

EFFECT OF VENTILATION SYSTEM LAYOUT ON PURGE TIMES AND CONTAMINANT DISTRIBUTION IN A BUILT-IN-PLACE REFUGE



Joseph Bickson

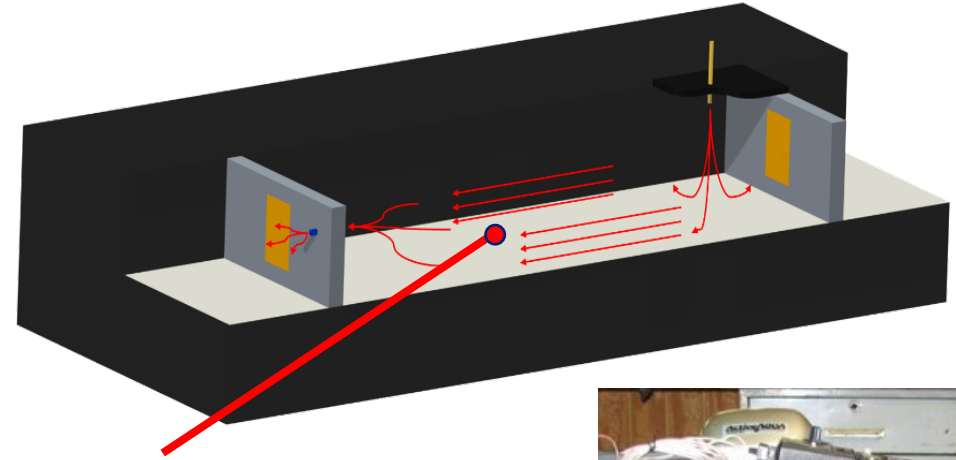
**Pittsburgh Mining Research Division
RA Partnership**

November 17-18, 2021

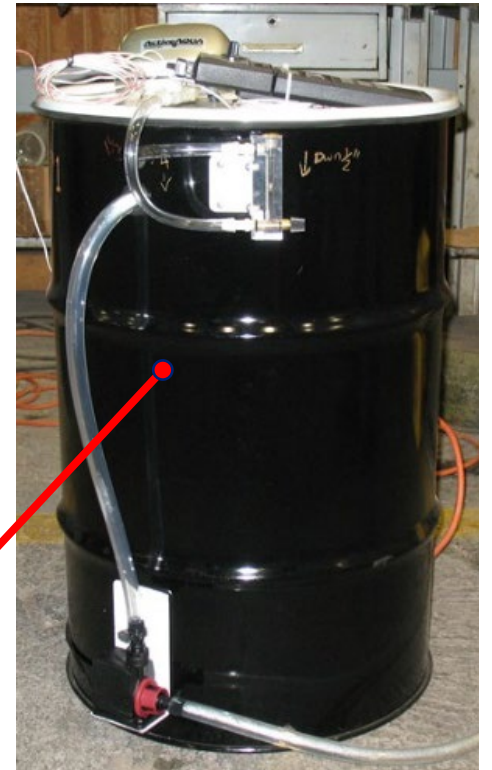
NIOSH researchers evaluated the effect of different ventilation system configurations on the average times to purge SF₆ from 1,000 ppm to 25 ppm in a 60-person BIP RA

Test set-up

- A 60-person BIP RA in the Bruceton Experimental mine
- 60 simulated miners (barrel people)
- SF₆ as a surrogate gas for carbon monoxide
- A borehole air on the surface supply to provide airflow



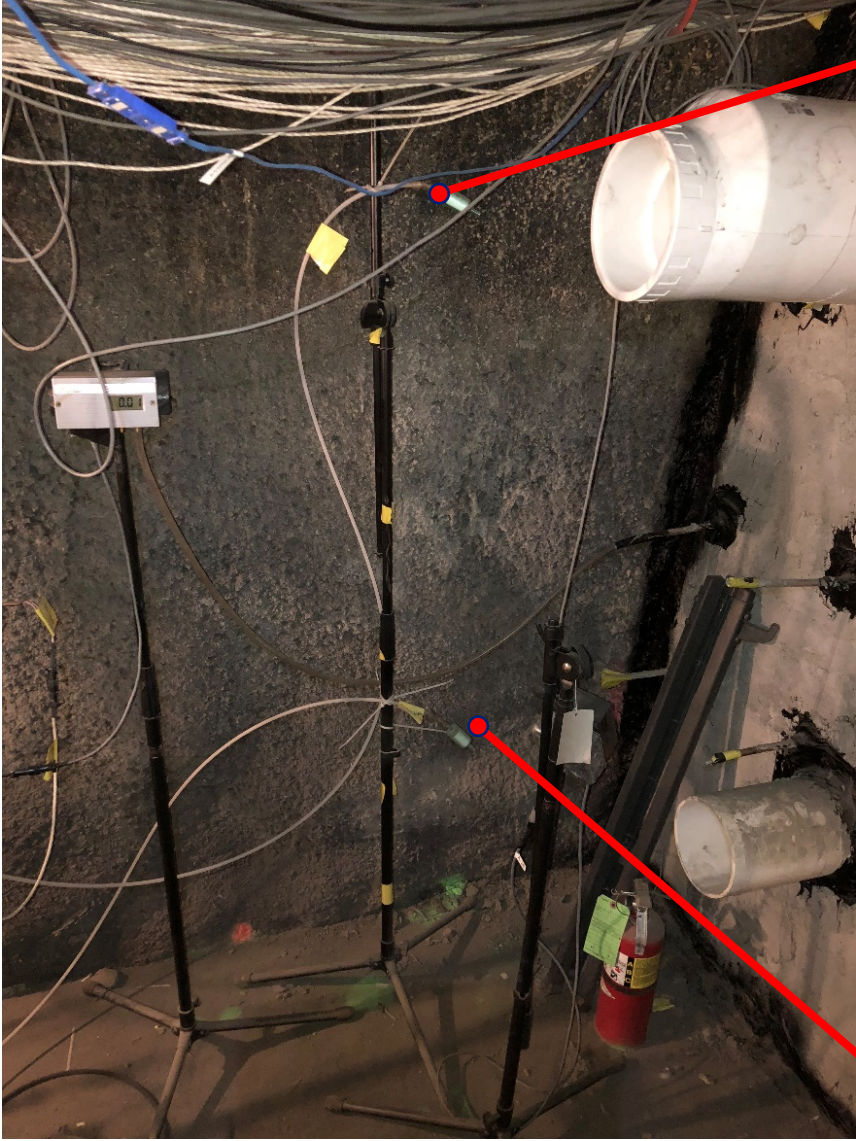
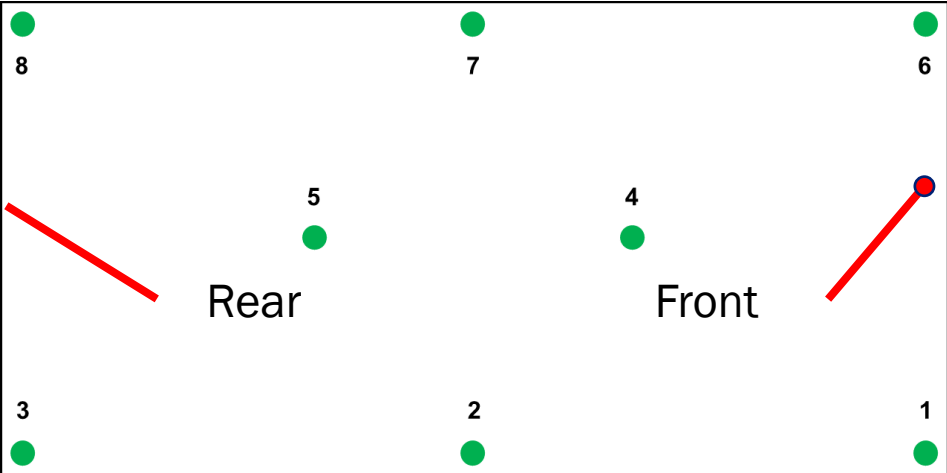
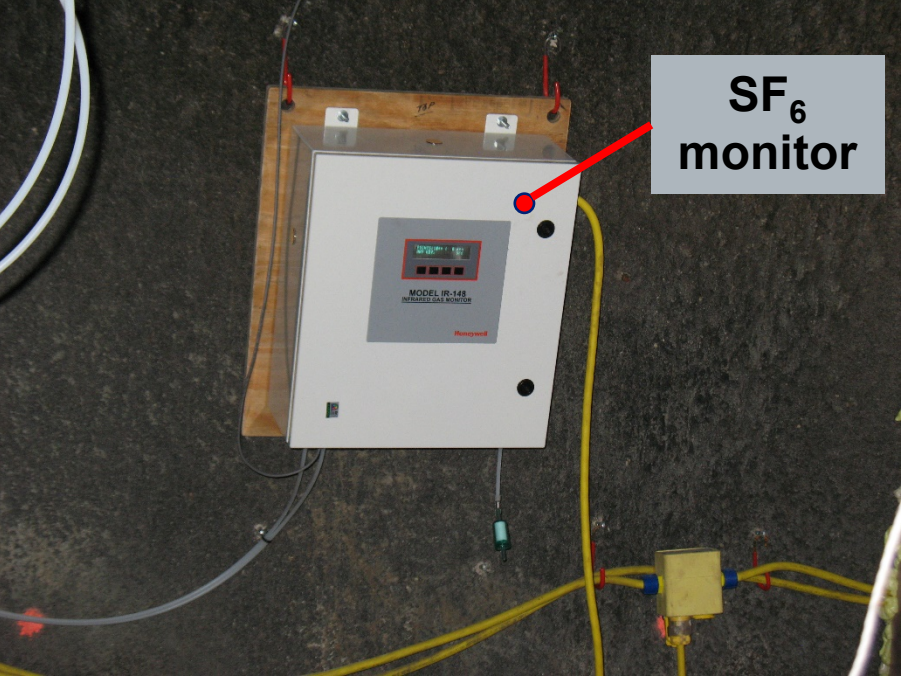
3-D layout of the BIP RA



Simulated miner

Eight SF₆ monitors were used to read the concentration level at 16 locations

Note: For safety purposes, SF₆ tracer gas was used as a surrogate for CO



62"

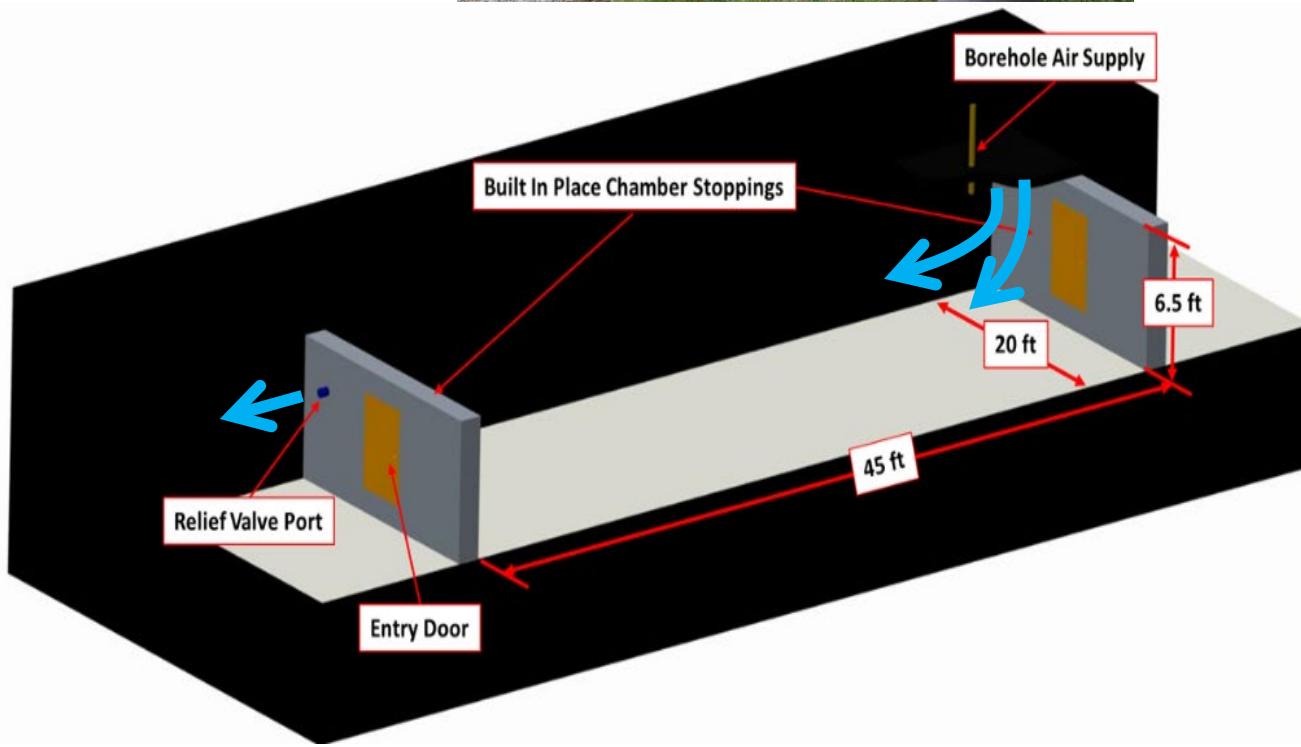
28"

A borehole air supply was used to provide flow rates of 750 SCFM and 1,000 SCFM

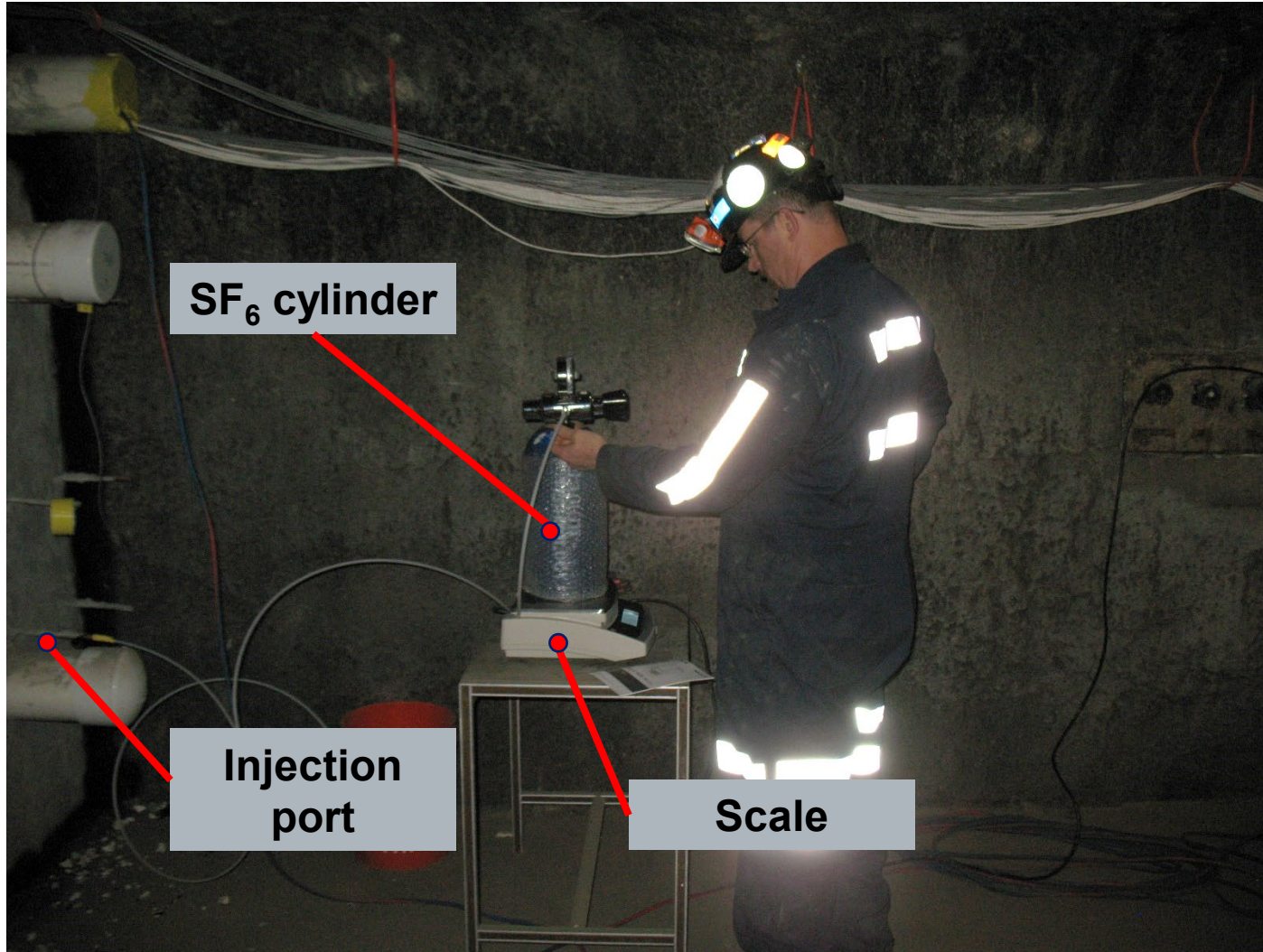


Airflow

- 750 SCFM based on 12.5 SCFM per miner requirement according to the regulation
- 1,000 SCFM is the maximum capacity of the borehole air supply



2.2 lbs. of SF₆ were injected to achieve an initial concentration of 1,000 ppm

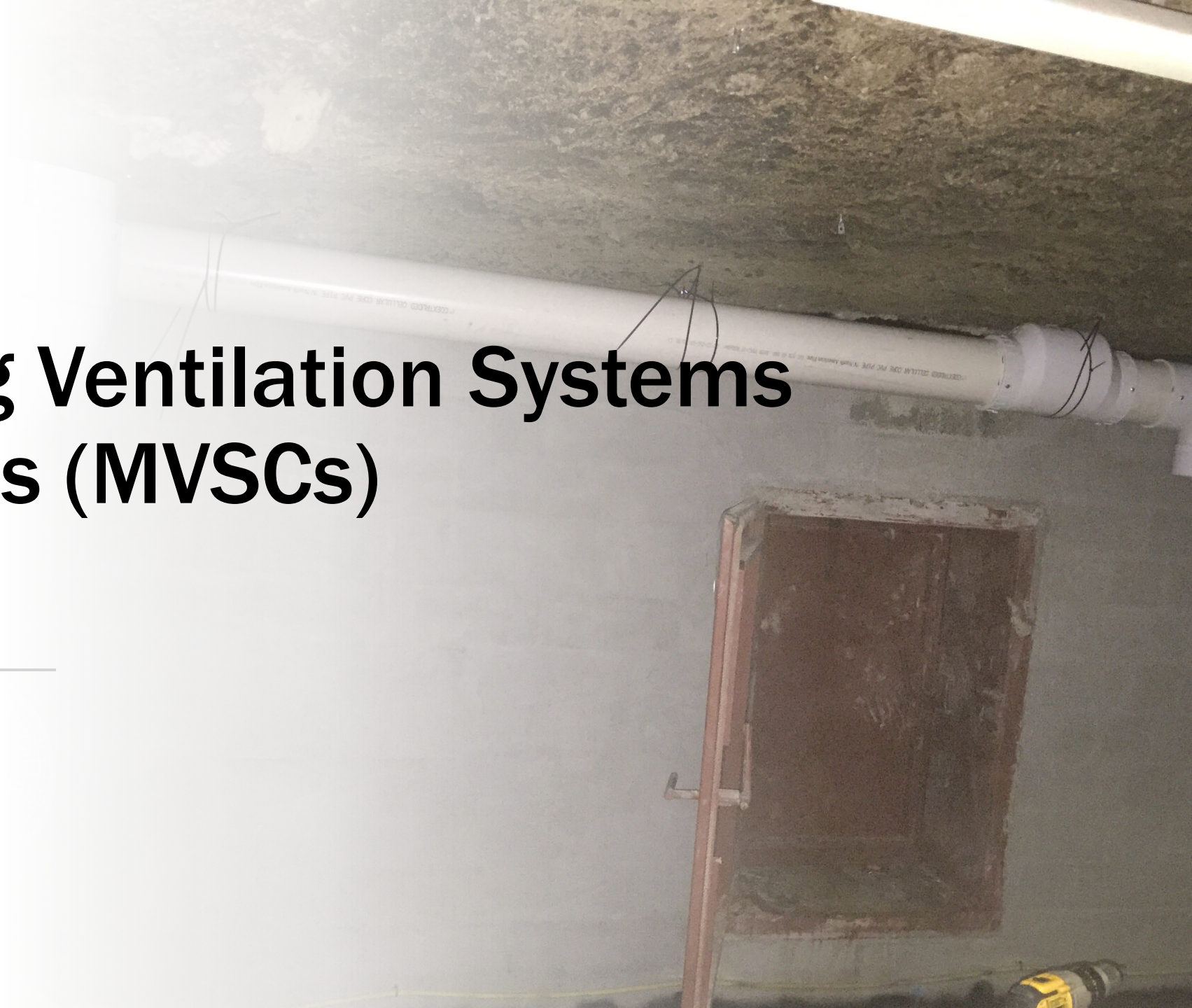


Procedure

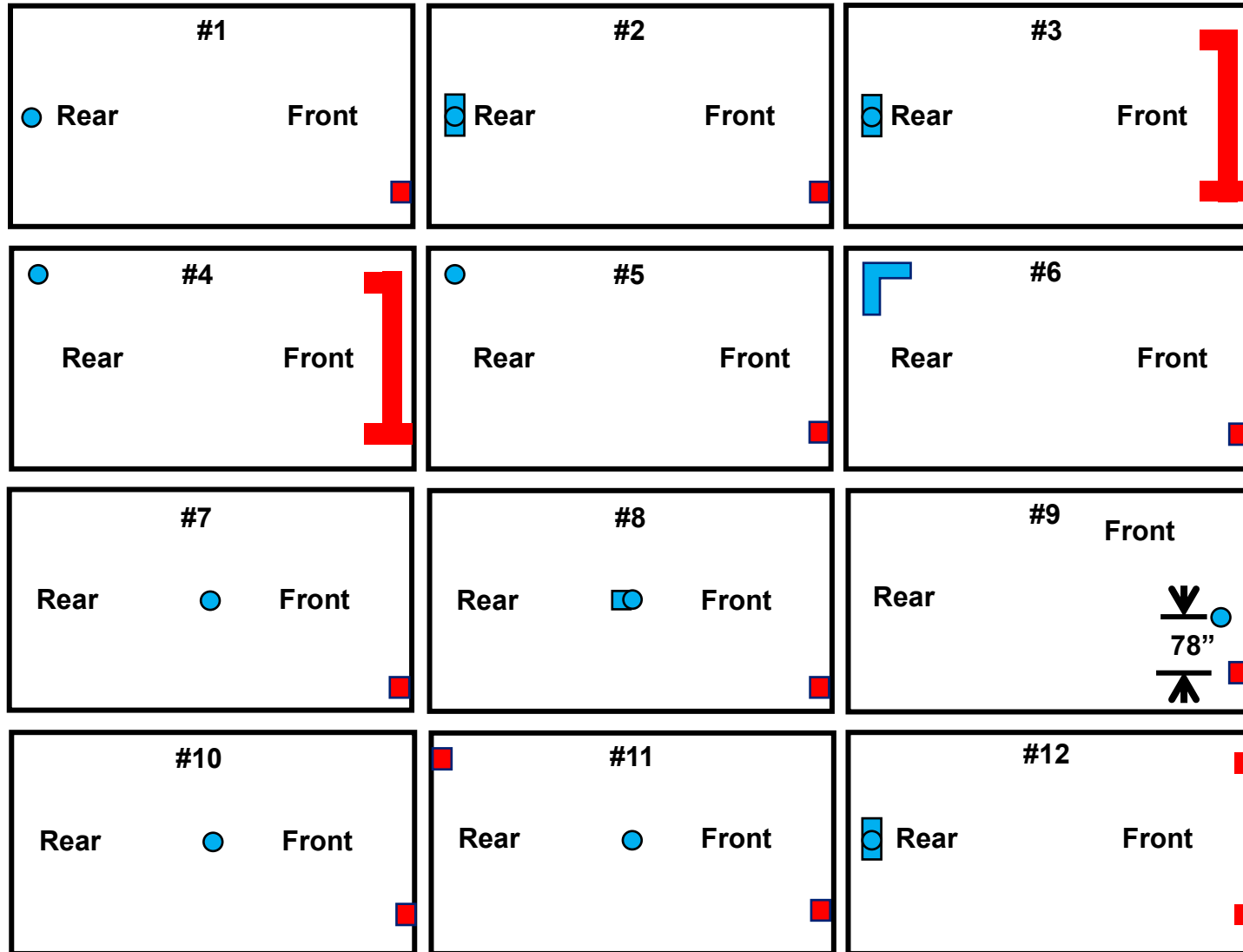
- Inject SF₆
- Turn on the mixing fans
- Start recording
- Wait 5 minutes
- Turn off the mixing fans
- Turn on the borehole air supply
- Stop recording when all sampling locations are below 5 ppm



Part 1: Mixing Ventilation Systems Configurations (MVSCs)



Purging research was conducted using 12 MVSCs to examine the variation in purge time and identify the presence of stagnant areas

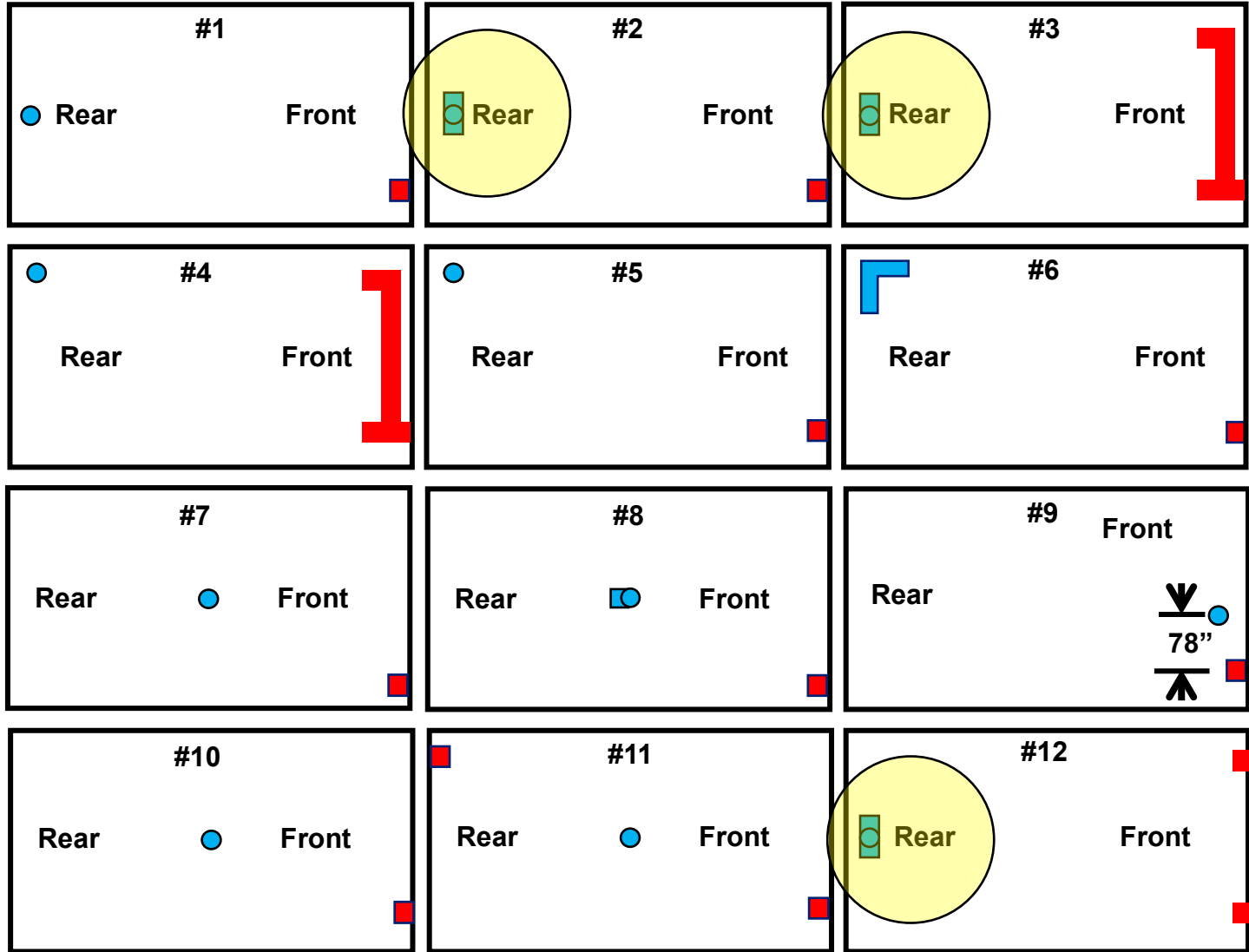


- Air inlet: geometric shapes in blue
- Air outlet: geometric shapes in red

The MVSCs concept

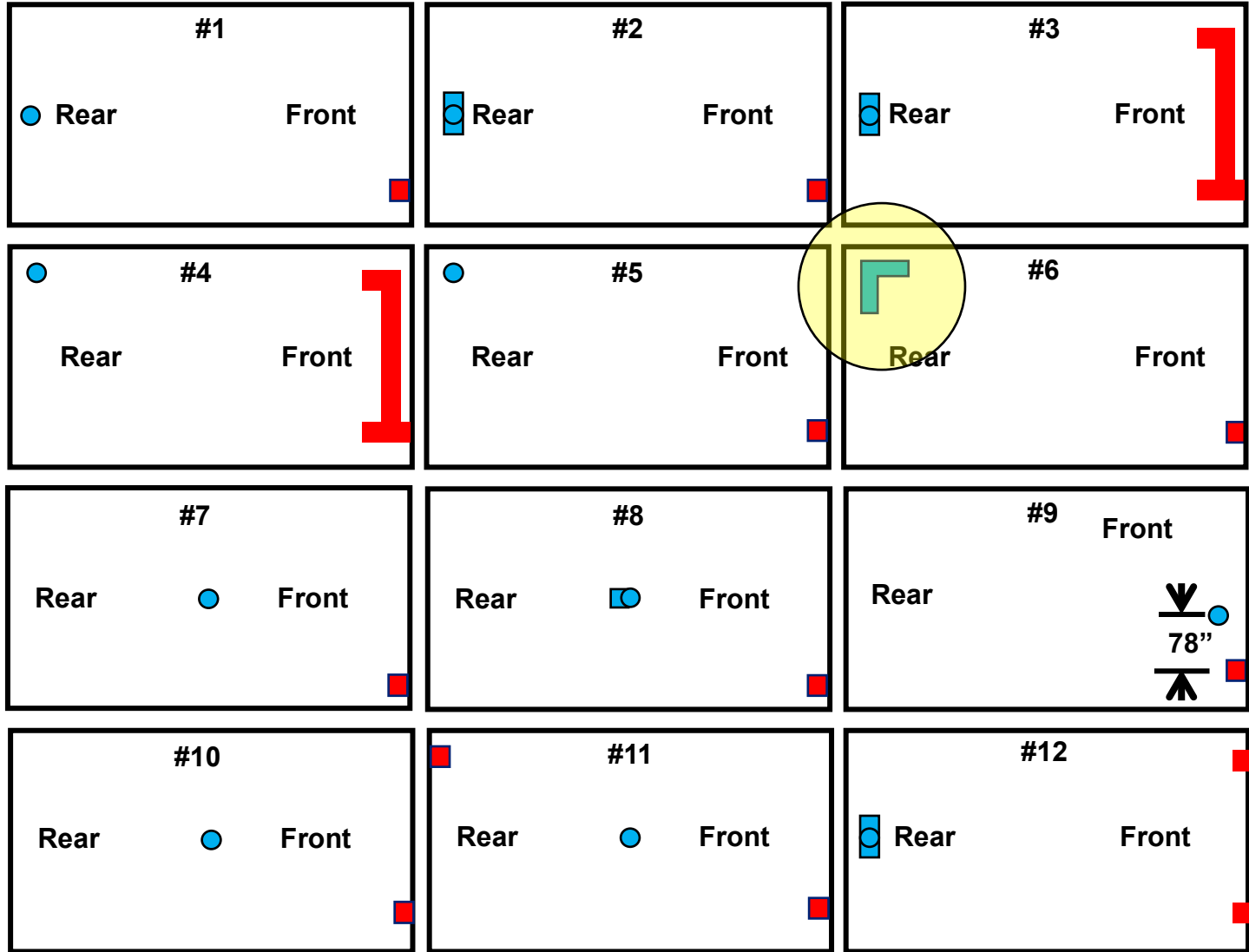
- High air velocity is introduced at a single point location
- The incoming air mixes with the stagnant air in the room and then exits the room

Purging research was conducted using 12 MVSCs to examine the variation in purge time and identify the presence of stagnant areas



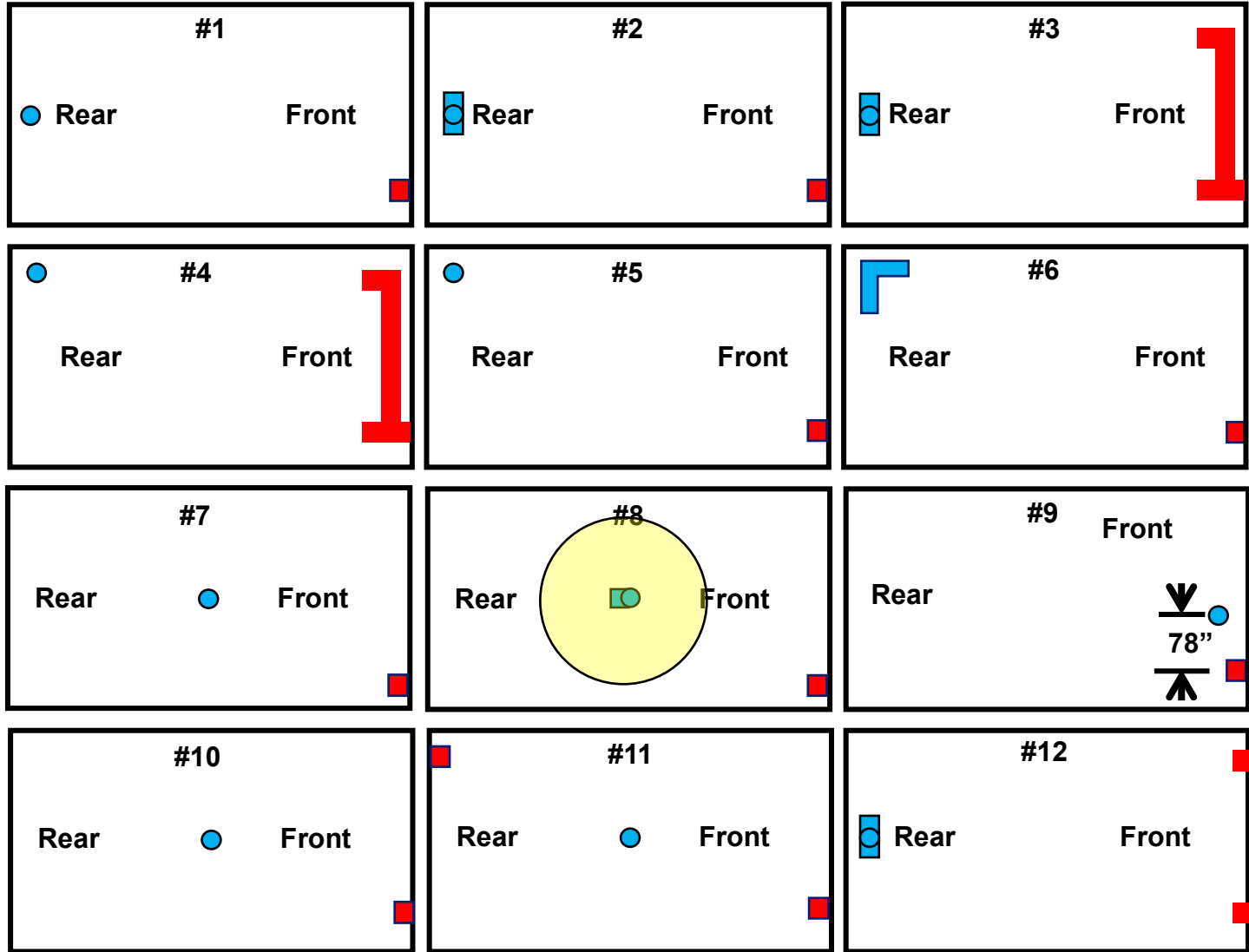
Air inlet for MVSC #2, 3, 12

Purging research was conducted using 12 MVSCs to examine the variation in purge time and identify the presence of stagnant areas



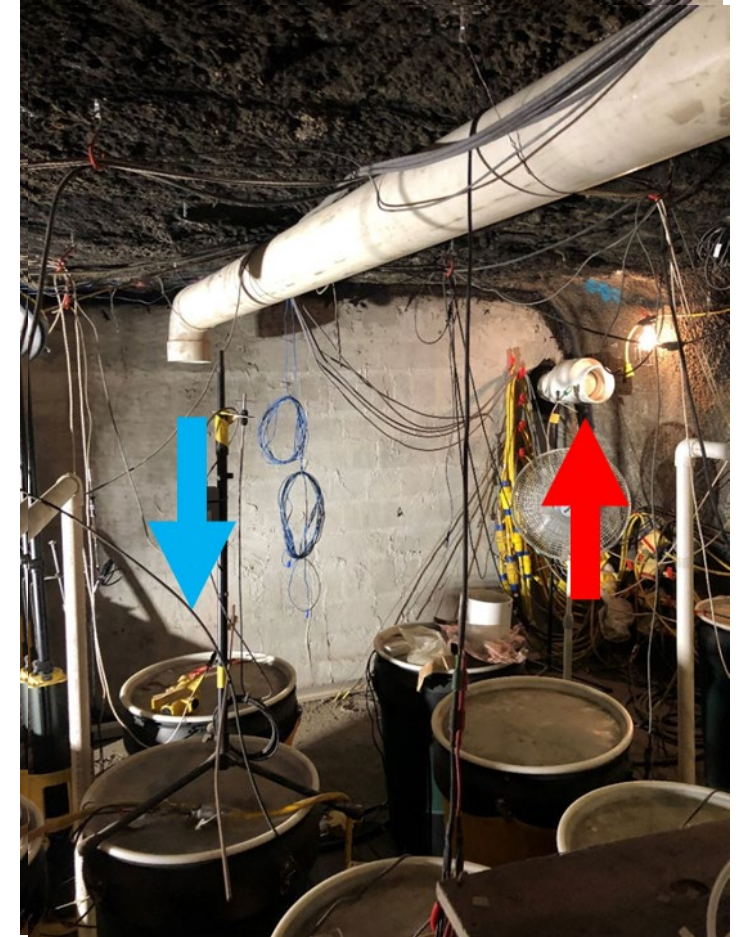
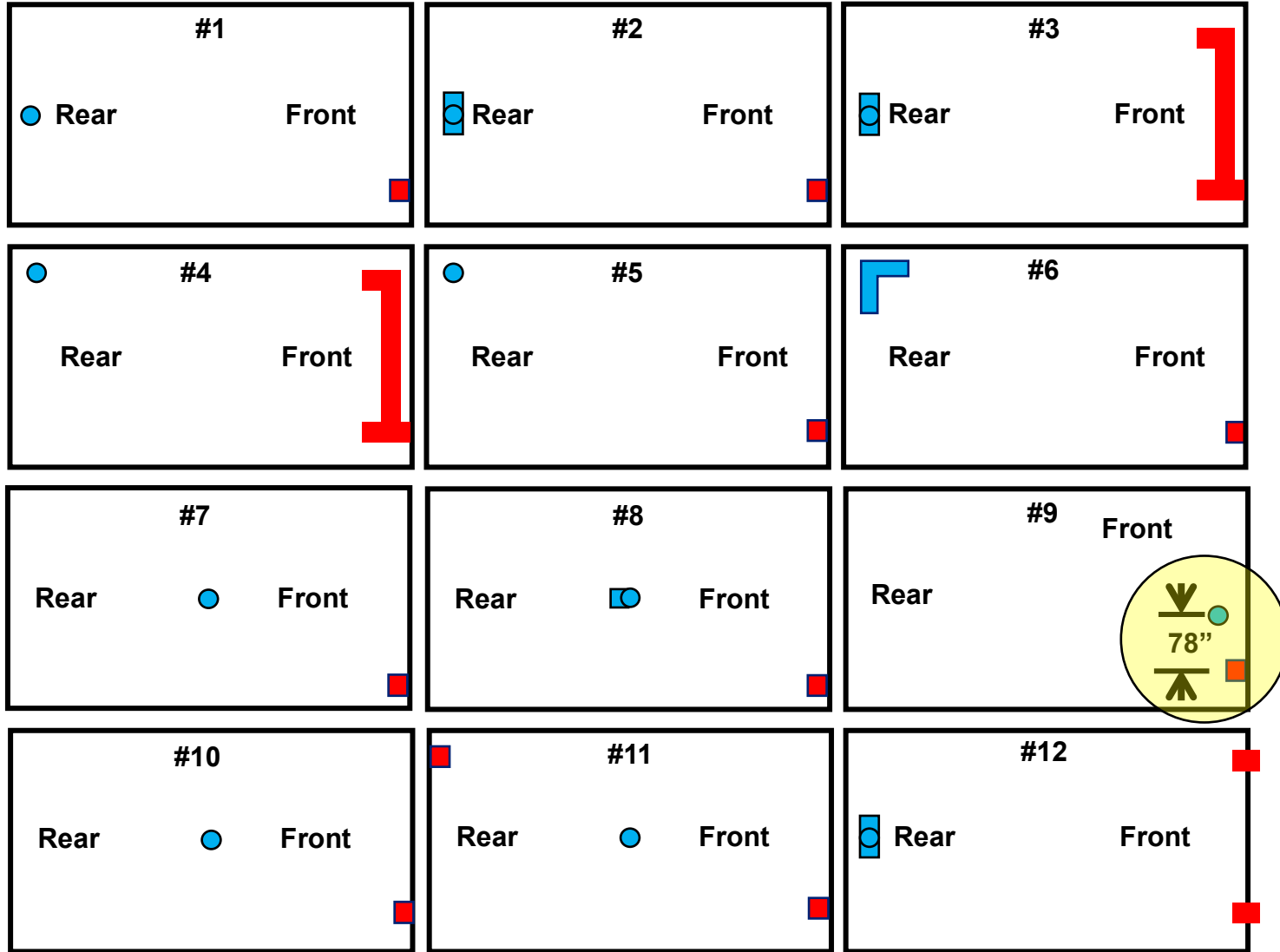
L-shaped air inlet for MVSC #6

Purging research was conducted using 12 MVSCs to examine the variation in purge time and identify the presence of stagnant areas



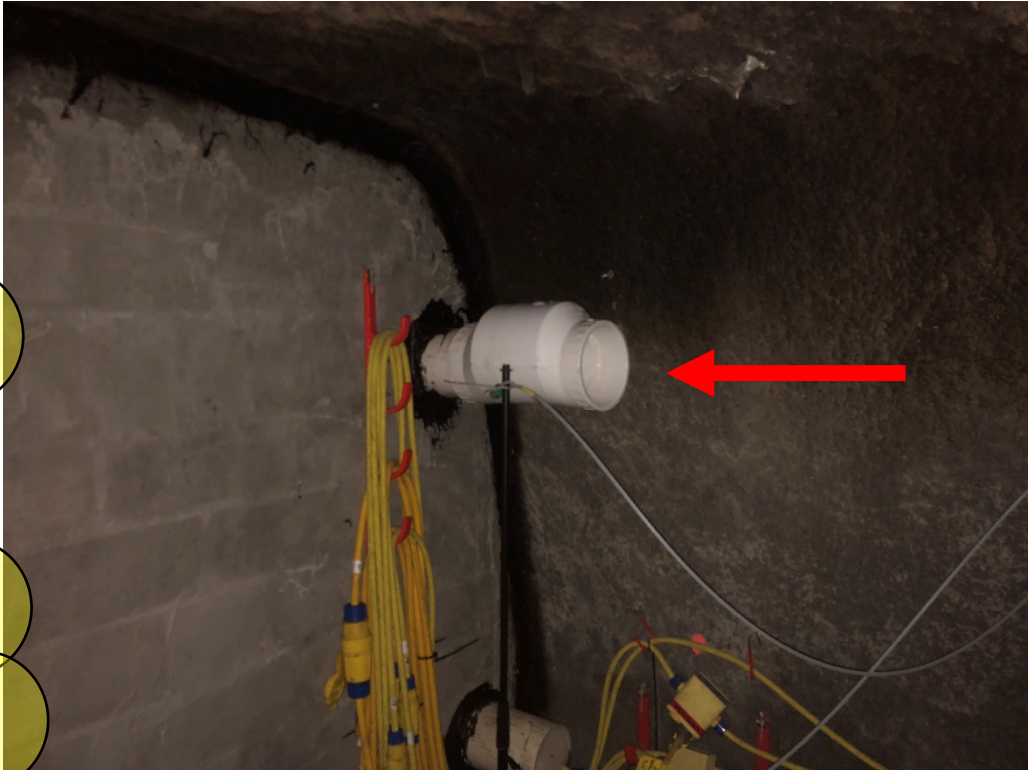
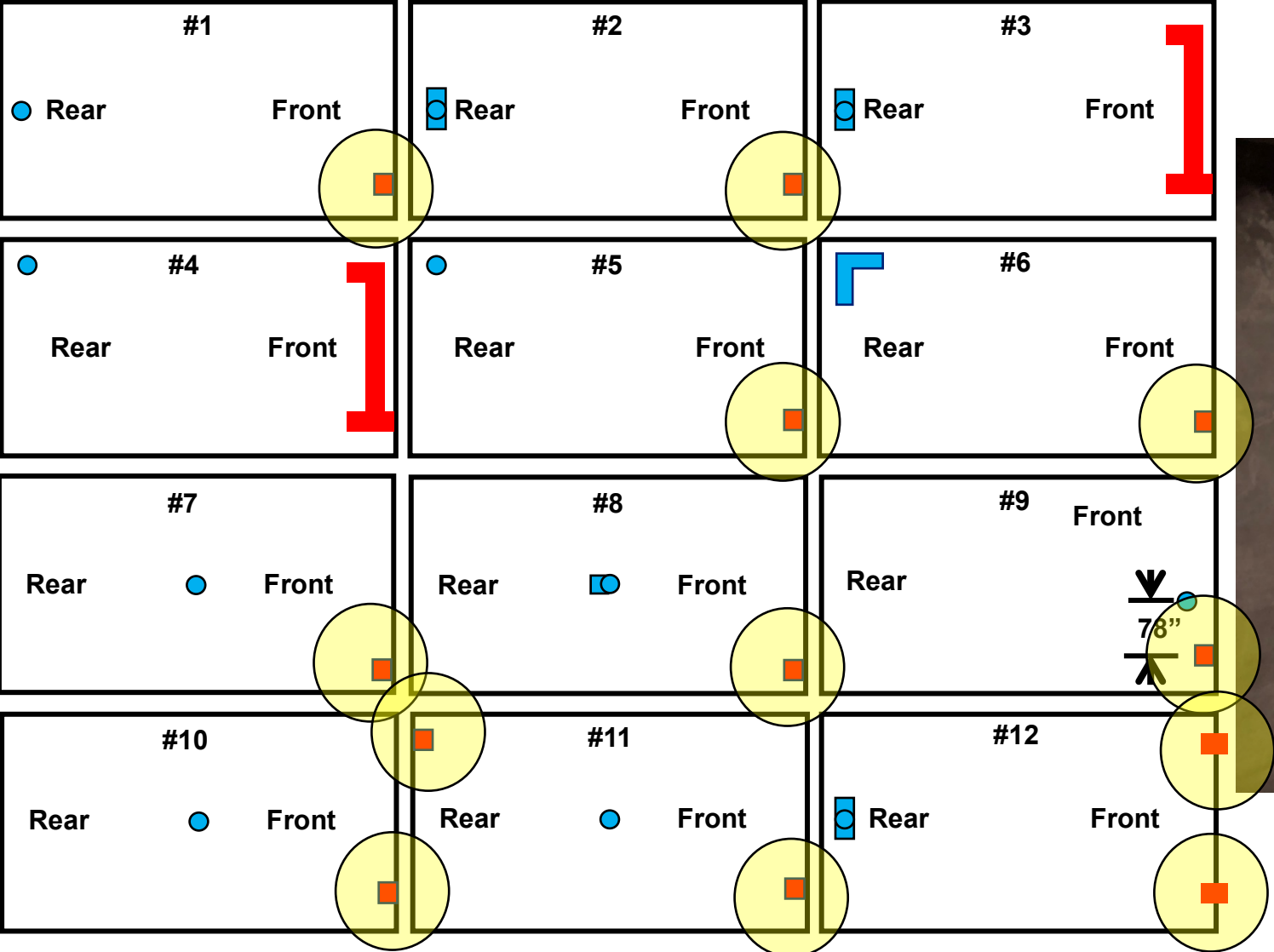
Air inlet for MVSC #8

Purging research was conducted using 12 MVSCs to examine the variation in purge time and identify the presence of stagnant areas



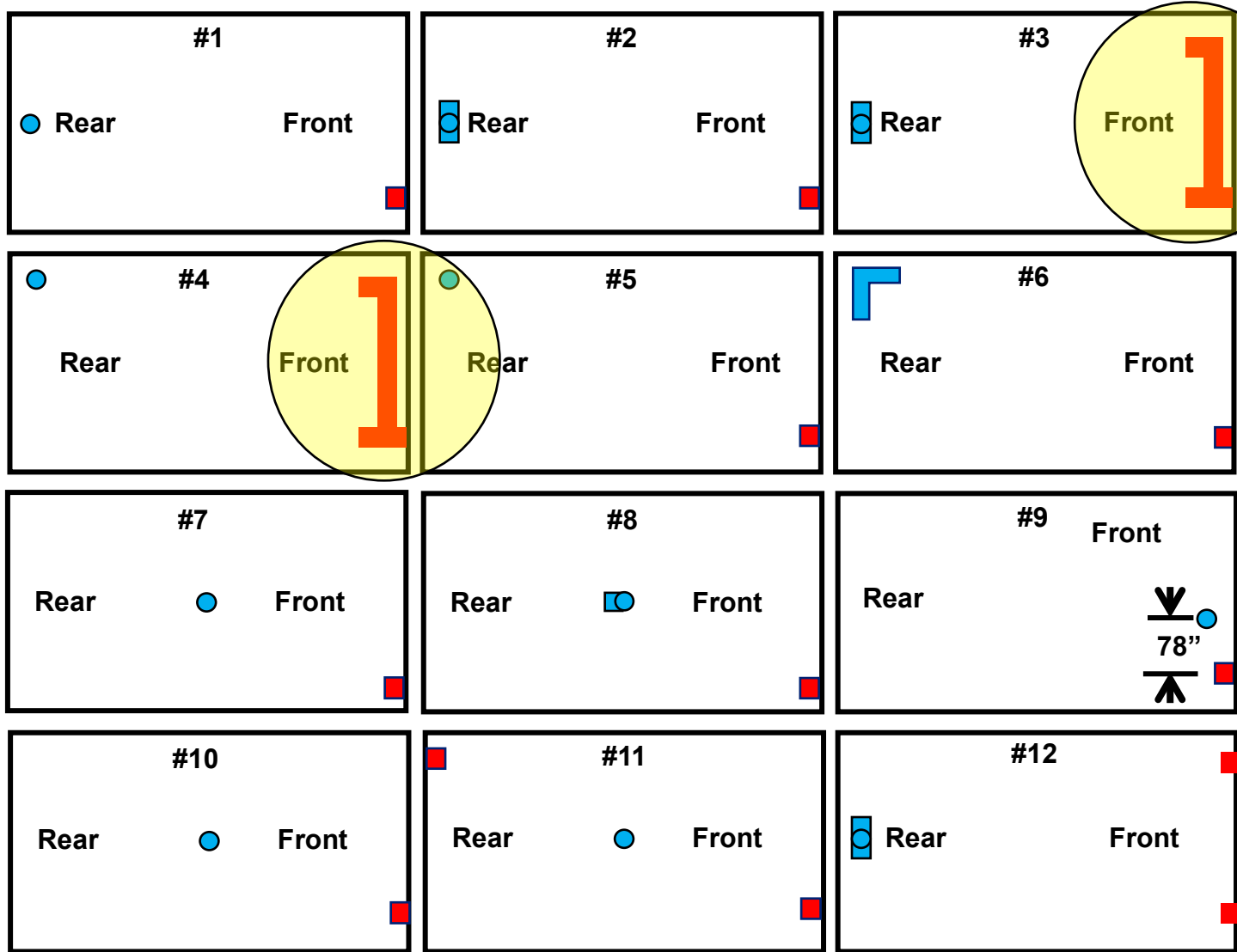
Air inlet and outlet for MVSC #9

Purging research was conducted using 12 MVSCs to examine the variation in purge time and identify the presence of stagnant areas



Air outlet for MVSC #1, 2, 5, 6, 7, 8, 9, 10, 11, 12

Purging research was conducted on 12 ventilation system configurations (MVSCs) to examine the variation in purge time and presence of stagnant areas



Y-shaped air outlet for MVSC #3, 4



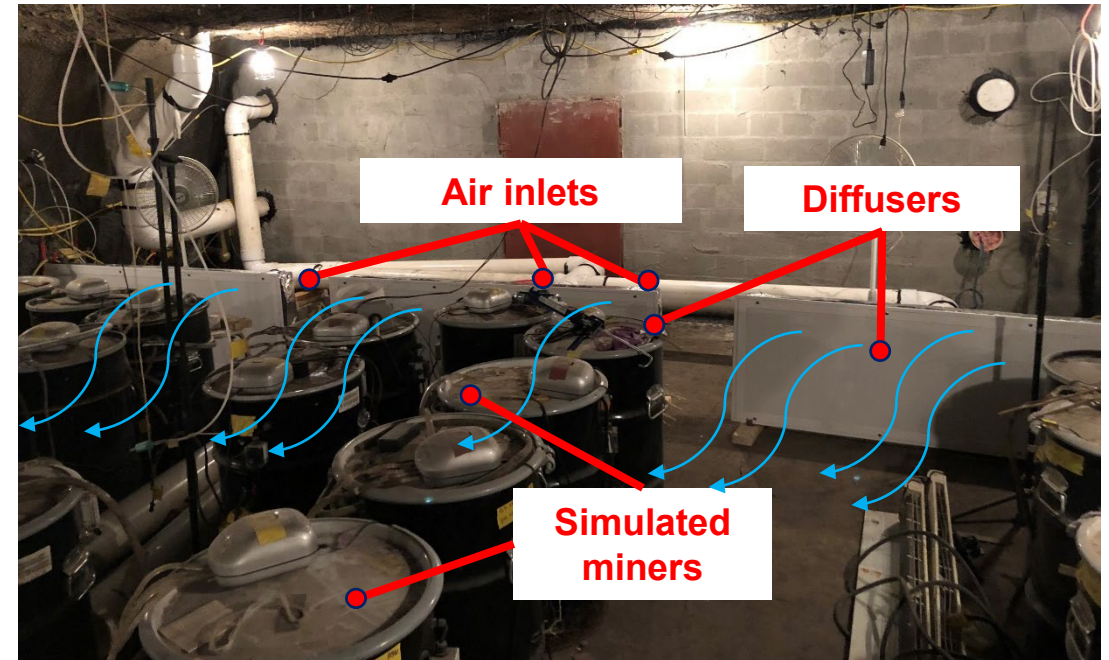
Part 2: Thermal Displacement Ventilation System Configuration (TDVSC)

Expanding on previous NIOSH purging research, the researchers tested a TDVSC to examine the variation in purge time and presence of stagnant areas



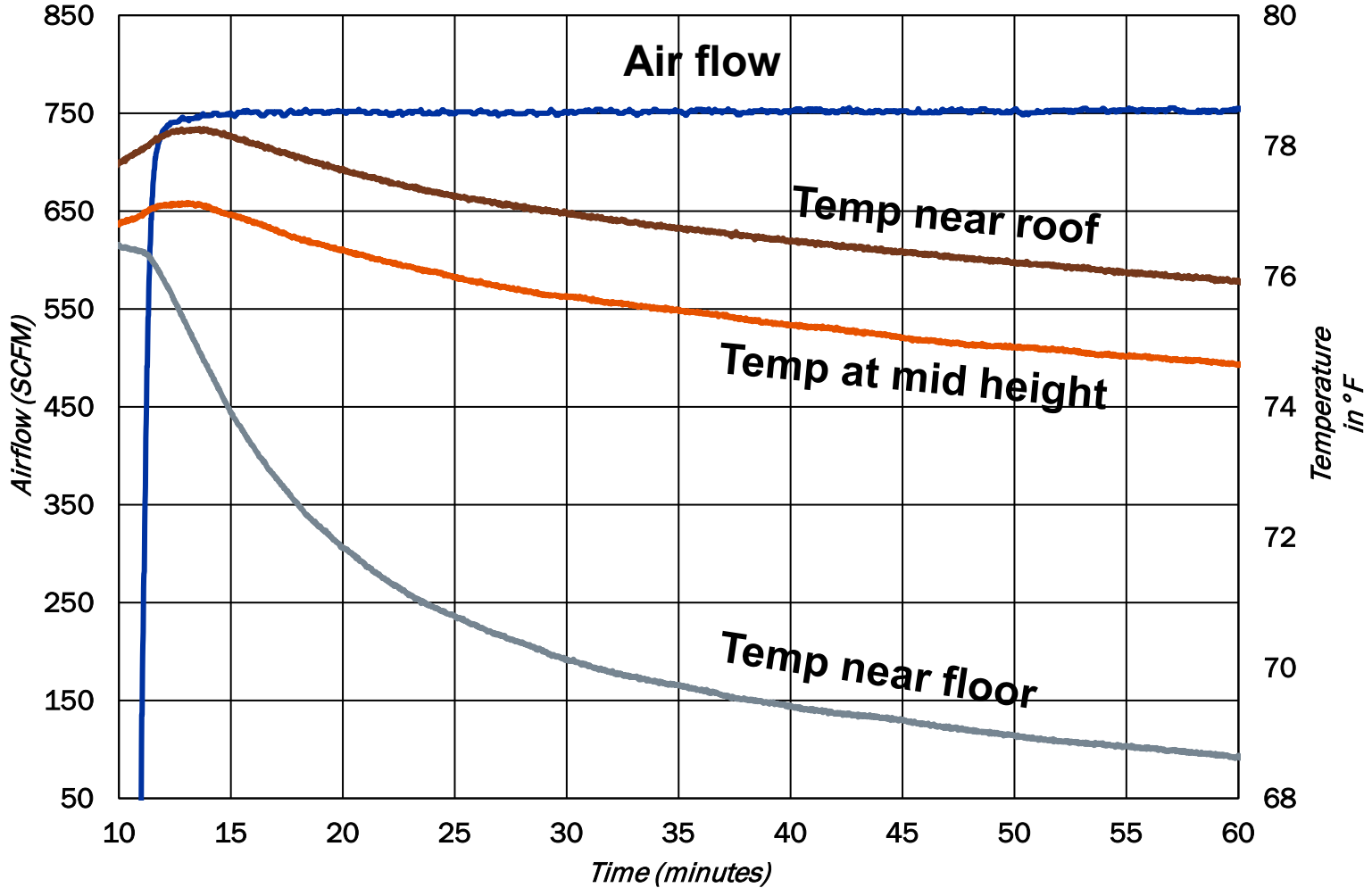
TDVSC Concept

- Low velocity air supply using diffusers
- Buoyancy forces (heated simulated miners)
- Temperature stratification



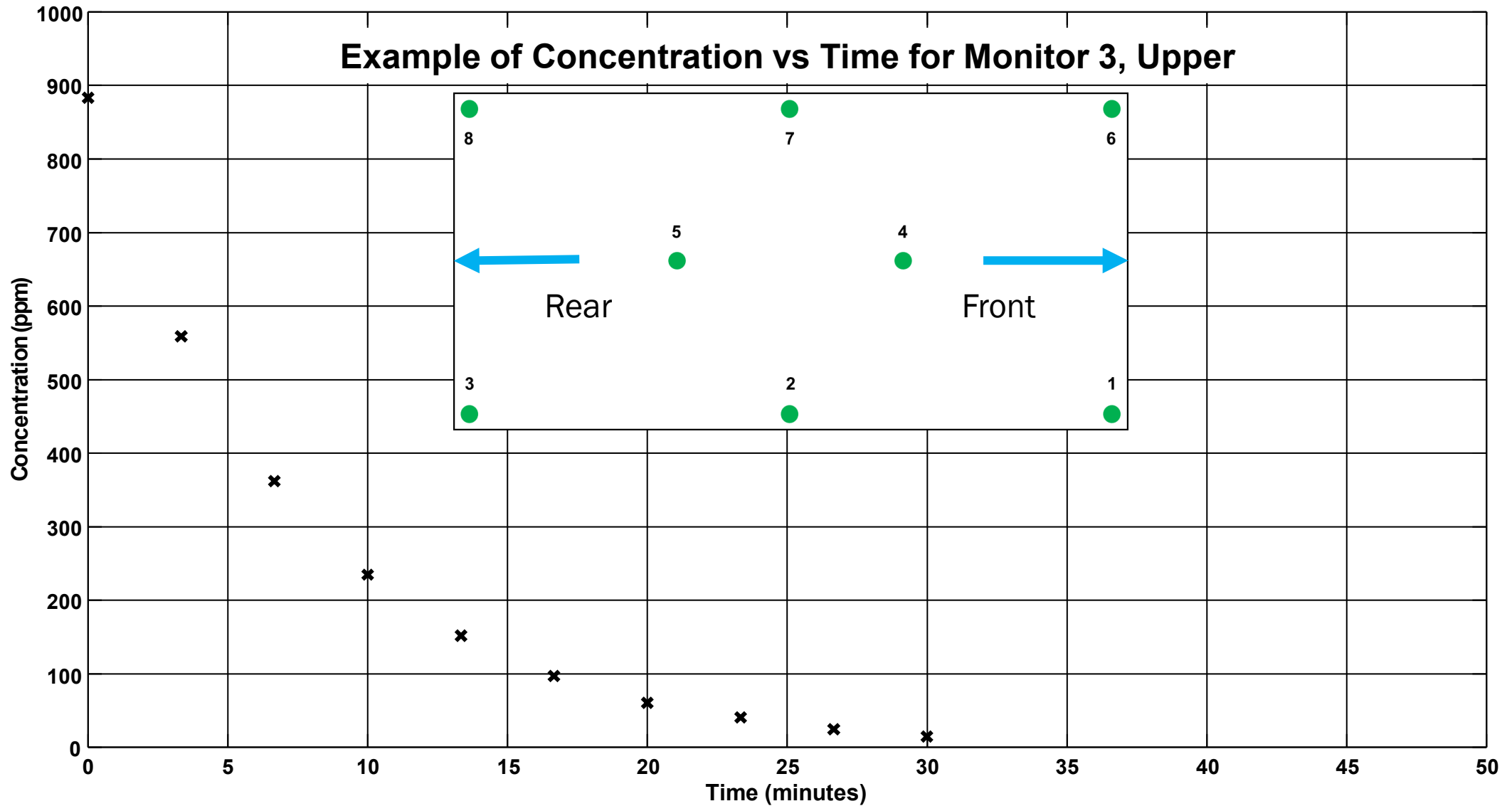
Inside the 30-person BIP RA

The ambient air inside the BIP RA showed temperature stratification during the purging test

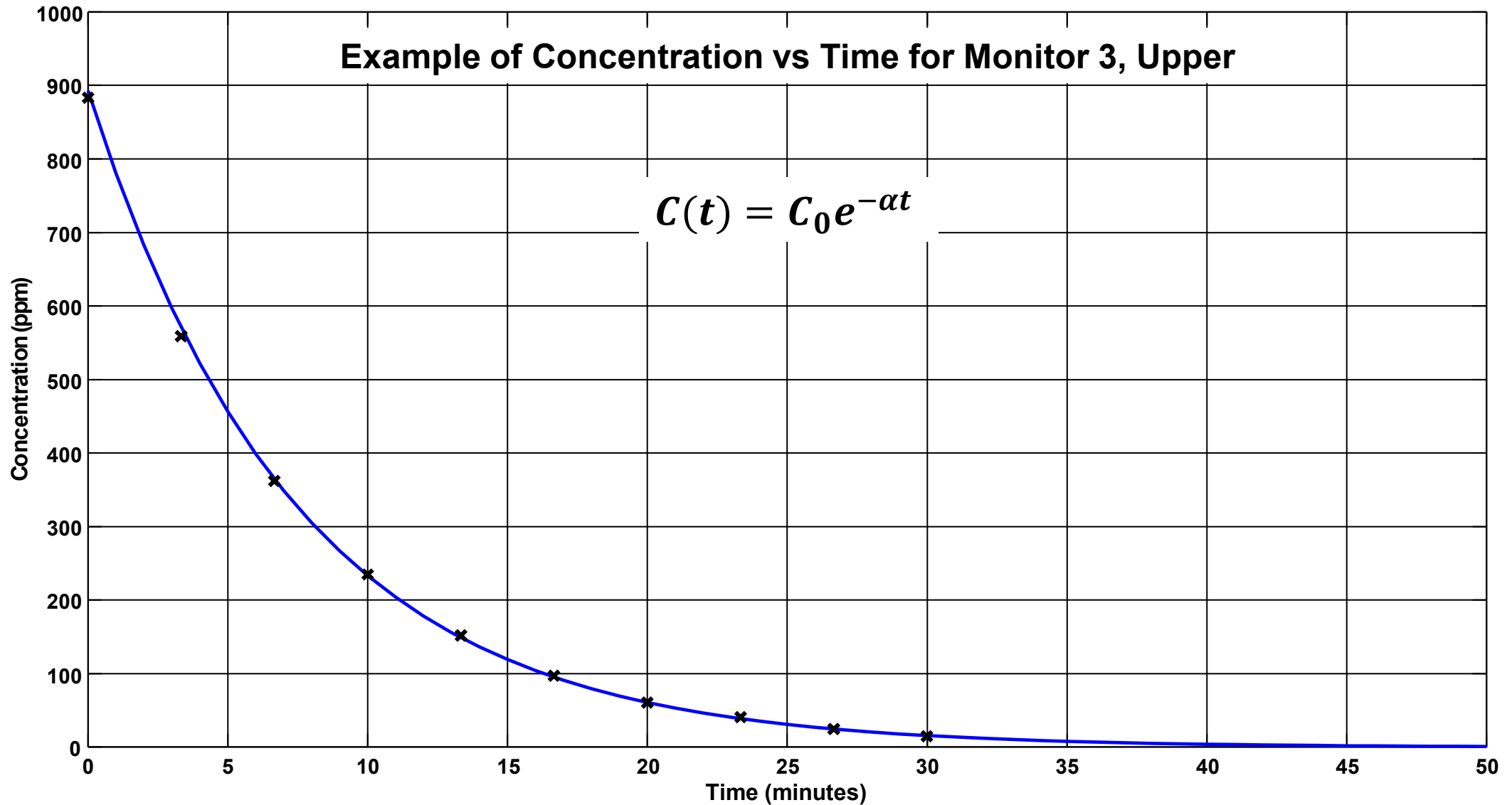


— BAS air flow
— Average T 12 in from the floor
— Average T 41 in from the floor (mid-height)
— Average T 12 in from the roof

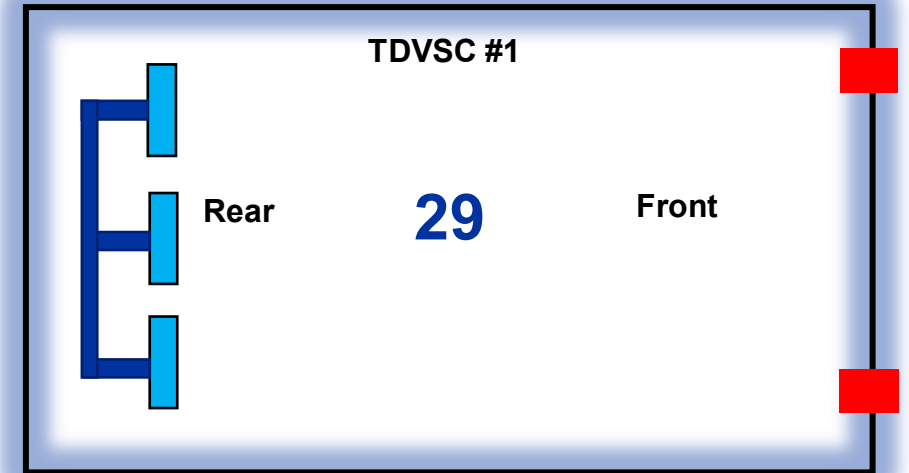
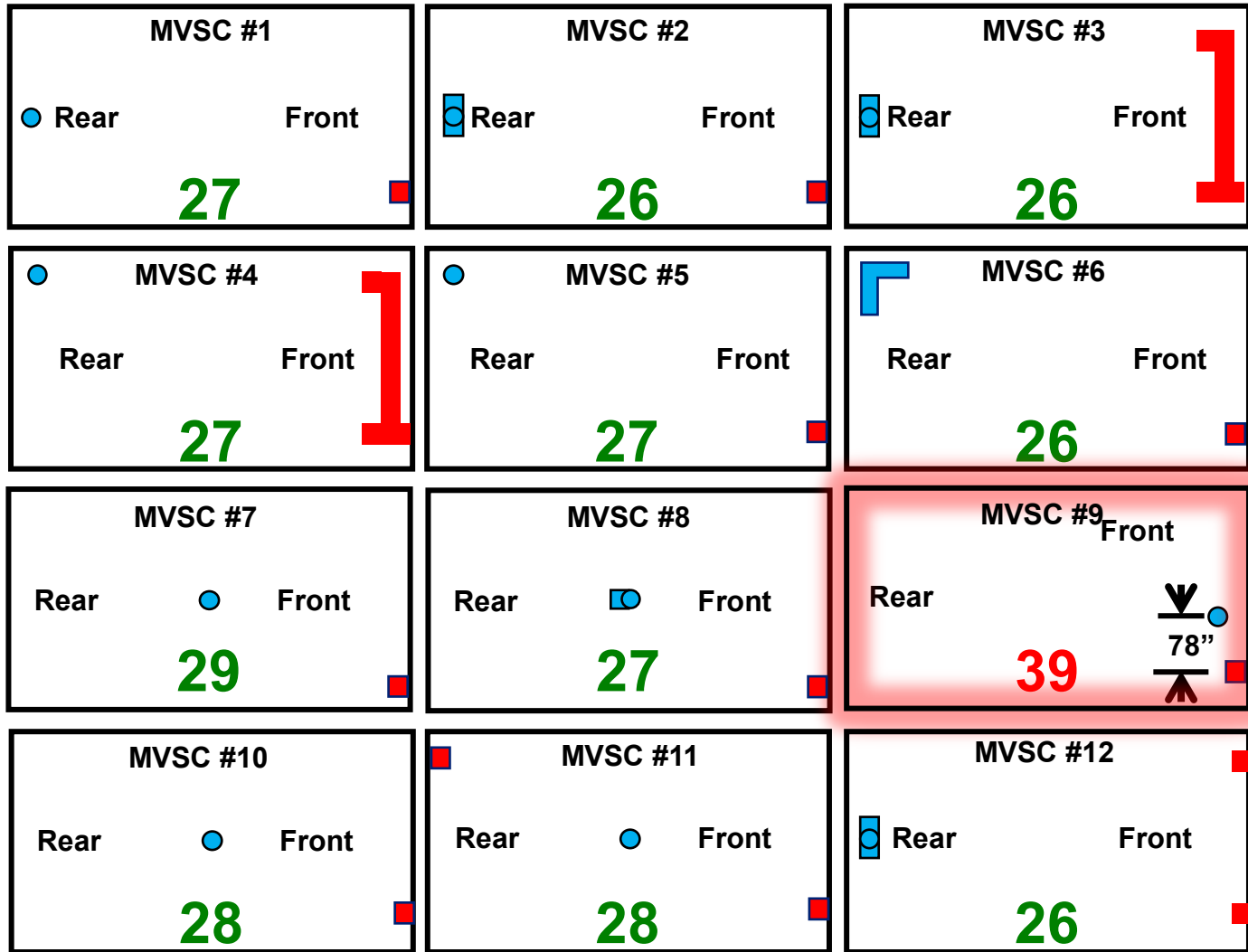
The data were curve fit and the results were used to calculate purge time from 1000 ppm to 25 ppm



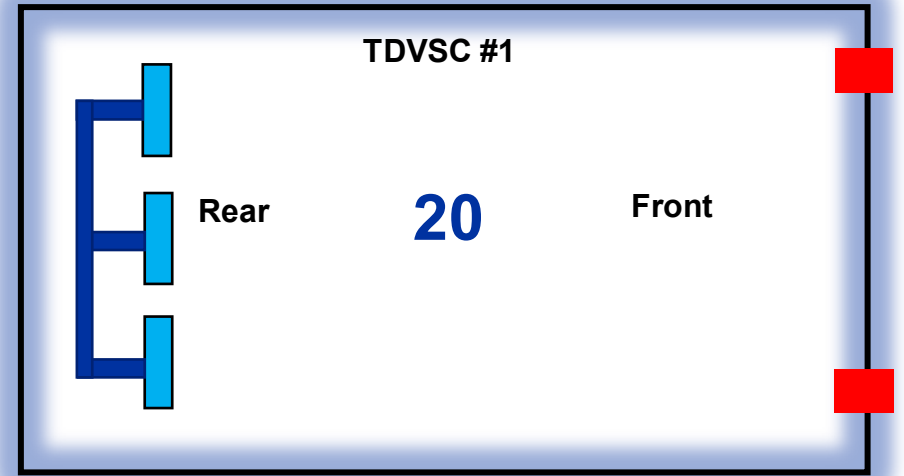
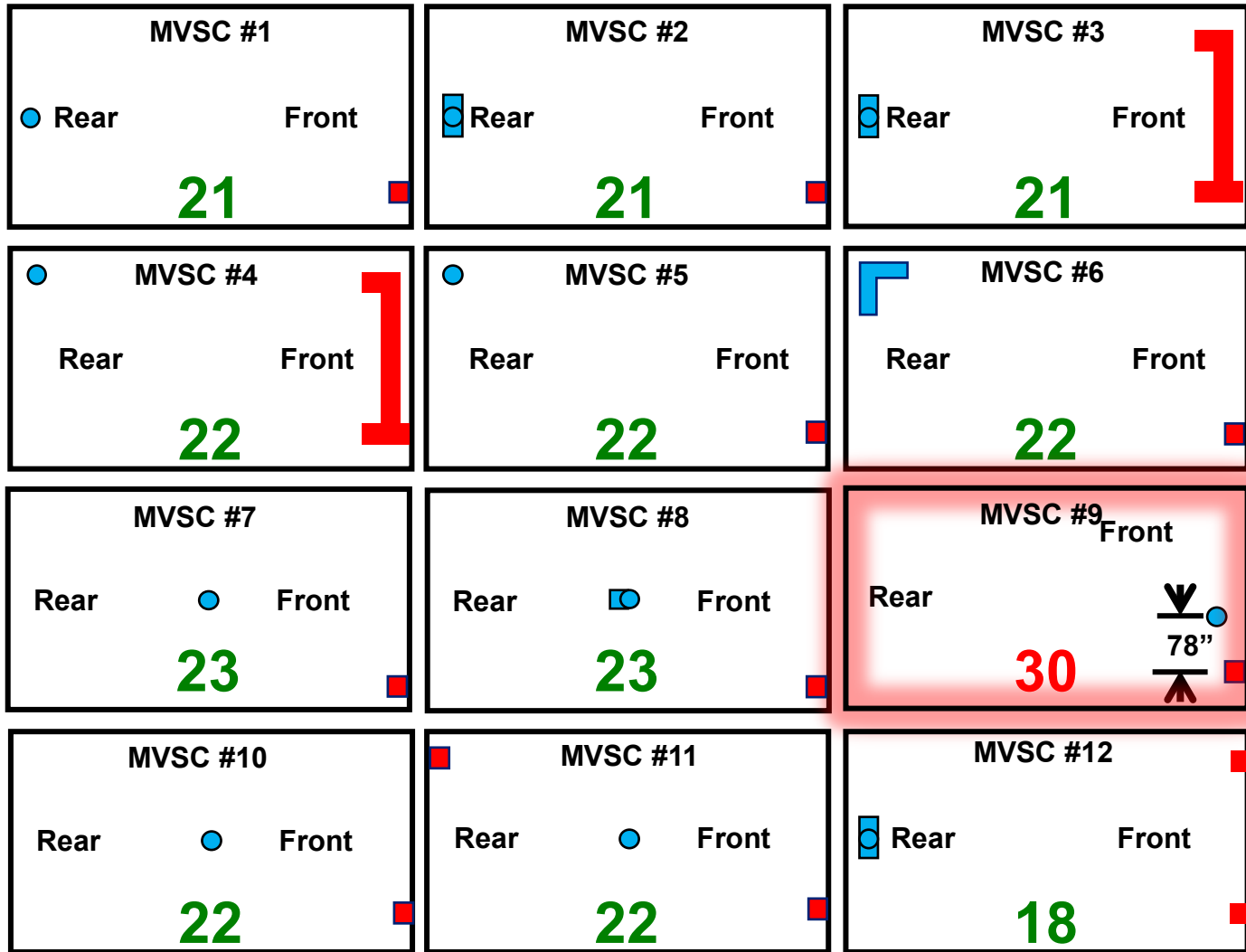
The data were curve fit and the results were used to calculate purge time from 1000 ppm to 25 ppm



At 750 SCFM, the average purge time for the TDVSC was 29 minutes, and the average purge times for the MVSCs ranged from 26 - 29 minutes, except for MVSC #9

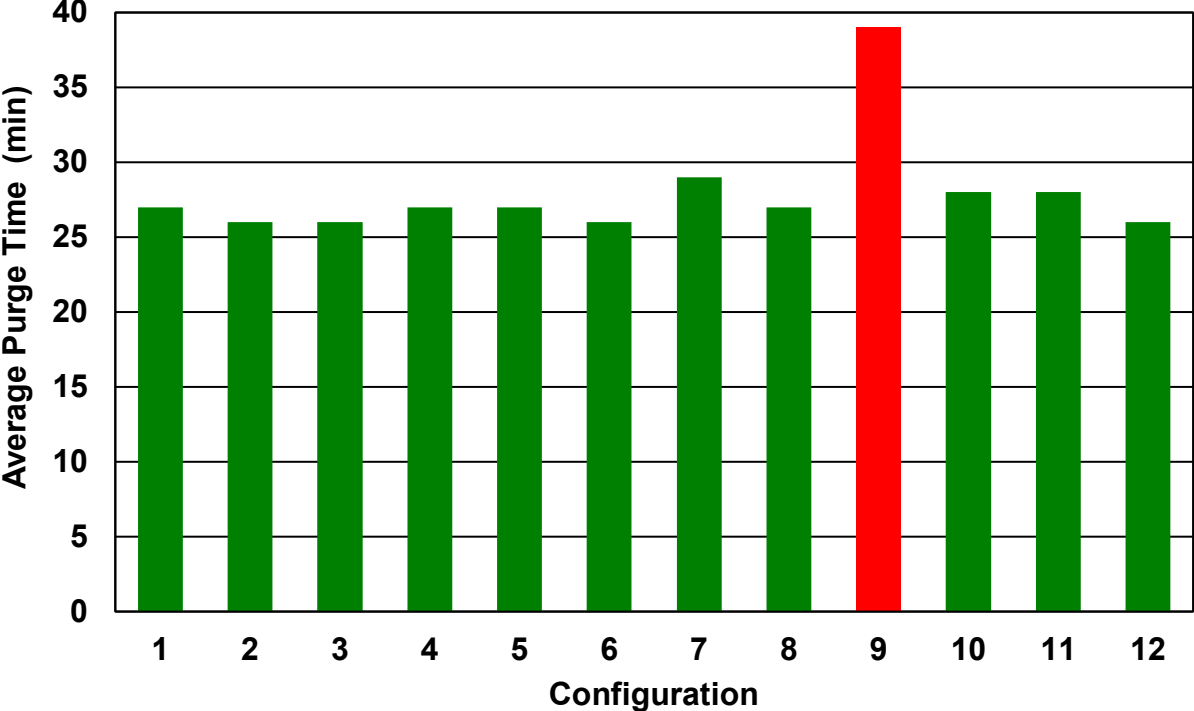


At 1,000 SCFM, the average purge time for the TDVSC was 20 minutes, and the average purge times for the MVSCs ranged from 18 - 23 minutes, except for MVSC #9

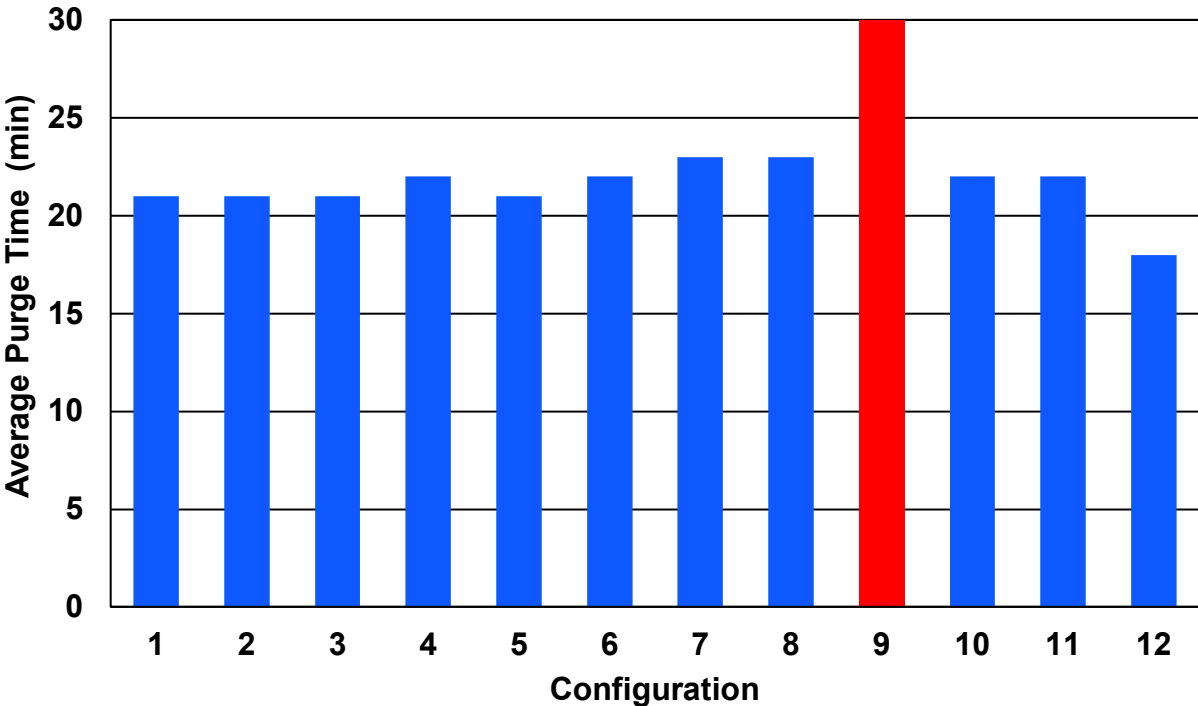


MVSC #9 was more than 6 minutes slower than the next slowest MVSC for both airflows

Average Purge Times at 750 SCFM

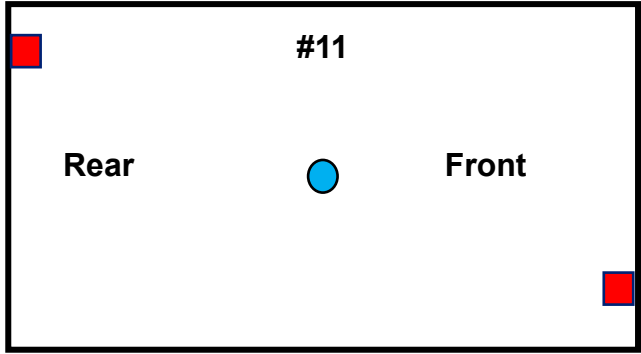
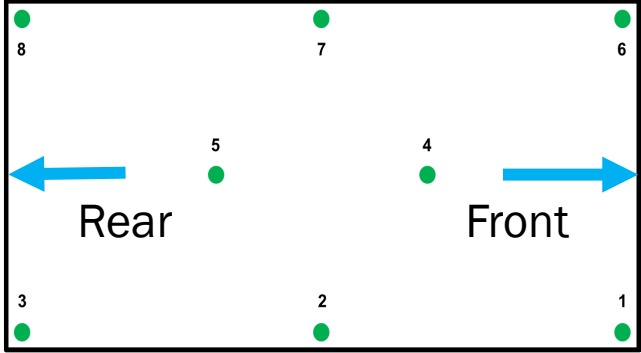
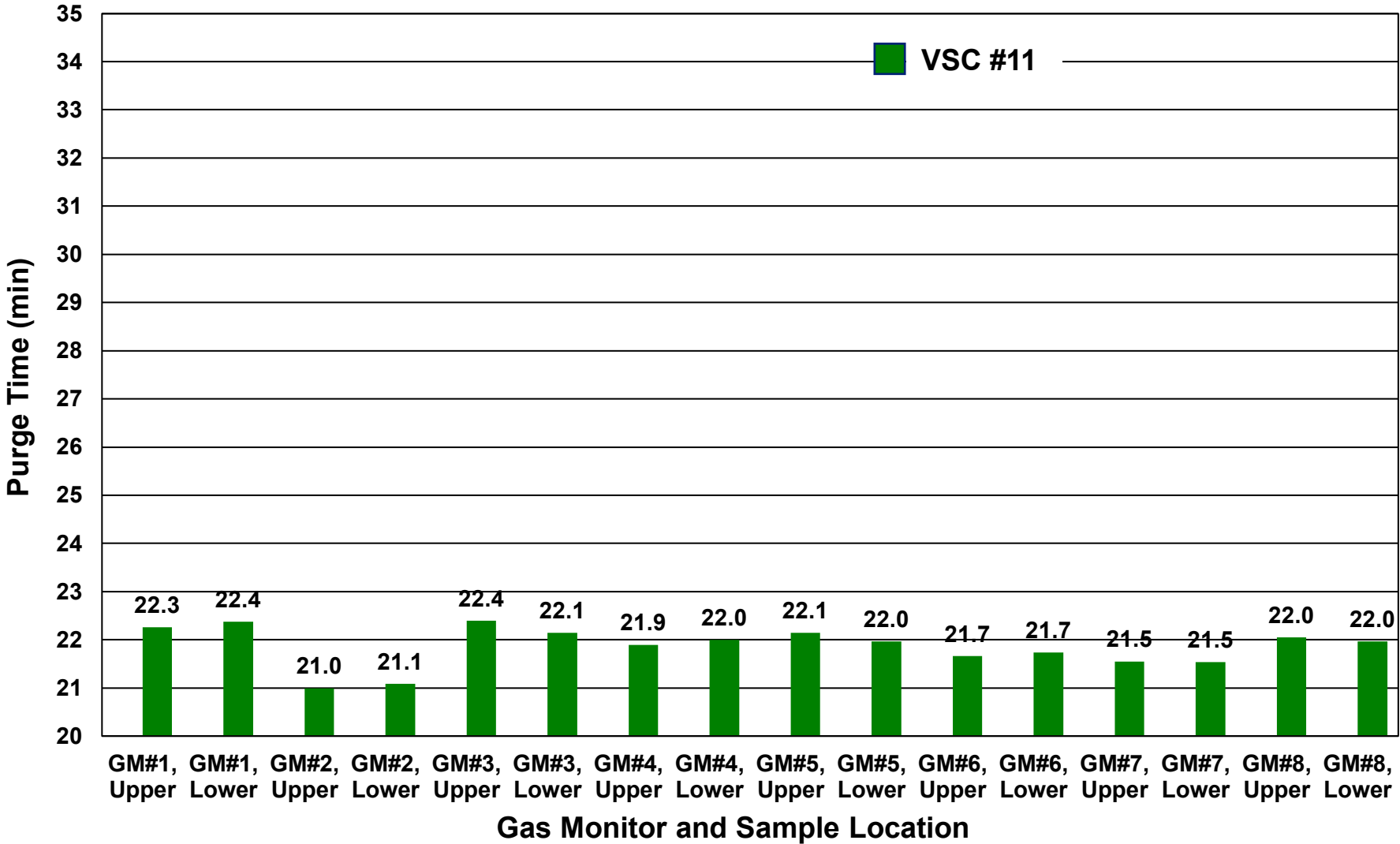


Average Purge Times at 1,000 SCFM



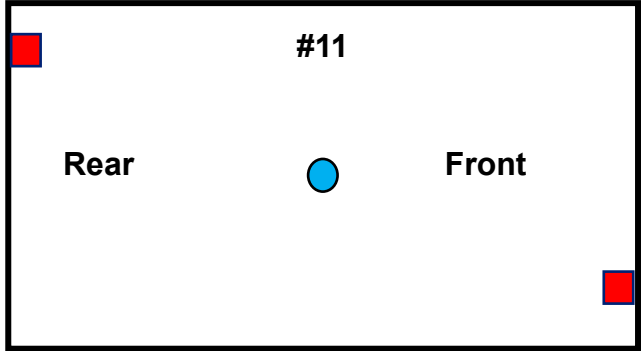
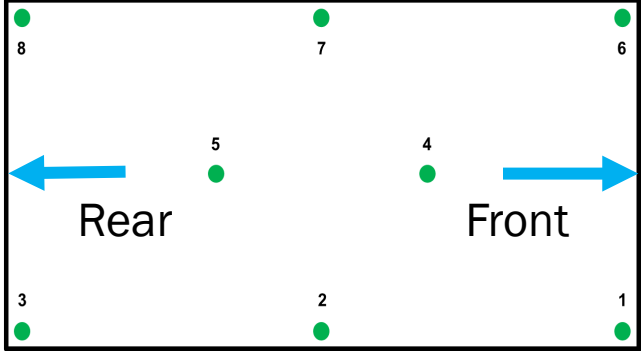
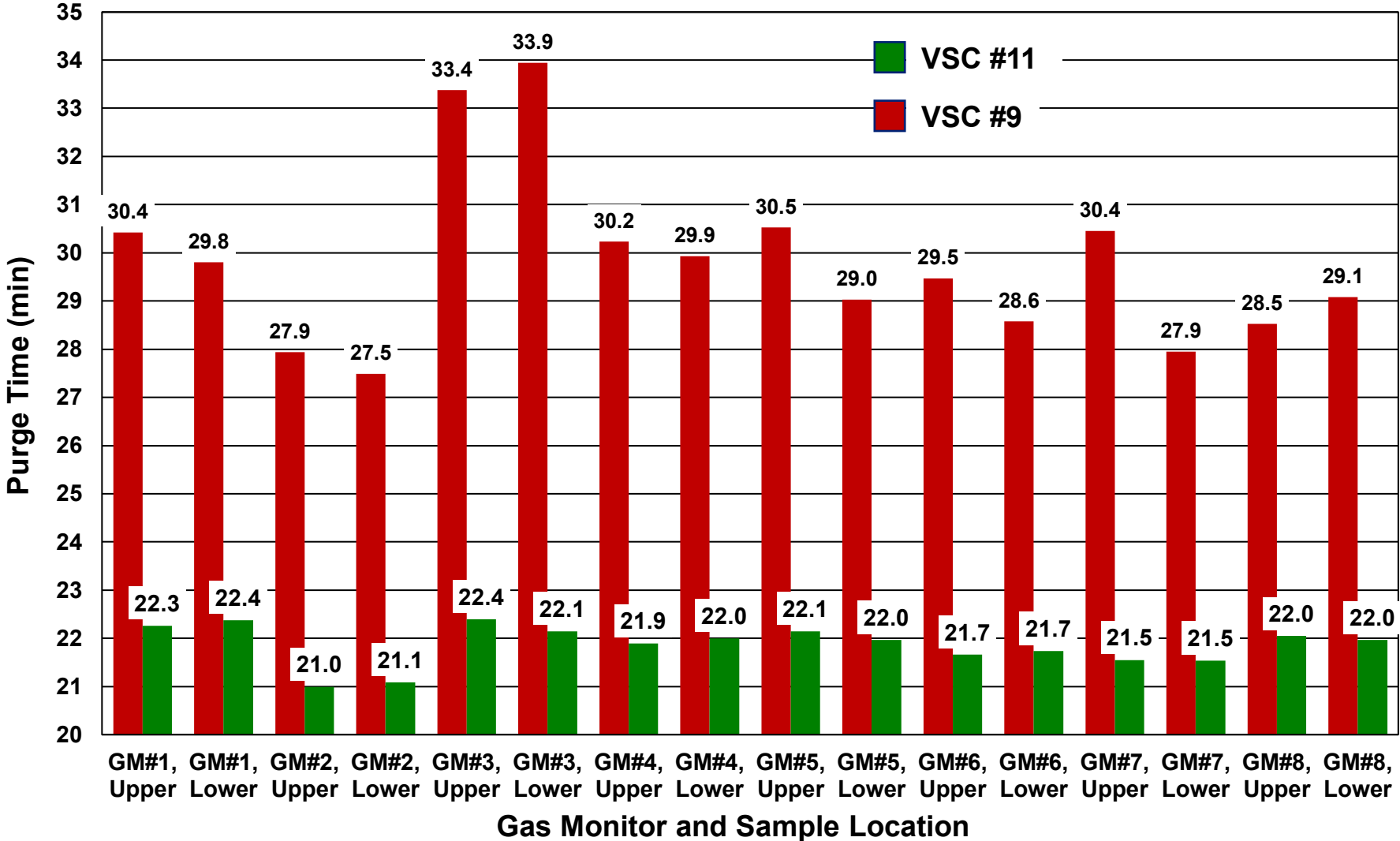
Except for MVSC#9, the variation in purge time from sample location to sample location was small for the MVSCs

Purge Time Variation for MVSC #9 and MVSC #11 at 1000 SCFM



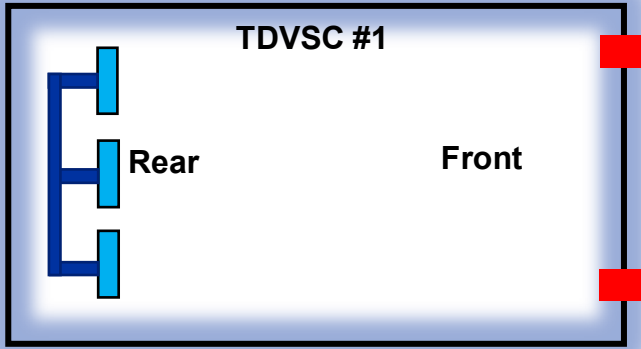
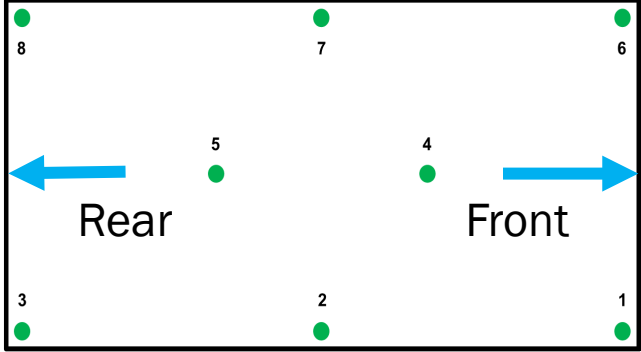
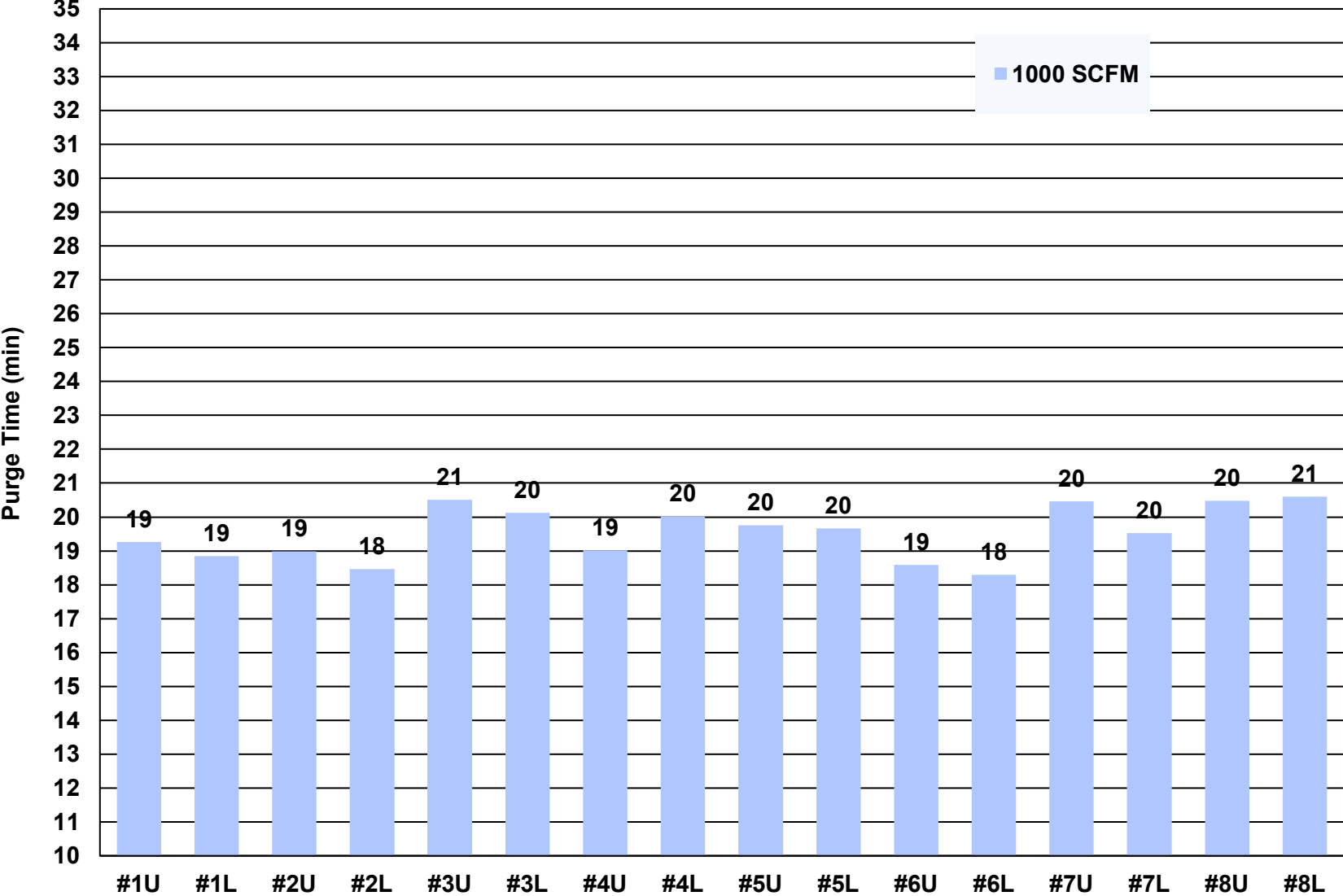
Except for MVSC#9, the variation in purge time from sample location to sample location was small for the MVSCs

Purge Time Variation for MVSC #9 and MVSC #11 at 1000 SCFM



The variation in purge time from sample location to sample location was small for the TDVSC

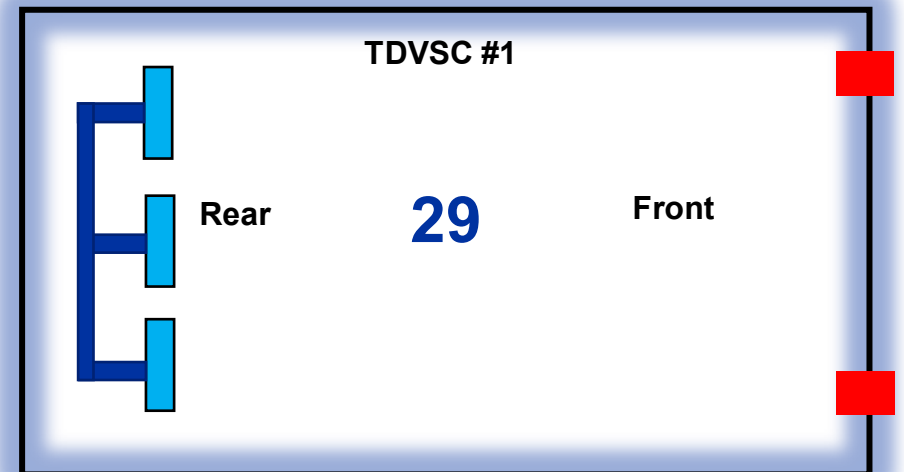
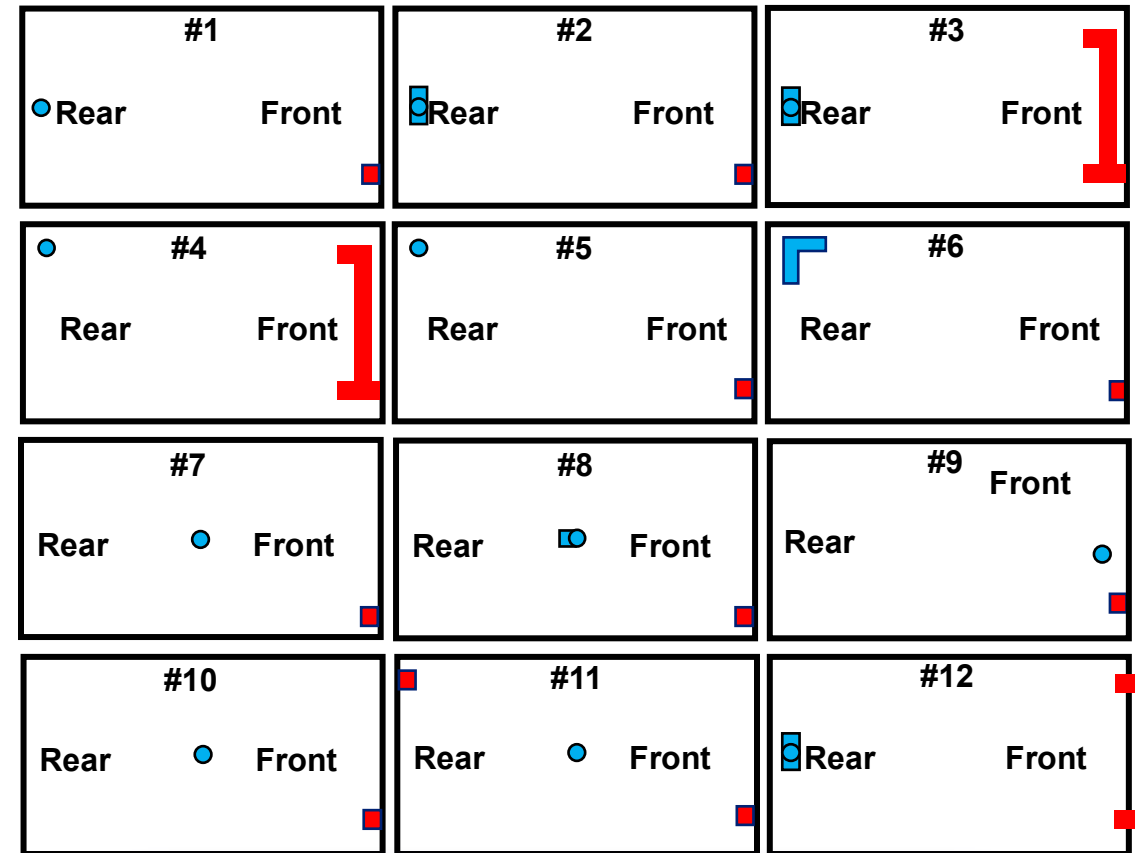
Purge Time Variation, TDVSC Configuration 1,000 SCFM



“U”= sample ports at 62”
 “L”=sample ports at 28”

In Summary

- Excluding MVSC #9, the data showed no clear advantage of using the TDVSC over the MVSCs.
- The average purge times for the TDVSC are within 3 minutes of the MVSCs
- TDVSC costs are more than the MVSCs and required more labor hours to install.
- This information can be used by mine operators and refuge alternative suppliers to ensure that efficient and effective ventilation is provided to purge contaminants from within an occupied refuge alternative



Thank you for your attention!

Joseph Bickson
JBickson@cdc.gov
412.386.5935



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