National Personal Protective Technology Laboratory

A Study To Determine the Effect of Differing Canister Resistance on Service Life in PAPR Applications Part 2

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CDC Workplace Safety and Health

NIOSH

NPPTL Research to Practice through Partnerships

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

CDC Workplace Safety and Health

NIOSH

NPPTL Research to Practice through Partnerships

NPPTL Year Month Day File name

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%
- Test Concentrations

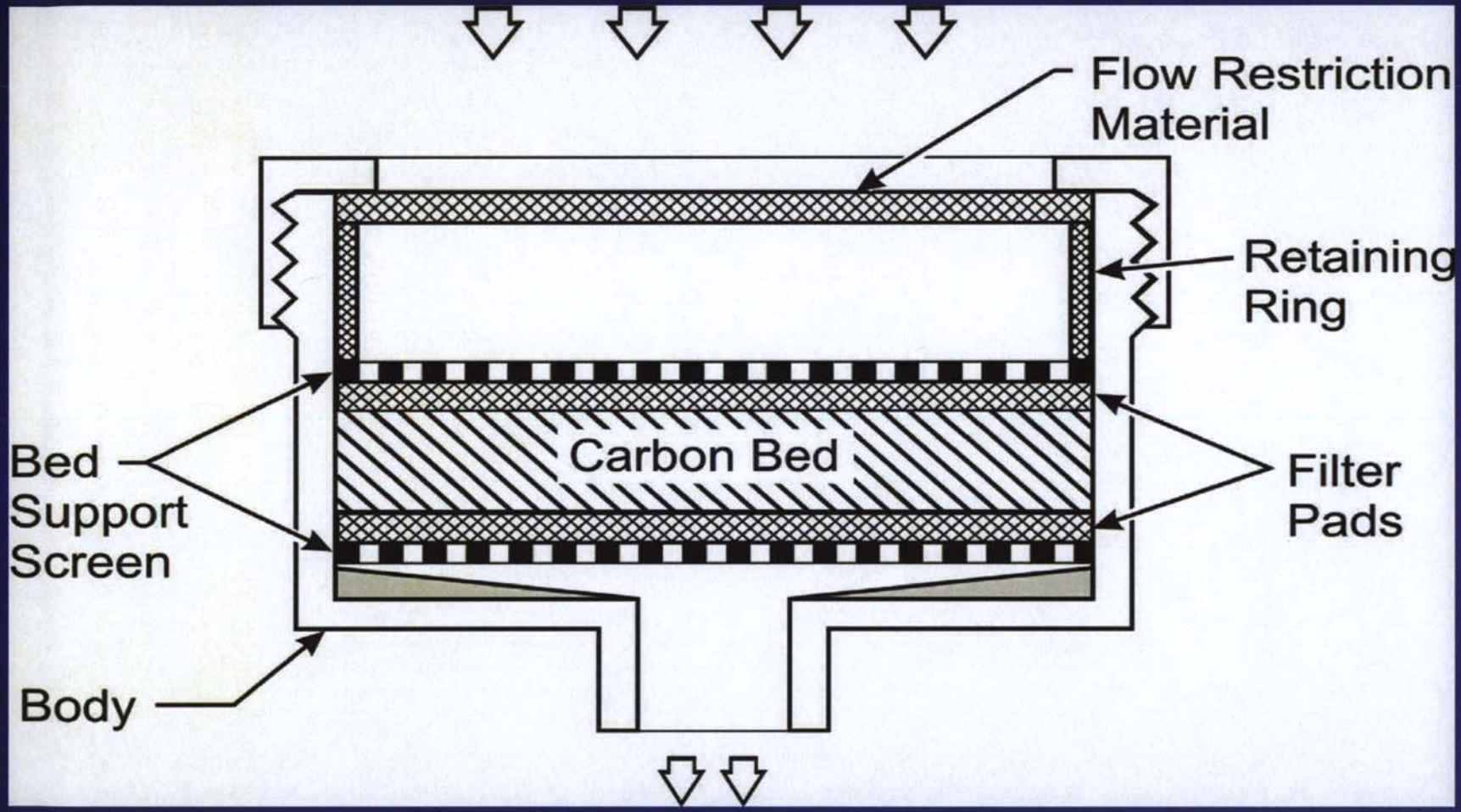
Gas/Vapor	Challenge Concentration	Breakthrough Criteria
Cyclohexane	2600 ppm	10 ppm
Sulfur Dioxide	1500 ppm	5 ppm
Phosphine	300 ppm	0.3 ppm
Cyanogen Chloride	300 ppm	2 ppm

Canisters

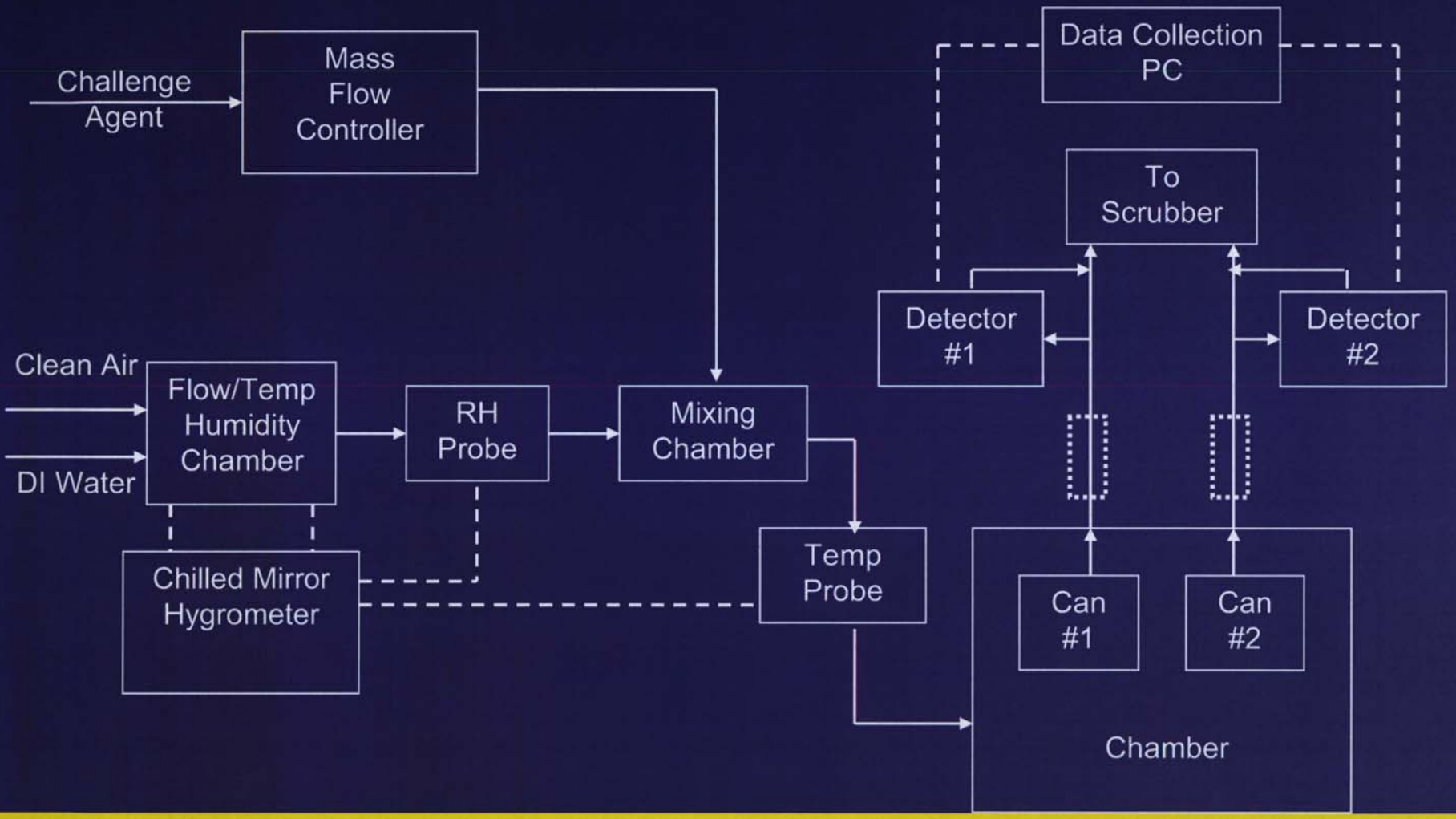
- 5 inch diameter, adjustable bed depth Carbon & Fill Volume
  - 12 x 30 mesh URC Respirator Carbon
  - (Calgon Carbon Corporation)
  - 250 & 300 cc fill / canister – 115 LPM
  - 500 & 600 cc fill / canister – 300 LPM

- 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



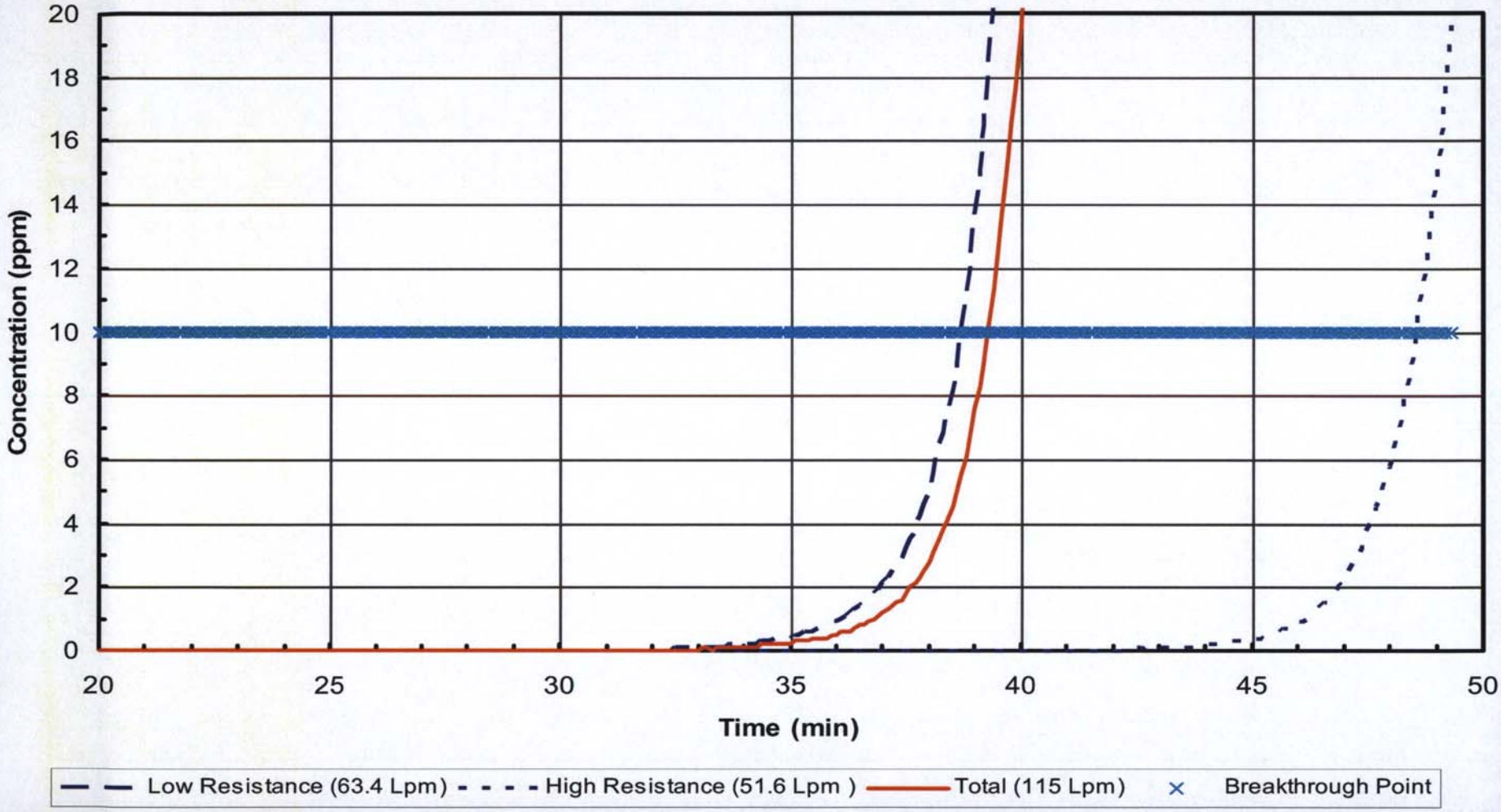
Calculations

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

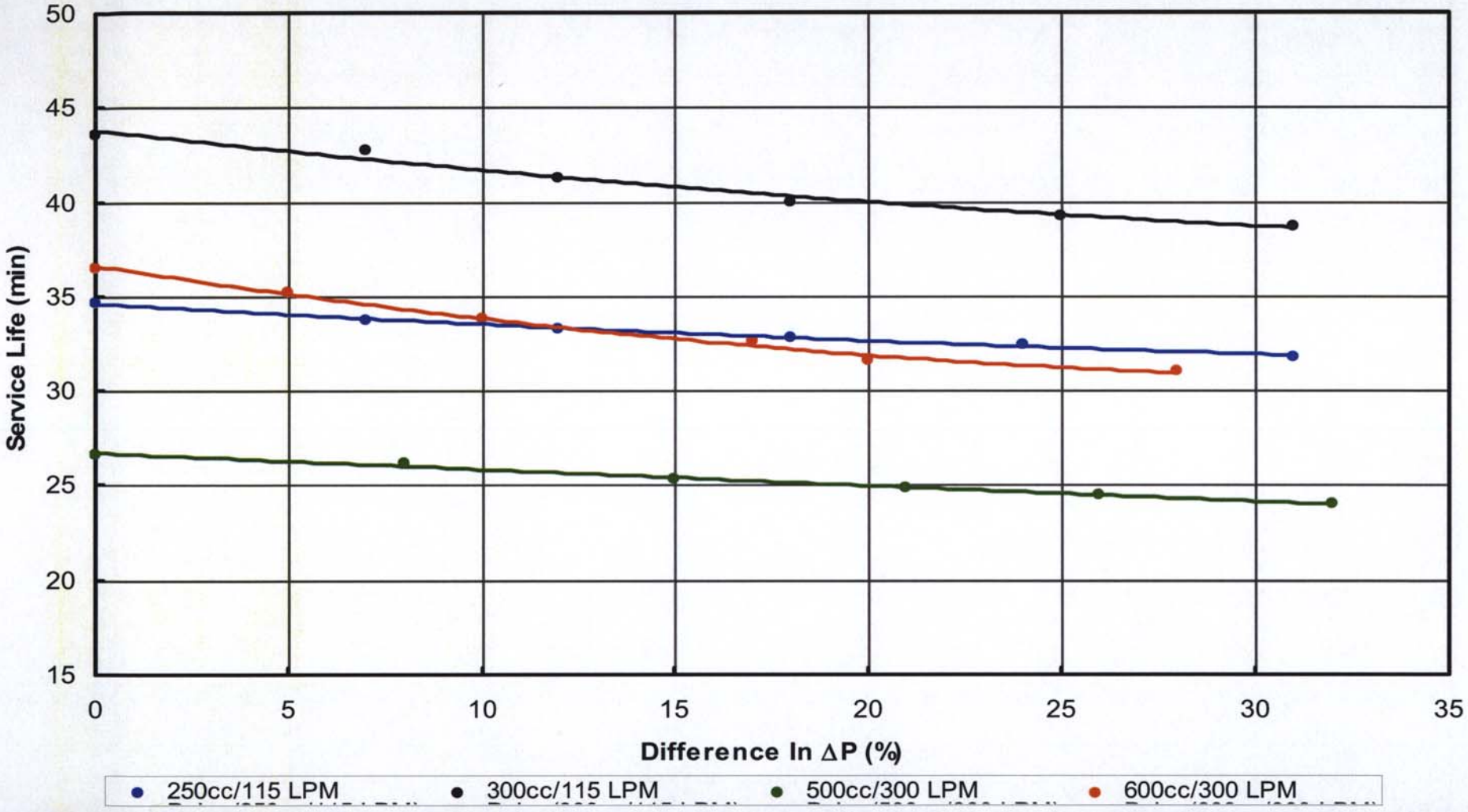
$$TotalConc = 1000000 * \left[\frac{(Conc1/1000000) * Flow1 + (Conc2/1000000) * Flow2}{Flow1 + Flow2} \right]$$

$$TotalConc = 1000000 * \left[\frac{(Conc1/1000000) * 63.4 + (Conc2/1000000) * 51.6}{115} \right]$$


2600 ppm Cyclohexane
31% Resistance Difference
Concentration (ppm)
0
2
4
6
8
10
12
14
16
18
20
20
25
30
35
40
45
50
Time (min)
Low Resistance (63.4 Lpm)
High Resistance (51.6 Lpm)
Total (115 Lpm)
Breakthrough Point

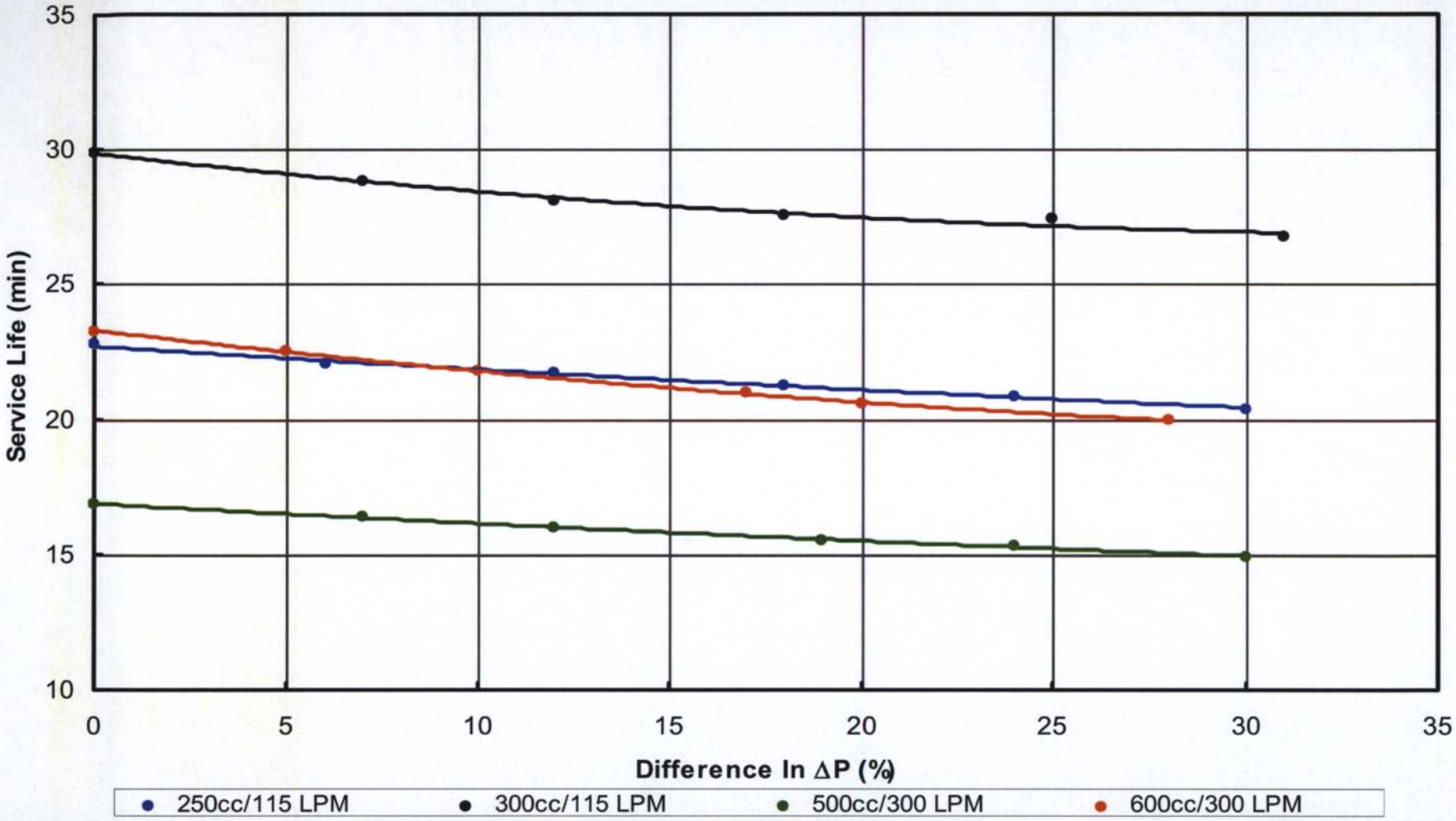
Service Life vs. Difference in ΔP of Cartridge Pair

2600 ppm Cylcohexane, 50% RH



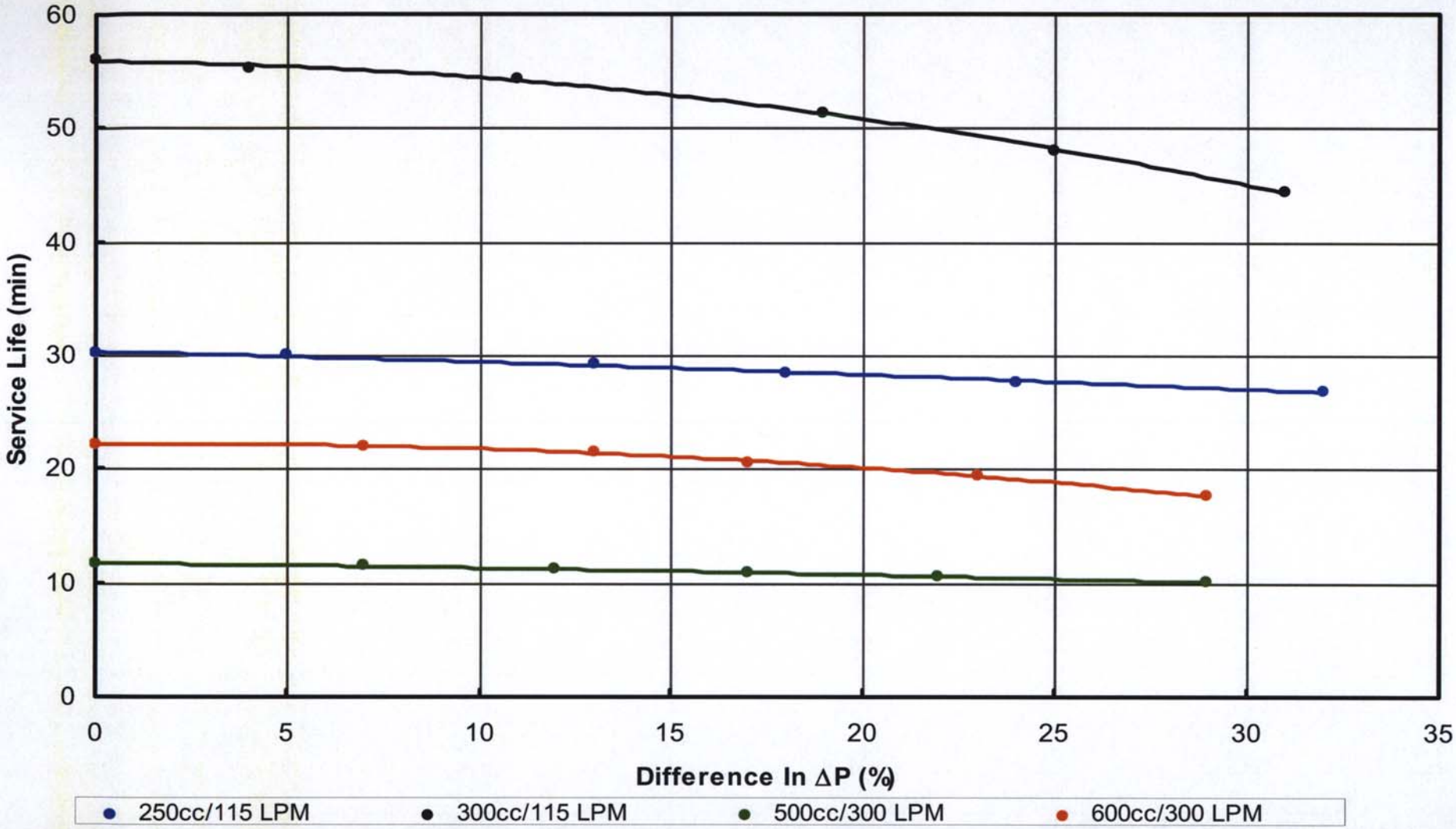
Service Life vs. Difference in ΔP of Cartridge Pair

1500 ppm Sulfur Dioxide, 50% RH



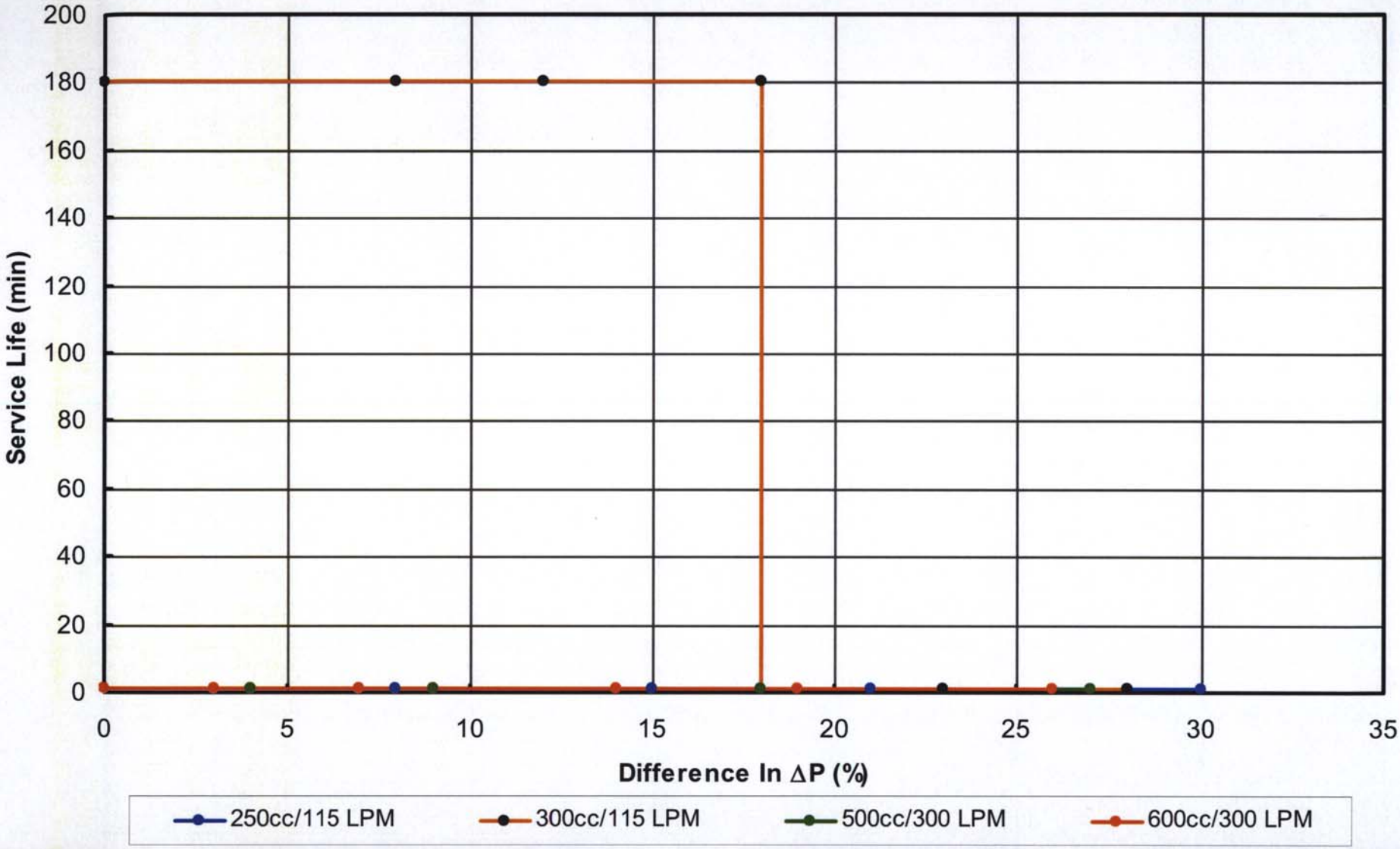
Service Life vs. Difference in ΔP of Cartridge Pair

300 ppm Cyanogen Chloride, 50% RH



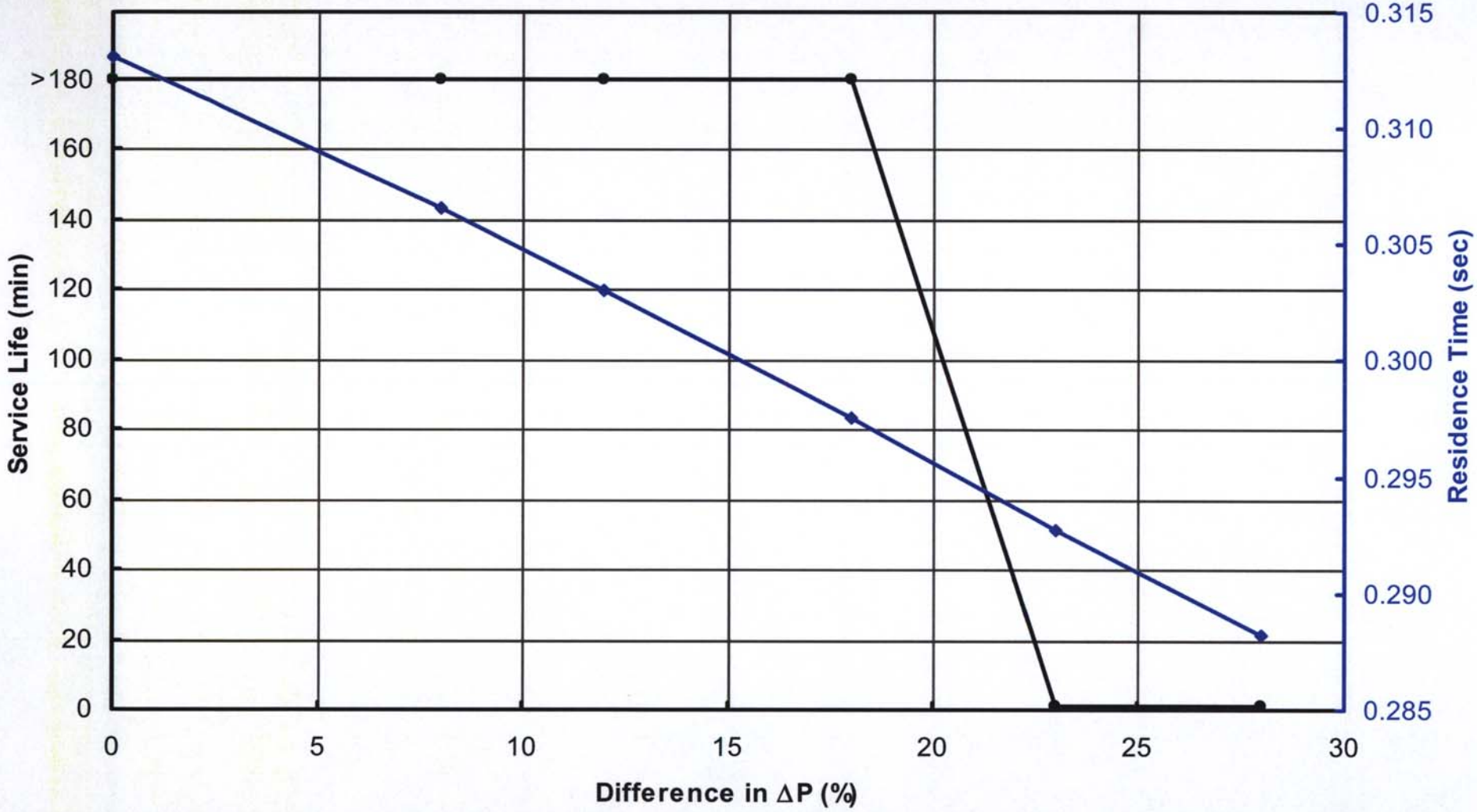
Service Life vs. Difference in ΔP of Cartridge Pair

300 ppm Phosphine, 50% RH

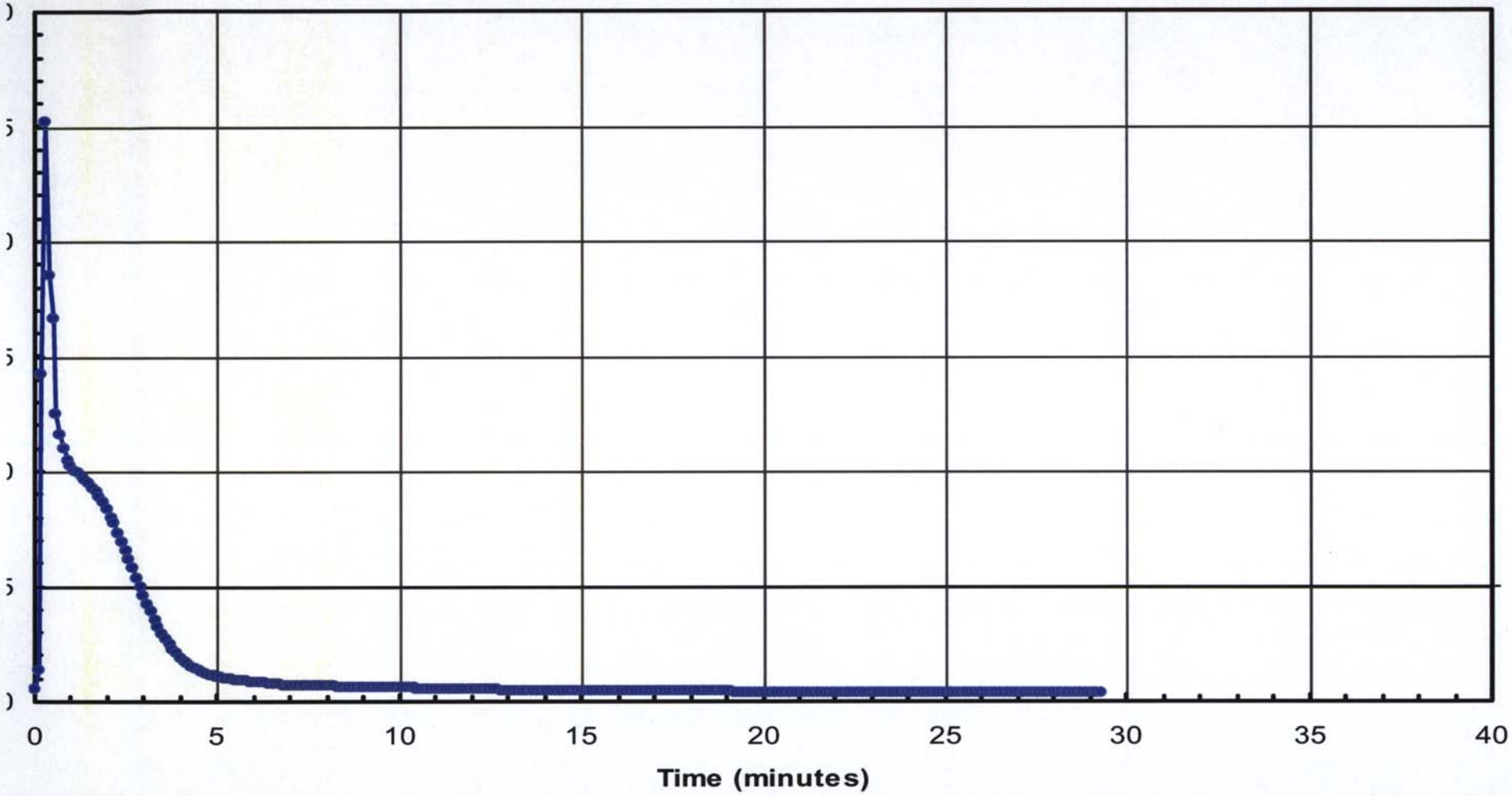


Service Life vs. Difference in ΔP of Cartridge Pair

300cc cartridges @ 115 LPM, 300 ppm Phosphine, 50% RH



Cartridge B--25% Resistance Difference
300 ppm PH3, 500cc, 130.4 LPM, 50% RH



Conclusions

- Difference in Resistance Between Canisters will cause:
  - Changes in air flow patterns between canisters
  - Lower Service Life will result
  - Type of contaminant can have an effect
    - Cyclohexane or Sulfur Dioxide
      - No significant difference in service life reduction due to the contaminant challenge
      - Contaminants are strictly chemically and/or physically absorbed

Conclusions

- Cyanogen Chloride
  - Higher flow rates conditions produce larger differences in service
  - Mechanism of absorption – may be a combination of chemical and catalytic
- Phosphine
  - Requires a sufficient residence time to be effective
  - These contaminants are removed via a catalytic effect, either in whole or in part

**Other adsorbents may show different results

Standard Implications

- Canister uniformity will be required
  - Resistance variation of ±10%
    - Option 1: Use the average resistance of the canisters within a Package Use Unit (Uniformity is based upon EN 141)
    - Option 2: For individually sold canisters, Uniformity will based upon average resistance reported by the manufacture as reported at the time of application. Allowable variance resistance is ±10% of the average
- System Service Test
  - Using the manifold and canisters, will allow design and canister resistance to effect service life