

16th Annual MDEC Conference – Toronto, Ontario Canada
Dave Willick – ABB Inc.

Underground Electric Haulage Trucks Introduction and Benefits

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ABB Underground Electric Mining Haulage Trucks Presentation Topics

- NIOSH observations
- MSHA regulations
- Benefits of the ABB electric trucks
- Truck Data
- Summary
- References
- ABB total customer commitment
- K635ED Video



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ABB Underground Electric Mining Haulage Trucks NIOSH Observations

- Short-term overexposure to diesel exhaust has been linked to health effects such as eye and nose irritation, headaches, nausea, and asthma.
- Based on a combination of chemical data, genotoxicity, and experimental carcinogenicity, NIOSH has determined that diesel exhaust is a potential human carcinogen.
- The International Agency of Research on Cancer regards diesel exhaust as a probable human carcinogen.
- The Environmental Protection Agency considers long-term exposure to diesel exhaust likely to cause cancer and environmental concentrations of diesel exhaust to potentially cause health problems.
- Underground miners can be exposed to over 100 times the typical environmental concentration of diesel exhaust and over 10 times that of other workplace exposures.
- About 34,000 underground miners and 200,000 surface miners are exposed to diesel exhaust, as are more than 1 million other workers in the United States alone.

References: <http://www.cdc.gov/niosh/mining/highlights/programareahighlights8.htm>

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ABB Underground Electric Mining Haulage Trucks MSHA Regulations

- Improving workplace health and safety by legislative reduction of DPM via total carbon limits
- MSHA will issue a noncompliance citation when valid personal total carbon (TC) exposure measurement demonstrates noncompliance with the 160TC $\mu\text{g}/\text{m}^3$ personal exposure limit at a high level of confidence
- For purposes of enforcement, Total Carbon (TC) is defined as the sum of Elemental Carbon (EC) and Organic Carbon (OC). Both EC and OC are measured by NIOSH Method 5040.1
- Diesel particulate filters and disposable filter elements, while effective at the reduction of total particles, in some cases, could actually increase the quantity of smaller particles

References:

www.msha.gov/01-995/TotalCarbonPersonalExposureLimit.pdf

Environ. Sci. Technol. 2009, 43, 6737-6743 – Effects of Diesel Exhaust After Treatment Devices on Concentrations and Size Distribution of Aerosols in Underground Mine Air;

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ABB Underground Electric Mining Haulage Trucks Assumptions

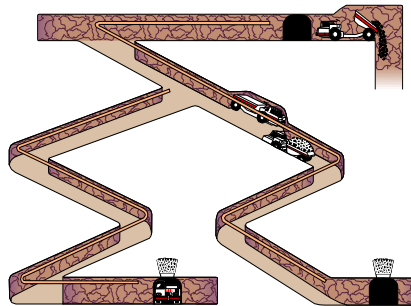
- Dissipation of underground diesel truck emissions to ensure compliance typically requires ventilation rates of 100 to 150 CFM per installed brake horsepower.
- Typical ventilation costs are in the range of \$5.75 per CFM
- Reducing TC, improves underground air quality and can reduce the CFM requirement which reduces operational costs

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ABB Underground Electric Mining Haulage Trucks Proven System

- First established in the 1950's in Kiruna Sweden
- DC versions replaced with modern AC trucks in 2007
- Truck availability over 85%
- ABB Canada obtained product responsibility in late 2008 for the North American Market
- Continuous improvement from customer feedback



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ABB Underground Electric Mining Haulage Trucks Benefits - General

- Minimal demand on ventilation systems
- Fast speeds
 - Shorter cycle times
 - More production
 - Fewer trucks for same haulage
- Quick installation on non dedicated ramps
- Regenerative braking down ramp adds power back to the network
- Fast benefit of production increase and early return on capital employed
- Long asset life approx. 60,000 hours
- Environmental, health and safety friendly
 - Minimal diesel fumes
 - Low noise level
 - Low heat generation
- Flexible and expandable solution

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ABB Underground Electric Mining Haulage Trucks Benefits – Compared to Diesel

- Fewer trucks for same haulage (roughly half)
- Environmental friendly – Minimal exhaust fumes
 - Fleet of 6 x 50 tonne diesel trucks @ 650 Hp each. \$3,363,750 / year ventilation costs*
 - Fleet of 3 x 50 tonne electric trucks @ 120 Hp each. \$310,500 / year ventilation costs*
 - OPEX Savings: \$3,053,350 EVERY YEAR for SAME PRODUCTION!!**
 - Ventilation rate: 150cfm/hp, \$5.75/cfm/year*
- Less heat, less noise compared to diesel trucks
- Lower operating cost on a fleet by fleet basis (about half)
- Fewer drivers
- Energy typically costs less than diesel fuel
- Dynamic braking on AC trucks generate power down ramp
- Can use steep ramps (shorter tunnels)

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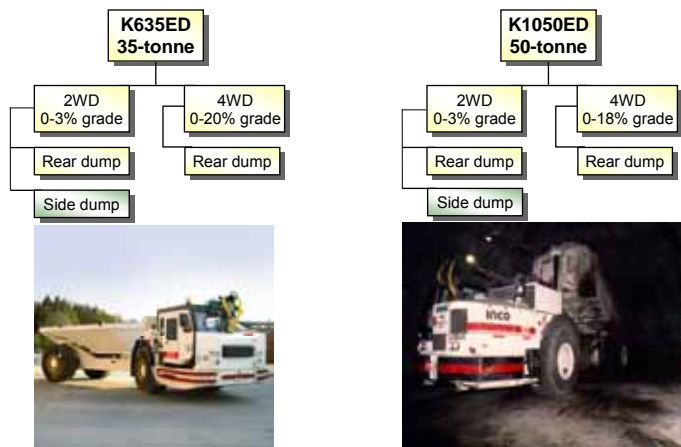
ABB Underground Electric Mining Haulage Trucks Benefits – Compared to Conveyors

- Flexible
 - No re-loading
 - Easy to extend
- No mobile crushers needed
- Redundancy (more than one truck for the production)
- Dedicated ramp not required / less width
- Early start of production
- Reuse trucks at next ore zone

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ABB Underground Electric Mining Haulage Trucks Truck Family



= on request

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ABB Underground Electric Mining Haulage Trucks Truck Data

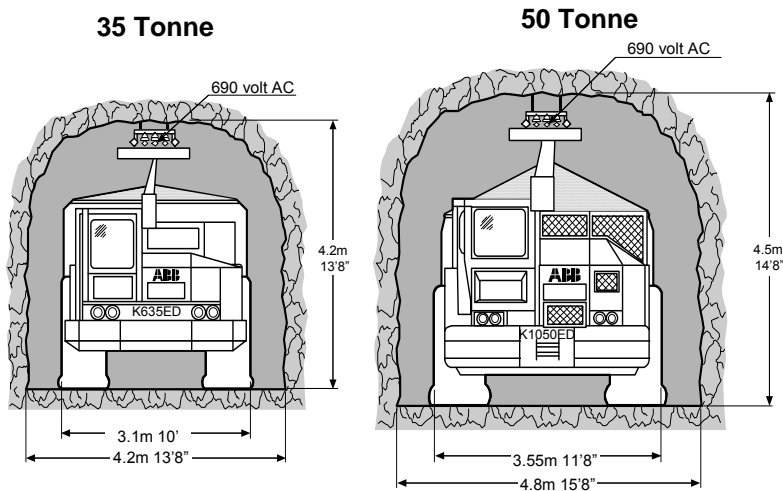
- K635ED, 35-tonne (38.6 short ton) net load
 - Power: **480** kw (2x200kw+80kw) (270hp main motors)
 - Speed: **18** km/h (11 mph) uphill loaded in ramp **+15%** grade
 - Speed: 21.6 km/h (13.42 mph) empty down ramp

- K1050ED, 50-tonne (55 short ton) net load
 - Power: **800** kw (2x355kw+90kw) (483hp main motors)
 - Speed: **19** km/h (12 mph) uphill loaded in ramp **+15% grade**
 - Speed: 21 km/h (13 mph) downhill empty

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ABB Underground Electric Mining Haulage Trucks Tunnel Dimensions



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ABB Underground Electric Mining Haulage Trucks K635ED – 35 tonne haulage capacity



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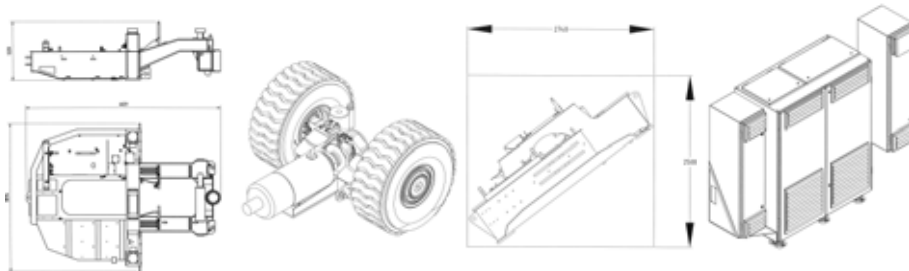
ABB Electric Underground Haulage Trucks K635ED – 35 tonne haulage capacity



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ABB Underground Electric Mining Haulage Trucks Challenges – Engineering / manufacturing modules



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ABB Underground Electric Mining Haulage Trucks Summary

- Fast speeds up steep inclines
- Minimal stress on existing ventilation systems
- Regenerative braking adds power back to the network
- Well proven system
- Proven availability
 - Truck availability over 85%
- Flexible layout
- Low OPEX costs

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ABB Underground Electric Mining Haulage Trucks Summary – ABB Strength

- Experience / reference installations
- Mining is a Core ABB Business
- North America based support
- World wide system support
- Standard electrical and mechanical parts
- Special Features
 - Automatic trolley connection / disconnection
 - Diesel motor / generator for off line duty
 - Diagnostic system

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ABB Underground Electric Mining Haulage Trucks Reference - *Zinkgruvan Mine*



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ABB Underground Electric Mining Haulage Trucks Reference – *Vale Coleman Mine*



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ABB Underground Electric Mining Haulage Trucks ABB Total Commitment

- Feasibility study
- Calculation of optimum grade, width and height of ramp
- Preparation of layouts for loading, dumping, turning and passing areas
- Assistance with approval by mining authorities
- Design, delivery and installation of trolley line and power supply
- Installation and commissioning of system
- Training of operators and maintenance staff
- Performing inspections and maintenance
- World wide system support

[K635ED Video](#)

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