Maximizing Volumetric Efficiency for Ventilation Systems in Temporarily Reduced Flow Environments of Block Cave Mines

S.I.V.M. 2018

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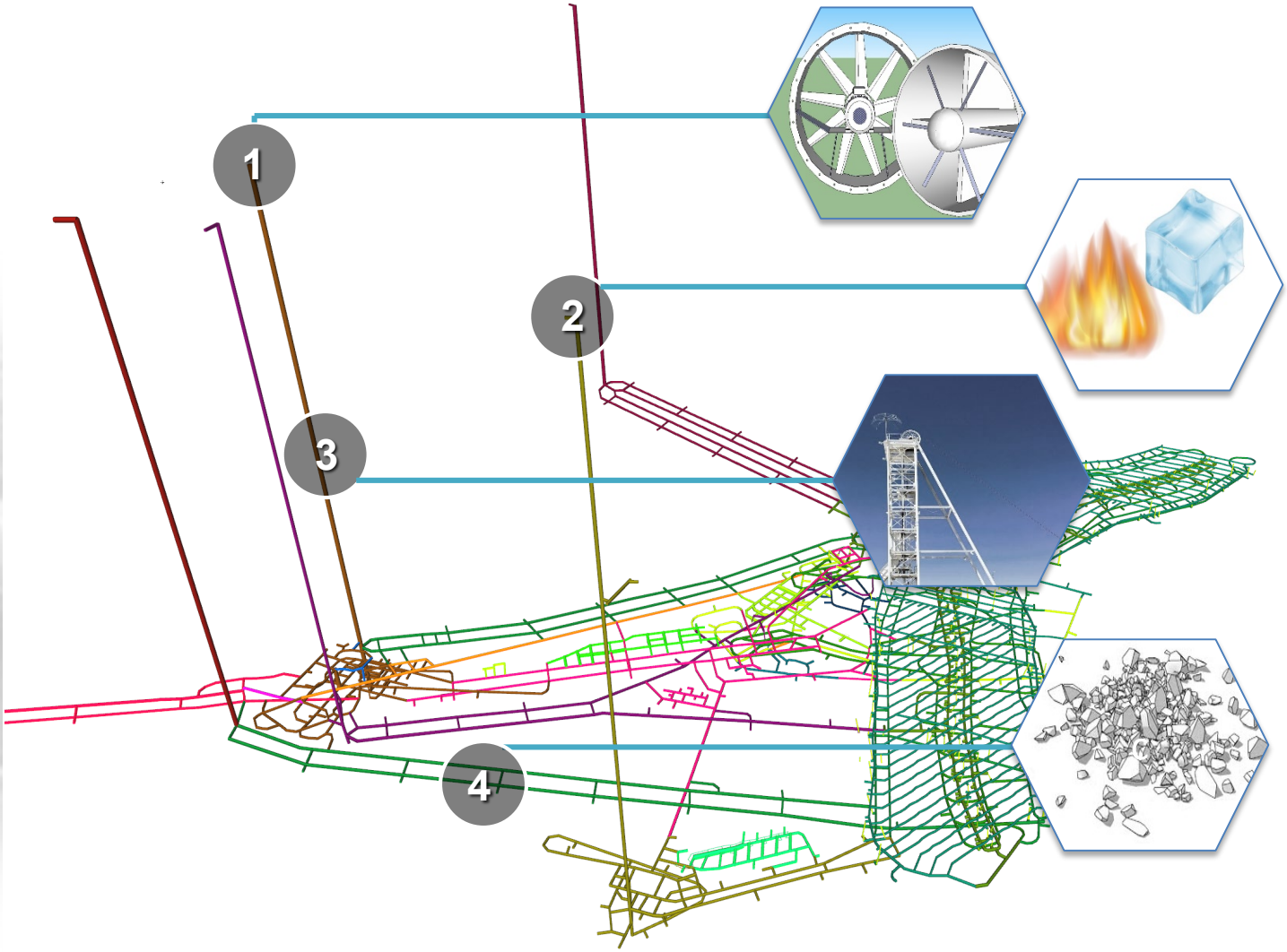
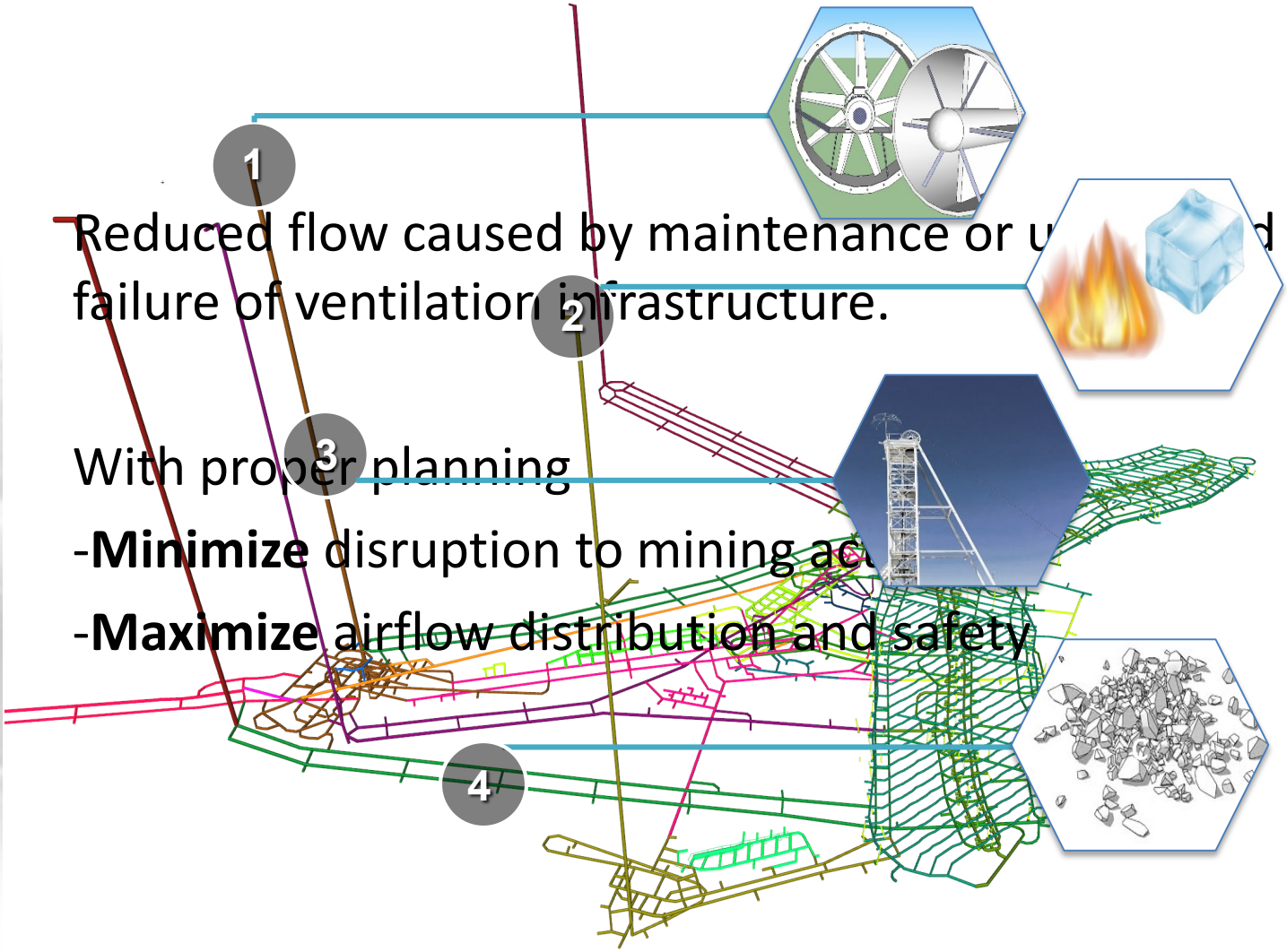
Introduction

1. Fan Failure/ Maintenance
2. Heater or Refrigeration Failure/ Maintenance
3. Hoist/Shaft Maintenance
4. Ground fall or Ground Control



Introduction



Reduced flow caused by maintenance or u d failure of ventilation infrastructure.

With proper planning

-**Minimize** disruption to mining ac

-**Maximize** airflow distribution and safety

Oyu Tolgoi Mine

- 2000+ drawpoints
- 200km lateral development
- 5 shafts each ~1.2km
- 7km UG Raisebore
- Production ramp-up to 95kt/d over 7 yrs
- 20 years production -> transition to Lift 2

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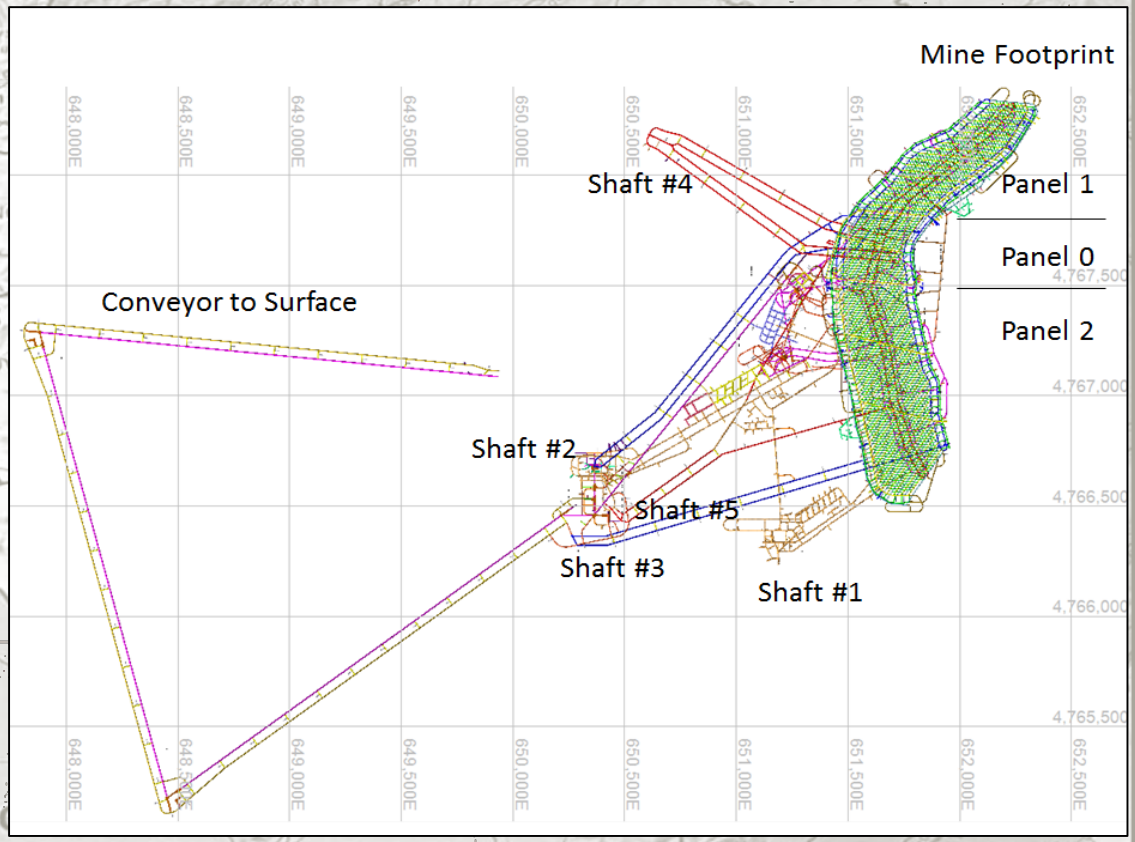
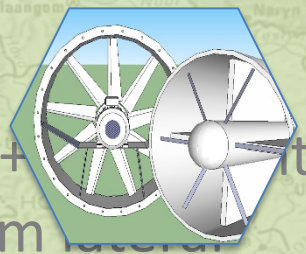


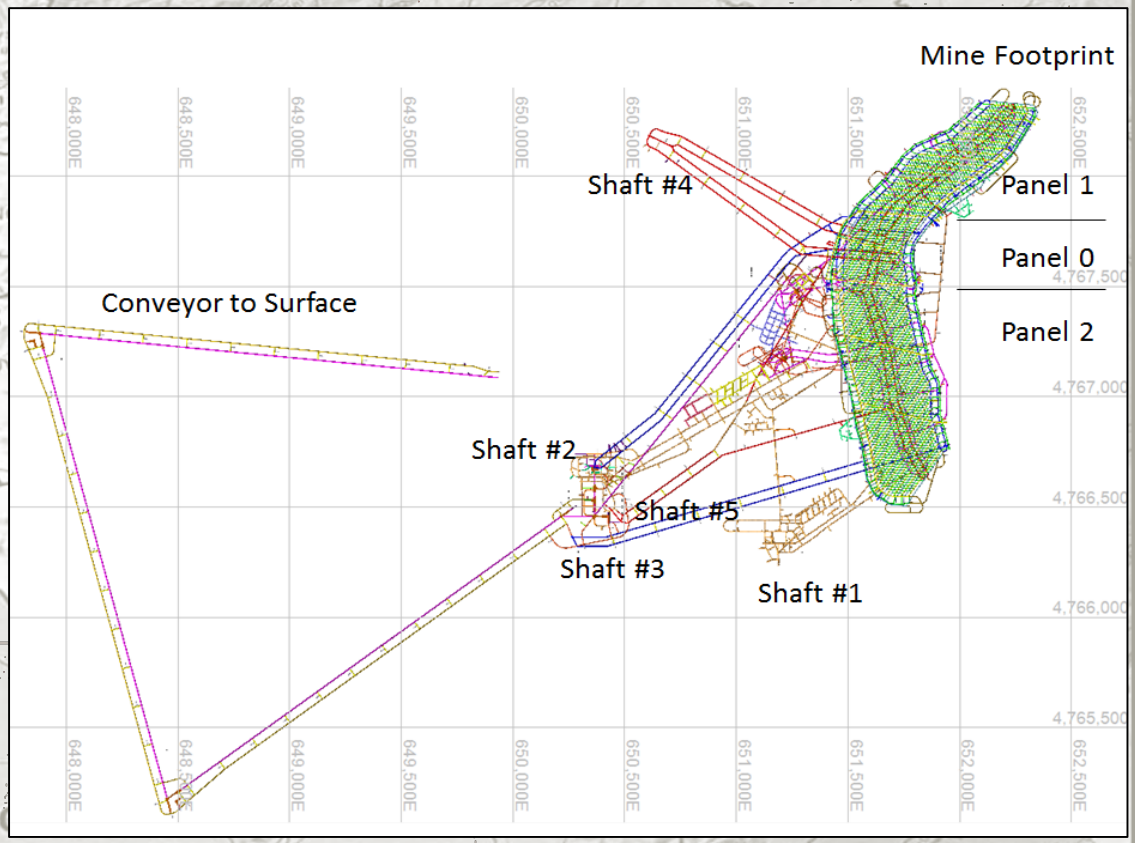
Oyu Tolgoi Mine



- 2000+ [illegible]ts
- 200km [illegible] develop[illegible]

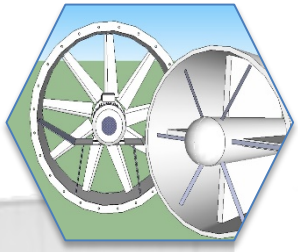
- 5 shaf[illegible]2km
- 7km U[illegible]ore
- Production ramp-up to 95kt/d[illegible]s

- 20 yea[illegible]tion -> transition [illegible] Lift 2



Background

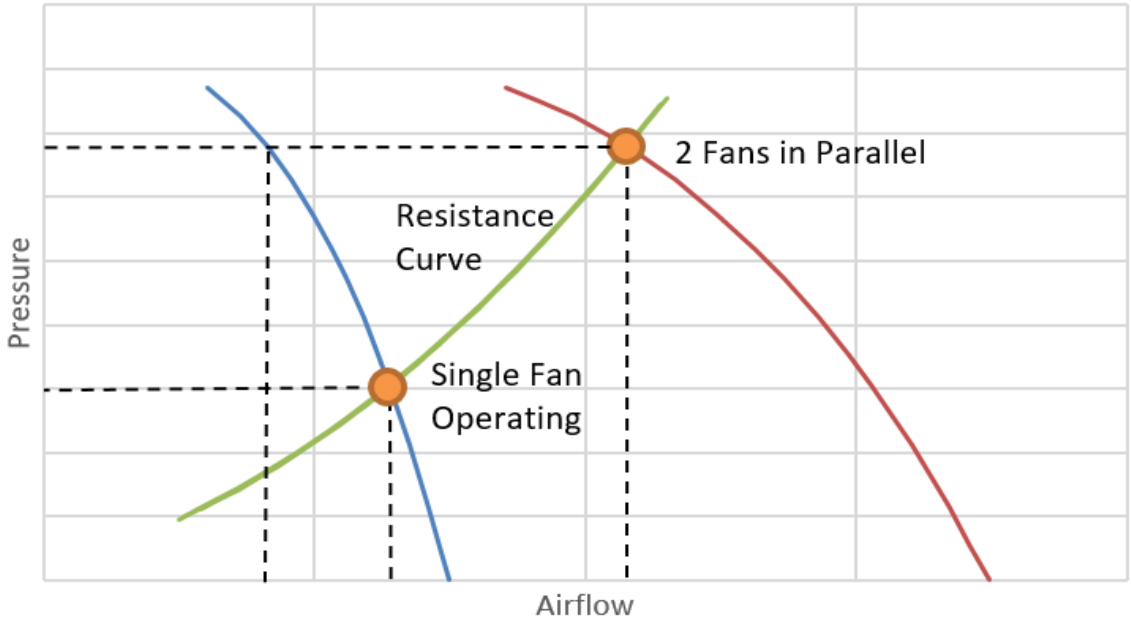
Removing a fan or heater/cooler module does not need to equal a one to one loss in airflow.



Background

An advantage of employing fans in parallel is that if one of them fails then the remaining fan(s) continue to supply a significant proportion of the original flow. Up to 70% for two fans in parallel. (McPherson)

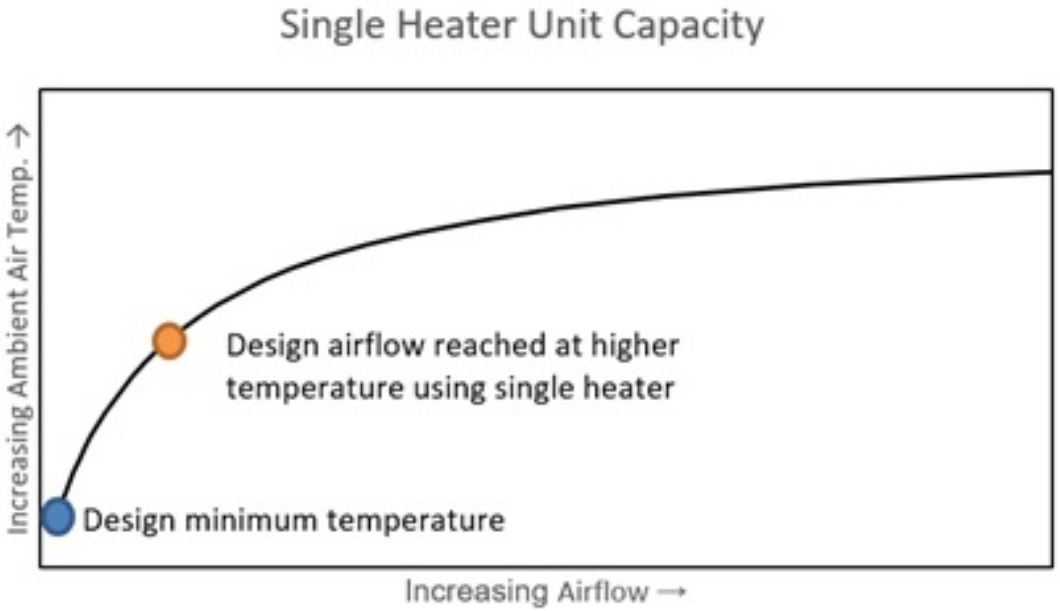
Removing a fan or heater/cooler module does not need to equal a one to one loss in airflow.



Background

If the mine is equipped with multiple heater modules and one is taken offline then it may be possible to partially or completely make up the difference with other heating modules.

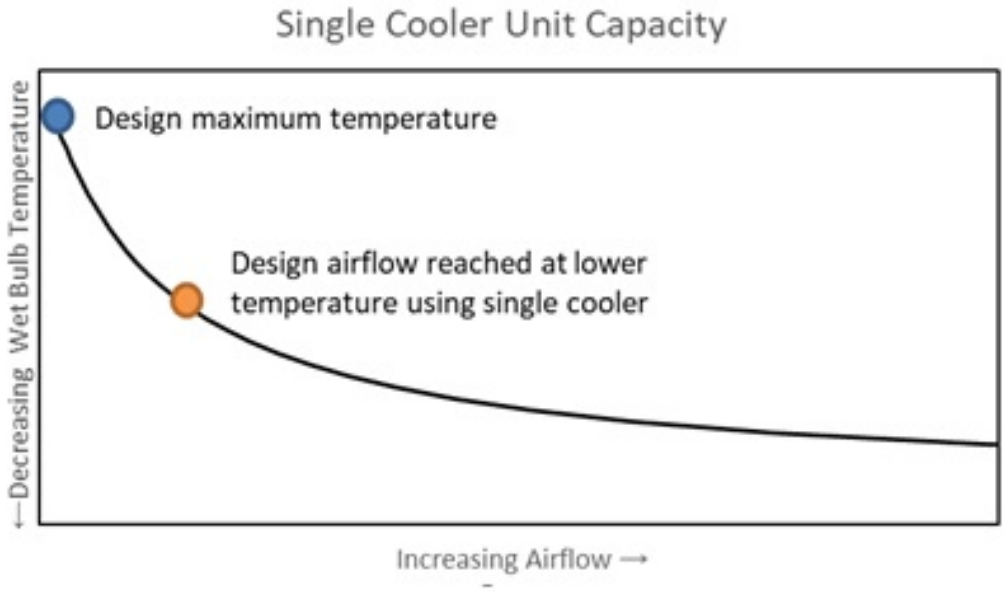
Removing a fan or heater/cooler module does not need to equal a one to one loss in airflow.



Background

Removing a fan or heater/cooler module does not need to equal a one to one loss in airflow.

The same theoretical adjustments can be made as surface air heaters, only inversed.



Methodology

The following steps is a generate an approach in developing a plan for reduced airflow scenarios.

Step 1: Accurate ventilation model
Step 2: Determine reduced flow scenarios
Step 3: Define how effects of airflow reductions can be minimized
Step 4: Determine target airflows and areas that may have reduced flow
Step 5: Model each scenario
Step 6: Communicate the plan
Step 7: Maintain the plan
Step 8: Check actuation of the plan

Accurate ventilation model

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

- Results only be as accurate as the data that is placed in the ventilation model.
- Manufacturers' fan curves need to be entered.
- Correlated to field data

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Step 1

Step 2

Step 3

Step 4

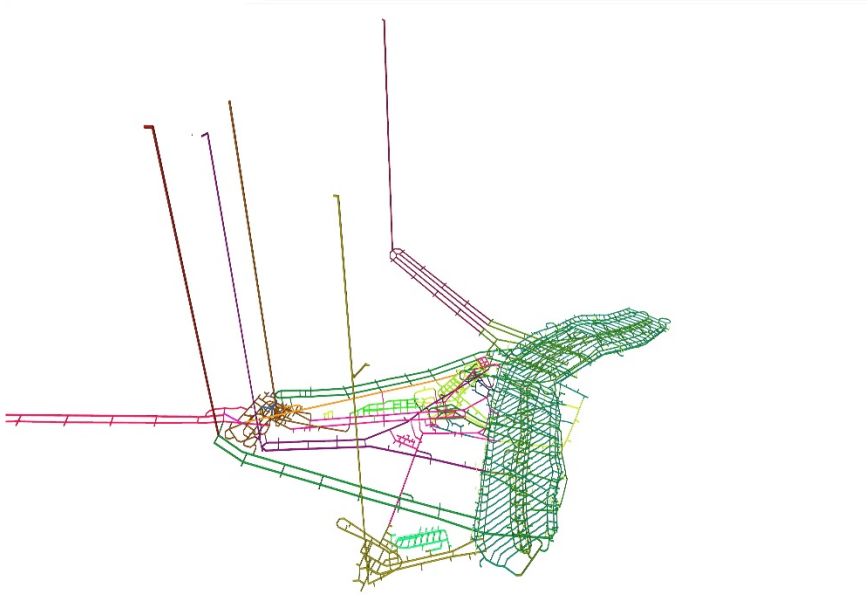
Step 5

Step 6

Step 7

Step 8

- k-factor model (mine is still under development)
- Models six key development stages



Determine reduced flow scenarios

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

Maintenance or failure of

- Fans
- Heaters
- Bulk air coolers
- Hoist systems
- Ground control
- Other site specific issues

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Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

- Fans
- Heaters
- Shaft Velocity Limitations

Determine how effects of airflow reductions can be minimized

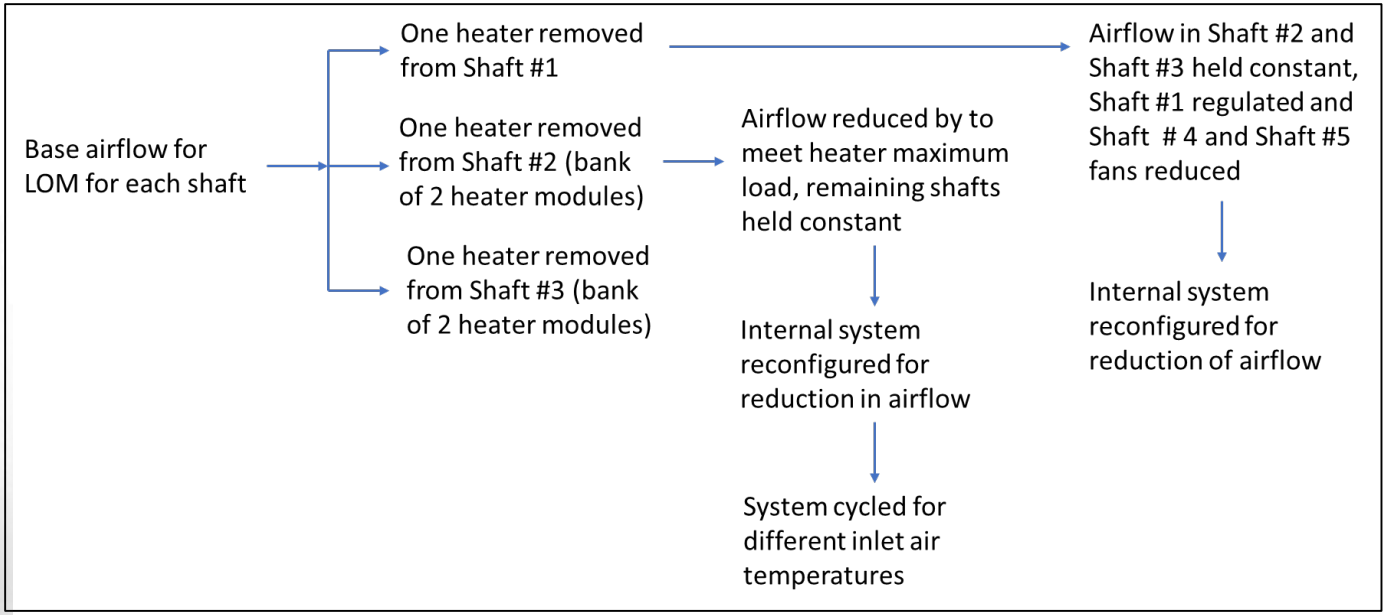
Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8

Maximize airflow through existing infrastructure.

- Parallel installations
  - Fans
  - Heaters
  - Coolers
- Fan VFD

Determine how effects of airflow reductions can be minimized

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8



Determine how effects of airflow reductions can be minimized

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8

Identify the ventilation requirements

- Legislative
- Internal Requirements

Airflow, Velocities, Exposure, Limits, and Climate

Determine how effects of airflow reductions can be minimized

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8

Identify areas to remove from the ventilation circuit

- Shops
- Development Headings
- Other unique locations

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Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

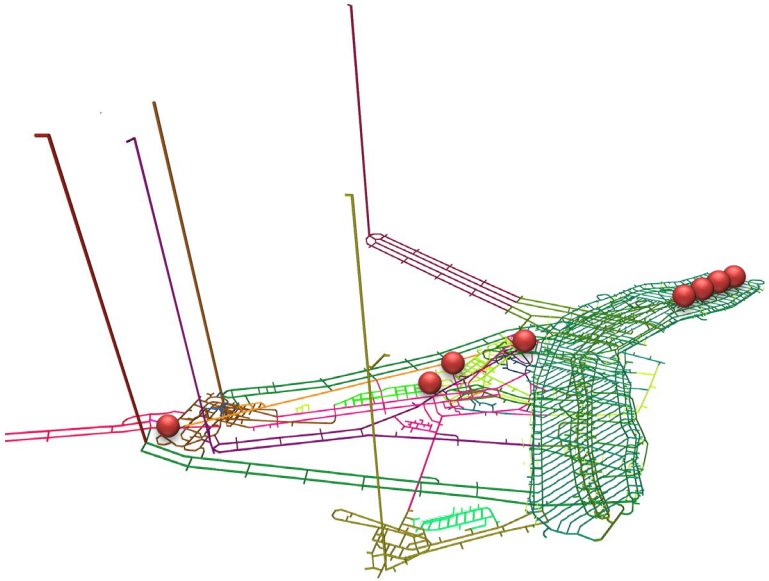
Step 8

Maximizing

-extraction panels airflow

Minimizing

-shops and development headings airflow



Model each scenario

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8

- Maximize airflow through available main fans
- Reduce flow to low priority areas first
- Completed when all target requirements are met.

Model each scenario

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8

1. List the steady state conditions
2. For air heaters or coolers, vary inlet temperatures
3. Total change in mine flow
4. Observe changes of differential pressure on infrastructure
5. Fans are operating in design range
6. Check for reversed airflow and recirculation
7. List of locations regulator changes
8. Changes to escape plans (update maps?)

Model each scenario

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
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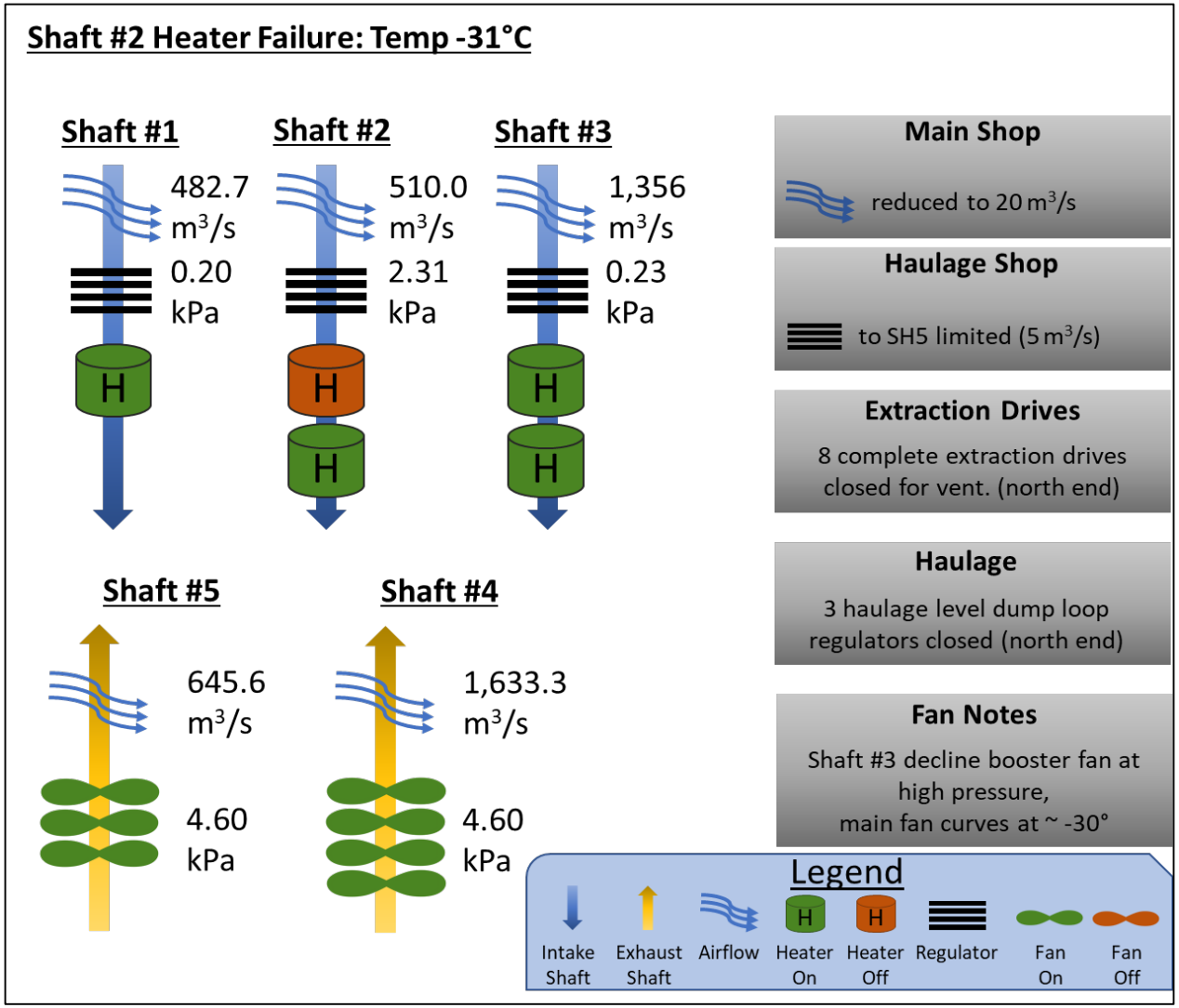
Step 8

Scenario	Intake Shafts		Exhaust Fans		Airflow Reduction Summary
	Shaft A	Shaft B	Shaft C		
	Airflow (m^3/s)	Airflow (m^3/s)	Airflow (m^3/s)	Pressure (kPa)	
Steady state	-	-	-	-	List changes needed to the ventilation system and any potential issues
Heater Shaft A -15 °C	-	-	-	-	
Heater Shaft A at -12 °C	-	-	-	-	
Loss of 1 Fan Shaft C	-	-	-	-	

Communicate the plan

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8



Maintain the plan

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8

Mines evolve and so should the plan.

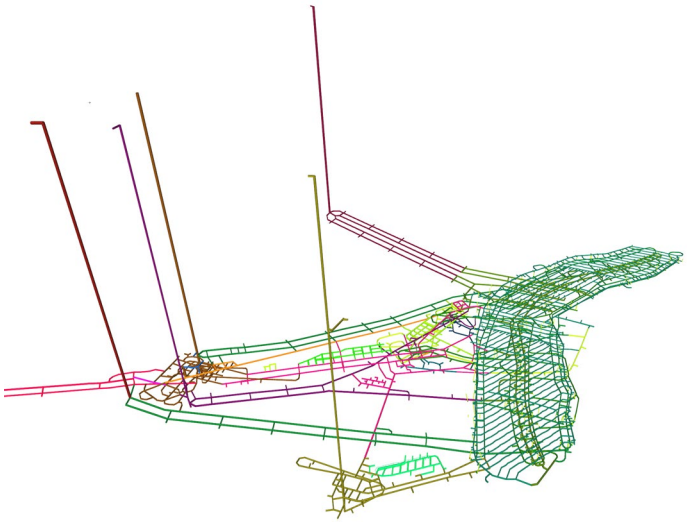
Check actuation of the plan

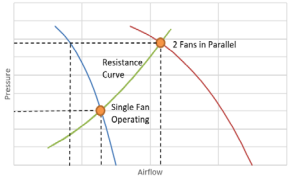
Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8

- Field tests
- Check the viability of the controls
- Model validation

Conclusions

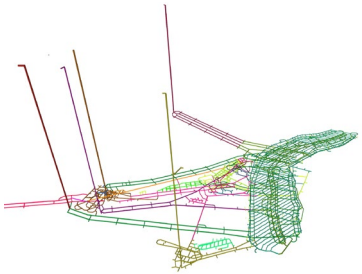
- An accurate and correlated ventilation model is must have.

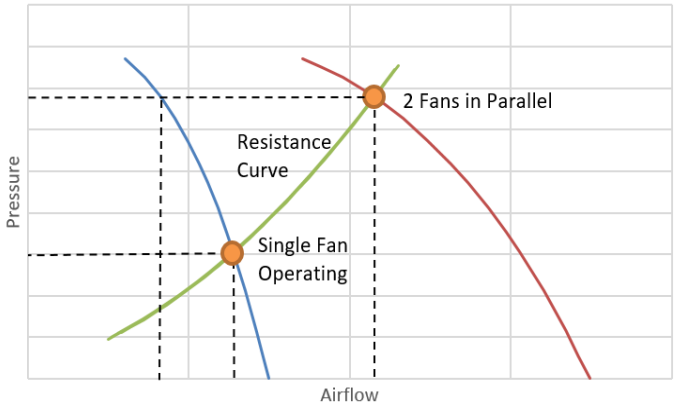




Conclusions

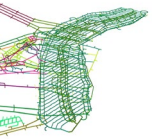
- Maximize Airflow through existing infrastructure.

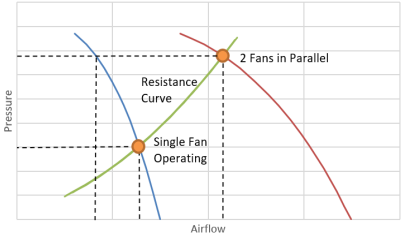


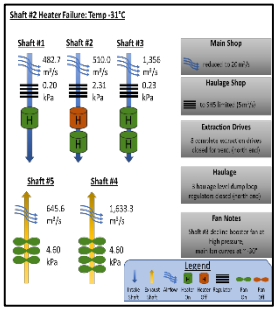


Conclusions

- Regulatory and target airflows must be met.

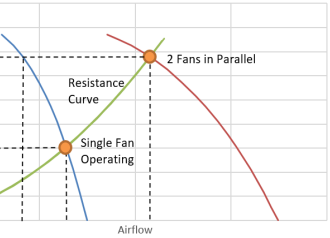


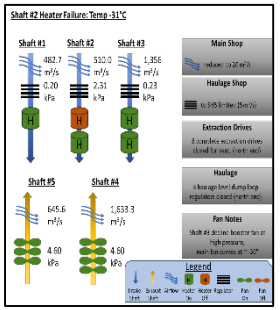




Conclusions

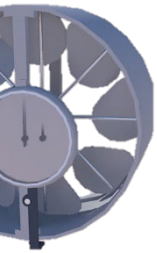
- Planning ahead minimize downtime and Maximize volumetric efficiency.

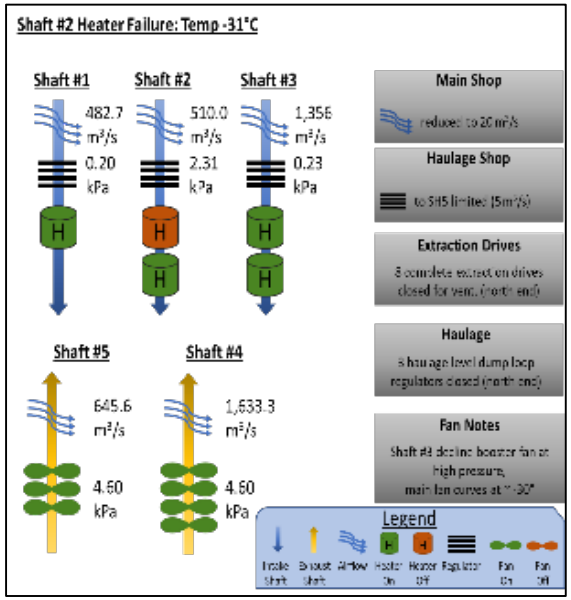




Conclusions

- As each mine is unique each plan will be unique. Commination will be key.





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Questions?

Garrett Schult

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