

# **SHORT CBM RICH GAS SYSTEM OPERATION MANUAL**

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## **Start System, Purging the RICH and Recirculation Mode**

### **1.0 Purpose and Scope**

The goal of this procedure is to instruct Rich Group personnel in the correct procedure for starting the RICH gas system and for purging the RICH with dry Nitrogen then with Carbon Dioxide and start the recirculation Mode.

This procedure contains the steps necessary to start the RICH gas system from a fully shutdown state and to purge the RICH and secondary systems with dry nitrogen. In this operation, nitrogen gas is routed from the cylinder through all portions of the RICH gas system and then into the RICH itself. The gas returning from the RICH is vented outside the experiment area. The gas flow will be less than 10 liters per minute (LPM).

The primary purpose of purging the RICH with dry nitrogen is to eliminate the air from the gas system and RICH, reducing the Oxygen and Water content to below 100 ppm. At the end of this procedure the RICH can be maintained in a standby state with a low flow of Nitrogen or the operator can continue on and purge with Carbon Dioxide.

### **2.0 Prerequisites**

- 2.1 Required training to operate the gas system
  - 2.1.1 RICH Gas System training with a previously qualified gas system user.

### **3.0 Precautions**

- 3.1 Overpressurization of the RICH (above 5mBar) will result in severe structural damage. Primary care should be given to monitoring the internal pressure of the RICH throughout the duration of this procedure, especially when adjusting flow rates.

## 4.0 Procedures

### 4.1 Power on the Gas System

- 4.1.1 Supply AC power for Rack
- 4.1.2 Turn on AC power inside Rack
- 4.1.3 Turn on AC power H2O Analyzer
- 4.1.4 Turn on and boot up the gas system PC.
- 4.1.5 Start the gas system control program.
- 4.1.6 Turn on TIC1 AC Power

**NOTE: All solenoid valves, mass flow controller and compressor are controlled with the gas system PC.**

### 4.2 Prepare for Nitrogen Flow and Purging

- 4.2.1 Confirm that SV1(n/o), SV2, SV3, SV4, SV5 and SV6 are closed(red color).
- 4.2.2 Confirm that SV7(n/o) is open(Green color)
- 4.2.3 Confirm that PI1 Nitrogen pressure is about 1.0Bar.
- 4.2.4 Confirm that FI1 valve closed
- 4.2.5 Open SV1
- 4.2.6 Adjust FI1 flow to 100LPH
- 4.2.7 Close SV1
- 4.2.8 Set 3mBar pressure for PT4 on PC control program
- 4.2.9 Open SV2
- 4.2.10 Exchange 3 RICH volumes.

**NOTE: Steps 4.2.9 and 4.2.10 are executed automatically by [Purging Mode] button in the gas system control software. The advantage of using software controlled purging is that it counts the gas volume passed through the detector and estimates the finish time of purging.**

### 4.3 Purging with Carbon Dioxide

- 4.3.1 Close SV2
- 4.3.2 Connect CO2 to Gas system Rack.
- 4.3.3 Confirm that PI1 pressure is about 1.0Bar.
- 4.3.4 Open SV2
- 4.3.5 Exchange 4 RICH volumes
- 4.3.6 Open SV3 and purge Analyzers.

**NOTE: Steps 4.3.4 - 4.3.6 are executed automatically by [Purging Mode] button in the gas system control software. The advantage of using software controlled purging is that it counts the gas volume passed through the detector and estimates the finish time of purging.**

### 4.4 Start Recirculation Mode

- 4.4.1 Set 2mBar pressure for PT4 on PC control program
- 4.4.2 Close SV7
- 4.4.3 Start Compressor
- 4.4.4 Open SV6
- 4.4.5 Open SV5
- 4.4.6 Close SV3.
- 4.4.7 Check O2 and H2O content . If theirs level is below 100ppm,
- 4.4.8 Open SV4 and close SV5
- 4.4.9 Check FM1 flow rate. It should be above 0.2LPM. If not,
- 4.4.10 Slightly decrease PI2, PT2 pressure by BPCV1 to have at least 0.4slpm FM1 flow.

**NOTE 1: Steps 4.4.2 - 4.4.9 are executed automatically by [Start Normal] button in the gas system control software. The software checks automatically Purifier and Dryer quality and also checks FM1 flow.**

**NOTE 2: Opening and closing BMV1 permits reduce or increase the recirculation flow through RICH**

#### **4.5 Stop Recirculation Mode**

4.5.1 Open SV7

4.5.2 Stop compressor

4.5.3 Close SV4

**At this point Gas system may be shut down or kept in Purging mode**

**NOTE: Steps 4.5.1 - 4.5.3 are executed automatically by [Stop circulation] button in the gas system control software.**

#### **4.6 Shut down Gas System**

4.6.1 Close SV2

4.6.2 Close CO2 Cylinder

4.6.3 Open SV1

4.6.4 Turn OFF TIC1 AC Power

4.6.5 Stop the gas system control program.

4.6.6 Turn OFF the gas system PC.

4.6.7 Turn OFF AC power H2O Analyzer

4.6.8 Turn OFF AC power inside Rack

#### **4.7 Purifier and Dryer Regeneration**

**Purifier regeneration**

**Note: Purifier should be regenerated using gas mixture containing H<sub>2</sub>(Hydrogen). It may be N<sub>2</sub>+5%H<sub>2</sub>**

**Instruments: 1. Two stage pressure regulator  
2. Flow indicator with the range of 0-1 LPM**

- 4.7.1 Connect two stage regulator (TSR) to cylinder and to Flow indicator(FI)
- 4.7.2 Purge slightly TSR and FI
- 4.7.3 Connect Flow indicator to MV1
- 4.7.4 Open MV2
- 4.7.5 Turn ON TIC1
- 4.7.6 Open MV1
- 4.7.7 Set mixture flow to 0.2 LPM
- 4.7.8 Regenerate Purifier for 20 hours
- 4.7.9 Turn OFF TIC1
- 4.7.10 After 2 hours Close MV1 and MV2
- 4.7.11 Close Cylinder
- 4.7.12 Disconnect FI from MV1

### **Dryer Regeneration**

- 4.7.13 Connect TSR to Nitrogen Cylinder
- 4.7.14 Connect FI to MV3
- 4.7.15 Open MV2
- 4.7.16 Turn On TIC2
- 4.7.17 Set mixture flow to 0.2 LPM
- 4.7.18 Regenerate Dryer for 20 hours
- 4.7.19 Turn OFF TIC2
- 4.7.20 After 2 hours Close MV3 and MV2
- 4.7.21 Close Cylinder
- 4.7.22 Disconnect FI from MV3

## **4.9 Leak Test**

- 4.9.1 Connect RICH to gas system
- 4.9.2 Supply AC power for Rack
- 4.9.3 Turn on AC power inside Rack
- 4.9.4 Turn on and boot the gas system PC.
- 4.9.5 Start the gas system control program.
- 4.9.6 Close SV1
- 4.9.7 Set 1Bar pressure on PI(PT1)
- 4.9.8 Close SV7
- 4.9.9 Close FI1
- 4.9.10 Open SV1
- 4.9.11 Using FI1 set 2.5mBar pressure on PT4 and close FI1.
- 4.9.12 Watch PT4 pressure and the barometric one. Pressure drop at the stable barometric pressure means that there is a leak.

