Hall B Drift Chamber Gas System Controls and Monitoring Software

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This note presents the controls and monitoring system hardware and software developed for the operation of the gas system of the Drift Chambers (DC).

Hall B's gas system comprises four custom designed chassis, which supply power to mass flow controllers (MFCs) and sensors, and interfaces signals between sensors and three National Instruments CompactRIOs (cRIOs).

The cRIO located on Space Frame Level Three of Hall B monitors the DCs, and one in the gas shed monitors DC gas mixing and provides the system interface GUI (Fig. 1) for changing gas flow.

Argon and carbon dioxide located in tanks outside the gas shed are mixed by two sets of model# GE250a dual mass flow controllers, Mix 1 and Mix 2, in the proportion Ar:CO_2 90% :10%, by volume, Fig. 2. Mix 1 supplies Regions 1 and 3, while Mix 2 supplies Region 2.

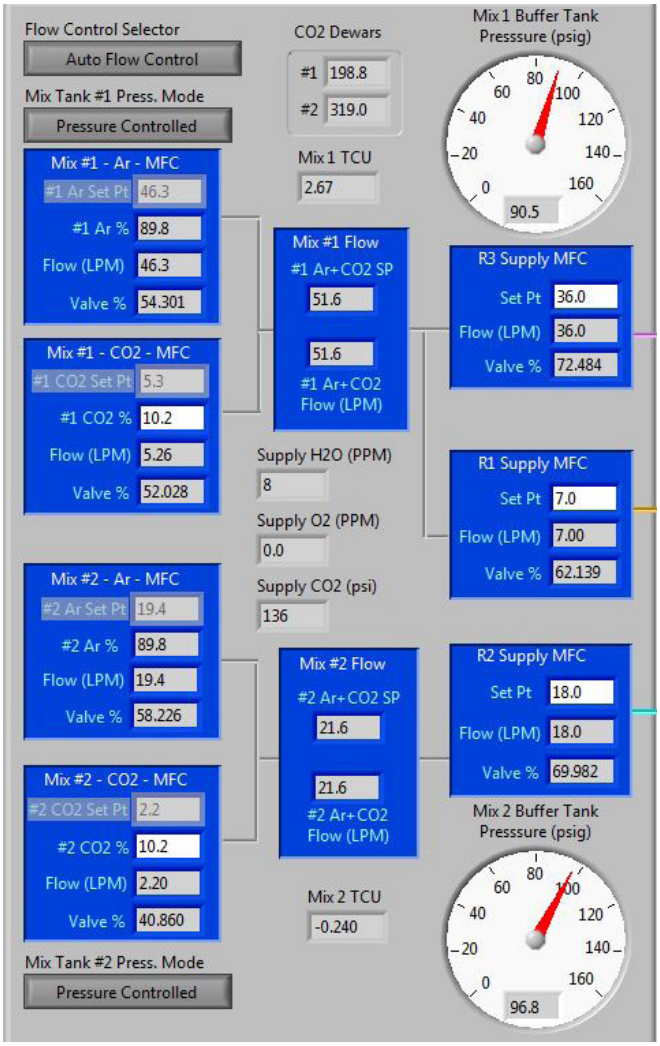

FIG. 1. LabVIEW GUI for DC gas system.

To determine the exact mix ratio [1], the mixed gas is compared with an Ar:CO_2 90%:10%, premixed reference gas. Both mixed and the reference gas flow through a thermal conductivity transmitter, which outputs a 4–20 mA signal that is converted to a 0–10 V signal using an Omega DP25e process controller. By comparing the results of the signals, the mixed gas ratio can be tuned to match the reference gas.

The mixed gas flows to the mix tanks—two 2000-gallon tanks for Region 2 and two 5000-gallon tanks for Regions 1 and 3. From the tanks, the gas is piped by the supply MFCs to corresponding DC regions.

Typical gas flow rates are 7 Lpm, 18 Lpm, and 36 Lpm for Regions 1–3, respectively. Mixing buffer tanks are maintained between 80 and 100 psi. Nominal pressures in the DCs, controlled by mineral oil bubblers on the exhaust to the atmosphere, are 0.06 InWC for Regions 1 and 2, and 0.1 InWC for Region 3.

Moisture (~6 ppm) and oxygen content (~1 ppm) of the supply is measured, as well as monitoring the carbon dioxide pressure at the tanks (~300 psi) and after the regulator (~120 psi).

In Automatic Flow Control mode, the following steps are taken:

1. The percentage of carbon dioxide for the mixture and the supply flow setpoint (SFS) to the DCs are manually entered.
2. The software automatically establishes SFS as the base flow value for the mixing system MFCs (Mix 1, Mix 2), Fig. 2.
3. Once the mixing system MFCs base flow values are established, the software ensures that the mixing system's argon MFC and carbon dioxide MFC flow appropriate amounts (at the manually entered percentage) through the mixing volume to the mix tanks.

Note, SFS of Regions 1 and 3 are combined to set the base flow value for the Mix 1 MFCs. SFS of Region 2 sets the base flow value for Mix 2 MFCs.

In Manual Flow Control mode, base flow values for the argon MFC and the carbon dioxide MFC are entered manually.

Note, SFS of the MFC to the DC regions does not update the mixing MFC base flow values.

Base flow values for the mixing MFCs vary to maintain appropriate pressure in the mix tanks. To maintain differential

pressure, the software monitors the mix tank pressures and modifies base flow values of Mix 1 and Mix 2 MFCs.

When the pressure of a mix tank set reaches 100 psi, the base flow value of the corresponding MFC set is reduced by 20%. The SFS of the MFC to the DCs are not changed, effectively reducing pressure in the mix tanks, Fig. 2.

When the mix tank pressure reaches 80 psi, the base flow value of the MFCs for that mix tank is increased by 20%. SFS of the MFC to the DCs is not changed, effectively increasing pressure in the mix tanks, Fig. 2.

An interlock in the code sets the flow to the mixing MFCs to zero if that MFC's mix tank pressure reaches 120 psi.

The DC gas system has been operating since late 2017 and has run without any problems.

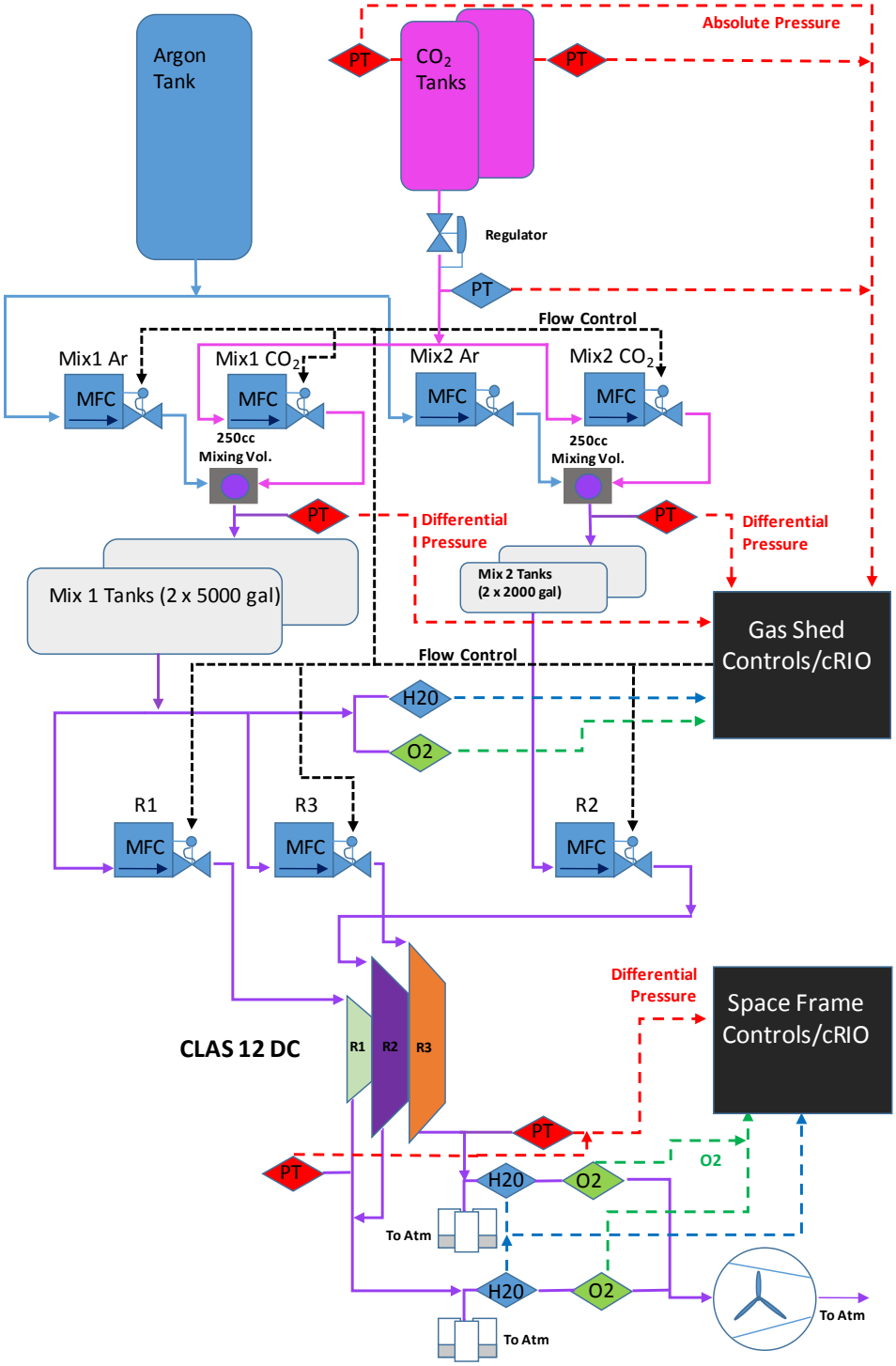

FIG 2. DC gas controls.