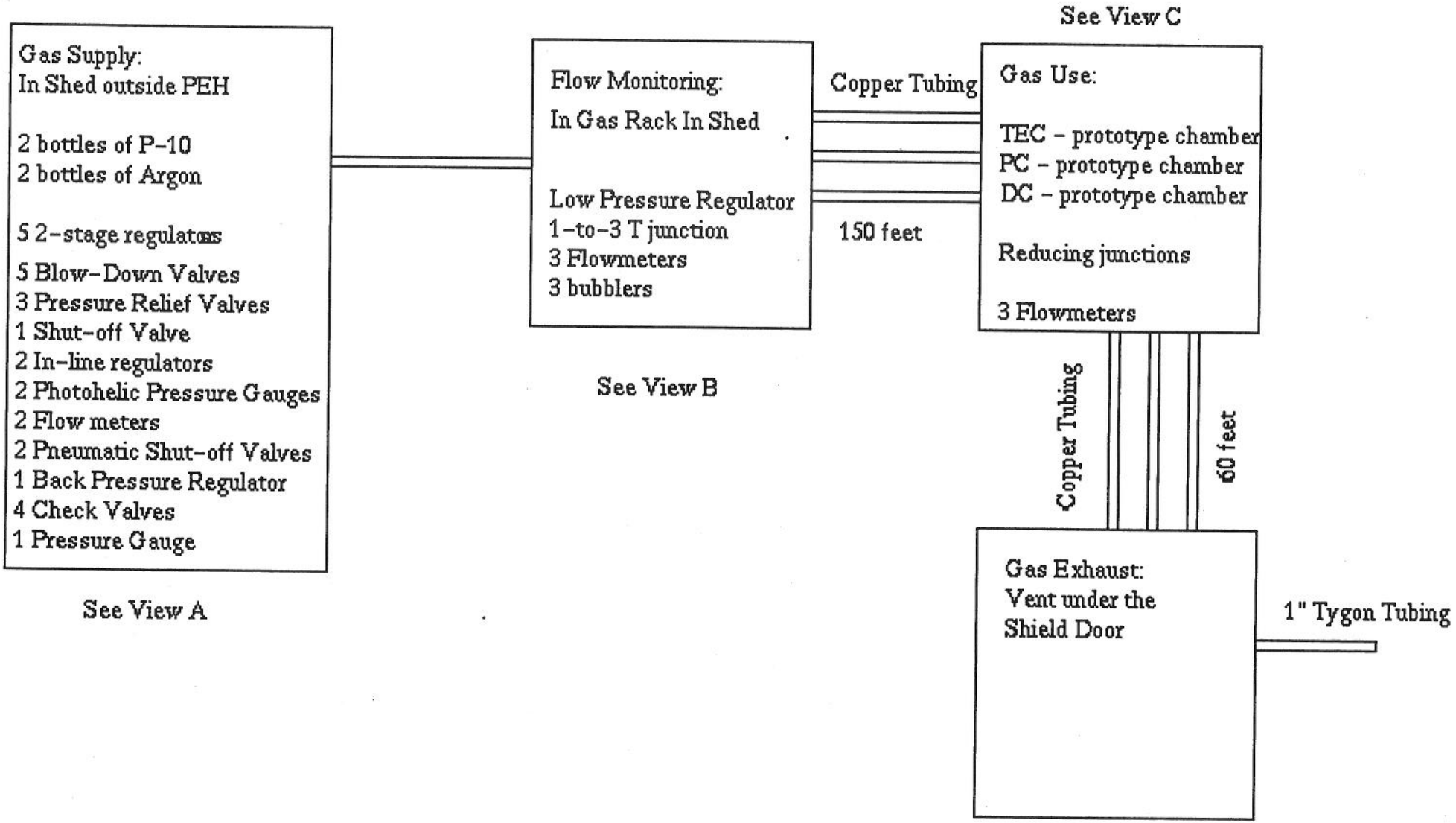
8.3 Attachment 3 – Schematic of the Central Tracking Gas System.

- 8.3.1 Overall Gas System Schematic
- 8.3.2 Detail of Mixing Panel
- 8.3.3 Detail of Distribution Panel
- 8.3.4 Detail of Return Panel

Attachment 1:

9.1 Call list for the Central Tracking Gas System Experts.

9.1.1	Leigh Hawkins	x-3942
9.1.2	Michael Sivertz	x-6102
9.1.3	Vicki Greene	x-6102
9.1.4	Ed O'Brien	x-4318
9.1.5	Tom Hemmick	632-8111
9.1.6	Achim Franz	x-4750
9.1.7	Carter Biggs	x-7515
9.1.8	Bill Licciardi	x-6395
9.1.9	Richard Hutter	632-8235
9.1.10	Julia Velkovska	632-3273
9.1.11	Vlad Pantuev	632-8112



Attachment 2
Figure 9.3.1
ER.fig
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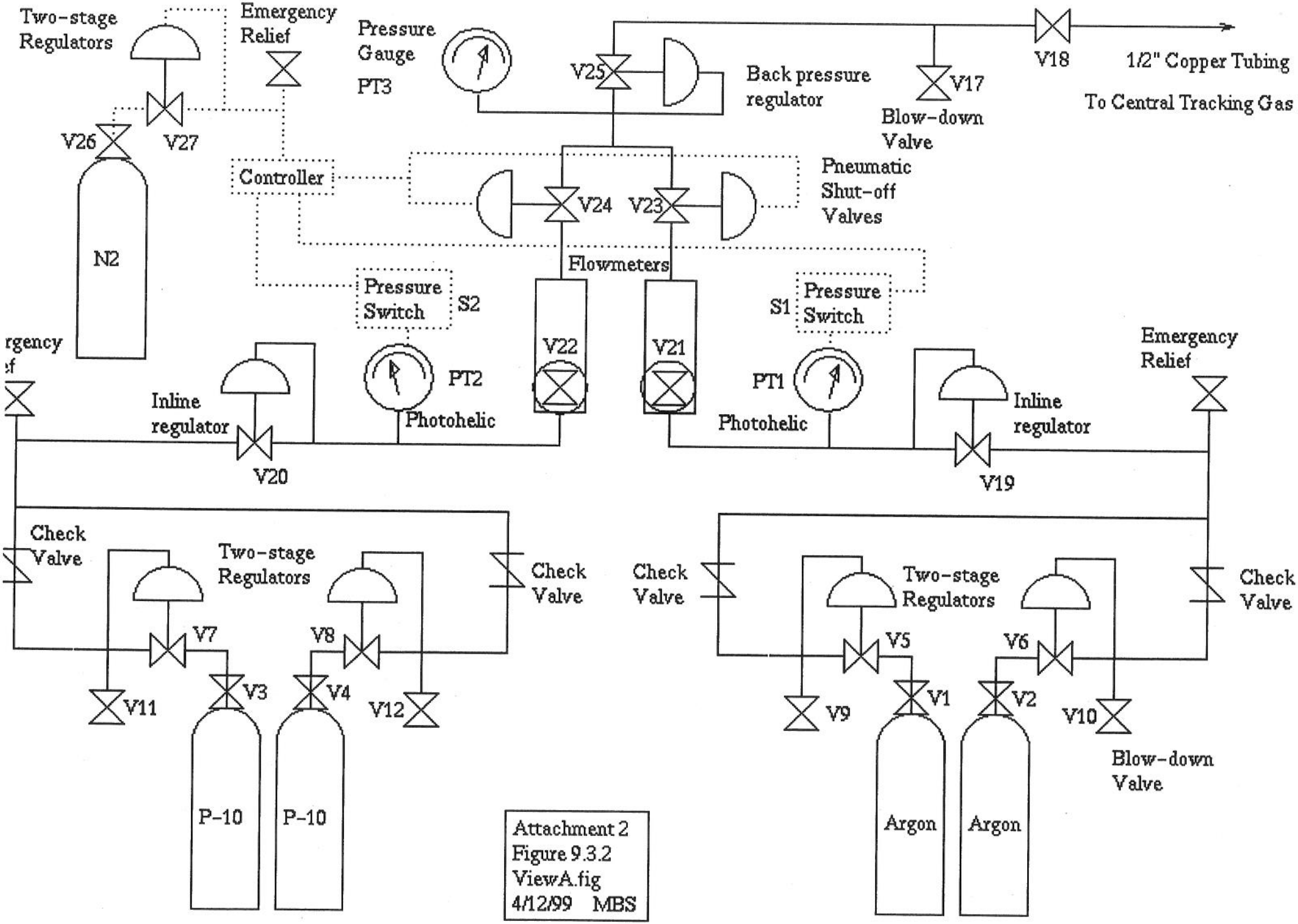
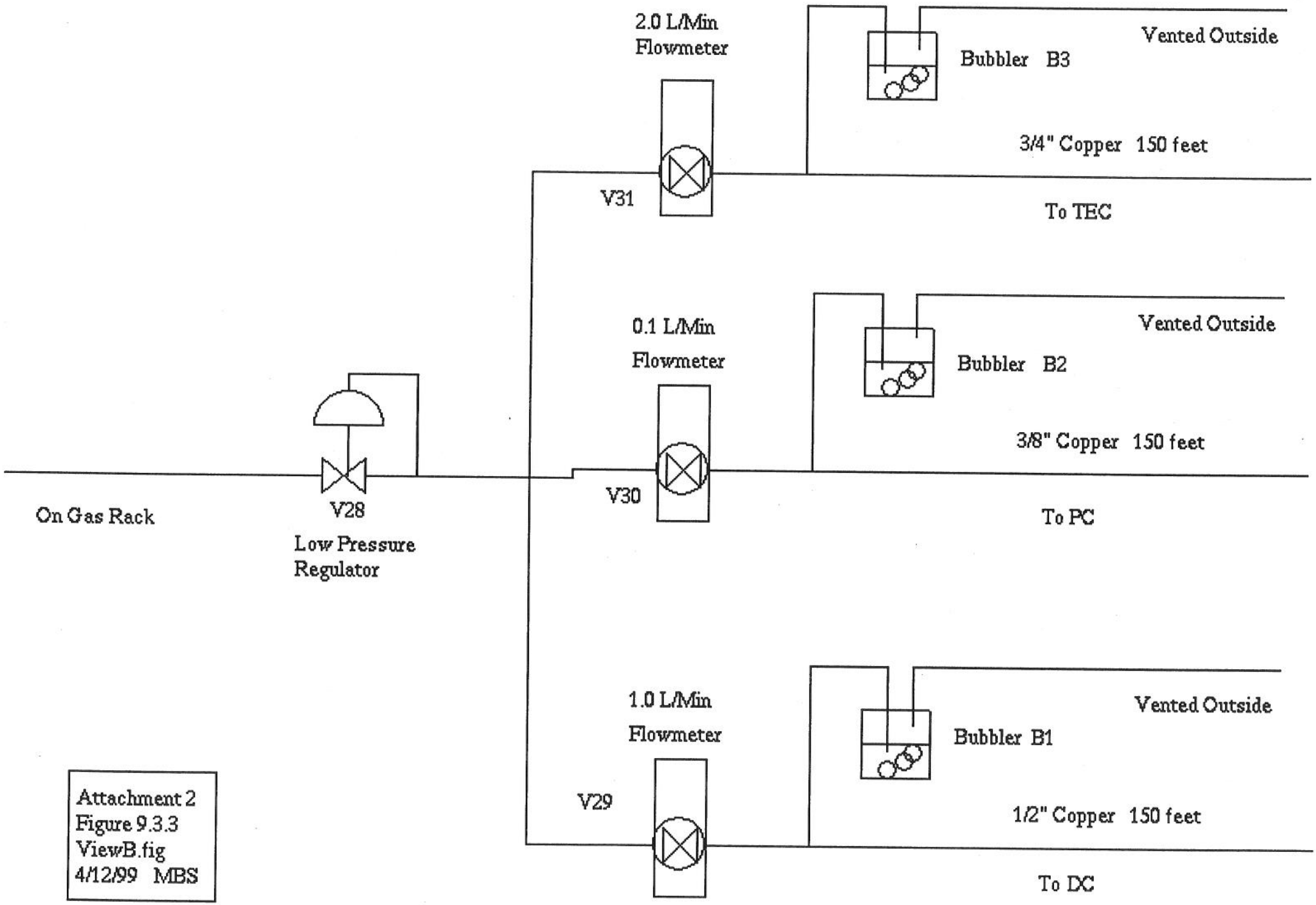
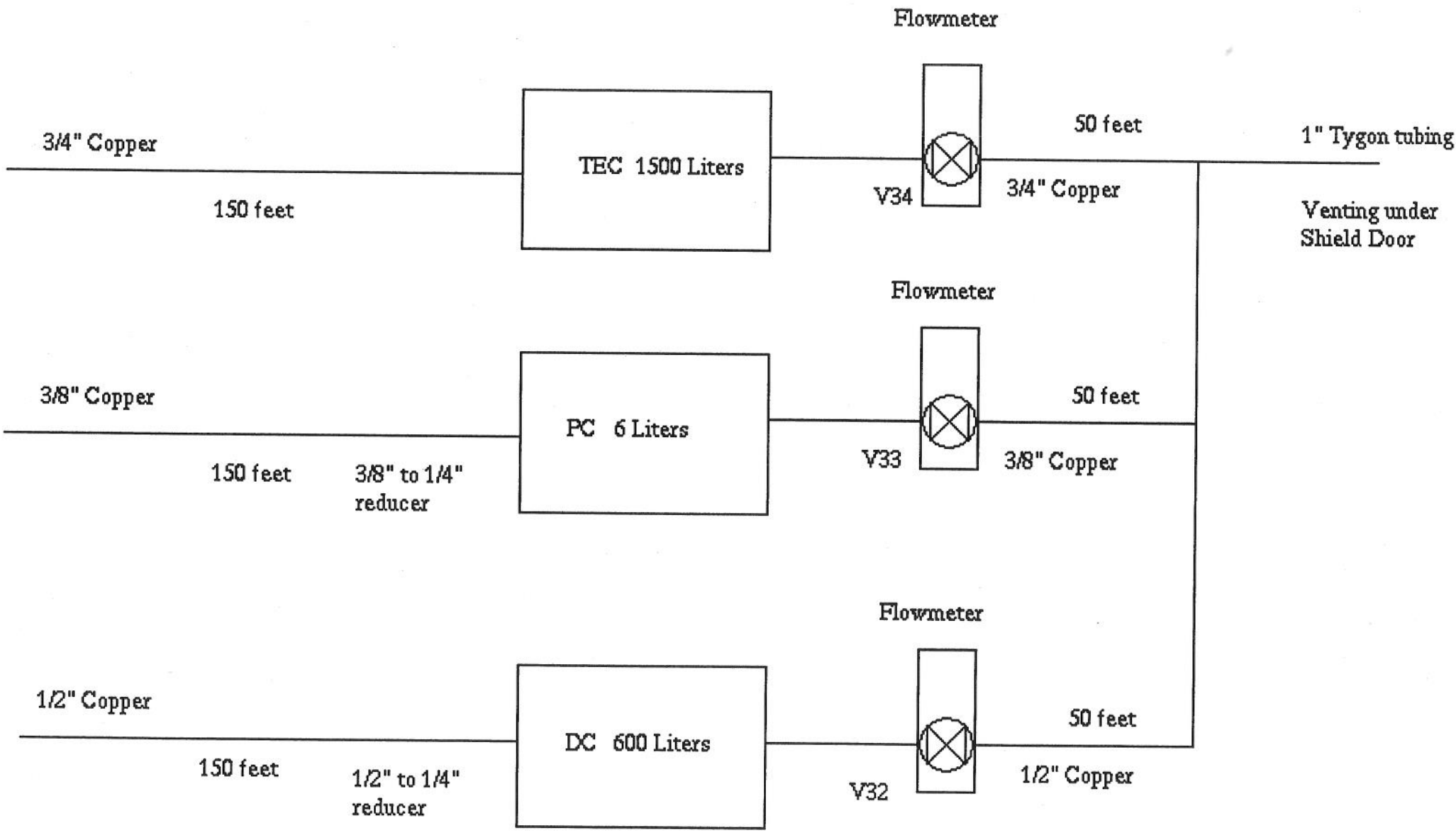
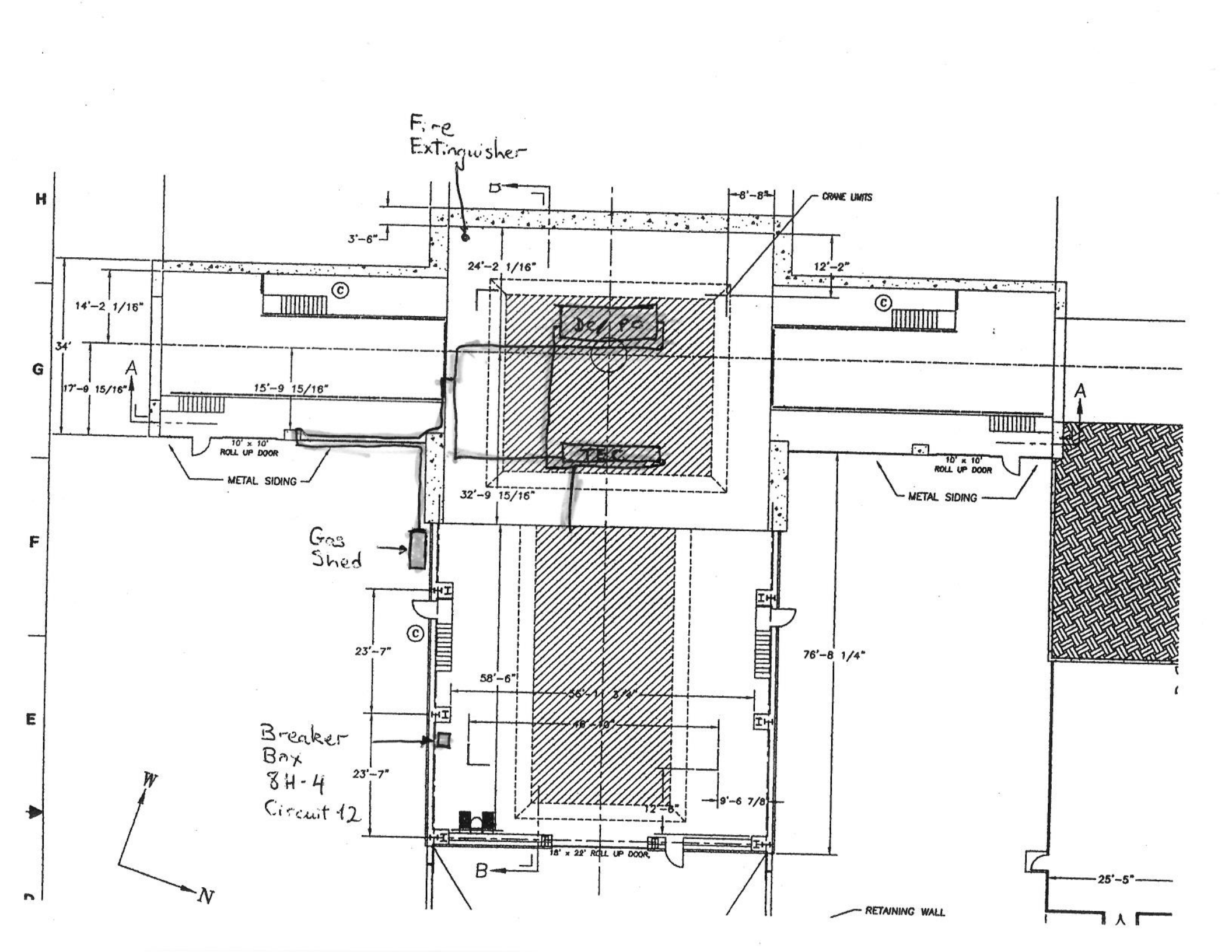

Two-stage Regulators
Emergency Relief
Pressure Gauge PT3
V25
Back pressure regulator
V17
Blow-down Valve
V18
1/2" Copper Tubing
To Central Tracking Gas
V26
V27
Controller
Pneumatic Shut-off Valves
V24
V23
N2
Flowmeters
Pressure Switch S2
S1 Pressure Switch
V22
V21
rgency
Emergency Relief
PT2
PT1
Photohelic
Photohelic
Inline regulator
Inline regulator
V20
V19
Check Valve
Two-stage Regulators
Check Valve
Check Valve
Two-stage Regulators
Check Valve
V7
V8
V5
V6
V11
V3
V4
V12
V9
V1
V2
V10
Blow-down Valve
P-10
P-10
Argon
Argon
Attachment 2
Figure 9.3.2
ViewA.fig
4/12/99 MBS



Attachment 2
Figure 9.3.3
ViewB.fig
4/12/99 MBS

Attachment 2
Figure 9.3.4
ViewC.fig
4/12/99 MBS




Fire Extinguisher
CRANE LIMITS
8'-8"
3'-6"
24'-2 1/16"
12'-2"
14'-2 1/16"
34'
17'-9 15/16"
15'-9 15/16"
10' x 10' ROLL UP DOOR
METAL SIDING
32'-9 15/16"
Gas Shed
23'-7"
58'-6"
56'-11 3/4"
18'-10"
23'-7"
9'-6 7/8"
12'-8"
18' x 22' ROLL UP DOOR
76'-8 1/4"
25'-5"
RETAINING WALL
Breaker Box 8H-4 Circuit 12
W
N
A
B
H
G
F
E