

A Study To Determine the Effect of Differing Canister Resistance on Service Life in PAPR Applications

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A Study To Determine the Effect of Differing Canister Resistance on Service Life in PAPR Applications

Summary of Work Contracted by NIOSH
to: AJE Testing & Research

Objective Of Study

To conduct a study to determine the effect of differing canister resistances on service life of a PAPR by artificially altering the pressure drop through pairs of simulated test canisters

Targeted Pressure Drops

The pairs of simulated test canisters were prepared with differing pressure drops by adding appropriate restrictor plates on the influent side of the canister according to the following table:

Targeted Difference in Pressure Drop Measured at 85 LPM					
0%	5%	10%	15%	20%	25%

Test Conditions

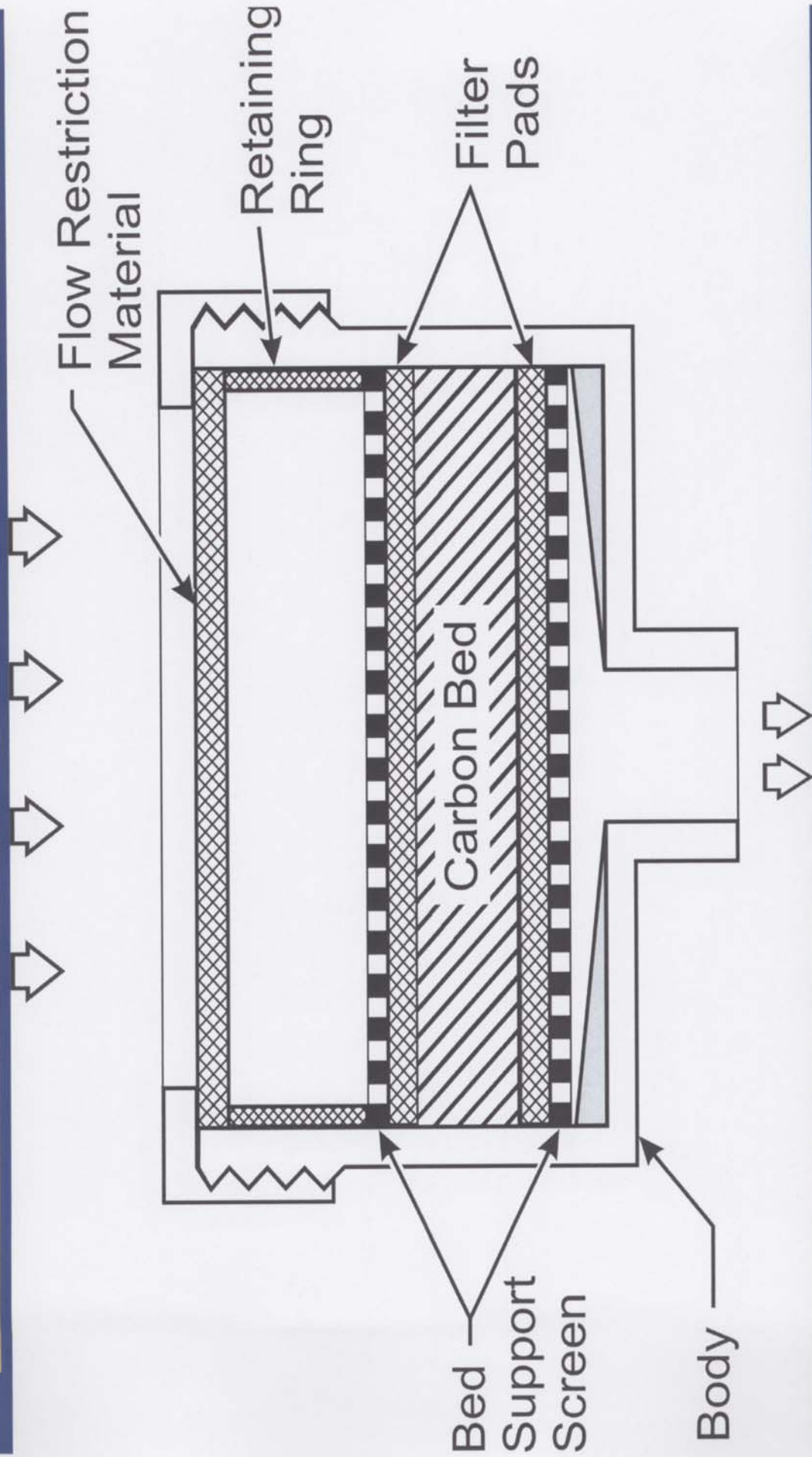
- Temperature – 25°C
- Humidity – 50%

Set	Gas/Vapor	Challenge Concentration	Total Flow	Breakthrough Criteria
1	Cyclohexane	2600 ppm	115 LPM	10 ppm
2	Sulfur Dioxide	1500 ppm	115 LPM	5 ppm
3	Cyclohexane	2600 ppm	300 LPM	10 ppm
4	Sulfur Dioxide	1500 ppm	300 LPM	5 ppm

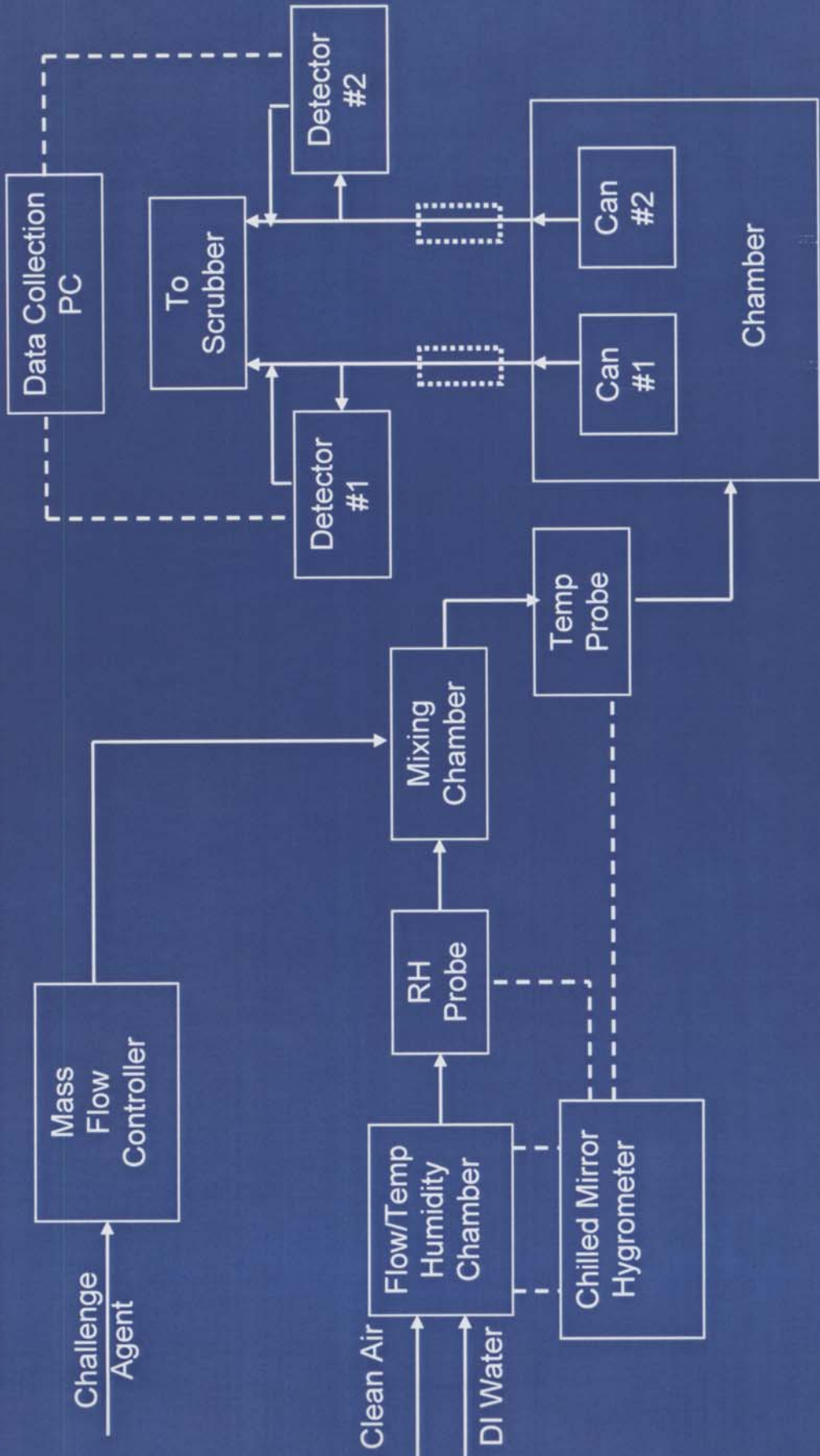
Canisters

- 5 inch diameter, adjustable bed depth
- Carbon & Fill Volume
 - 12 x 30 mesh URC Respirator Carbon
(Calgon Carbon Corporation)
 - 115 LPM – 300 cc / canister
 - 300 LPM – 600 cc / canister
- Effluent air flow and Breakthrough Point were determined for each canister of the pair tested
- System Breakthrough Time was determined by combining the data from the individual flow and breakthrough concentrations

Test Fixture



Apparatus Diagram



Calculations

Resistance of Cart1 @ 85 LPM = 13.1 mm water column

Resistance of Cart2 @ 85 LPM = 17.2 mm water column

Conc1 = Effluent concentration from low resistance cartridge

Conc2 = Effluent concentration from high resistance cartridge

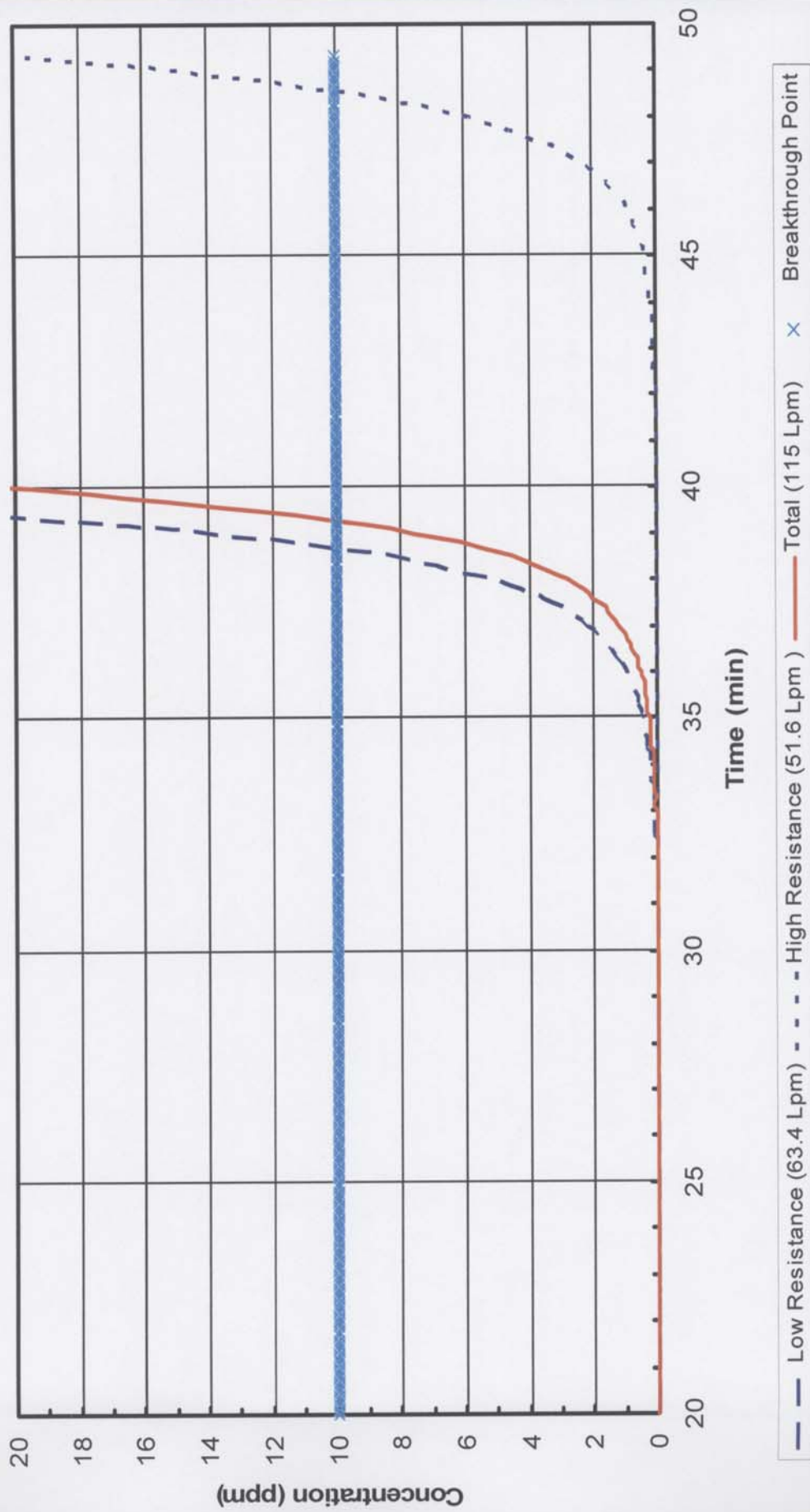
Flow1 = Measured Flow from Cart1 = 63.4 LPM

Flow2 = Measured Flow from Cart2 = 51.6 LPM

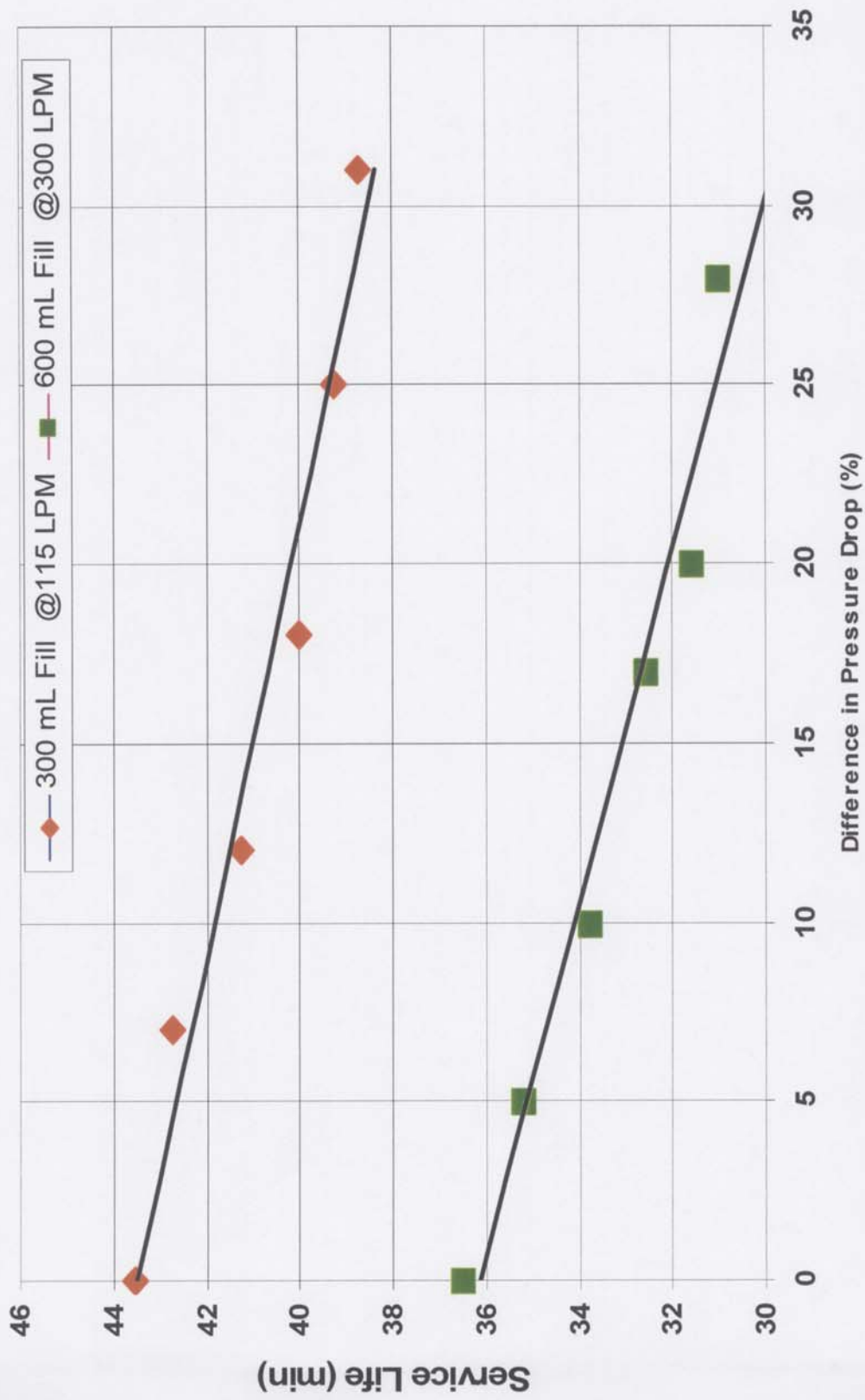
$$\text{TotalConc} = 1000000 * \left[\frac{(\text{Conc } 1 / 1000000) * \text{Flow } 1 + (\text{Conc } 2 / 1000000) * \text{Flow } 2}{\text{Flow } 1 + \text{Flow } 2} \right]$$

$$\text{TotalConc} = 1000000 * \left[\frac{(\text{Conc } 1 / 1000000) * 63.4 + (\text{Conc } 2 / 1000000) * 51.6}{115} \right]$$

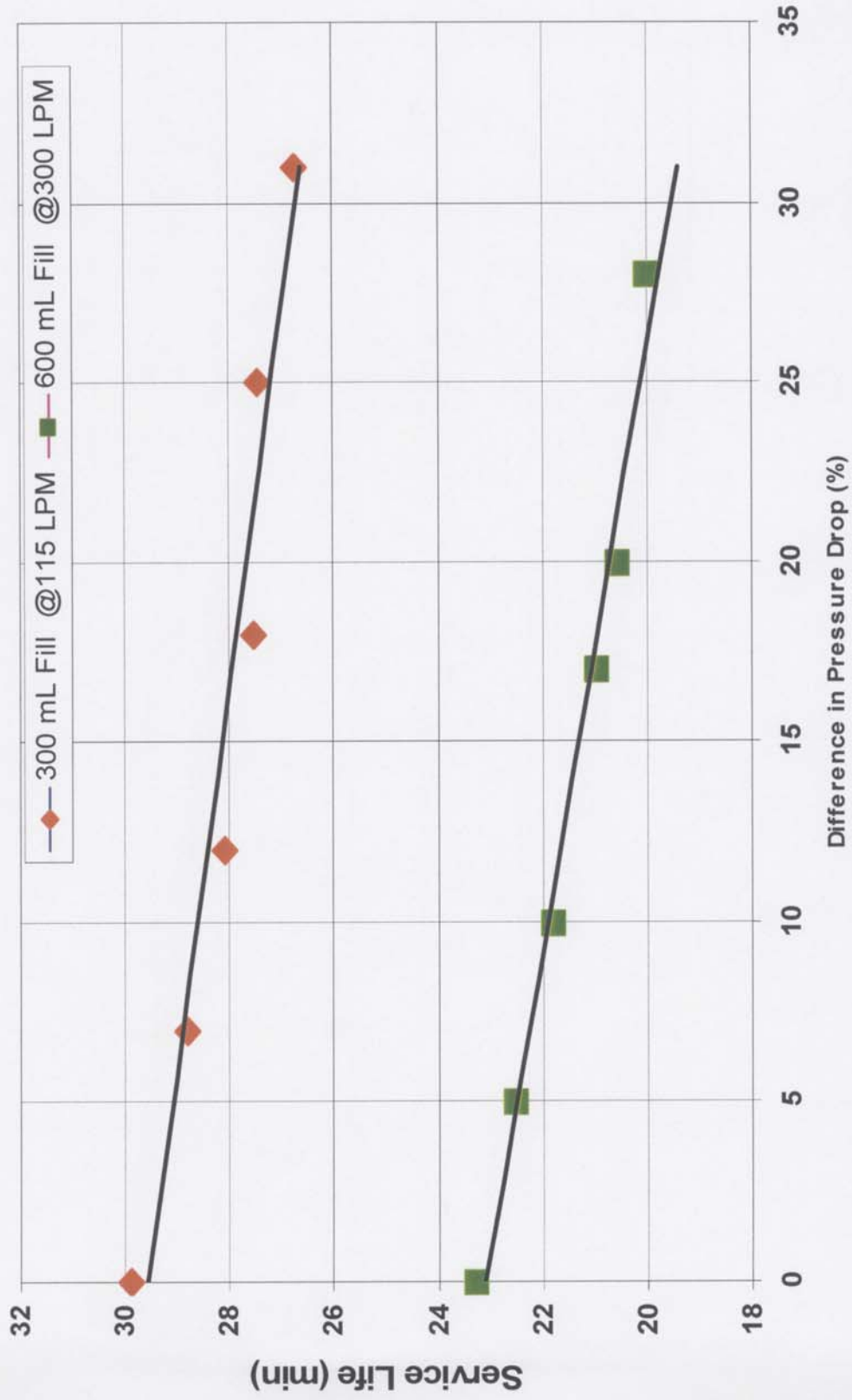
2600 ppm Cyclohexane 31% Resistance Difference



Effect of Differences in Canister ΔP on Cyclohexane Service Life



Effect of Differences in Canister ΔP on Sulfur Dioxide Service Life



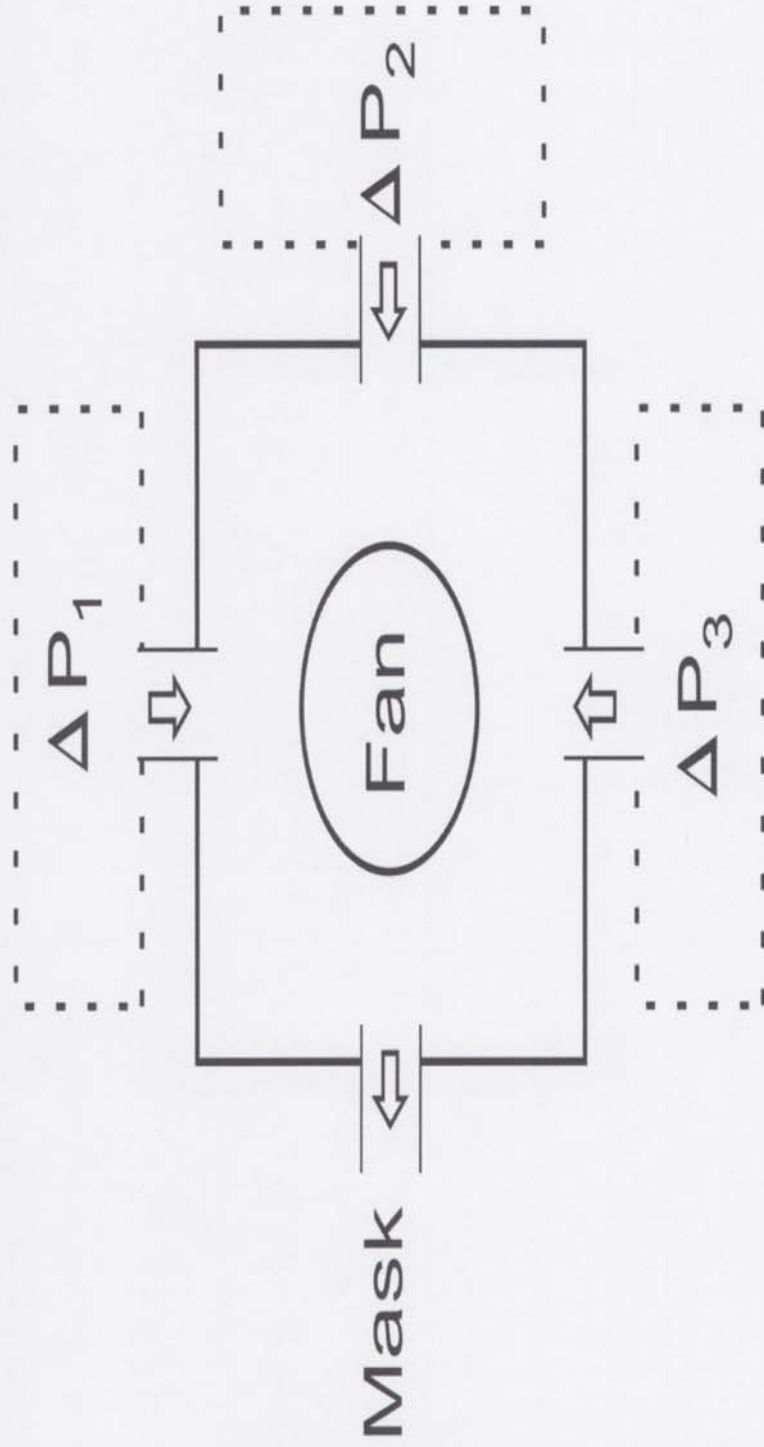
Conclusions

- **Difference in Resistance Between Canisters will cause:**
 - Changes in air flow patterns between canisters
 - Lower Service Life will result
 - Decrease in service life is more severe at higher flow rates
- **There was no significant difference in service life reduction due to the contaminant chosen, Sulfur Dioxide or Cyclohexane**
 - Another significant issue when considering contaminants that are not strictly chemically and/or physically adsorbed
 - Contaminants removed via a catalytic effect, either in whole or in part, would be expected to have more significant differences, especially when combined with high flow rates (Further Study Needed)

Additional Issue

- Preliminary benchmark testing of PAPER showed variance in pressure drops at different ports in the manifold

Manifold Issue



$$\Delta P_1 \neq \Delta P_2 \neq \Delta P_3$$

Additional Pressure Drop/Service Life Studies

- Effect of catalytic adsorbed chemicals (Cyanogen Chloride, Phosphine)
- Effect of bed depth
- Estimated Time to complete additional studies 3 months

Standard Implications

- **Single Canister Testing**
 - Canister uniformity will be required
 - Allow range of variation based upon average value
 - Reduce certification testing cost
- **System Test**
 - Will allow design and canister resistance to effect service life