ABB Drives Retrofit
Electric Shovels
BU Process Industries

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- Engineering experience
BU Process Industries
References Open Pit Mining, Germany

- Market leader for electrical equipment on bucket wheel excavators (285 units over 50 years)
- Established business with shovel and dragline applications
  - Engineering Expertise
    - Turn-key new and retrofit of electrical equipment for mining machines
    - Electrical and Automation Services, system analysis, development
BU Process Industries
Shovel retrofit with ABB AC Drives

- 1 BE295 BII, Mexico, Pena Colorada, 1999
- 2 BE295 BII, Brazil, Vale, 2001
- 2 BE295 BII, Brazil, Vale, 2002
- 1 BE295 BIII, Brazil, Vale, 2005
- 1 BE295 BIII, Brazil, Vale, 2006
- 1 BE295 BIII, Brazil, Vale, 2007
- 2 EKG5, Germany, Lafarge, 2008
- 1 BE395 BI, US, Drummond, 2012
- 1 BE495 BI, USA, Colowoyo, 2015 (Offer)
- 1 BE495 BI, Chile, Escondida, 2014 (Offer)

BE 295 BIII – Itabira, Vale, Brazil.

Success story with VALE in Brazil – 6 retrofits.
BU Process Industries
AC Shovel project references

P&H 4100 BOSS,
Canada, 1. AC Shovel,
2007

EKG 5 Retrofit
Germany,
2007

P&H 4100 XPC, USA,
1. XPC with AC drives

P&H 4100 XPC HA,
Chile, 2012, Alt. 4500m
BU Process Industries
Shovel AC Drives installed base 12-2014

Shovel total: 70+
P&H AC Testlab: 1
AC Drives Solution Technology
Technology
AC drives differences

Shovel drives system A

- Single motion drives
  - fast re-positioning to bank

- IGBT low voltage multidrive
  - 690V industrial platform
  - customized, IP42
  - air cooled system

- Direct Torque Control DTC
  - faster cycle time, 25µs
  - variable switching frequency
  - reduced resonance potential

- IGBT Supply Unit (ISU)
  - Regenerative mode
  - Switching frequency ~ 2kHz
  - no DC-chopper needed
  - low harmonics

Shovel drives system B

- Switch-over Crowd/Propel
  - time delay for re-positioning

- IGBT- Medium Voltage drives
  - 1400V, traction platform
  - customized, IP65
  - liquid cooled cabinets

- PWM control
  - cycle time 3 – 5 ms
  - fixed switching frequency
  - resonance possible

- Active Front End (AFE)
  - Regenerative mode
  - Pulse staggering at 750Hz
  - DC-chopper used
  - medium harmonics
**Technology**

**ABB Drives for Mining**

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**FE-Simulation and shaking test for ACS 800MD**

- Based on vibration measurements and field experience
- In accordance with EU, US and factory standards regarding shock & vibration
- Expert consulting from Woelfel, IABG and ABB

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**Test IGBT Supply Unit (ISU 2xR8i with LCL)**

- Vibration test Modulation
  - 3 – 11 Hz with 0.5 g
  - 13 – 50Hz with 0.7 g
  - 50 – 100Hz with 1g
- Shock test
  - 10g vertical (16ms)
  - 5g horizontal
Technology
Drives for Mining

- Customized with about 30 different mech. features
- Based on analysis and test results
- In accordance with country code / factory standards
- In operation on shovels since 7 years
- No cracks or mech. damages found
Technology
Mining Drive Control Program

PLC
Control Unit

MDCP

Drive

Motor Control Program
RMIO-12 or AMC-34

DRIVES 1 … 4

Process Controller

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DDCS

Motor Control Program
RMIO-12 or AMC-34

Monitoring
Motor X
Inverter X
Communication X

SPEED CONTROL

TORQUE CONTROL

DTC CORE

Status Words
Fault/Alarm Words
Actual Values

DTC CORE

SPEED CONTROL

DRIVES 1 … 4

Motion Interface

SPEED CONTROL/LOAD SHARE

Motor Speed P1.04
Fault/Alarm Words
Actual Values

Communication

Profibus-DP or DDCS CH

PLC MDCP Drive Control Unit

Technology
Mining Drive Control Program

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Shovel Control Program

- Software package for ABB AC Drives only
- Running on Drive Control Unit (RDCU)
- Software packages for LV and MV drives

- MCCP – Mining Conveyor Control Programm
- CMCP – Continuous Mining Control Program
- TVCP – 2-Track- Crawler Control Program
- SHCP – Shovel Control Program
  - Sart/Stop ramp
  - Starting torque
  - Backlash protect
  - Brake control
  - E-Stop, Fast-Stop
  - Emergency Mode
  - Alarm processing
  - Torque and stall monitor
  - Acceleration and over speed
  - Magnetizing and flux monitor
  - Overload monitor
  - Brake monitor
AC Drives Solution
Case Study
Casy Study
P&H 4100 AC vs. DC Comparison

Results of a field study in Canada

- The AC Drive System outperforms conventional DC Drives solutions for Mining Shovels
- Specific energy consumption per ton is 15% lower than DC
- AC Drives Shovel productivity up to 3% higher
- 1.5% higher mechanical availability
Casy Study
P&H 4100 AC – Productivity

Source: Joy Global, 2010
Casy Study
P&H 4100 AC – Energy Efficiency

Source: Joy Global, 2010
AC Drives Solution Retrofit
Retrofit
Shovels with AC Drives - Benefits

Tailored electrical upgrade
- Using existing transformer
- MV switchgear new or reuse
- LV 700V motors can be used
- Improved motion control
- New operators seat and control
- Visualization and remote access
- Build in spare parts (drives)
- 2 years warranty
- ABB drives service
Retrofit
Deck Layout 495BI with AC Drives - Concept
Retrofit AC Drives Solution

Retrofit decision maker

- Obsolete AC drives on existing shovel
- Limited CAPEX investment
- Reduction of maintenance
- Potential for energy savings and productivity increase

- ABB Multidrive concept with a modular design
- DTC drives control as favorite for dynamic requirements and encoder-less operation
- Low Voltage power range and power density
- Standardized inverter module design and redundancy
- Air cooled principle for the drives line-up

- ABBs position as world leader in drives
- Global drives service network
Retrofit
For electric shovels

Questions?
Power and productivity for a better world™