Upgrade to the LTCC Gas Controls

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LTCC Controls System Update

- New hardware installation and configuration change
  - Updated control power for solenoids (Solenoid Power Chassis)
  - Added new transducers
  - Added pump controls
  - \( \text{H}_2\text{O} \) sensor
  - Implemented new controls logic and interface software
  - New Forward Carriage GUI
  - Updated Gas Controls GUI (Gas Shed)
- Reconfigured operation of safety system
  - Omega DP25e process controllers are independent safety system
  - Hall B Gas Controls software is operational control
- Completed functionality and initial system testing
**LTCC C$_4$F$_{10}$ Supply and Recovery System**

- First stage of upgrade, which includes Supply and Recovery of C$_4$F$_{10}$
- Sector solenoids and pumps are controlled by LTCC logic software from Forward Carriage
- C$_4$F$_{10}$ is supplied from buffer tanks unless they are empty
- If buffer tank pressure is less than 4 psi, fresh C$_4$F$_{10}$ tank becomes supply. **This would indicate a loss of gas from the system.**
LTCC Solenoid Controls GUI

- GUI is displayed on FC cRIO monitor
- Main gas controls GUI tab has been updated with same features
- Upper portion represents Forward Carriage equipment
- Lower portion represents Gas Shed equipment
LTCC Solenoid Controls GUI, cont.

- Operator enters initial set points for pressure, flow, gas type, and H$_2$O content
- Operational set points: low pressure is 1.7 wc (fills to 1.8 wc per deadband set point)
- High pressure is 2.5 wc (returns down to 2.25 wc per deadband set point)
Controls System Interlocks

- $\text{C}_4\text{F}_{10}$ overpressure closes all sector supply solenoids
- Sector under minimum pressure (1.0 wc) closes both sector solenoids and shuts off all pumps.
- Sector over maximum pressure set point (2.75 wc) closes both sector solenoids
- Either buffer tank or pump output over pressure closes all return solenoids and shuts off all pumps
- $\text{H}_2\text{O}$ sensor out of range closes $\text{C}_4\text{F}_{10}$ supply solenoid
System is designed to keep pressure between operational set points (green lines)
- When pressure is outside of operational pressure, appropriate solenoid opens and pumps engage (if appropriate)
- If system pressure is outside of safe operating range (red lines), both solenoids close and pumps are secured (if pressure is < 1 wc)
  - At that point, passive pressure controls protect sector (bubbler)
Start

Is Return Gas Bad (H2O)?
- Yes: Set hall supply solenoid (NO) to closed.
- No: Sector Pressure Safe?
  - Yes: Pressure within Operational SPs?
    - Yes: Stable Pressure
      1. Set sector supply and return solenoids to normal (NC) state.
      2. Turn pump off.
    - No: Low SP > Pd
      1. Return pumps are off
      2. Return solenoid is in normal (NC) position.
  - No: Pressure within Operational SPs?
    - Yes: GS C4F10 supply > 12 psi?
      1. GS C4F10 supply > 12 psi?
      - Yes: C4F10 Supply Overpressure
        Set Supply All Solenoids to normal (NC).
      - No: Open sector supply solenoid
    - No: GS Buffer or Pump Outlet Overpressure
      1. GS Buffer or Pump Outlet Overpressure
      - Yes: Buffer or Pump Outlet Overpressure
        1. Set ALL return pumps to off.
        2. Set return solenoids to normal (NC).
      - No: GS Buffer or Pump Outlet Pressure Tank > 18 psi?
        1. GS Buffer or Pump Outlet Pressure Tank > 18 psi?
        - Yes: Pressure too Low
          1. Set ALL return pump signal to off.
        - No: GS Buffer or Pump Outlet Pressure
          Supply solenoid is in normal (NC) position
          1. GS Buffer or Pump Outlet Pressure
          - Yes: GS Buffer or Pump Outlet Pressure
            1. Set supply solenoid to normal (NC) position.
            2. Set return solenoid to normal (NC) position.
          - No: Supply solenoid is in normal (NC) position
            1. Set MFC to 0 Lpm
            2. Set supply solenoid to normal (NC) position.
            3. Set return solenoid to normal (NC) position.
    - No: Pressure Too Low
      1. Set supply solenoid to normal (NC) position.
      2. Turn pump on.

Sector Pressure Safe?
- Yes: Pressure within Operational SPs?
  - Yes: Stable Pressure
    1. Set sector supply and return solenoids to normal (NC) state.
    2. Turn pump off.
  - No: Low SP > Pd
    1. Return pumps are off
    2. Return solenoid is in normal (NC) position.
- No: Pressure Too Low
  1. Set ALL return pump signal to off.

Pressure within Operational SPs?
- Yes: Stable Pressure
  1. Set sector supply and return solenoids to normal (NC) state.
  2. Turn pump off.
- No: Low SP > Pd
  1. Return pumps are off
  2. Return solenoid is in normal (NC) position.
Conclusion

• DSG has upgraded LTCC gas controls to operate as supply and recovery system
• Functionality test completed
• Operational test was conducted from 1/14 to 1/22
  • System performed as expected