

CASE NOTE

# ABB drive systems control a 10 km conveyor supplying bauxite ore to an alumina refinery in Western Australia



ABB supplied three ACS1000 medium voltage drive systems, each rated at 2500 kW, for Alcoa of Australia’s Huntly mine, which is one of the world’s biggest bauxite mines.

The variable speed drives (VSDs) ensure reliable, energy-efficient operation of the long overland conveyor for the transportation of bauxite ore.

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01 Alcoa of Australia is engaged in the primary aluminum production business, with the process starting at the Huntly and Willowdale bauxite mines in Western Australia.

02 Bauxite ore leaving the Myara crusher region at Alcoa’s Huntly mine.

## Alcoa

Alcoa of Australia is part of Alcoa Inc., which is a global leader in lightweight metals technology, engineering and manufacturing. Alcoa of Australia is engaged in the integrated bauxite mining, alumina refining and aluminium smelting systems, with the process starting at the Huntly and Willowdale bauxite mines in Western Australia. The two mines supply bauxite to Alcoa’s alumina refineries in Kwinana, Pinjarra and Wagerup.

## Transportation of raw material

Alcoa of Australia’s Huntly mining operations were based about 24 kilometers from the Pinjarra refinery. Bauxite is transported from the mine to the refinery via long overland conveyors, as they have proven to be more efficient and cost-effective than transportation by rail or truck.

## Challenge

An additional overland conveyor was required when the Huntly mining operations were relocated 10 km further from the Pinjarra refinery. The new conveyor has to be available 24/7. The maximum ambient temperature is 45 °C and there is no cooling water available on-site.

## Highlights

- Energy savings due to process flexibility
- Precise control for minimizing starting/stopping stress and belt tension waves
- Accurate load-sharing between multiple drives on a single conveyor
- Extended lifetime and increased availability of conveyors
- Low-speed operation for belt inspection
- Equipment is installed in harsh environment
- Highly efficient single-loop fin fan VSD cooling reduces life cycle costs



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# ABB drives for Alcoa of Australia


## Solution

ABB provided three ACS1000 medium voltage variable speed drives, each rated at 2500 kW. In addition, three high voltage input RESIBLOC® transformers rated at 3.15 MVA and a single-loop fin fan cooling system were in ABB's scope of supply.

The three variable speed drives are running one conveyor and are arranged in a master-follower configuration.

## Benefits

### Energy savings

 Starting and stopping conveyors with variable speed drives does not cause additional stress to the equipment.

Therefore, conveyors can be stopped or operated at reduced speed if material demand is intermittent resulting in decreased energy consumption.

The dry-type transformers are placed outdoors so that their losses are dissipated into the ambient air. The primary voltage was 33 kilovolts (kV), which made an additional main transformer unnecessary, increasing efficiency as well as reducing the number of network components for availability and simplicity.

In order to minimize external cooling system CAPEX and OPEX, a water-cooled VSD was chosen. In general, airconditioning systems have to be provided to deal with losses into the electrical room. The losses of a water-cooled VSD dissipated into the room are down to 1 kW.

Figure 1: System comparison with and without step-down transformer.

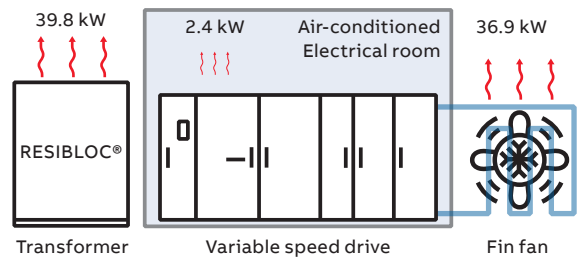
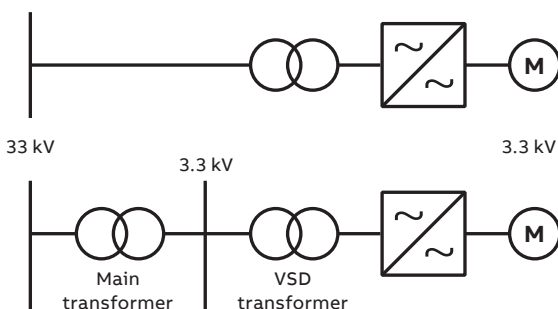


Figure 2: Overview of VSD losses.

Compared to a solution with an air-cooled variable speed drive with an integrated transformer, the losses into the room are reduced from 79.1 kW to 2.4 kW per VSD for this particular project.

The majority of the VSD losses dissipate into the water. The water is pumped through a set of outdoor coils which are cooled by fans. The fin fan is a type of heat exchanger which is used in applications where large quantities of heat need to be transferred. Air is forced over a bundle of finned tubes that dissipate the heat generated by the engine.

In the case of a single loop fin fan the internal/ treated water is circulated through the finned tubes directly, without an additional heat exchanger.

For VSD systems with shaft power greater than 1800 kW, water cooling has to be considered to minimize complexity and cost of the external cooling system. If there is no plant water available and the maximum ambient temperature is not higher than 45 °C a single loop fin fan can be used. It is a technically simple solution which leads to low maintenance, high availability, low energy consumption and low cost.

It is easy to introduce redundancy by adding fans. Alcoa decided to go for 100 percent redundancy, which means that two fin fans are installed for every VSD system.

The figure below compares the life cycle costs of different cooling solutions. Maintenance and installation costs are not considered, but it should be noted that the design of electrical rooms containing forced air-cooled equipment is challenging.

One 2500 kW variable speed drive system with identical system efficiency and an electrical energy cost of A\$ 0.10 (US\$ 0.08) per kilowatt-hour (kWh) were used for the following comparison.

Figure 3: Overview of external cooling system costs for different configurations.

VSD transformer Location	VSD cooling Method	VSD losses into		System cooling		External cooling system	
		E-room (kW)	Water (kW)	Air	Water	CAPEX (kA\$)	OPEX (25yr) (kA\$)
Indoor	Air	79.1	-	A/C	-	119	866
Outdoor	Air	39.2	-	A/C	-	59	430
Outdoor	Water	2.4	36.9	A/C	Plant water	7	42
Outdoor	Water	2.4	36.9	A/C	Fin fan	29	42
Outdoor	Water	2.4	36.9	A/C	Chiller	59	389

**Accurate and fast load sharing**



ABB medium voltage drives provide accurate and fast loadsharing between several drives. This is useful for conveyor applications where two or more motors operate on the same conveyor belt, making sure all motors are loaded as needed. The converter control provides a window speed limitation to prevent belt slippage.

In a master-follower configuration, the motor shafts are either hard-coupled, i.e. connected to the same pulley (on the same shaft or through a gearbox) or soft-coupled, where a slight speed difference between the drives is possible.

The conveyor in the Myara region of the Huntly mine is driven by three variable speed drives. The master motor is softcoupled to the two hard-coupled speed followers.

The configuration requires different converter control schemes which are part of the standard software package for ABB’s medium voltage drives. This software ensures accurate load-sharing in master-follower configurations.

**High availability**



The master-follower configuration permits the continued use of the conveyor system with reduced performance in case of failure of one variable speed drive. If the master drive fails, one follower drive can be assigned to be the master.

Due to the power loss ride-through function, ABB drive systems are able to withstand disturbances to the power supply. The drive will continue to operate in an active but non-torque producing mode if the incoming supply voltage is interrupted. The drive is active as long as the motor rotates and generates energy for the drive within an adjustable time. It will smoothly resume normal operation immediately upon return of the power supply.

**Low-speed operation for belt inspection**



For maintenance inspection, belt changes and repairs it is possible to run the conveyor belt at low speed.

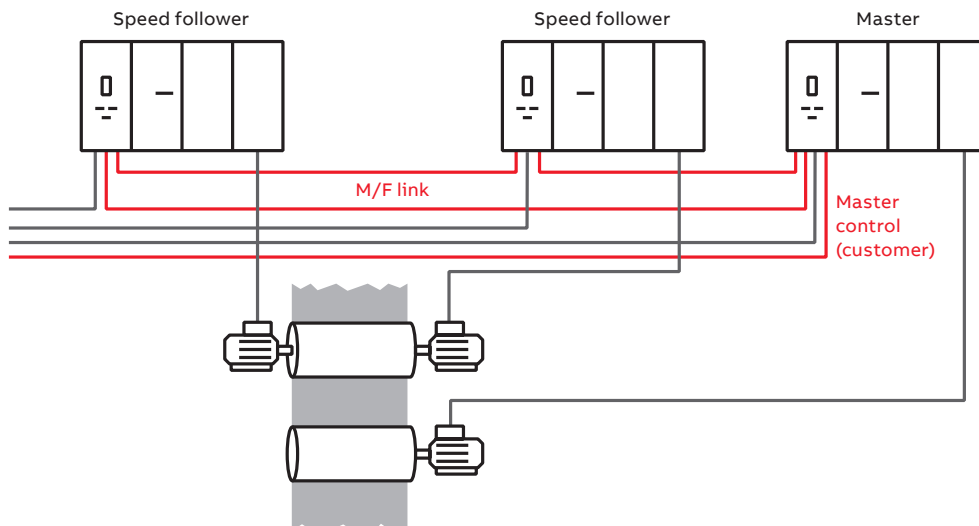


Figure 4: The master-follower configuration.

03 The variable speed drive system comprising three ACS1000s ensures precise control of the 10 km conveyer belt.



### Smooth ramp up



VSD's provide a smooth ramp-up of conveyors. They deliver high starting torque for the current drawn from the power system and have a programmed upper limit to reduce peak torque during the startup of the conveyor. The low starting currents and high starting torque enable smooth startup of the conveyor, even when it is fully loaded.

### High control accuracy



Direct Torque Control (DTC), the motor control platform of the ACS1000 drives family, controls the torque and stator flow of the motor directly. This results in high control accuracy and better dynamic properties, especially in the starting and braking phases.

### Extended lifetime and increased availability



Variable speed drives provide accurate torque and speed control of conveyors. This reduces the stress on mechanical equipment such as gearboxes, pulleys and belts, especially during startup and stopping, but also during operation and maintenance.

### Remote monitoring



ACS1000 variable speed drives are optionally equipped with DriveMonitor™, ABB's intelligent monitoring and diagnostics system, which allows real-time access to the drive using Internet connections. Long-term monitoring functions deliver important information on equipment status, upcoming service routines, trends and input for possible performance improvements.



#### ACS1000 key data

Inverter type	Three-level Voltage Source Inverter (VSI)
Power range	Air cooling: 315 kW - 2 MW Water cooling: 1.8 MW - 5 MW
Output voltage	2.3 kV, 3.3 kV, 4.0 kV, 4.16 kV (optional: 6.0 kV - 6.6 kV with step-up transformer)
Maximum output frequency	66 Hz (optional: 82.5 Hz)
Converter efficiency	Typically > 98%
Type of motor	Induction motor

For more information please contact:  
[new.abb.com/drives](http://new.abb.com/drives)  
[www.alcoa.com/australia](http://www.alcoa.com/australia)

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