ABB Smart ventilation
Integrated Mine automation and electrification

Mine Operation Center

Communication network
- Wired & wireless
- Supervision
- IP Telephony, video
- Asset & people tracking

Mine ventilation

Mobile assets
- Remote monitoring
- Production reporting
- Work order mgmt.

Substations

GIS Substations

Transformer

E-Houses

MCC & Drives

Stockyard management

Hoisting systems

Water handling
- Drainage system
- Water pumps

Crushing and conveying
- Loading pockets
- Crushers
- Feeders
- Conveyors
Why control underground mine ventilation?

- Ensuring a healthy working environment underground
  - Dilution of hazardous substances
  - Climate control
- Quicker evacuation of blast gases
  *Shorter downtime*
- Minimize energy consumption
  *Reduce cost*
- Better utilize existing infrastructure
  *CAPEX and OPEX control*
Potential for energy savings
NRC Study: Energy consumption by mining activities

AVG total consumption of 10 mines = 90.4 kWh / tonne ore hoisted, 44.3 kW in ventilation

Ref: 2005, Natural Resources Canada, Benchmarking the Energy Consumption of Canadian Underground Bulk Mines
Example of potential ventilation energy savings for an underground mine with a production of 2,5 MT/year

- 72% Energy need to keep healthy environment
- 30% Level 1 - Manual control from central control room
- 20% Level 2 - Ventilation on demand
- 10% Level 3 - SmartAir Mine ventilation Optimization
- 12% Level 3 - SmartAir Mine ventilation Optimization with air quality sensors

Percentage of nominal ventilation energy consumption over a 365 days
ABB Smart Ventilation
Select your level of monitoring, control and optimization

- **Level 1 - Smart Basic**
  Basic control and monitoring of fans, louvers and ventilation doors. All are monitored and controllable in the ABB 800xA System together with air quality and air flow sensors.
  - Reduced energy costs and increased safety by improved operator supervision and control

- **Level 2 - Smart Mid**
  Full scale Ventilation on Demand solution. Automatic control of all fans, louvers and controllable ventilation doors
  - Improved air quality by providing fresh air where demanded
  - Energy savings up to 30-50% per year

- **Level 3 - Smart Perfect**
  Mine ventilation optimization using ABB SmartAir™ optimizer. Uses airflow sensor feedback to perform online optimization of main ventilation fans
  - True mine wide control & optimization of air flows and air quality while minimizing energy consumption in real-time.
ABB Smart Ventilation
Built on System 800xA – complete, open and flexible

System 800xA, a world class collaboration platform
- Operators, Engineers and Mine managers can supervise and control the total ventilation system both centrally as in mobile devices
- Energy consumptions and KPI's are easily accessible for all users

Modularized solution
- Smart ventilation software library provides standardized operator environment - efficient operation
- Modularized hardware solution built on System 800xA standard components - efficient engineering and reduced maintenance cost

Open platform
- Easy to hook up fans connected or controlled in other ways to the ABB Smart ventilation system via open interfaces like OPC and Modbus TCP
ABB Smart Ventilation System Overview

Main fan + Heater

Ventilation objects with embedded control

Wired communication network

MCC room

DCS room

Control room

Supervisory controllers

System servers

Engineering workplace

Extended Operator Workplace

Communication Node

Sensor Equipment

Gate control

Temperature/motion

Flow/humidity

Gas concentration

Vibrations

ID control

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ABB Smart ventilation
System architecture

- System Servers
- Ethernet Control Network
- Supervisory Controllers
- Operator Workplace
- Maintenance
- Operation
- Engineering
- Operator Workplace

- Gate control
- Temperature/motion
- Flow/humidity
- Gas concentration
- Vibrations
- ID control

- Frequency conv.
- Fan
- Power Supply
- Ethernet Control Network
- Power Supply

- Instruments
- Communication nodes
- Control box with I/O
Scheduled & Event Based control
- Ventilation need based on time schedule reflecting production activities
- Blast activities (pre-, post & shutdown) based on time schedules or connected to blasting device.
- Support for fire situations

Sensor controlled
- Control of ventilation through physical sensors locally - Air quality, flow or pressure control

Flow control based on calculated demand
- Control by calculated need of air dilution. Calculations are based on vehicle/personnel detection and identification via Local vehicle tracking or a Global tracking system

Handling of parent-child relations
- Easy setup of the correlation between fans

Local distributed intelligence
- ensures that air quality is kept under control even if the communication network suddenly goes offline - "intelligent fail-safe function"
On/Off, 2-speed, VFD and Louvers
- All types of fan motor controls are supported by standard modules. Also louvers are supported with standard module
- Fans with or without controlled dampers supported by standard module

Gates & Doors
- Gates with different level of instrumentation and actuators are supported by standard modules

Moveable / Duct building
- System provides functions and procedures for moving and adding fans efficiently. No need for programming
- Built-in practical functions for duct building, expansion of ducts and more.

Other types and special functions
- Mine specific adaptations and requirements are easy to implement when all modules are built on System 800xA and 800xA standard engineering tools can be used
Main surface fans
- Support for large surface fans with full redundancy
- Coordinated control of parallel fans control for optimal point of operation
- Control of burners or air coolers are coordinated with fans for air temperature control - minimizing energy consumption

Single fans and clustered fans
- Both single fans and clustered fans are supported with full functionality
- Standardized hardware modules for local intelligence controllers

Example 1: Cut and fill stoping
- Total number to be used for dimensioning: 120 fans
- Normally single or small clusters of fans

Example 2: Sub-level caving large scale
- Total number to be used for dimensioning: 700 fans
- Majority of fans in clusters - about 6-8 fans per cluster
Global Location Tracking

- Information from any global location tracking system can be used by ABB Smart ventilation to generate presence-driven ventilation demand calculation.
- This can be used instead of, or in combination with, the Local vehicle tracking instrumentation.

ABB Mine Location intelligence system

- Provides a complete location based decision system adapted to underground mines.
- Reuse of your existing data/telecom solution into a technology agnostic RTLS solution.
- ABB Smart ventilation integration provides an efficient way of configuration and maintaining ventilation zones.
ABB Smart Ventilation
System overview - complete system supply

System 800xA
Smart Ventilation application
- Centralized Ventilation Controllers
  Controller hardware and software for basic ventilation objects
- Operator workplace, ventilation
- Engineering workplace

Supervisory Ventilation Controller
Multi-fan coordination
Controller hardware and software

Primary ventilation fans
Centralized monitoring and remote control. Operator sets on/off/speed reference

Local Intelligence
Distributed controllers
Box w. controller and I/Os.

Motor control
VFD for secondary fans

Centralized monitoring and remote control. Operator sets on/off/speed reference

Secondary ventilation fans
Controller hardware and software for basic ventilation objects

Local Intelligence
Distributed controllers
Box w. controller and I/Os.

Motor control
VFD for secondary fans

Centralized monitoring and remote control. Operator sets on/off/speed reference

Local Intelligence
Distributed controllers
Box w. controller and I/Os.

Motor control
VFD for secondary fans

Communication network

Air flow measurements
Ultrasonic sensors for drifts, ducts and fans

Air Quality Station
Sensors for CO2, SO2, NOx, etc

Pressure measurements
Differential pressure over fans, walls and doors

Ventilation door/gates
Control box w. controller and I/Os software

Local vehicle tracking system
Radio based vehicle tracking system at fan locations. Requires local controller at fan location

Actuator
2-directional motor control

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ABB Smart Ventilation
Software and user interface

Operator workplace
- Graphical process displays
  - Ventilation overview layout
  - Main fans and heater/cooling equipment
  - Ventilation layout for each level/area
- Alarm and event
  - Alarm and event lists for whole ventilation and each area
  - Advanced alarm statistics for mine ventilation
- Production statistics displays – current & historical
  - Overall mine ventilation KPI’s
  - Energy consumption total, area and down to each consumer
  - Run-time, energy statistics per fan and mode of operation
- Trends and logged data for all important data
ABB Smart Ventilation
Software and user interface

- **Easy overview**
  Fan operational data is presented in standardized faceplates, harmonized with ABB 800xA "look-and-feel".

- **Easy configuration**
  Normal fan configuration handled in HMI faceplate, no controller programming needed.

- **Easy re-configuration**
  Fans can be moved as one unit (Fan, VFD, Control equipment) when production ends in an area. Re-configuration in faceplate.
ABB Smart Ventilation
Layout for LCU Single
ABB Smart Ventilation
Layout for LCU Multiple

- Software
- VFDs
- LCU Multiple
- Communication network
- Extented Operator Workplace
- Supervisory controller
- System servers
- Operator workplace
- Engineering workplace
ABB Smart Ventilation
Layout for local mobile equipment detection

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<th>Id</th>
<th>Vehicle Name</th>
<th>Air Demand</th>
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<tr>
<td>1</td>
<td>Volvo Loader</td>
<td>13 m³/s</td>
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<tr>
<td>2</td>
<td>Drill</td>
<td>11 m³/s</td>
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<td>Volvo Loader</td>
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<td>4</td>
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<tr>
<td>6</td>
<td>AtlasCoppco</td>
<td>16 m³/s</td>
</tr>
</tbody>
</table>
ABB Smart Ventilation
Layout with integration of Global tracking system

ABB MLI
or other global tracking system

WIFI ACCESS POINTS

OPC

ABB 800xA Control System

CS server
ABB Smart Ventilation
SmartAir™: online ventilation optimization

- A new and unique method for mine wide coordinated control of the main (primary) fans and booster fans
- Providing air needed for healthy working environment
- Model based approach, with models for airflows, pressures and fan powers
- Relies on feedback from field sensors
- Model parameters obtained empirically from operational data
- Can be implemented on top of any ventilation control solution.
ABB Smart Ventilation
SmartAir: Mine-wide coordination

- Determine airflow requirements (manual or system generated)

- Collect measurements
  - Airflows, fan powers, differential pressures, equipment statuses…

- Solve optimization problem, considering constraints
  - To fulfill minimum airflows
  - To ensure safe fan operation points

- Set all main fan speeds in a coordinated manner
ABB SmartAir™
Built on ABB APC platform

• Implemented on ABB’s Advanced Process Control (APC) platform

• Control logic built in Control Builder as a control module

• Calculation engine automatically created as a service, runs on dedicated APC node in the 800xA Control System
Different configuration for different needs

- Modular design enables adaptation to different mining operations and different ventilation layouts

- Versatile software application - the fan control software is prepared for a number of different needs which can be activated by the user

- Ventilation air flow demands can be controlled by different means: Air quality measurements, vehicle presence, time schedules or other events
ABB Smart Ventilation
800xA Simulator for Mine Ventilation

- Validate new ventilation layouts and control strategy in simulated environment enables optimal investment decisions
- Training operators in an identical operator environment as the real process gives maximum ventilation performance
ABB Smart Ventilation Summary

• Builds on powerful integration platform 800xA
• Modular design
• Easy to expand
• Different needs coordinated throughout the ventilation system.
• Central configuration, local control.
• More efficient use of available infrastructure
• Proven customer installations in operation
• Possibility of mine-wide optimization of main fans