“Pressure Balancing Methods Used to Reduce Spontaneous Combustion in Coal Mines”

By:

C. Bateman, F. Calizaya, and M. G. Nelson

February 2016

Outline

- Introduction
- Spontaneous Combustion
- Research approach
  - Mine Visits
    - Physical Modeling
    - Interpretation of Results
- Conclusions

Introduction

- Pressure balancing is practiced in many coal mining countries to combat sponcom, fires, explosions, and contamination.
- It is not commonly practiced within the United States.
- When implemented correctly, it can be used to control Sponcom and improve the health safety conditions in underground coal mines.

Introduction

"When pressure differentials across mined out areas are balanced self-heating is controlled within the gob then potential for sponcom is eliminated"

This requires:

- Efficient ventilation system design
- Changes of fan duties, and regulator resistances
- Pressure balancing applications

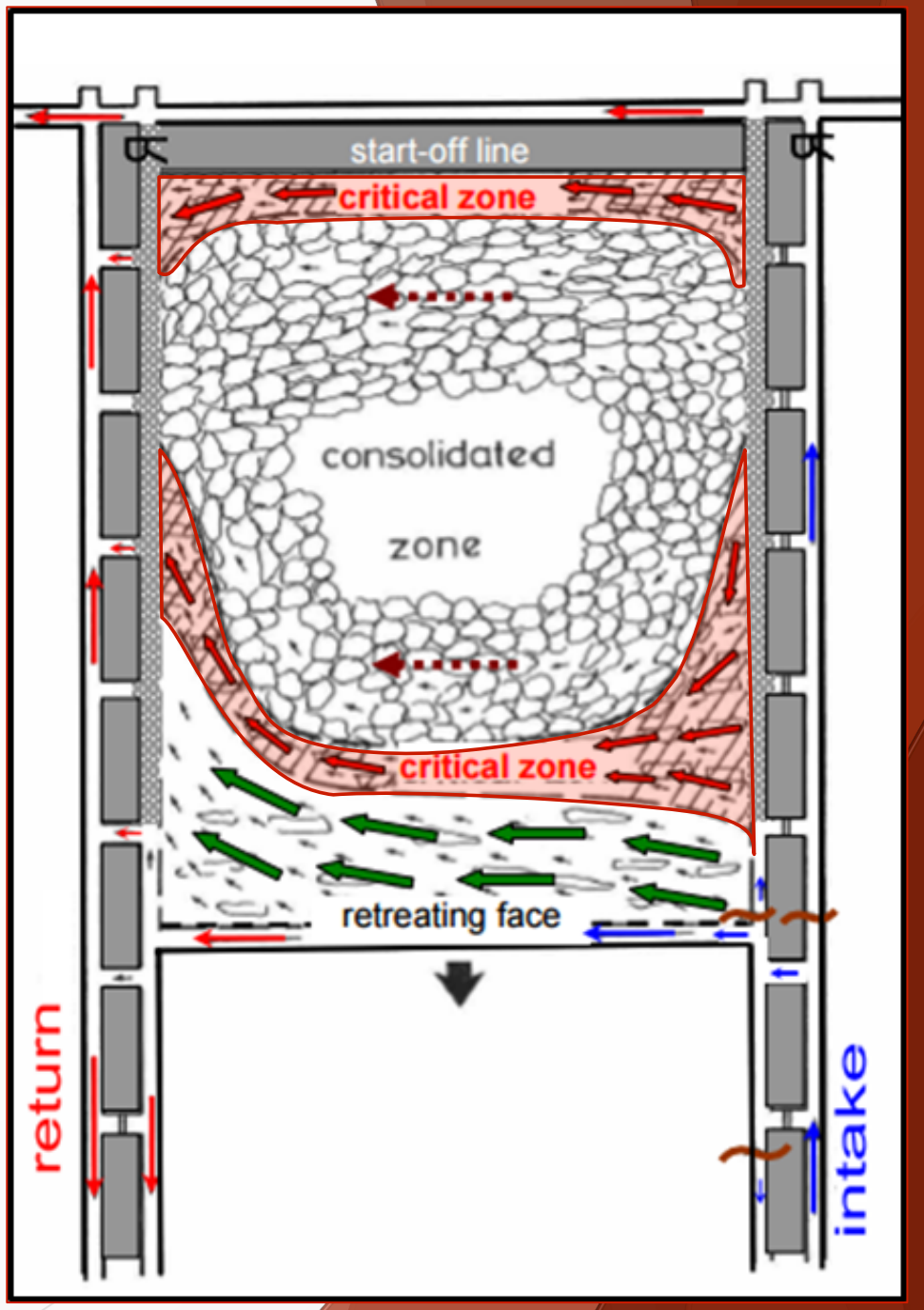
Spontaneous Combustion

"Spontaneous combustion (Sponcom) is a process in which certain material can ignite as a result of internal heat which rises spontaneously."

This is an exothermic process in which reactions generate heat faster than it can be removed by ventilation.

Critical Zones for Sponcom

- Most common areas for spontaneous combustion are worked areas where broken coal can oxidize at a higher than normal rate.
- Broken coal has a higher risk for combustion. All of the variables for fires and combustion are present in the so called “critical zones”.
- “These critical zones are where spontaneous heating and combustion are most likely to occur” (McPherson 1992).



Techniques Used to Control Sponcom

- Select an appropriate ventilation system
- Seal work out areas and inject nitrogen
- Apply pressure balancing techniques

Pressure Balancing

Pressure balancing is the process of neutralizing pressure differentials in critical mined out areas.

Pressure Balancing enables the user to control the flow of air into mined out areas to prevent spontaneous combustion.

Pressure Balancing

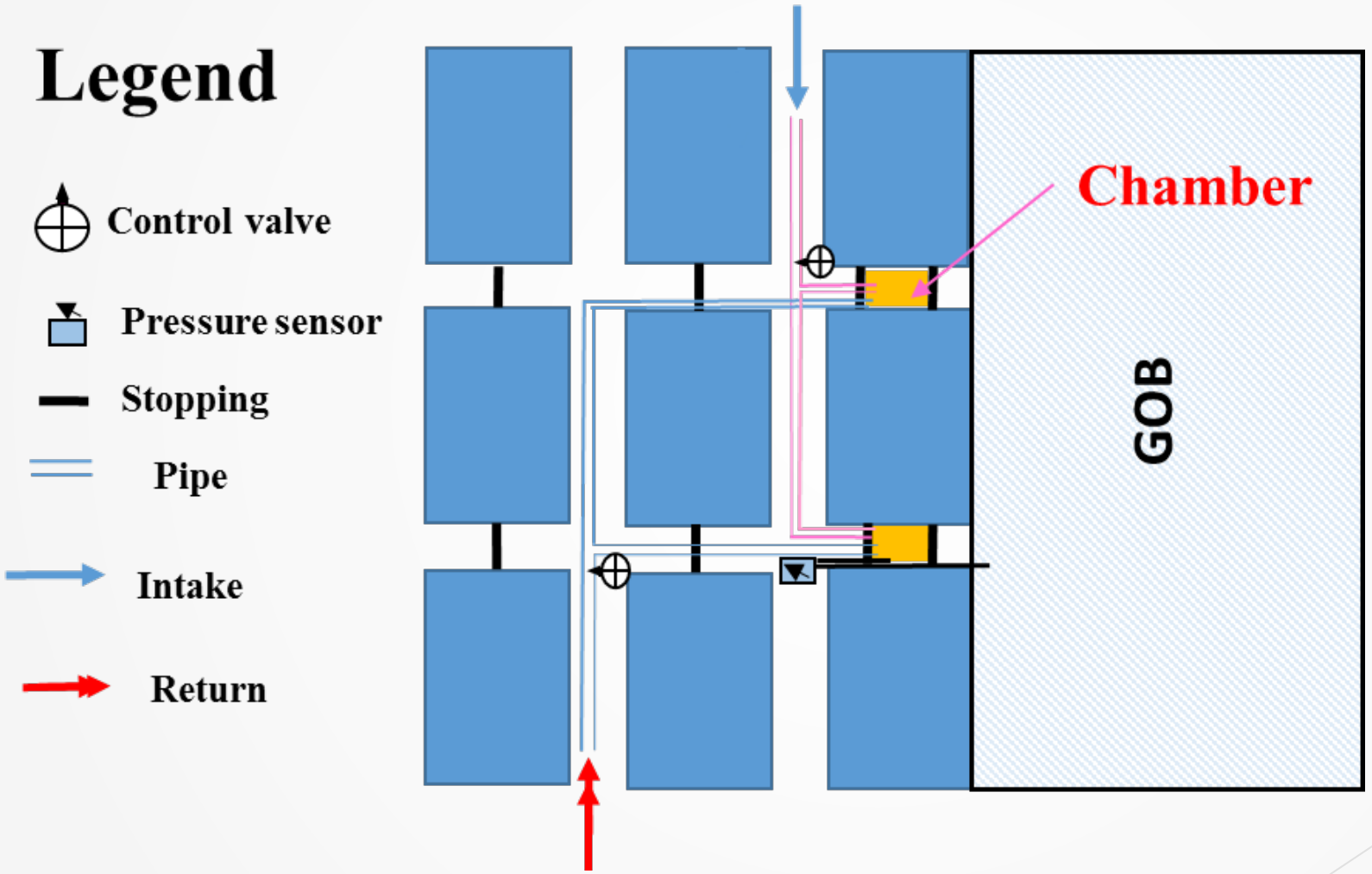
Passive Balancing

Includes the use of regulators, fans and surface boreholes to control pressure differentials across or around critical areas such as mine gobs.

Active Balancing

Includes an external pressure source, pressure chambers, and an atmospheric monitoring system to balance pressure differentials. The process can be manual or automatic.

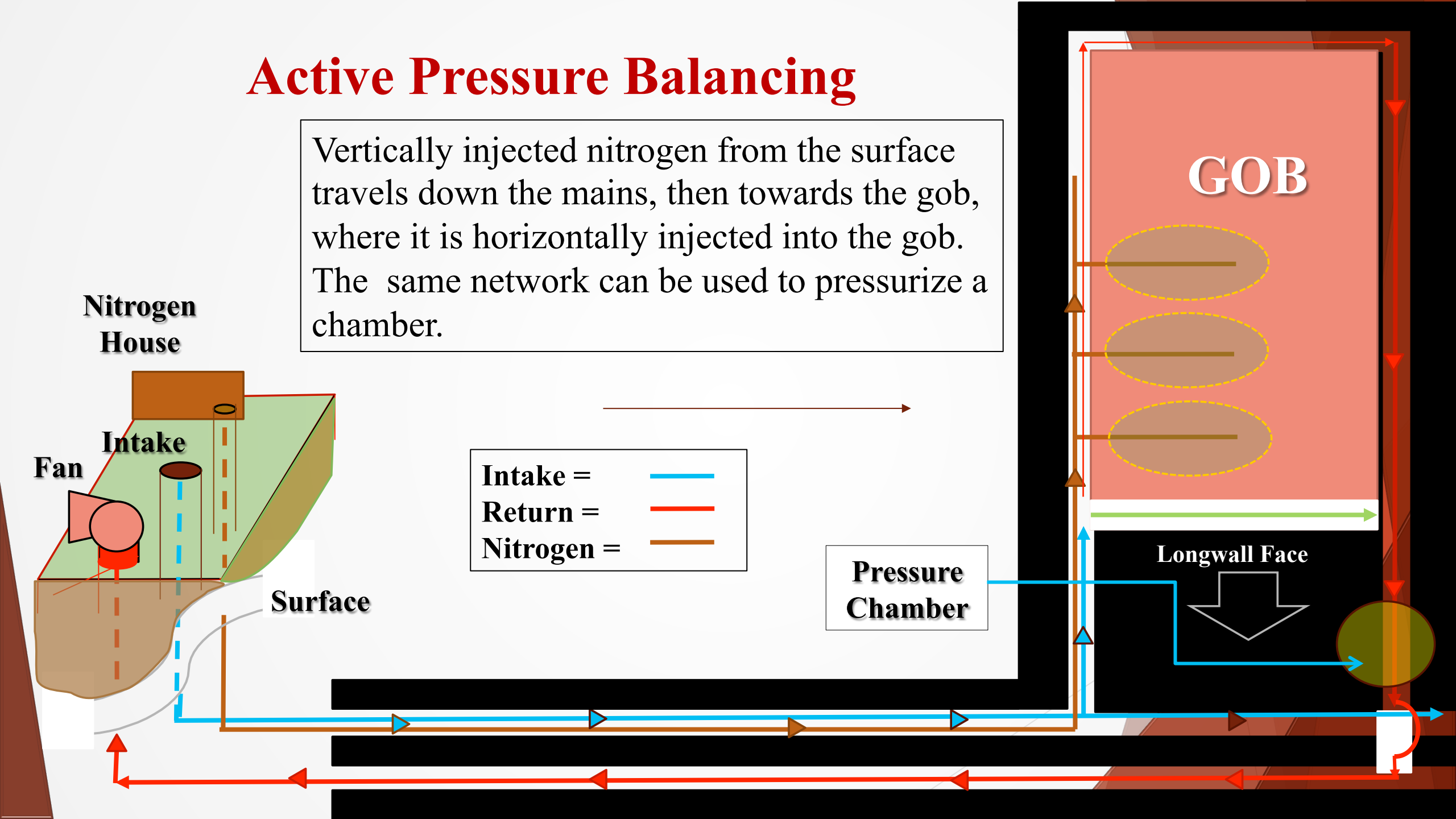
Passive Pressure Balancing



Vent air is used to pressurize the chamber

Active Pressure Balancing

Vertically injected nitrogen from the surface travels down the mains, then towards the gob, where it is horizontally injected into the gob. The same network can be used to pressurize a chamber.



Research Approach

Mine Visits – Ventilation Surveys

- Mines A, B, and C

Simulation Modeling

- Numerical Modeling
- Laboratory Experiments

Interpretation of Results.

Mine Visits

Ventilation surveys were conducted in three U/G mines (A, B, and C):

Mine A: One room and pillar (IL),

Mine B: One longwall, bleeder system (PA), and

Mine C: One longwall, bleederless system, (CO)

Mine B Layout

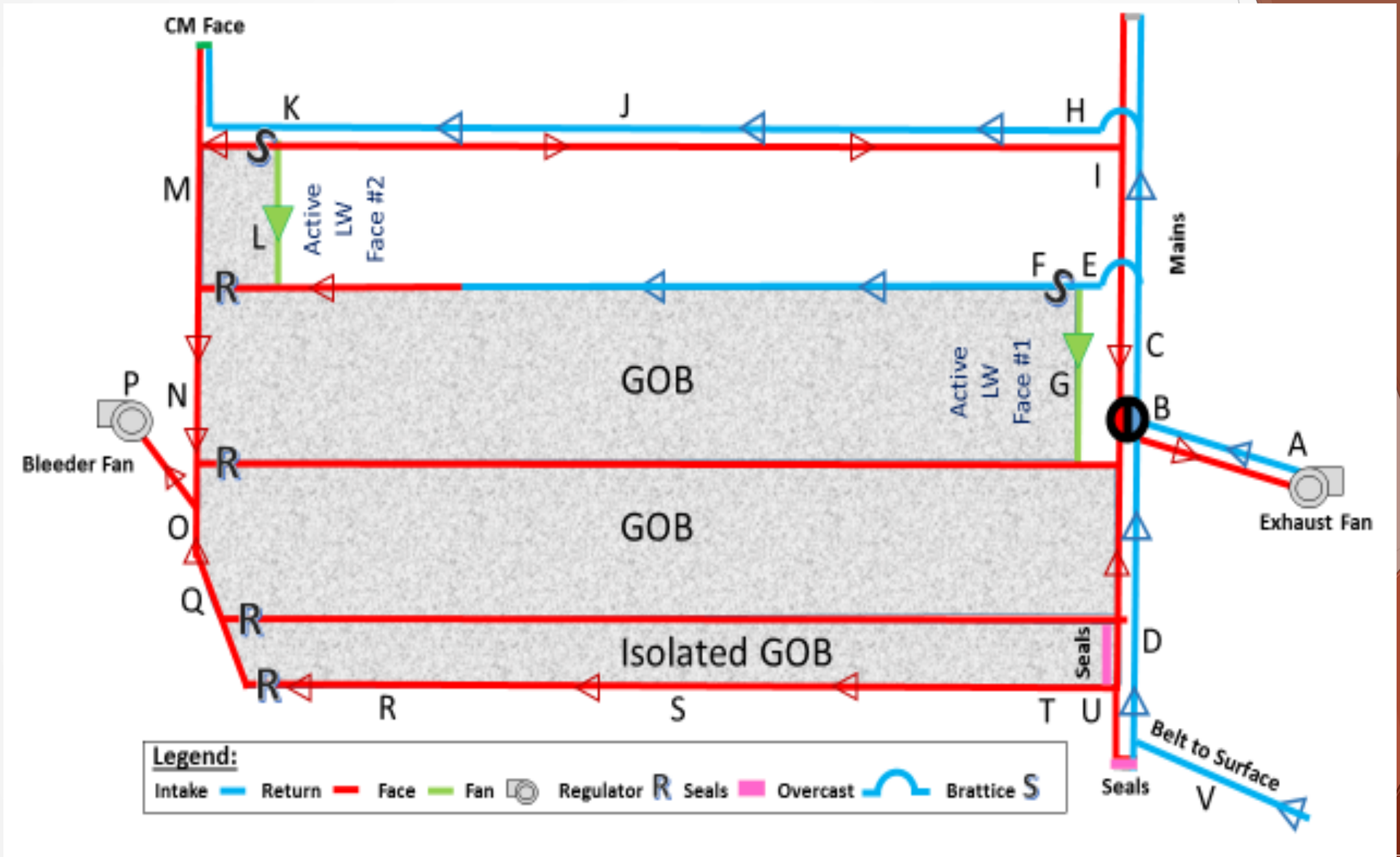
- Mine B uses a “Flow-though” system with a main exhaust fan and a bleeder fan. The fan duties are:

  Main Fan Q = 323 m^3/s P = 2.54 kPa

  Bleeder Fan Q = 139 m^3/s P = 5.28 kPa

- Flow rates, pressures, and airway dimensions were measured at multiple locations for future modeling exercises.

Mine B Line Diagram



Mine C Layout

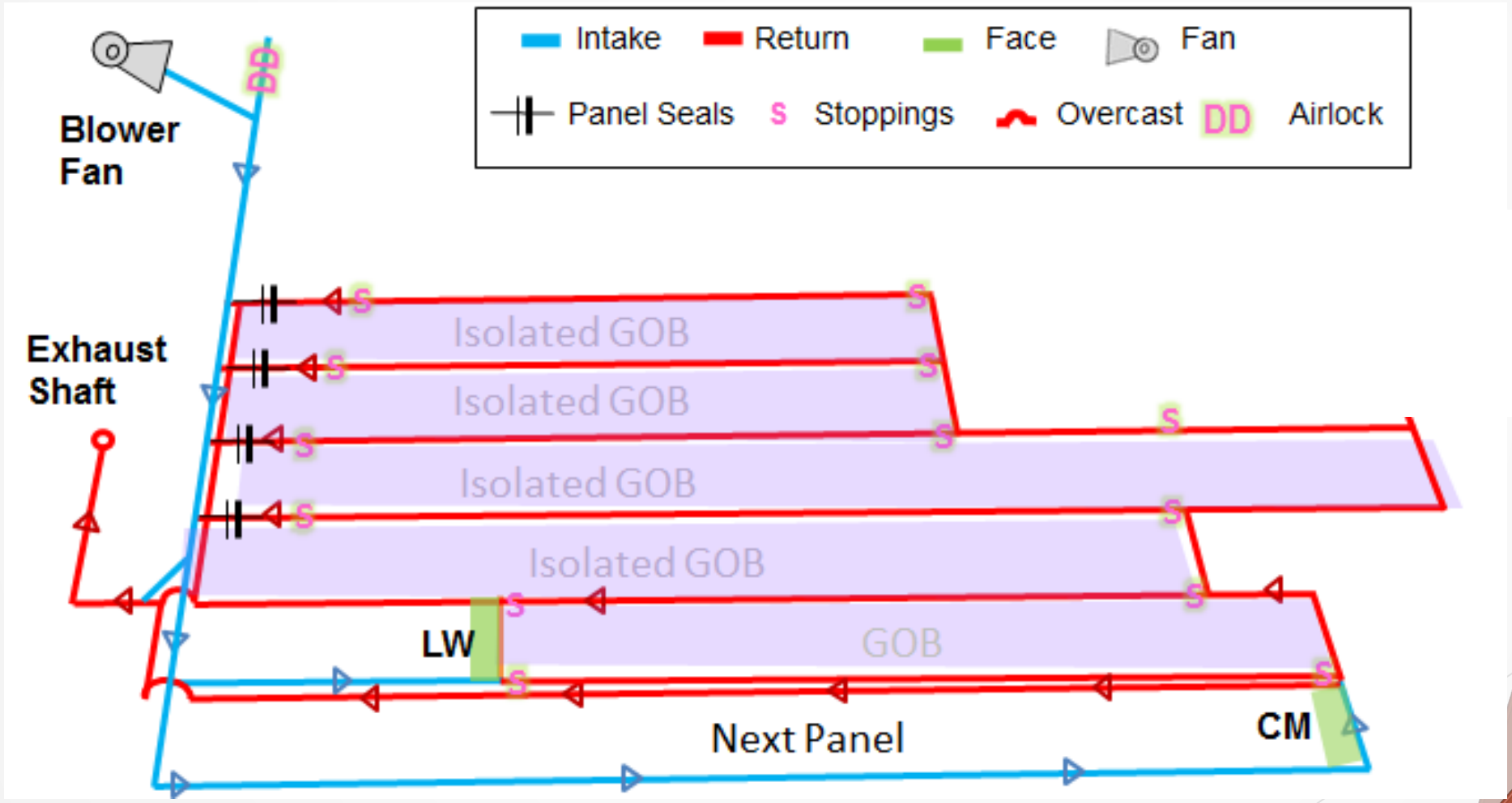
Mine C uses a “U-tube” bleederless system with two blower fans in parallel. The fan duties are:

Main Fan #1	Q = 328 m^3/sec	P = 2.50 kPa
Main Fan #2	Q = 273 m^3/sec	P = 2.55 kPa

This mine is considered a gassy mine

Vent surveys were conducted at multiple locations for future modeling exercises,

Mine C Line Diagram

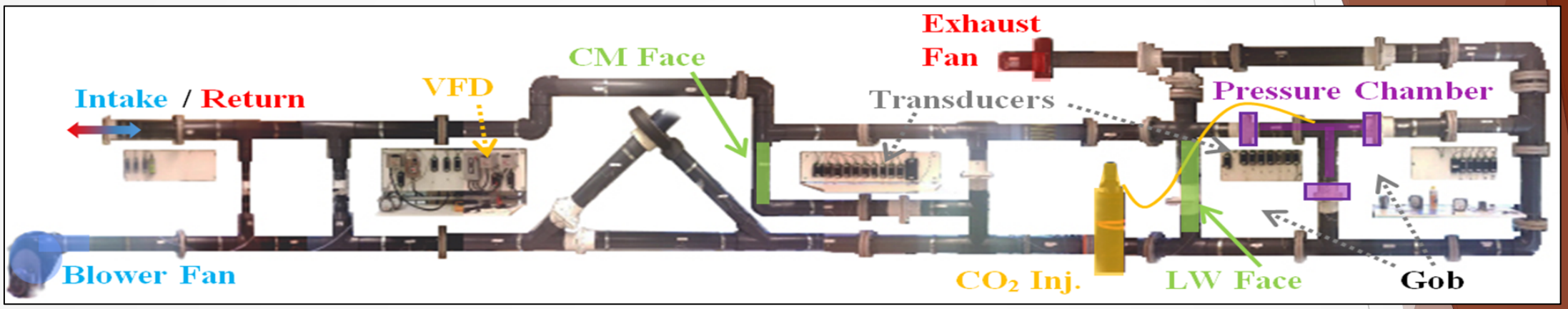


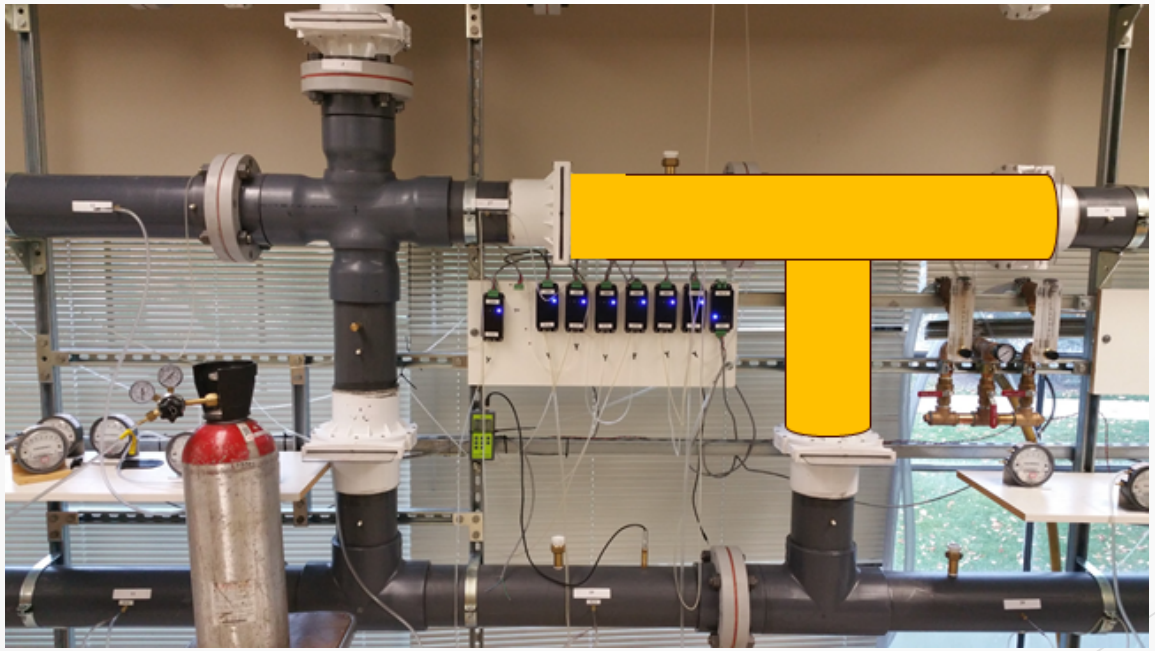
Physical Modeling

The University of Utah lab model is a versatile system for mimicking multiple ventilation layouts.

- ✓ 6” PVC Piping
- ✓ Three Adjustable Fans
- ✓ 14 Adjustable Regulators
- ✓ An Atmospheric Monitoring System (AMS)
- ✓ A Pressure Chamber
- ✓ An Automatic Pressure Balancing System.

The University of Utah Lab Model





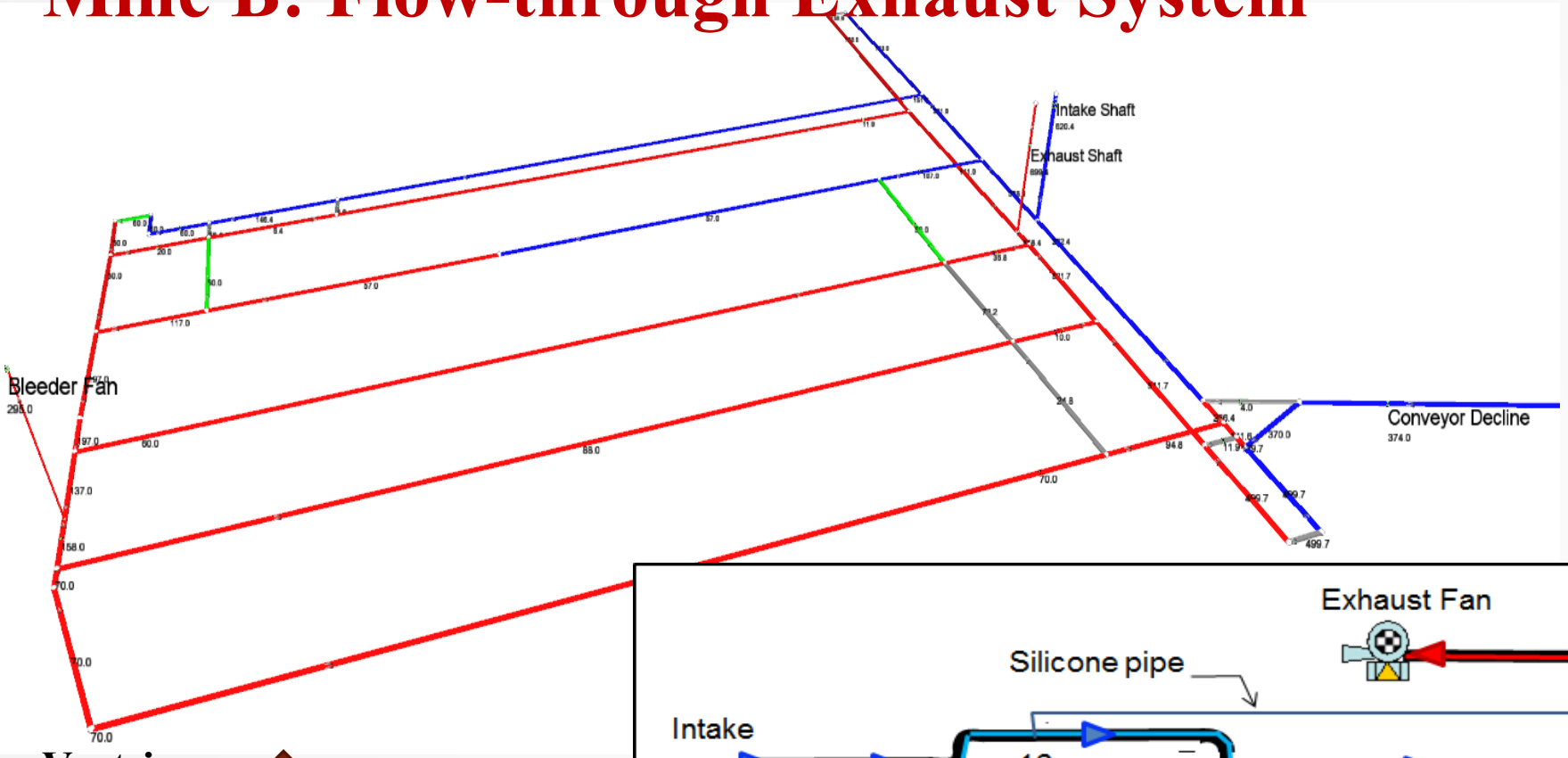
Pressure Chamber

Laboratory Modeling Exercises

1. Mine B: Flow-through ventilation system (Passive pressure balancing)

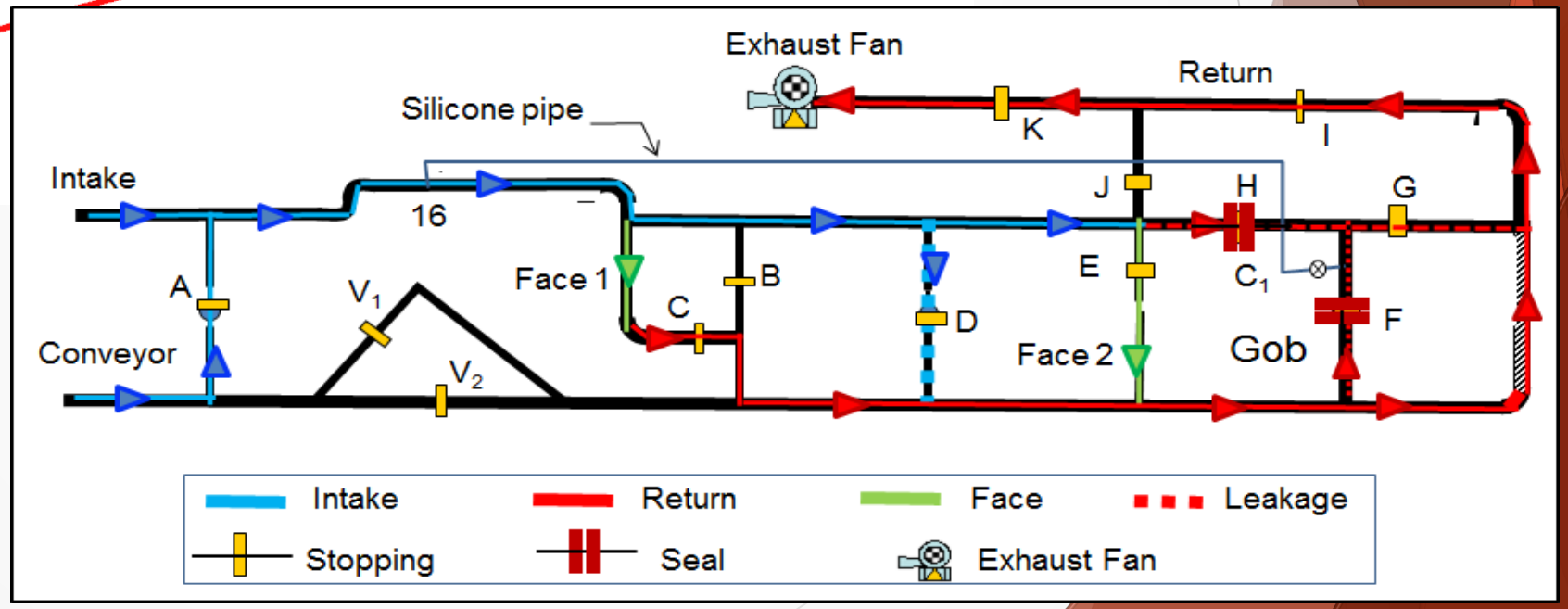
2. Mine C: Bleederless ventilation system (Active pressure balancing)

Mine B: Flow-through Exhaust System



Ventsim Model

Physical Lab Model



Mine B: Passive Pressure Balancing

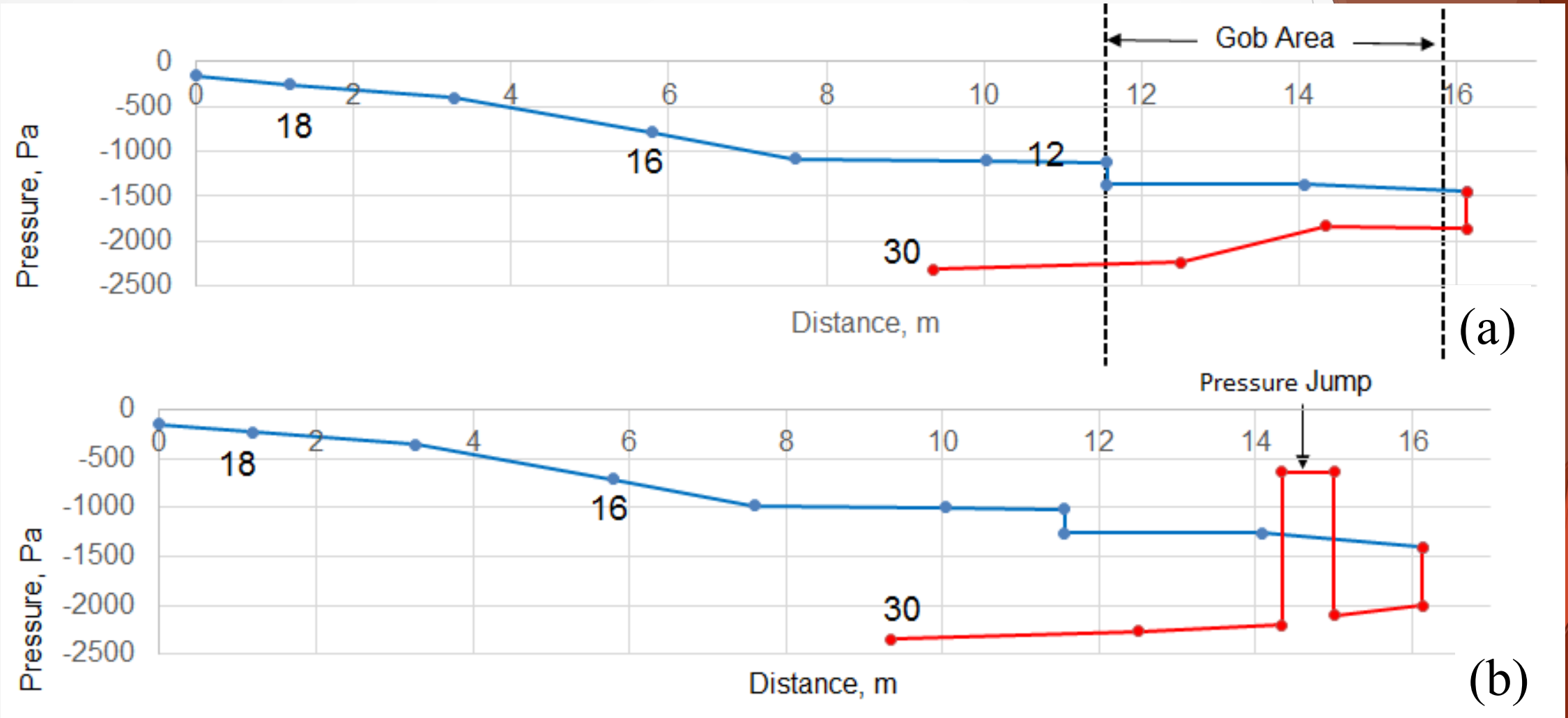
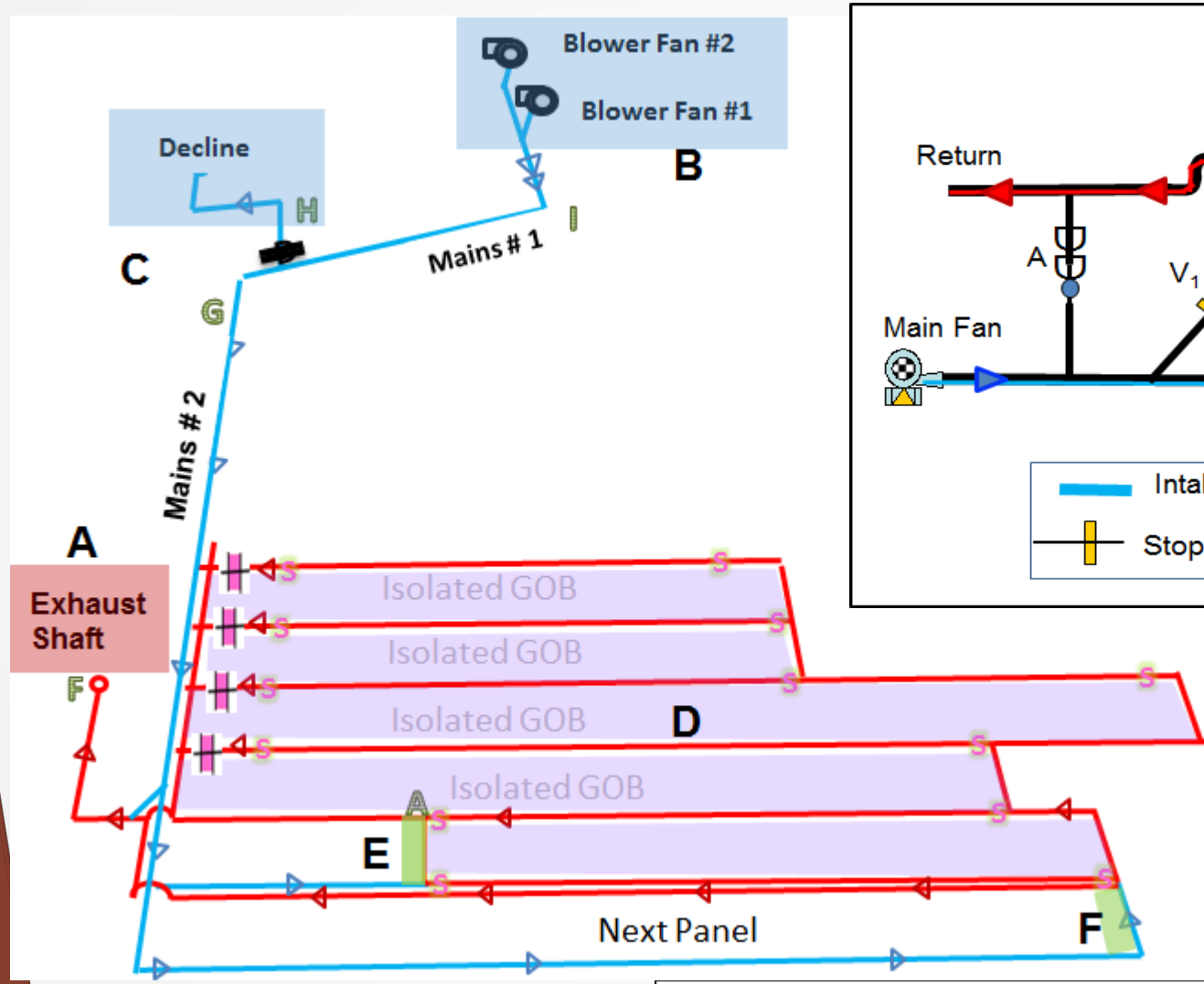
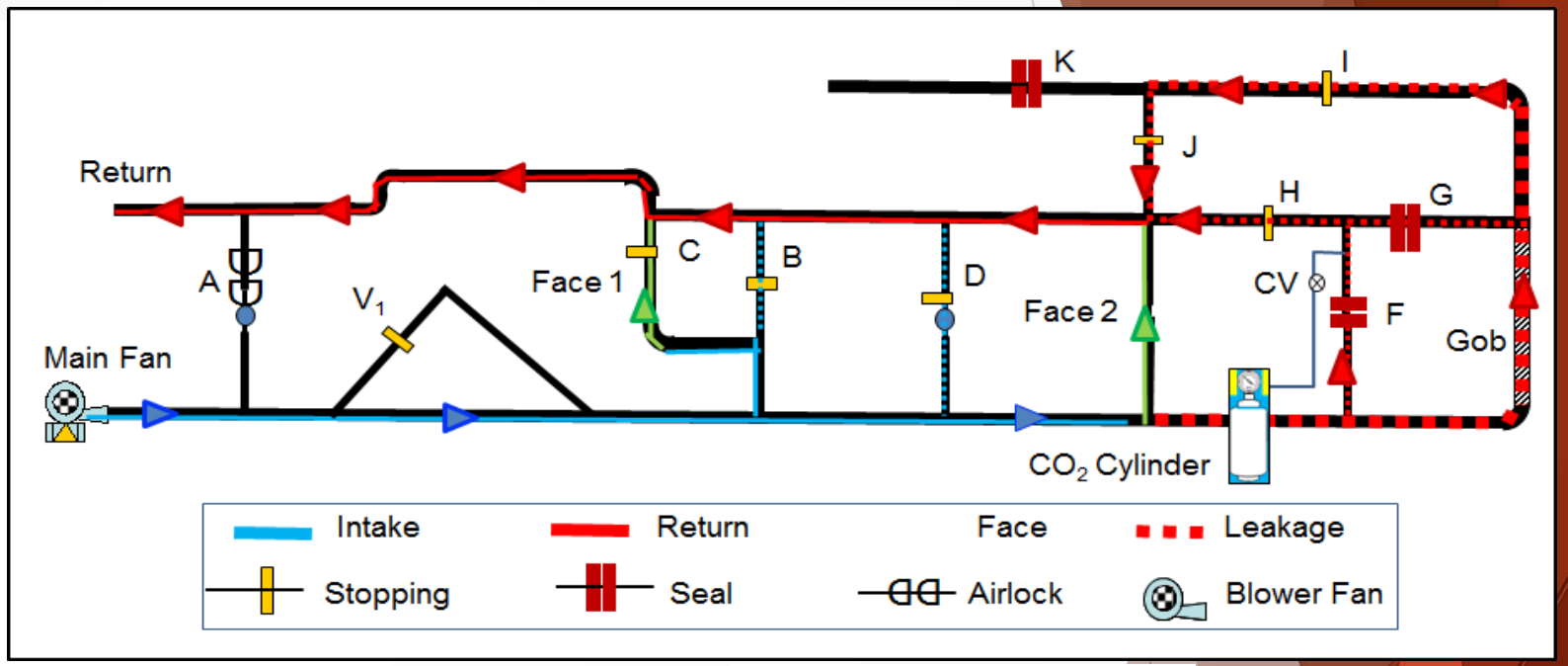


Figure 1. Pressure Profiles: (a) Control valve C1 closed, and (b) Valve C1 open

Mine C:Bleederless Blower System





Physical Lab Model

Ventsim Model

Mine C: Active Pressure Balancing

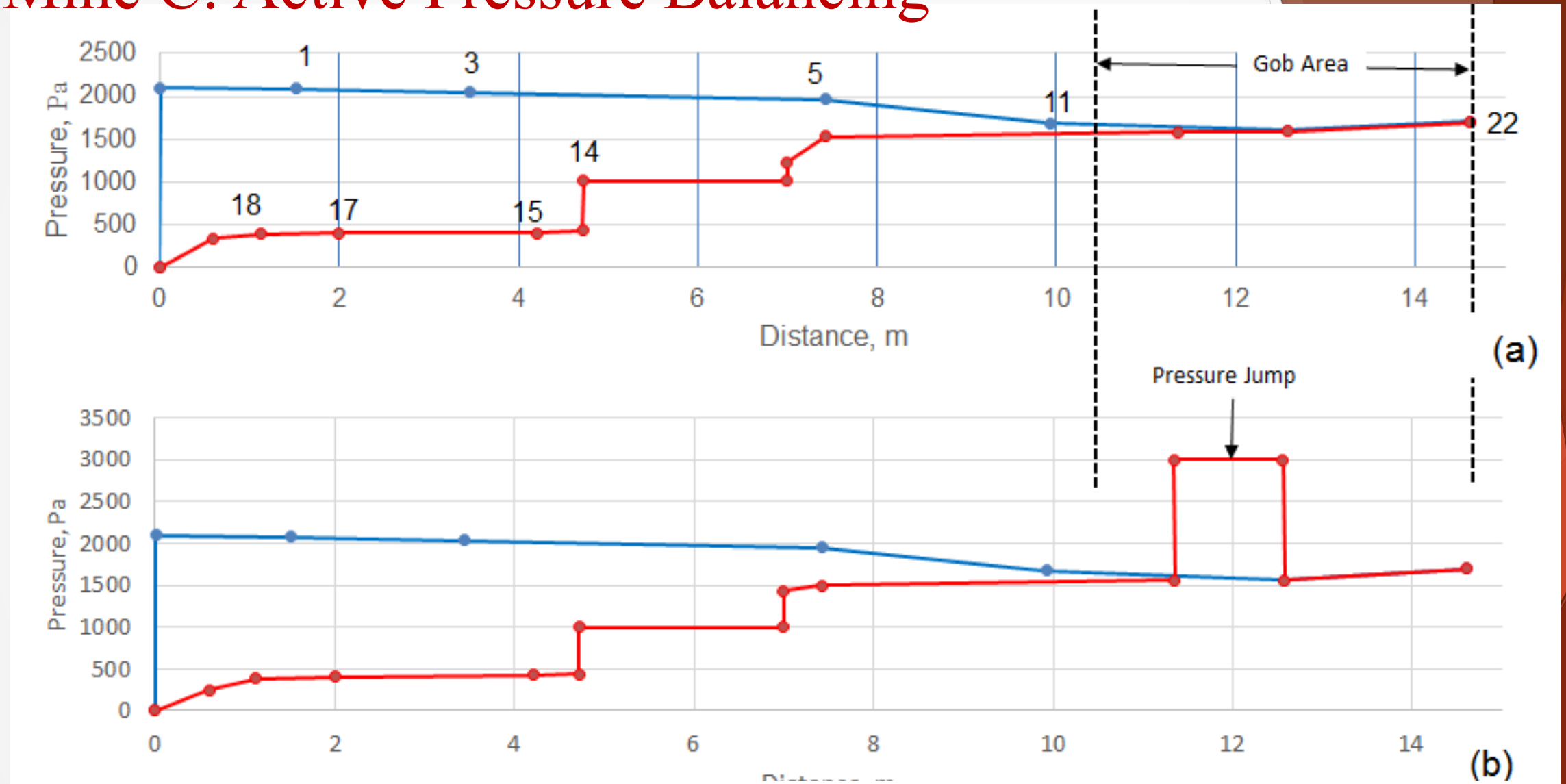


Figure 2. Pressure Profiles: (a) Control valve C1 closed, and (b) Valve C1 open

Conclusions

- This project demonstrates that pressure balancing systems can be used effectively to control spontaneous combustion in U.S. coal mines.
- Flow-through and bleederless ventilation systems have been found to be more efficient at balancing pressures than other comparable systems.
- Pressure balancing can be effectively designed for every mine's specific ventilation system

Conclusions

- The implementation of a sound pressure balancing system requires:
  - Determining the coal's propensity for Sponcom
  - Selecting an appropriate ventilation system
  - Sealing mined-out areas
  - Installing an atmospheric monitoring system
  - Operating and maintaining the pressure balancing system

Acknowledgement

This study was sponsored by the Alpha Foundation for the Improvement of Mine Safety and Health, Inc. (**ALPHA FOUNDATION**).

The views, opinions and recommendations expressed herein are solely those of the authors and do not imply any endorsement by the ALPHA FOUNDATION, its Directors and staff.

Questions?