Nitrogen Supply Outage to the RICH Detector: Consequences and Resulting Actions

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On June 6, 2019 at 15:33, nitrogen flow to the RICH detector stopped, which caused the relative humidity in the detector to increase by ~0.5%. Because of the aerogel in the detector, relative humidity is a critical parameter and is controlled to be less than 5% at all times. This note discusses the outage, the consequences of the outage, and the resulting actions taken to prevent such incidents.

On June 3, 2019, the valve on the main nitrogen supply line to the RICH detector was inadvertently closed. Consequently, the main supply pressure dropped and the two-stage backup system comprising two 12-cylinder nitrogen banks automatically started. After three days, the backup system ran out of nitrogen. On June 6, 2019, at 15:33, nitrogen flow stopped, which caused an increase in humidity in the detector, a critical parameter for the performance efficiency of the aerogel.

Figure 1 shows the pressure drop on 2019-06-03 at 13:51, from the normal ~35 psi to ~20 psi, the backup system's supply pressure, indicating nitrogen loss in the main supply line.

After about 34 hours, on 2019-06-04 at 23:29, there is another pressure drop from 20 psi to 10 psi, indicating that the first stage of the backup system had run out of nitrogen and that the backup system had switched to the second stage.

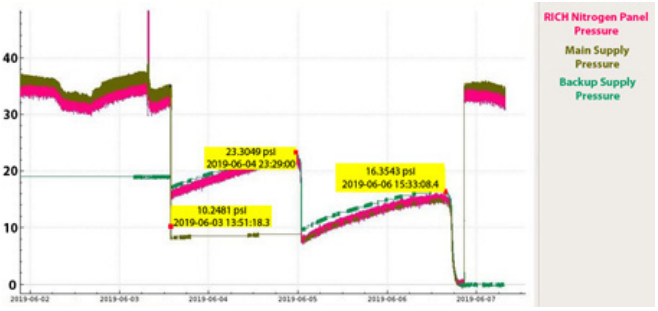

FIG. 1. Pressure drop on June 3 indicates the gas system switching to the backup system. June 5 pressure drop shows that the backup system switched to the second bank of nitrogen cylinders.

After about another 40 hours, on 2019-06-06 at 15:33 all pressures, Fig. 1, and flow, Fig. 2, dropped to zero, at which time the alarm system alerted Hall B staff.

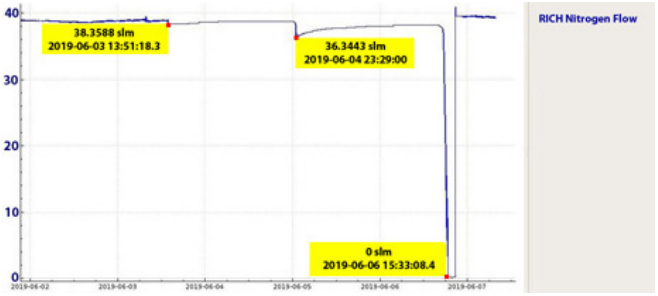

FIG. 2. Labels (left to right) indicate nitrogen flow reduction, due to valve closing, backup system's first stage runs out of nitrogen, and eventually second stage runs out of nitrogen. Zero nitrogen flowed to RICH on 2019-06-06 at 15:33.

System inspection revealed the closed valve, which was reopened about two hours after nitrogen flow had stopped, Fig. 2. During this period, the detector's relative humidity rose by ~0.5%, Fig. 3. After about twelve hours from restoration of nitrogen flow back to 40-slm, humidity sensors readings returned to their normal values.

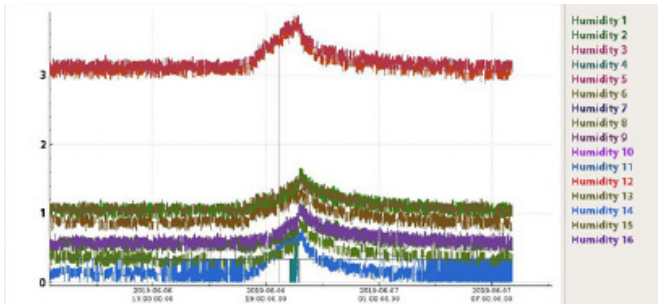

FIG. 3. RICH detector interior relative humidity readings before, during, and after the June 6, 2019 nitrogen outage. Except for sensor 12's 3% RH reading, due to its location behind the spherical mirrors where there is little nitrogen movement, all sensors normally read less than 1% RH. The spike in the relative humidity is due to nitrogen flow outage.

Based on the lessons learned during this incident, several precautionary measures have been implemented.

- To prevent inadvertent closing of the main nitrogen supply line valve, an administrative lock-out has been placed on the valve, which will be relocated to a secure location.
- To alert staff about changes in nitrogen flow, software alarms have been developed and implemented. The main nitrogen supply line pressure alarm will alert staff if the pressure drops below 20 psi for more than a minute; the backup system's supply pressure alarm will alert staff if the pressure drops below 10 psi for more than a minute.
- To extend the backup system's supply duration from three to six days, an additional set of two 12-cylinder nitrogen banks has been procured.
- To accommodate extended outage of the main nitrogen supply line, i.e. more than six days, once the backup supply banks have run empty, a plan has been developed to flow argon (more expensive than nitrogen), which is stocked in large quantities in the lab.