Static And Dynamic Contamination Ingress for a Built-in-place Refuge Alternative

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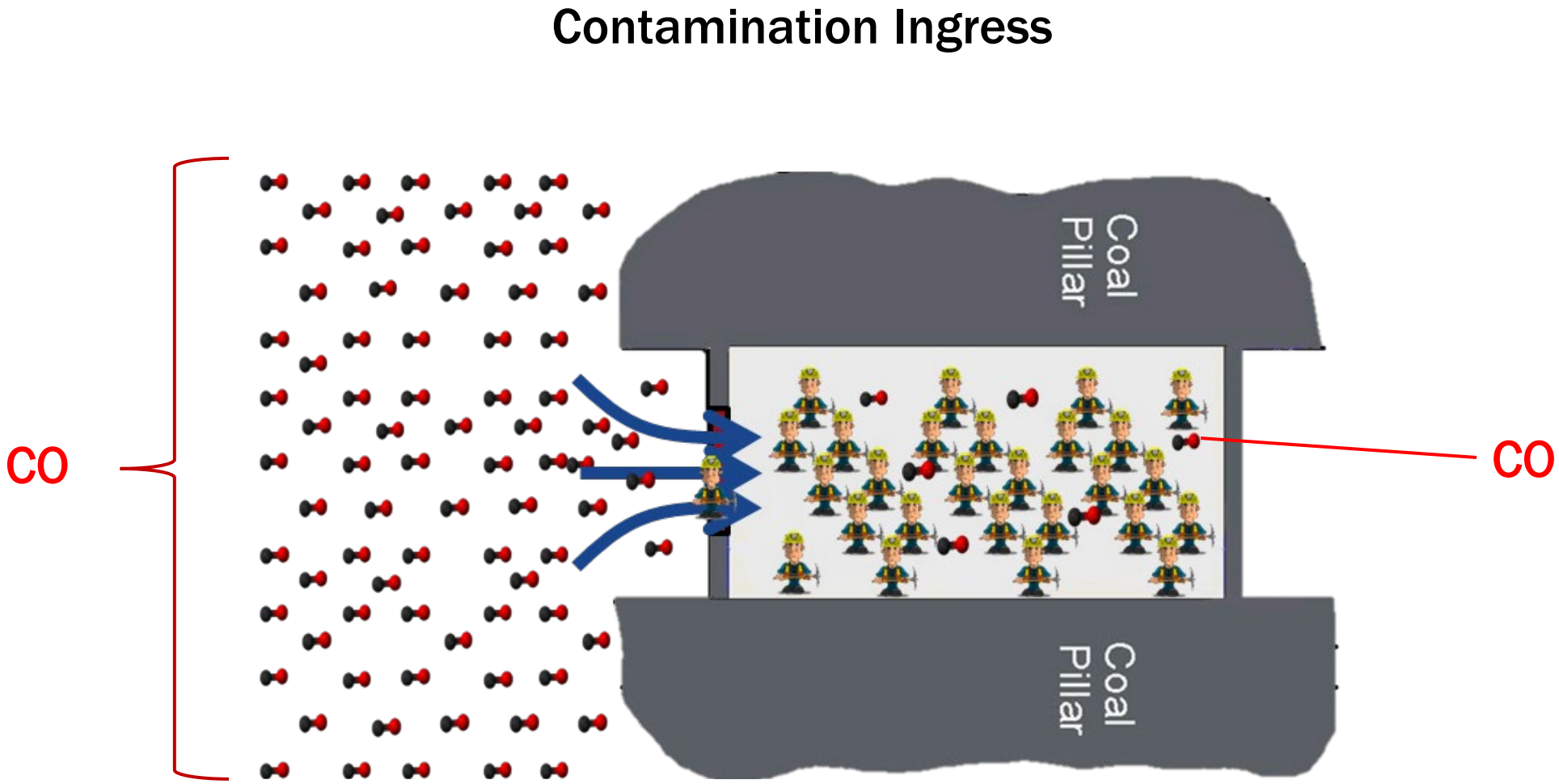
RAs protect miners from a potentially fatal post-disaster mine atmosphere

Effects of Exposure to Various Levels of Carbon Monoxide	
Conc. (ppm)	Symptoms
25 ppm	
200	Slight headache within two to three hours; loss of judgment.
400	Frontal headache within one to two hours.
3,200	Headache, dizziness, and nausea in five to ten minutes. Death within 30 minutes.
6,400	Headache and dizziness in 1 to 2 minutes. Convulsions, respiratory arrest, and death in less than 20 minutes.
10,000 ppm	
12,800	Unconsciousness after 2–3 breaths. Death in less than three minutes.

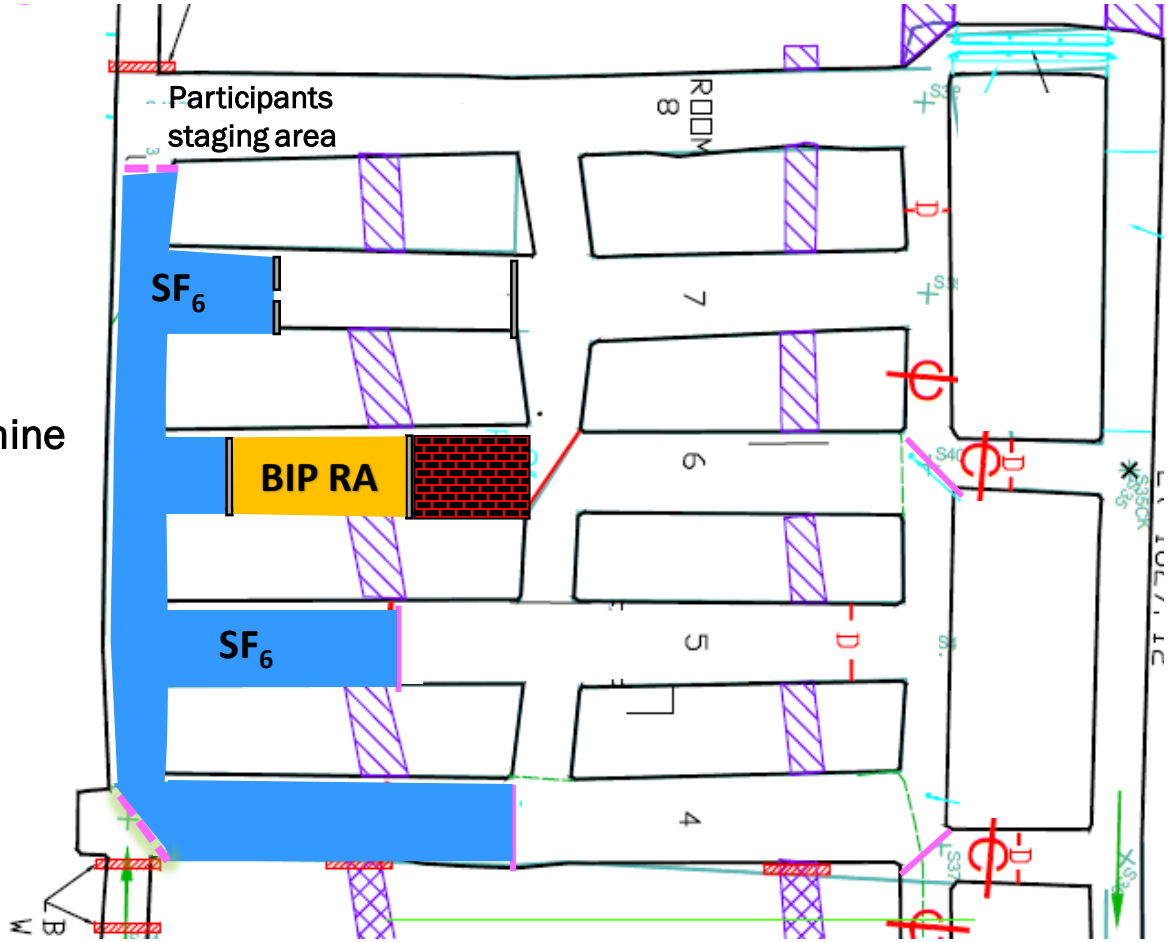
NIOSH researchers evaluated the contamination ingress due to humans entering a built-in-place (BIP) RA without an airlock



Previous static (without mine airflow) contamination ingress test results showed 2–3% of SF_6 contaminant concentration entered the BIP RA following the entry of 5–30 participants

SF_6 area (200 ppb)

Static test – no mine airflow



Contamination ingress area layout in the NIOSH Experimental Mine during previous static ingress testing

Vacutainers and gas chromatograph

NIOSH researchers conducted contamination ingress tests with 5, 15, and 30 participants using real-time SF_6 monitors

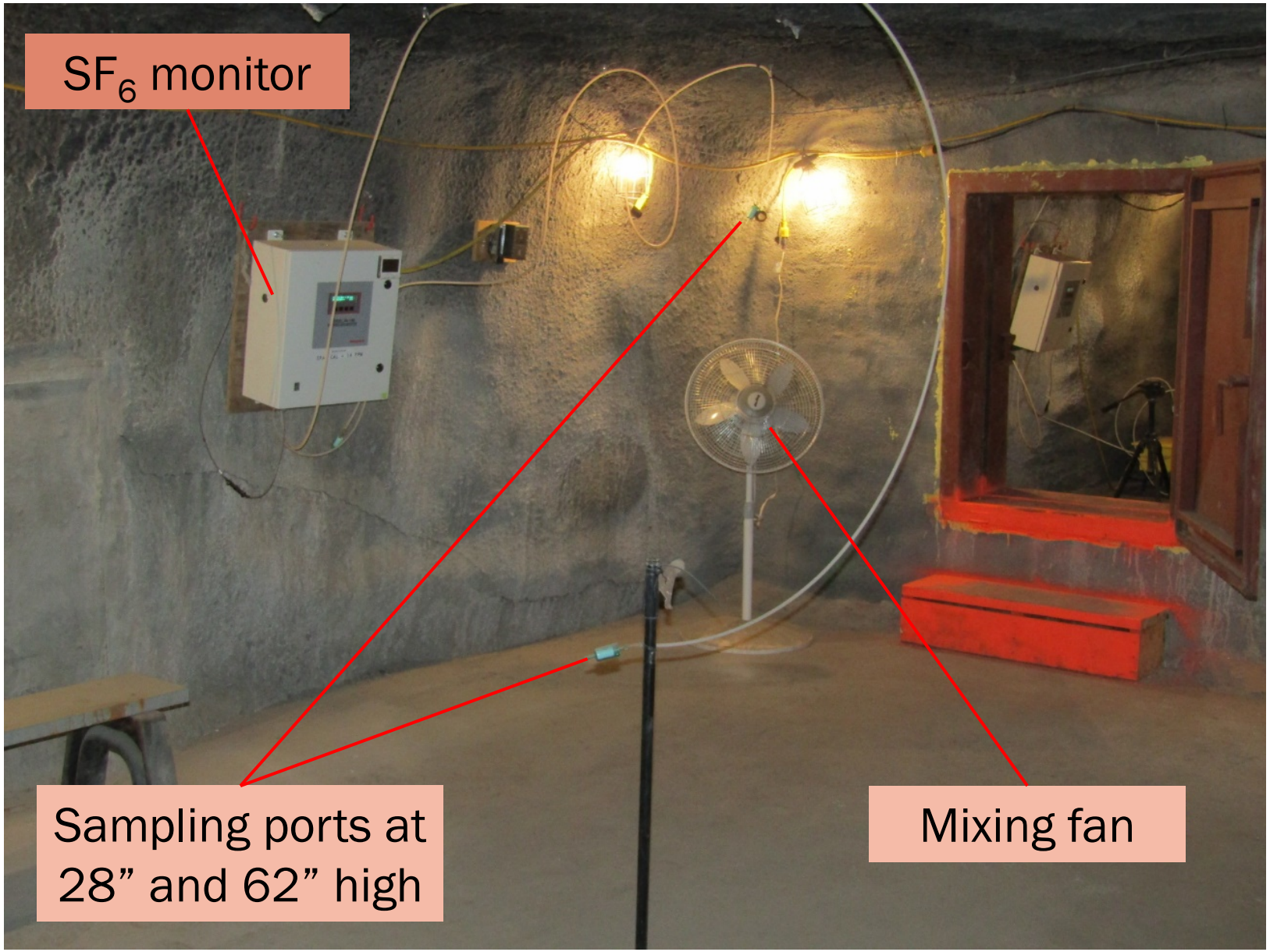
Real-time SF_6 monitors

Participants

Inside the BIP RA, we placed two SF_6 monitors to record the concentration levels at four locations.

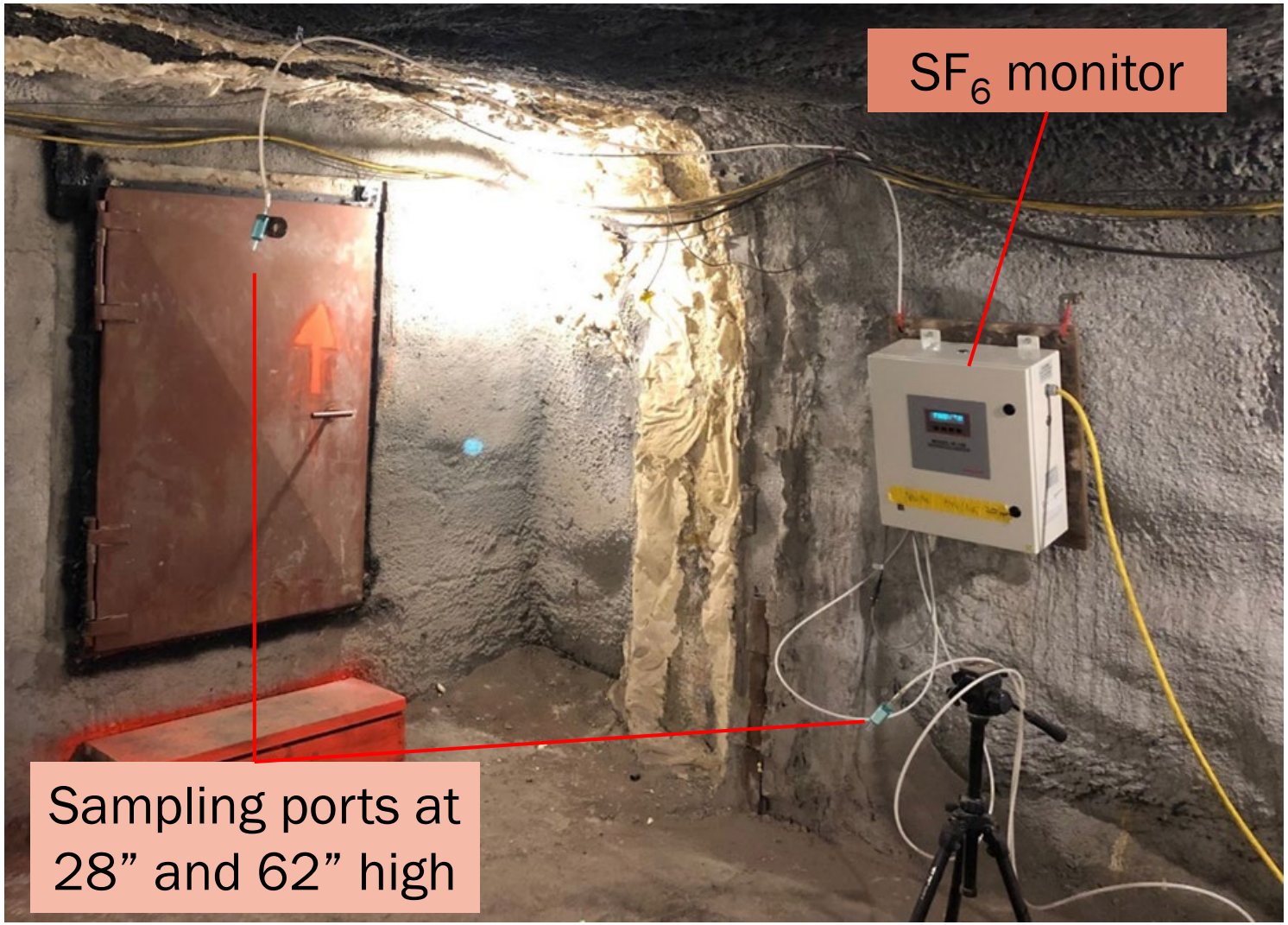
- Each monitor had two sampling ports collecting data at two heights

- Two mixing fans circulated the air to ensure uniform dispersion of the SF_6 contaminant.



Outside the BIP RA, we placed two SF_6 monitors to record the concentration levels at four locations.

Each monitor had two sampling ports collecting data at two heights



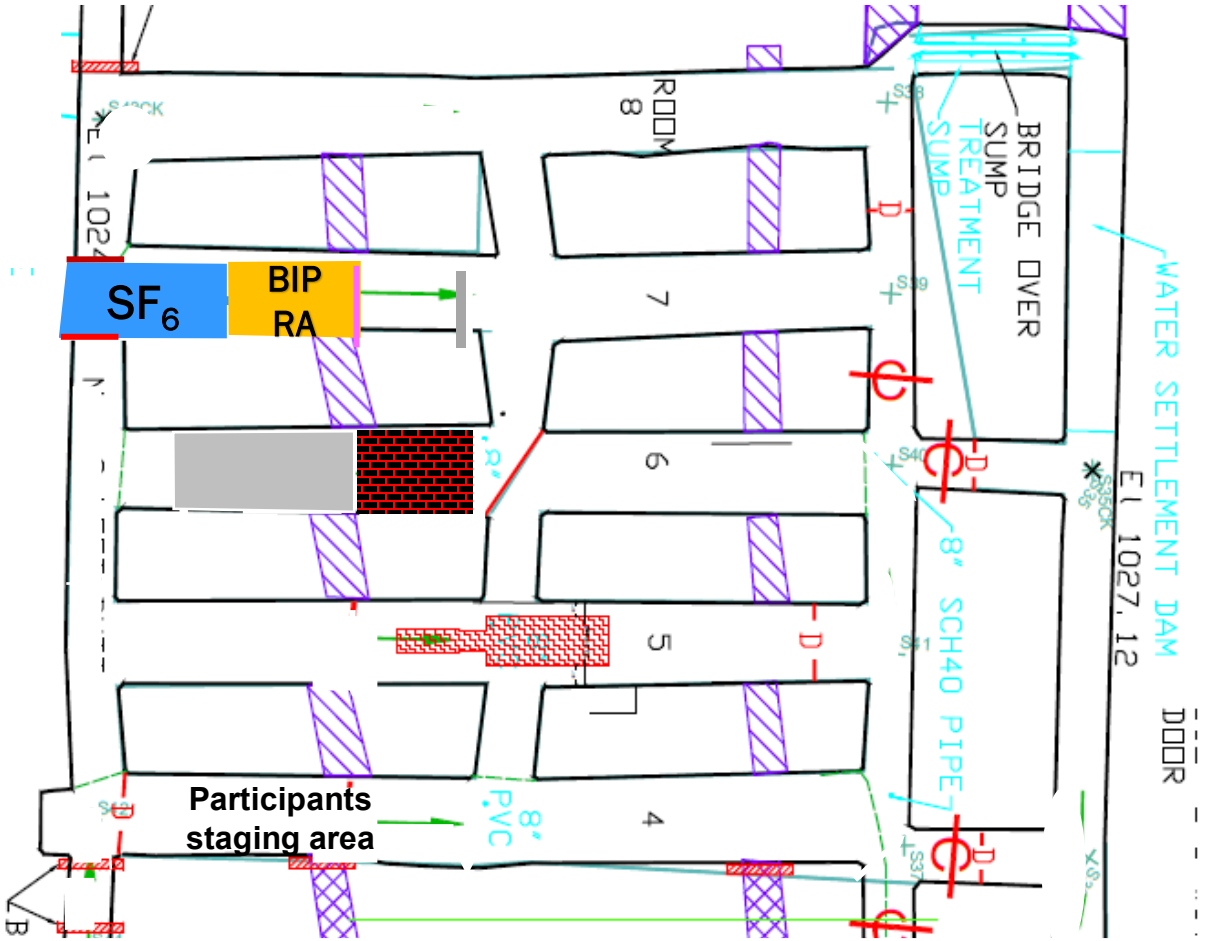
Outside the BIP RA

We tested four contamination ingress scenarios with each of the 3 groups of participants

- *Static tests* without mine airflow
  - Without borehole air supply
  - With borehole air supply delivering 375 cfm of fresh air
- *Dynamic* tests with mine airflow
  - Without borehole air supply
  - With borehole air supply delivering 375 cfm of fresh air

Borehole air supply on the surface

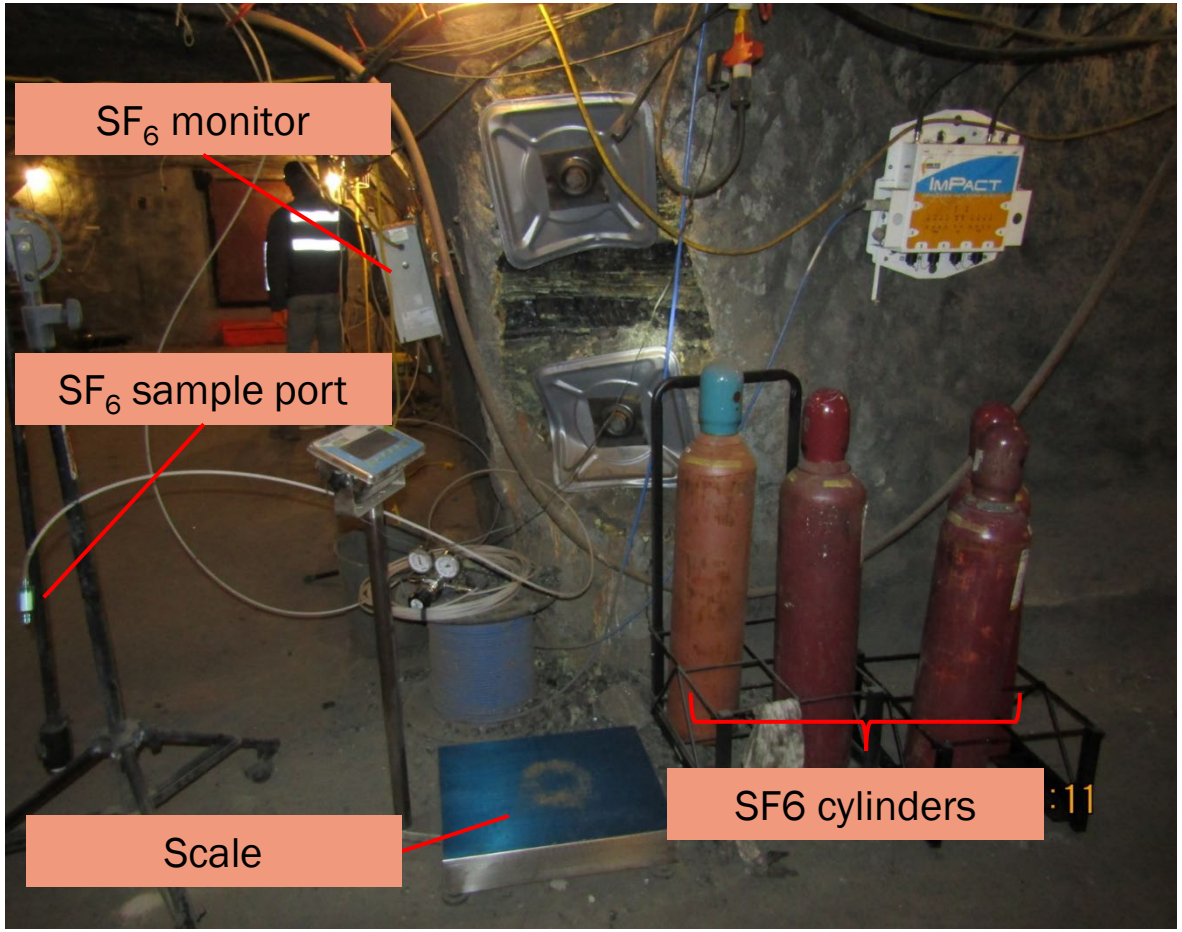
For the static tests, we constructed an area in front of the BIP RA to contain the SF_6



Static contamination ingress area in the NIOSH Experimental Mine

SF_6 Area (~500 ppm) Brattice Wall

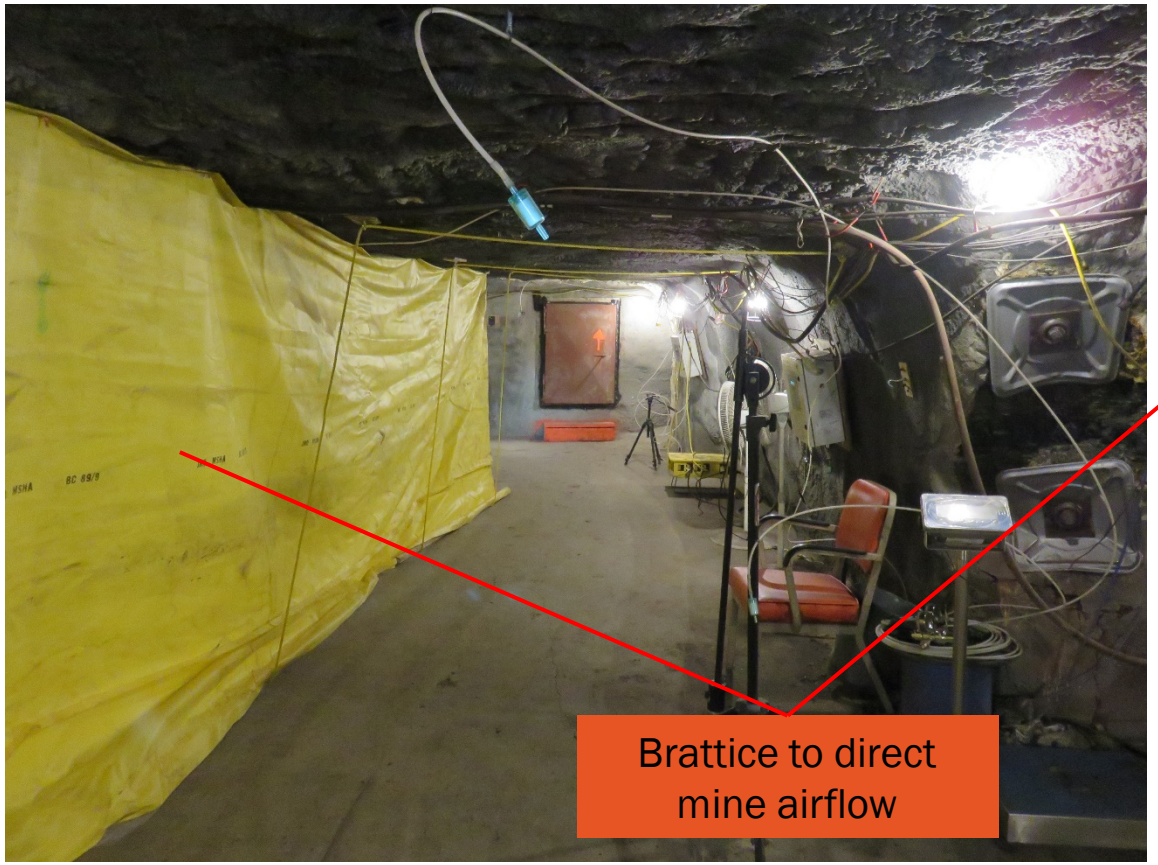
For the static tests, we released ≈1.1 lbs. of SF_6 inside the static area until the outside monitors indicated a uniform concentration of 450-500 ppm



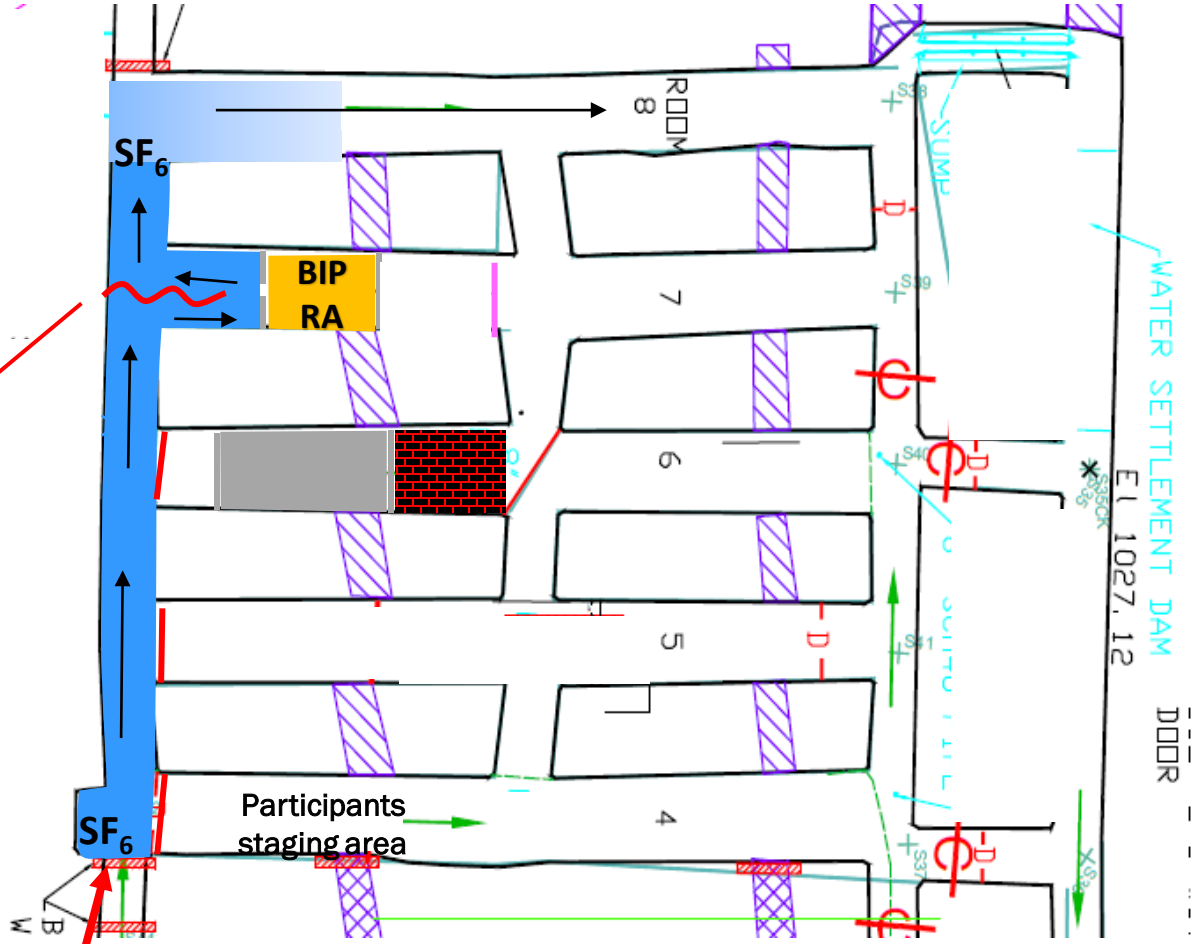
Static contamination ingress area in the NIOSH Experimental Mine

Participants entering the BIP RA for the static tests

For the dynamic tests, we released the SF_6 into the mine airflow that was directed toward the BIP RA front wall using a brattice

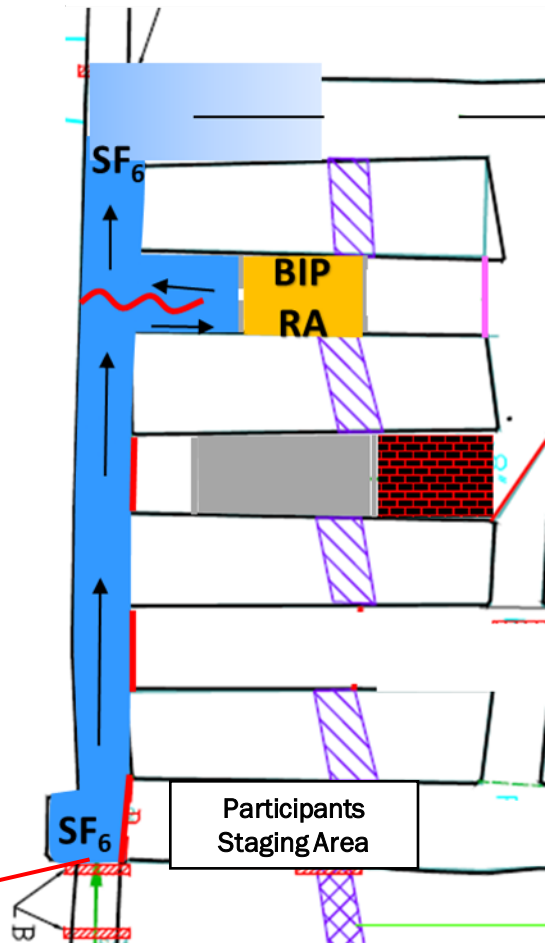


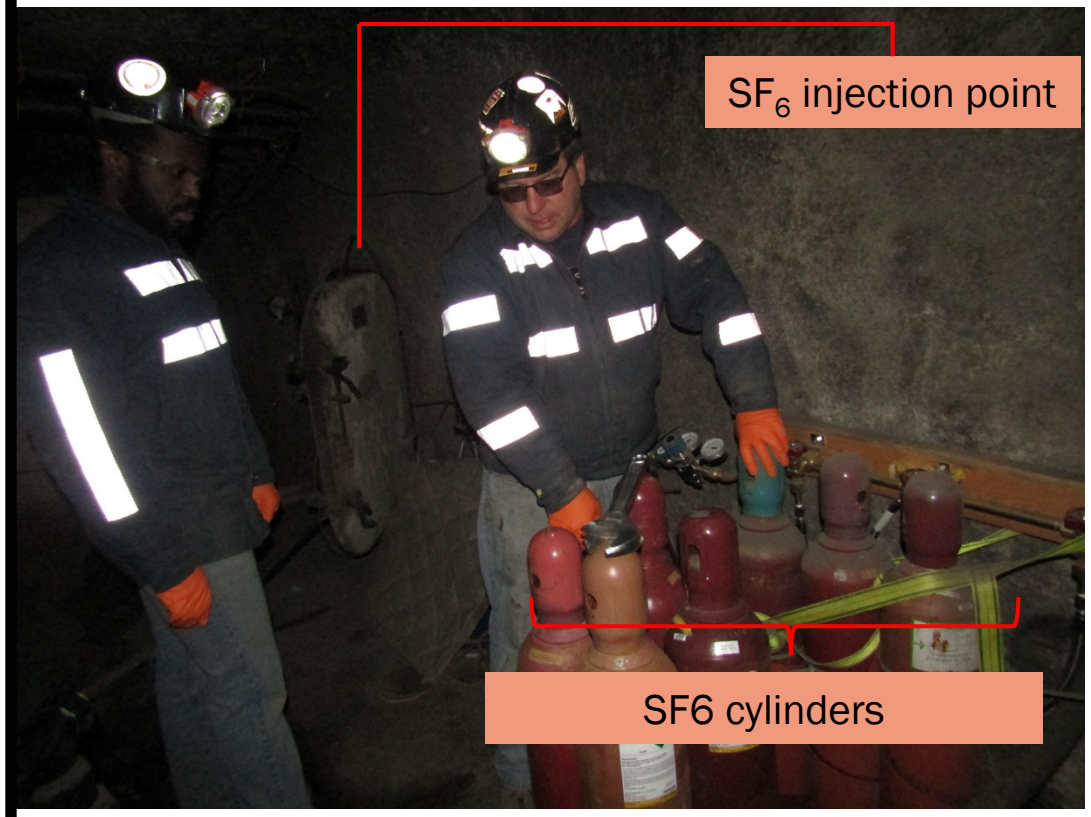
Dynamic contamination ingress area in the NIOSH Experimental Mine



For the dynamic tests, we released SF_6 contaminant into the mine airflow at a rate of ≈300 L/min until the outside monitors indicated a uniform concentration of 450-500 ppm

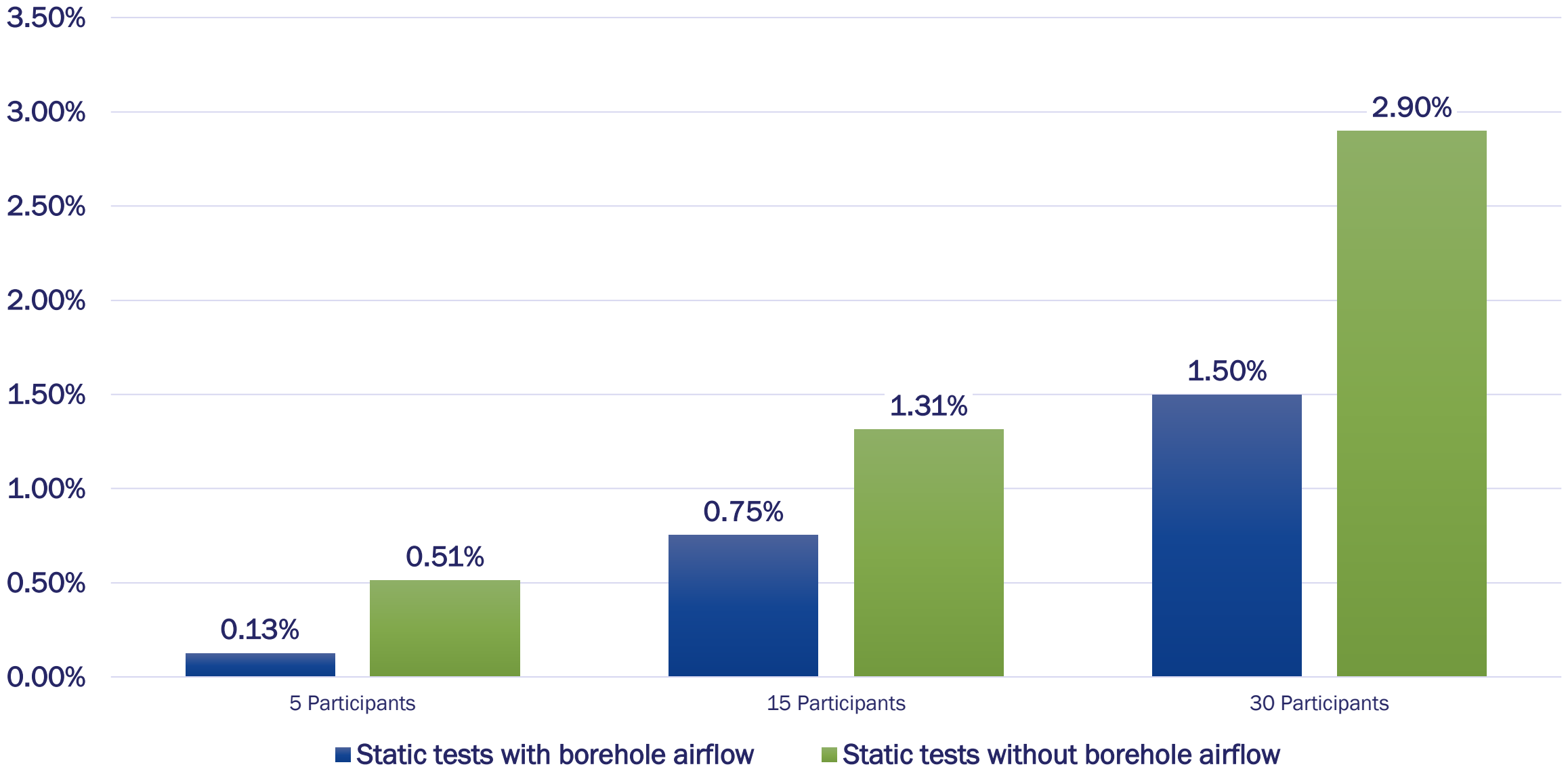
SF_6 injection point



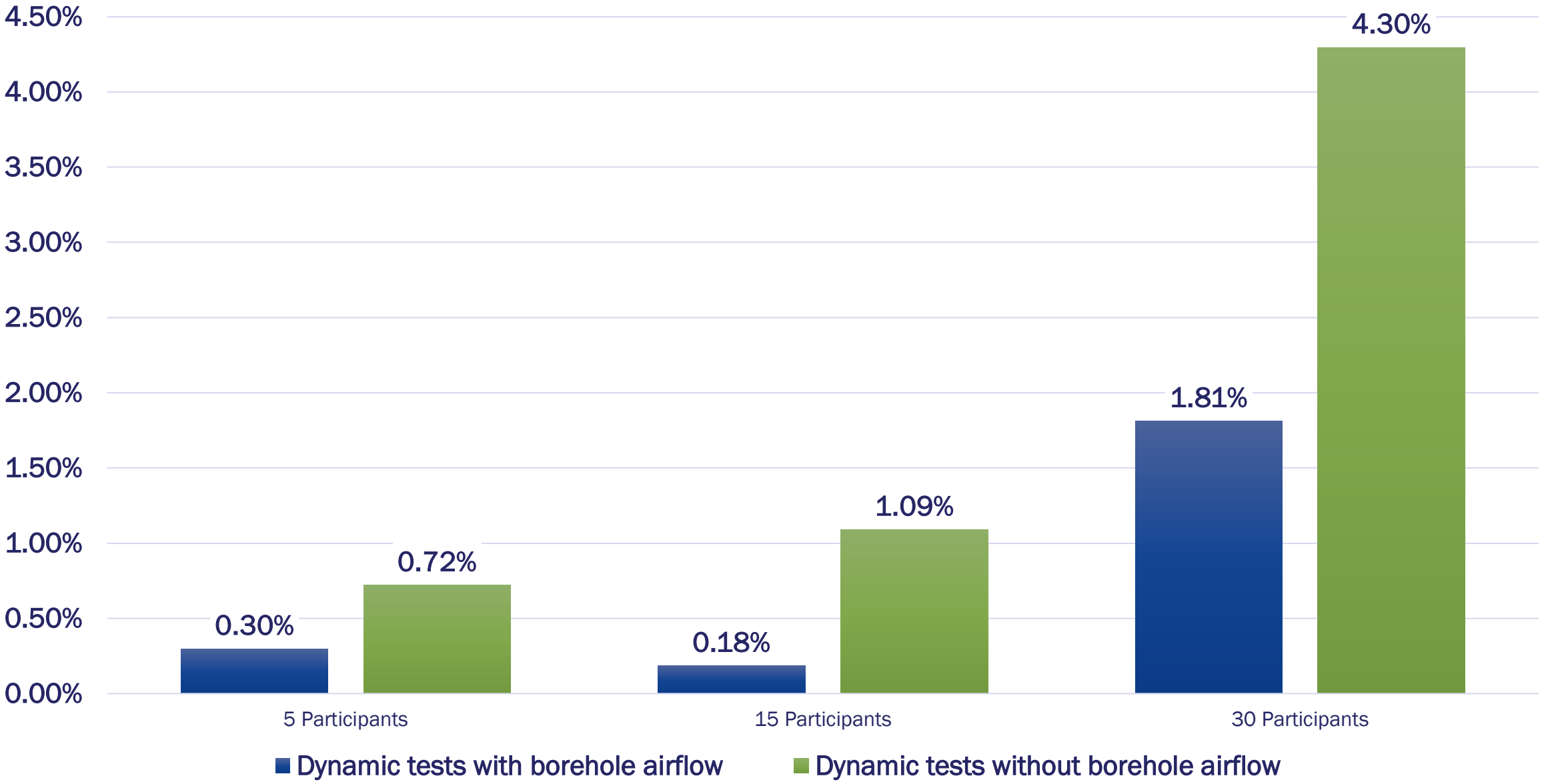


SF_6 cylinders for the dynamic tests

For the static tests, results indicated the resulting concentration in the BIP RA ranged 0.13–2.90% after the participants entered.



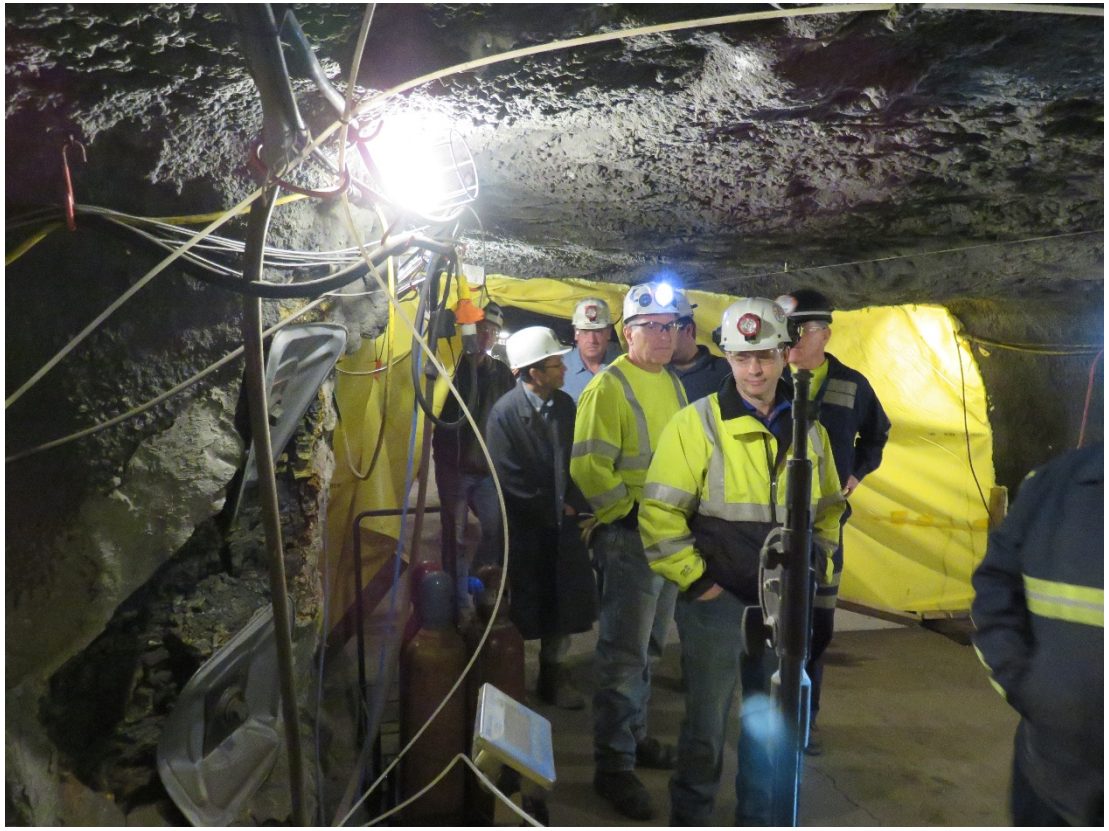
For the dynamic tests, results indicated the resulting concentration in the BIP RA ranged 0.18–4.30% after participants entered.



This study showed the importance of quickly establishing borehole airflow inside the BIP RA to limit outside contaminant from entering.

- The resulting concentration that entered the BIP RA in our tests was up to ***4.3%***, which could equate to ***430 ppm of CO*** if the outside concentration was 10,000 ppm

- Rapid deployment of ***a borehole air supply to establish positive pressure*** inside the BIP RA can reduce the percentage of outside contaminants concentration that enter with the miners



Thank you!

NIOSH Mining Program
www.cdc.gov/niosh/mining