The Hall B MVT Gas Mixing System Commissioning

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Conceptual Design

- The initial system concept was developed by G. Jacobs (DSG). It was presented in June of 2016.
  - This included a preliminary P&I diagram.
  - Controls operating set points.
  - Stated that the Gas Shed would need to be approved to mix flammable gas.

Installation Planning

- In Aug/Sept of 2017 the Design Authority informed the DSG that EHS/Fire safety would not approve the gas shed for flammable gas use due to ignition sources.
  - The target gas pad would be selected as the location for the mixing system.
  - The DSG informed Hall B and the DA of the issues presented by running mass flow controllers in the elements (B. Eng email 08/31/17).
    - Temperature parameters 10C – 50C.
  - The DA commented on the on the vapor pressure of C4H10.

Installation Completion

- Hall B Eng./Mech. completed the installation of the valve panel, using a modified version of the concept design.
- The MFC are enclosed in a box made with insulation. They are mounted to a metal plate which has heat tape wrapped around.
- The C4H10 tank has a temperature controlled blanket and the supply lines have heat tape applied under insulation.

Initial Testing

- On 11/27/17 the DA gave the approval to run the system using Argon. All MFCs operated within specification.
- On 12/06/17 electrical work need for the heating blanket was completed on the gas pad and system testing using C4H10 began.
  - Later that evening the MVT group sent a request for help through the log book. The C4H10 MFCs were unstable. Particularly mix 2.
  - During troubleshooting the mix 2 C4H10 MFC was disconnected at the output connection and liquid was observed leaking out and then evaporated.
    - Later this MFC was removed from the system and tested at room temperature using Argon. It was determined that the MFC no longer seals to within specification and leaks under supply pressure (> 10psi)

Current Status

- MKS representative has been contacted. He is determining whether the MFC currently used is compatible with C4H10.
- Hall B Eng./Mech. is working on stabilizing the temperatures for the MFC enclosure and the C4H10 gas lines.
- DSG has suspended C4H10 flow through mix 1 and mix 2 (the spare is installed). Once the temperatures are within operating range, testing can resume.
- 30 bottles of pre-mix have been ordered to support the engineering run.

BACK-UP

The Hall B MVT Gas Mixing System

George Jacobs
Physics DSG
6/24/2016

The Hall B MVT Gas Mixing System

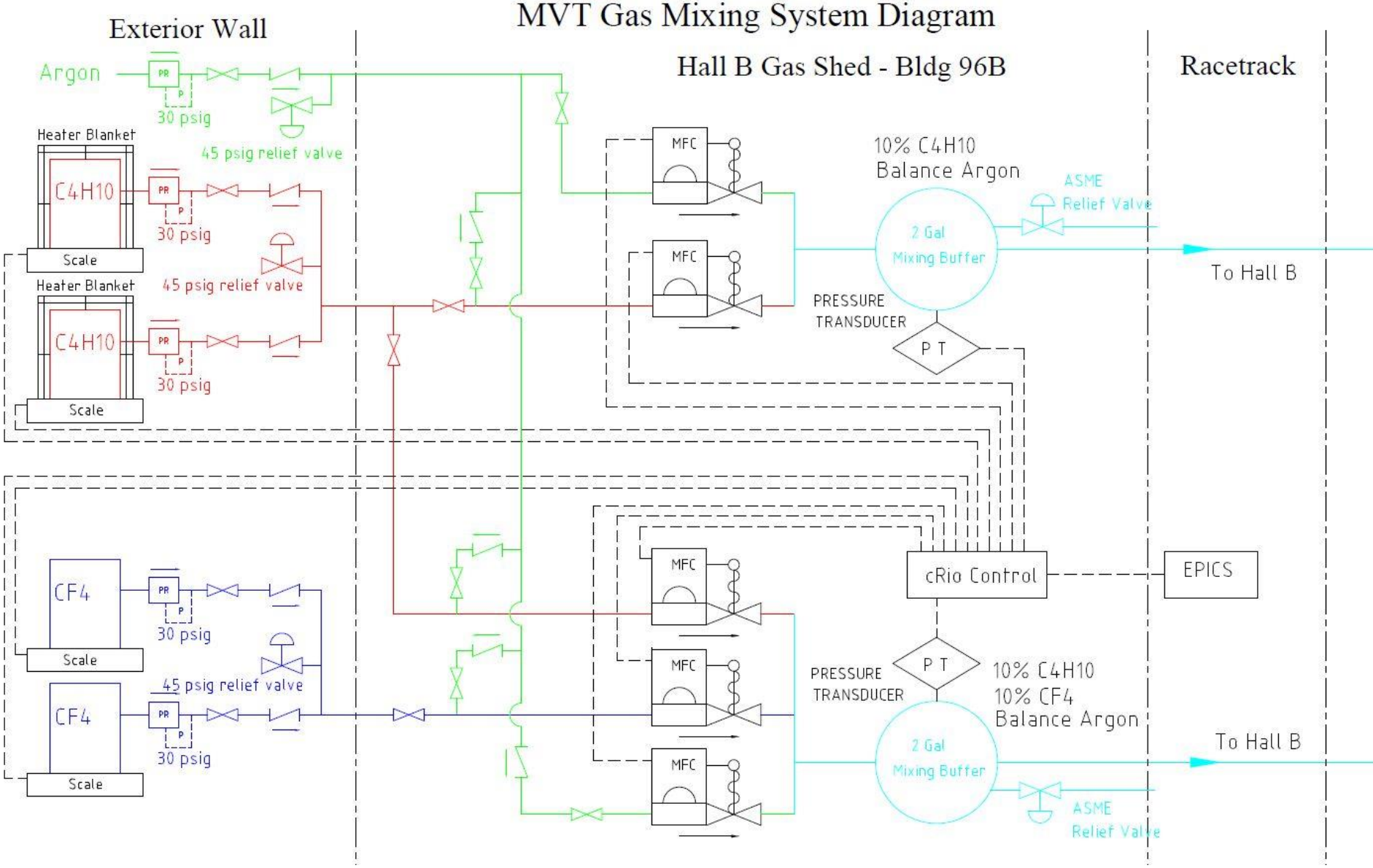
- Mixing System location will be in the Bldg. 96B Gas Shed
- System will Produce 2 Different Gas Mixtures
  Mixture 1 - 10% C4H10 in Argon
  Mixture 2 – 10% C4H10 10% CF4 in Argon
- MKS Mass Flow Controllers, MFCs, will be used to Mix the Gasses
- The MFCs are controlled by the cRio controller
- Mixed gas pressures are monitored by an MKS absolute pressure transducer
- Mixed Gas Pressure will be Automatically Controlled by Adjusting the MFC flows
- Mixed Gas Flows into the Hall in Temperature Controlled Piping

Design Goals in System Operation

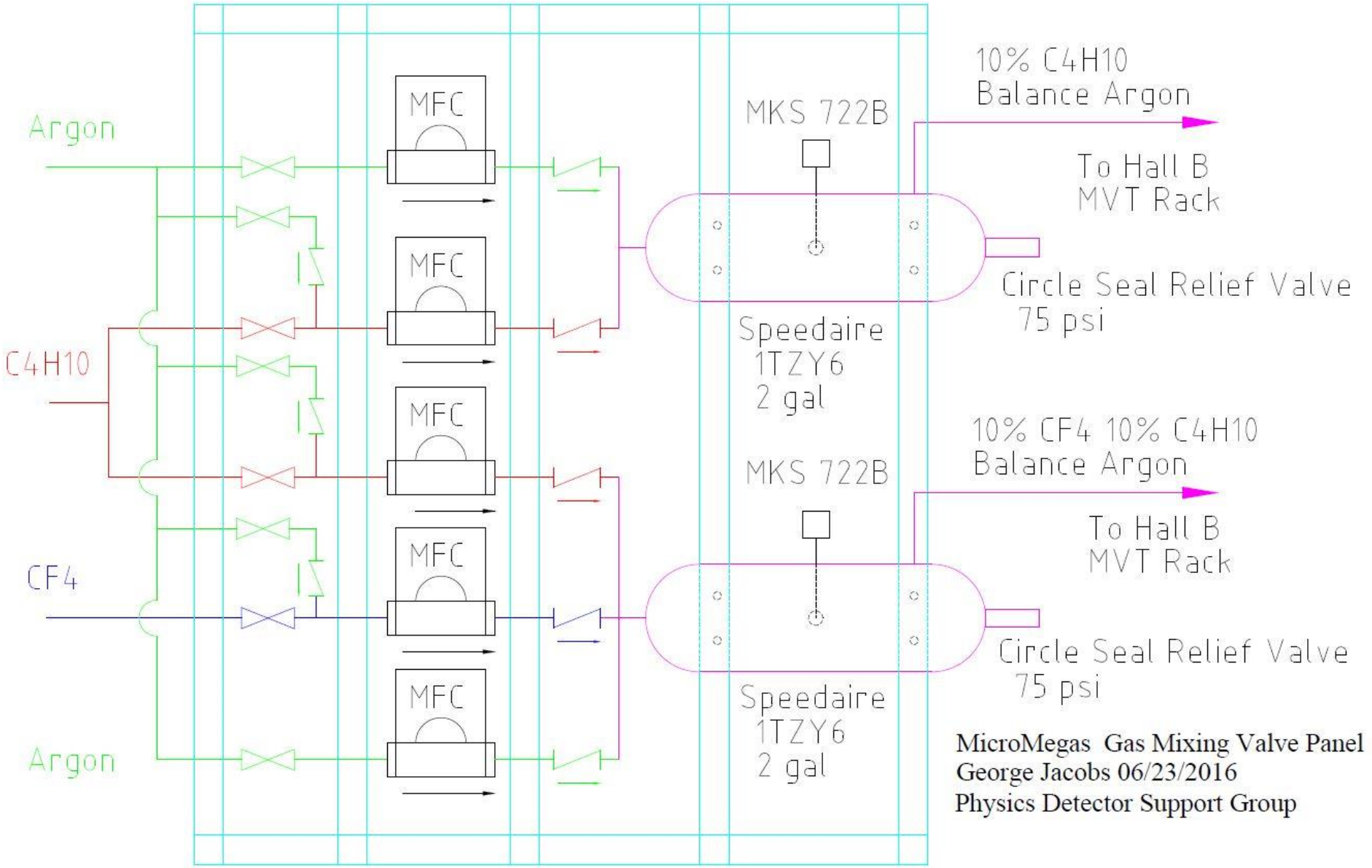
- Prevent detector damage due to improper gas mixture.
- Minimize any required operator actions.
- Minimize human errors.
- Automate system startup and shutdown.
- Prevent HV operation with improper gas mixture
- Prevent any flammable gas mixtures during maintenance or down times.
- Closely monitor the fill levels of the CF4 and C4H10 liquid gas cylinders
- Easy to adjust system operating parameters via GUI
- Integration with EPICS and the Alarm Handler

Mixing System Details

- Isobutane, C4H10, is a Flammable Gas with explosive limits of 1.4% to 8.3%
- Pressure System Requirements apply
- cRio Based Controls
- EPICS Monitoring and the Alarm Handler
- Trained Operators are Required to Replace the C4H10 and CF4 Gas Supply Cylinders (Liquid)
- Uses two pre-existing 300 ft long temperature controlled ½” SS tubing runs between the Gas Shed and Hall B Level 1 Space Frame


MVT Gas Mixing System Diagram
Exterior Wall
Hall B Gas Shed - Bldg 96B
Racetrack
Argon
PR
P
30 psig
45 psig relief valve
Heater Blanket
C4H10
Scale
Heater Blanket
C4H10
Scale
45 psig relief valve
CF4
Scale
45 psig relief valve
CF4
Scale
MFC
MFC
MFC
MFC
MFC
10% C4H10
Balance Argon
2 Gal
Mixing Buffer
ASME
Relief Valve
To Hall B
PRESSURE
TRANSDUCER
P T
cRio Control
EPICS
PRESSURE
TRANSDUCER
P T
10% C4H10
10% CF4
Balance Argon
2 Gal
Mixing Buffer
To Hall B
ASME
Relief Valve

MicroMegas Gas Shed Valve Panel



MicroMegas Gas Mixing Valve Panel
George Jacobs 06/23/2016
Physics Detector Support Group

The System Startup Sequence

The MVT gas GUI has a System Startup button

- When the System Startup Button is clicked the cRio runs the startup program
  1) Argon Purge is initiated – The C4H10 and CF4 MFCs close, the argon MFCs flow at the purge rate of 650 sccm and 325 sccm
  2) Argon Purge continues for 4 hours or 156 liters total flow for MIX1 and 78 liters total flow for MIX2
  3) Mixed gas purge begins and continues for 2 hours or 78 liters total flow for MIX1 and 39 liters total flow for MIX2
  4) Then the cRio program switches to normal mixing and pressure control operation

Mix 1 Pressure Control

- Mix 1 – 10% C4H10 in Argon
- Pressure is monitored by an MKS absolute Baratron transducer
- Maintain line pressure 12-16 psi
- Normal detector flow is 750 sccm
  - Vary flowrate between 400-900 sccm
  - @ 16 psi flow is reduced to 400 sccm
  - @ 12 psi flow is increased to 900 sccm
  - @ 17.2 psi flow is turned off
- Purge flow of 1000 sccm
  - Vary flowrate between 500-1500 sccm
  - @ 16 psi flow is reduced to 500 sccm
  - @ 12 psi flow is increased to 1500 sccm
  - @ 17.2 psi flow is turned off

Mix 2 Pressure Control

- Mix 2 – 10% CF4 10% C4H10 in argon
- Pressure is monitored by an MKS transducer
- Maintain line pressure 12-16 psi
- Normal detector flow is 250 sccm
  - Vary flowrate between 200-300 sccm
  - @ 16 psi flow is reduced to 200 sccm
  - @ 12 psi flow is increased to 300 sccm
  - @ 17.2 psi flow is turned off
- Purge flow of 325 sccm
  - Vary flowrate between 200-400 sccm
  - @ 16 psi flow is reduced to 200 sccm
  - @ 12 psi flow is increased to 400 sccm
  - @ 17.2 psi flow is turned off

The System Shut Down Sequence

The MVT gas GUI has a System Shut Down button

- When the System Shut Down Button is clicked the cRio runs the shut down program
  1) Argon Purge is initiated – The C4H10 and CF4 MFCs close, the argon MFCs flow at the purge rate of 650 sccm and 325 sccm
  2) Argon Purge continues for 4 hours or 156 liters total flow for MIX1 and 78 liters total flow for MIX2
  3) The cRio turns off the argon purge and turns off all the MFCs

Integration with the FT and Saclay PLC

- Current gas distribution system in hall requires manual flow adjustments and operation of the valves in the distribution racks for system start, purge, and shut down.
- Mixing System Startup Sequence automation
- Mixing System Purge automation
- Mixing System Shut Down Sequence automation
- Automatic Mixing System Shut Down in case of Large Downstream Leak
- EPICS Signals from Saclay PLC for EPICS GUI
- Detector Total Gas Flow Signals for Mixing System Optimization.

Critical Path Includes

- Purchase Components
- Fabricate and Install Gas Shed Valve Panel
- Fabricate and Install scales and regulators for the C4H10 and CF4 Cylinders
- Fabricate and Install Controls Chassis and Cables
- Run SS tubing in Gas Shed to Connect Valve Panel to Temperature Controlled lines to Hall B
- Run SS Tubing in Hall B to Connect Temperature Controlled lines to the MVT and FT Gas Panels
- Develop cRio Controls
- Test cRio Controls
- Test with Saclay and FT Gas Distribution Systems

Conclusion

- Current detector gas distribution system is manpower intensive and requires manual valve operation and flow adjustment for system startup, purge, and shut down.
- Further Controls Development required to automate the detector gas distribution equipment in the hall.
- Estimated time for gas mixing system completion once all components are purchased is ~ 4 months.
- Hall B Gas Shed location for flammable gas mixing system requires approval.