SOLVING MINING'S TOUGHEST CHALLENGES THROUGH WORLD-CLASS PRODUCTS & DIRECT SERVICE℠

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# Variable Speed Drives on Armored Face Conveyors

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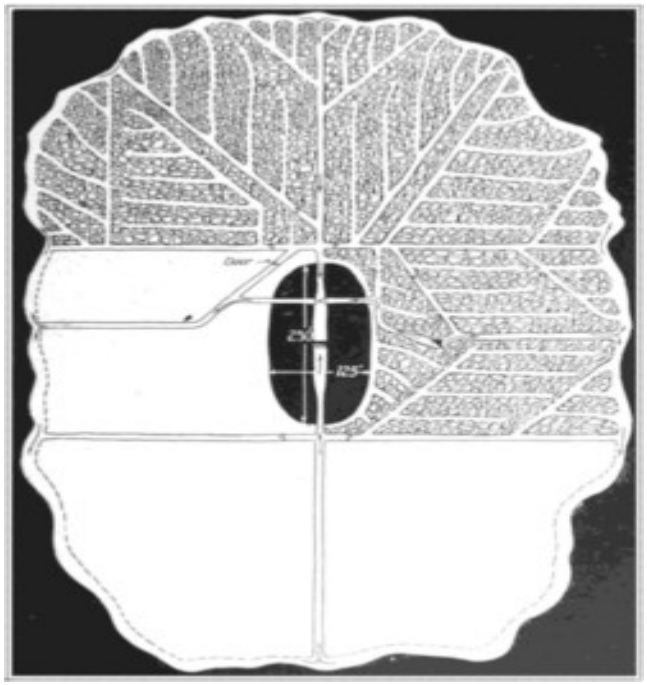
# A Brief History of AFC Time

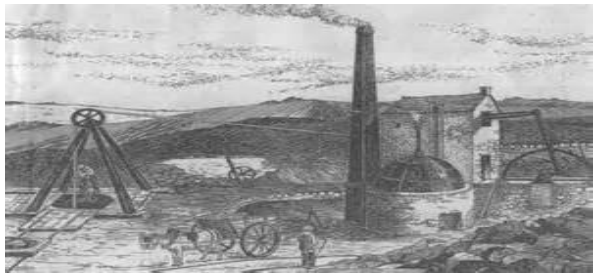
# Variable Speed Drives on AFC's - A Brief History of AFC Time

## 1650's

- 'Shropshire Method' began to be used for Ironstone Mining and was an early attempt at 'Longwalling'.
- Children were used in these early times to Convey the won mineral along the coalface.

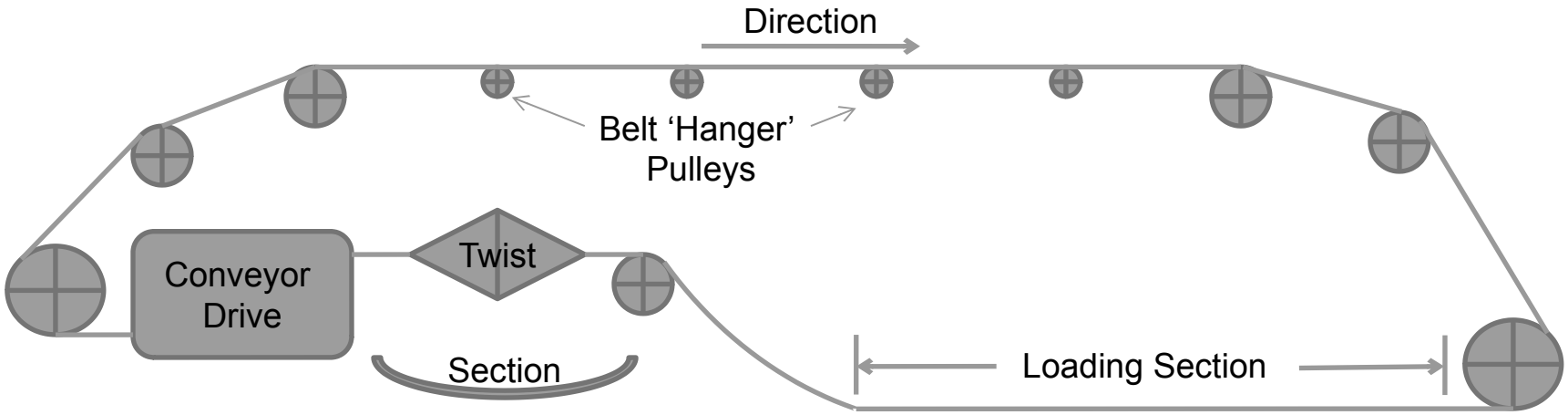
- Approximate power of a child is 1/6 of a horsepower therefore total installed conveying power of 1/3 hp with 2 children on a single longwall.



# Variable Speed Drives on AFC's - A Brief History of AFC Time

## Early 1900's

- Introduction of Belt Conveyors onto the longwall coalface.
- 'Twist belts' as they were known were used to aid manual loading.
- Drive powers of around 15 hp.

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# Variable Speed Drives on AFC's - A Brief History of AFC Time

## 1950's

- Introduction of first Armoured Face Conveyor in the UK.
- Designs would utilise twin outboard chains.
- Drive powers of up to 50 hp.

## 1970's

- AFC's are becoming established as the machine of choice for longwall mineral clearance.
- Fluid coupling used to aid starting.
- Typical powers of between 60 hp and 120 hp.



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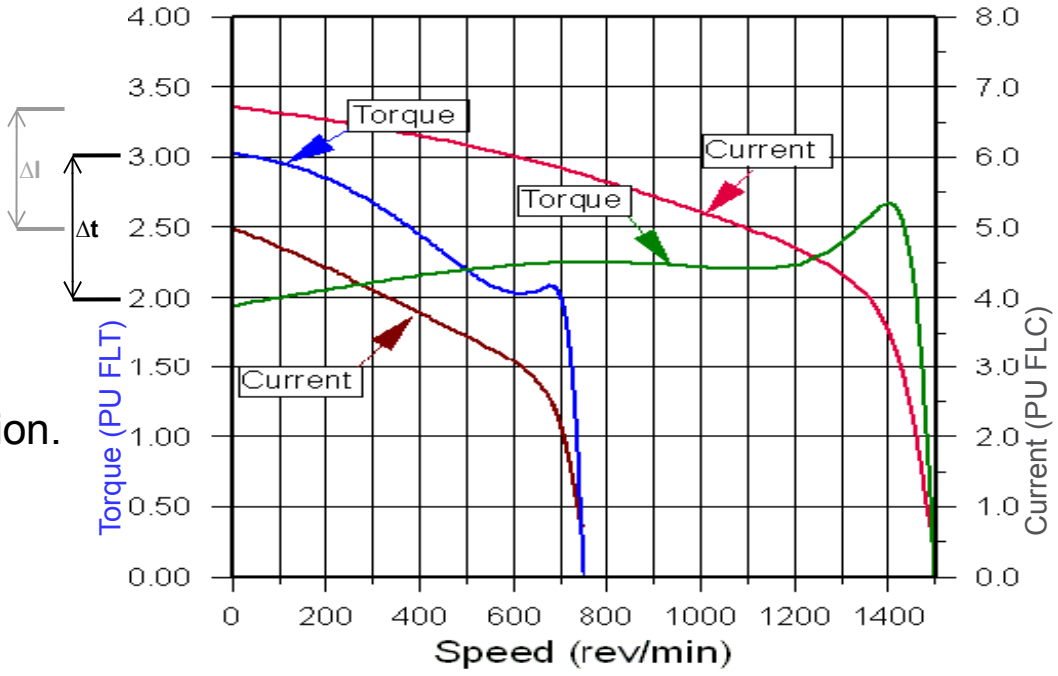
# Early 1990's

- Fluid Couplings were well established as the primary means of starting AFC's.

- Motor powers of up to 700 hp were used.
  - Robust power supplies required in order to handle large starting currents.
  - Multiple motor applications now possible.
  - Higher voltage motors become a necessity in order to be able to keep up with increasing power demands.

# Mid 1990's

- Increasing power demands lead to the use of 2 Speed motors started in 'Wye' / 'Delta' as a high torque, low start current solution.
- Systems still require multiple motors to start simultaneously so power systems still require high starting current capabilities.
- Typical starting torques increase significantly with the introduction of the 2 Speed, 'Wye'/ 'Delta' Started AFC Motor.
- Fluid couplings are not used with this configuration.



# Late 1990's

- JoyGlobal's Turbo Transmission Technology (TTT) Controlled Fill Fluid Couplings introduced to the market.
- Independent starts of large AFC Motors becomes possible.
- From this point the limits on AFC motor sizing change significantly.

- Power Supply system requirements relaxed significantly.
- Joint development with partners Voith.
- Power transmission up to 2400 hp and 13,650 Ft.Lbs at 1800 RPM.

# Mid 2000's

- Variable Speed Drive (VSD) is developed for use with AFC's.
- Low Voltage option only (1000V).
- 670 hp Max installed power.
- Very low current drawn on start but limited by range of output powers available.

# Late 2000's

- 11,000V AFC Motors developed at 2175 hp and used in Australia.
- ⅓ Reduction in current requirements at full power over the 3,300V Alternative.
- Very high torque motor with high torque ratio down to pull out speed.
- Significantly reduced losses within the power supply system particularly to the TG AFC Drive.

| Load (%) | 3300 V / 1600 kW | | | | | 11000 V / 1600 kW | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Efficiency (%) | Power Factor | **Current (A)** | Speed (Rev/Min) | Torque (Ft.Lbs) | Efficiency (%) | Power Factor | **Current (A)** | Speed (Rev/ Min) | Torque (Ft.Lbs) |
| **100** | 97.7 | 0.893 | 320.9 | 1493 | 7543.5 | 97.4 | 0.842 | 102.4 | 1495 | 7533.5 |
| 75 | 97.8 | 0.859 | 249.7 | 1495 | 5651.6 | 97.3 | 0.8 | 80.9 | 1496 | 5646.1 |
| 50 | 97.6 | 0.778 | 184.3 | 1496 | 3763.9 | 96.8 | 0.703 | 61.7 | 1497 | 3761.4 |
| 25 | 96.4 | 0.554 | 131 | 1498 | 1880 | 94.6 | 0.474 | 46.8 | 1498 | 1879.5 |
| No Load | - | 0.02 | 109.1 | 1500 | - | - | 0.026 | 41.4 | 1500 | - |

# Variable Speed Drives on AFC's - A Brief History of AFC Time

## 2013

- JoyGlobal AFC Commissioned in Dahlgren, IL, with over 5000 hp installed.

## 2014

- 4160V Fully integrated VSD's Released to the market.
- Sizes range from 670 hp to 2150 hp allowing full range of AFC's to be catered for.


## 2015

- AFC's now available at over 6,500 hp with 1 ¼ Million Ft.Lbs at Sprocket.



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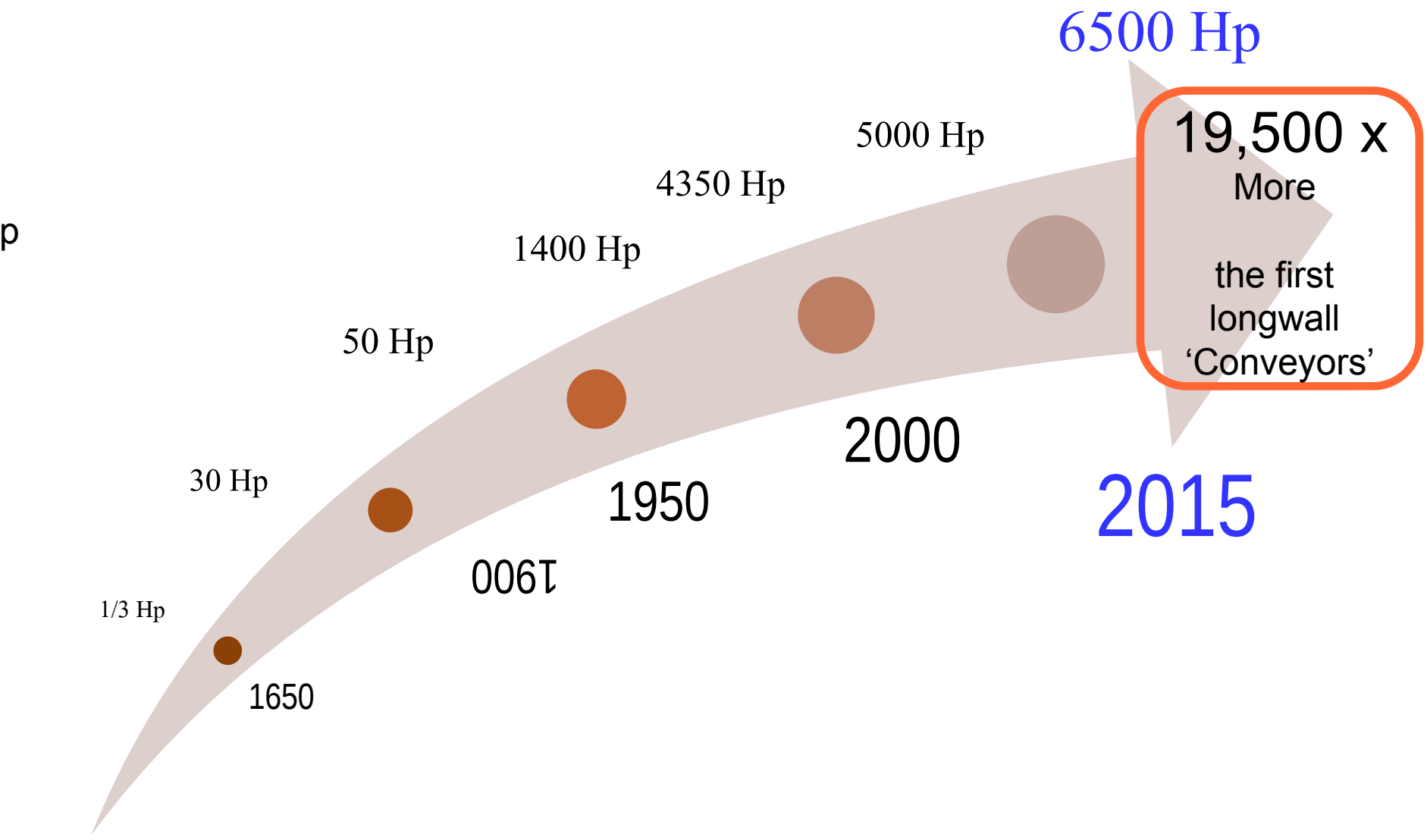
# Variable Speed Drives on AFC's - A Brief History of AFC Time



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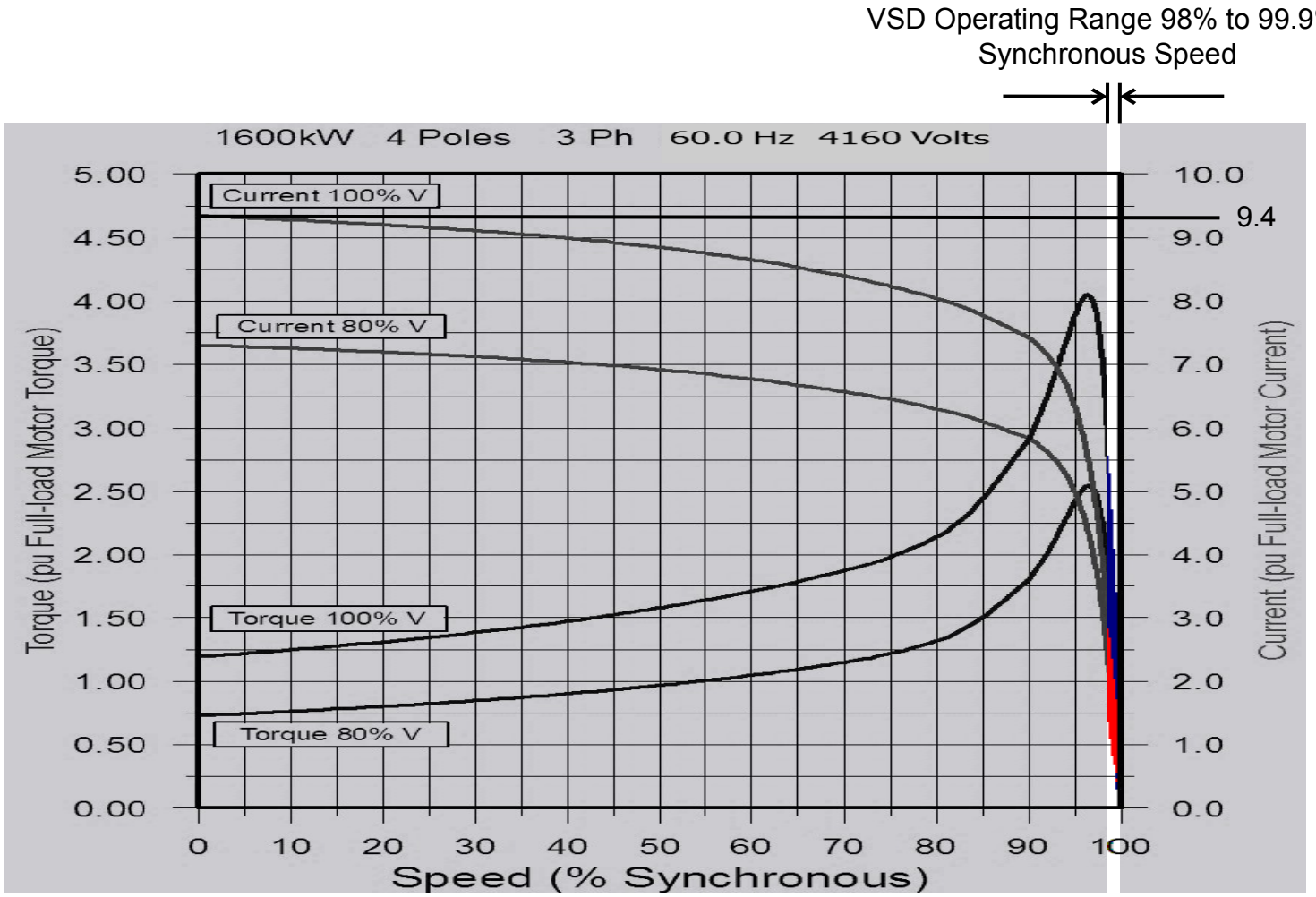
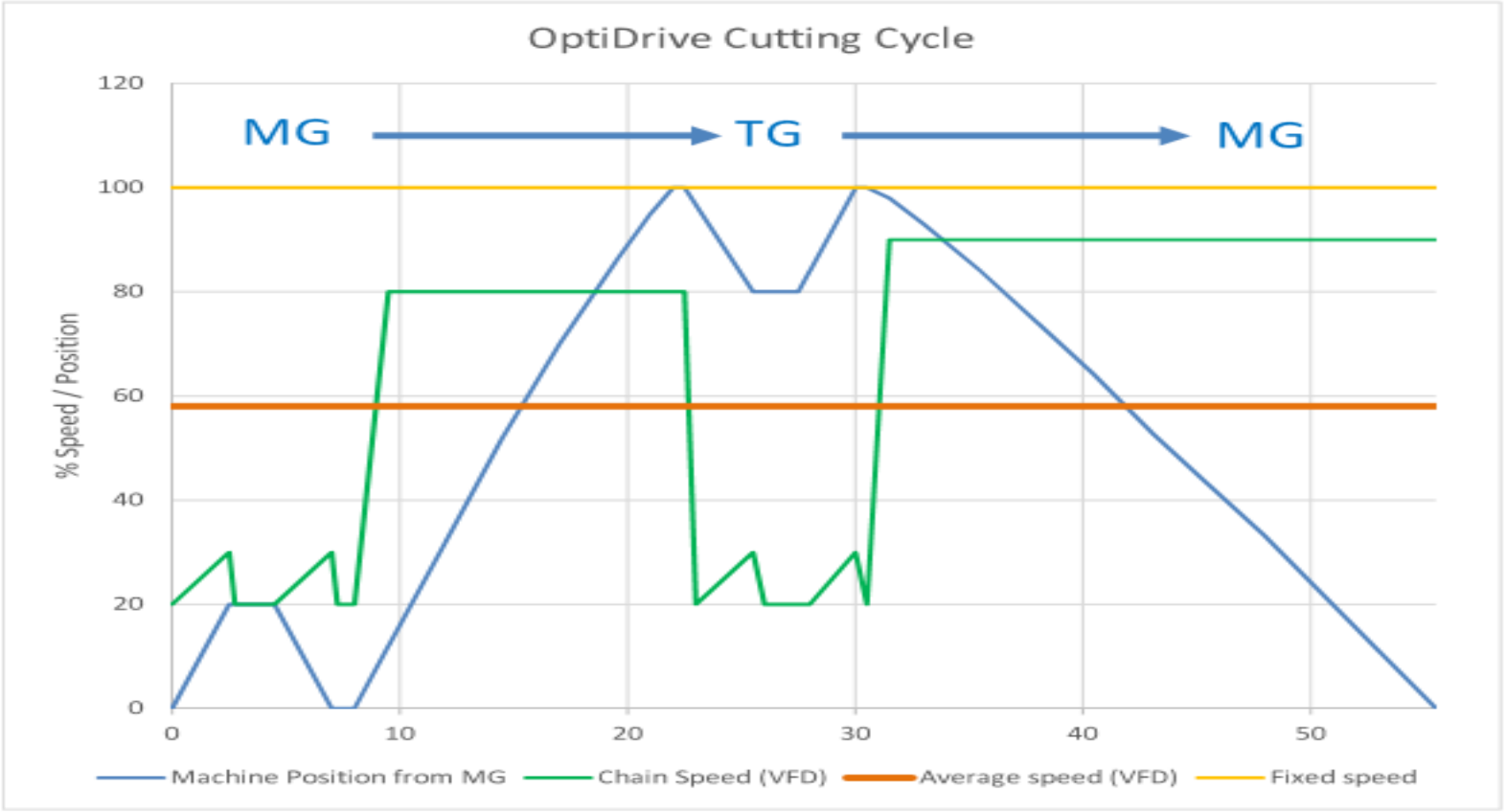
# VSD Technology and Benefits to AFC's

# Fixed Vs. Variable Speed - Current Demands



# Equipment Wear Life Improvement

- Intelligent speed control can reduce AFC Chain travel by up to 40%



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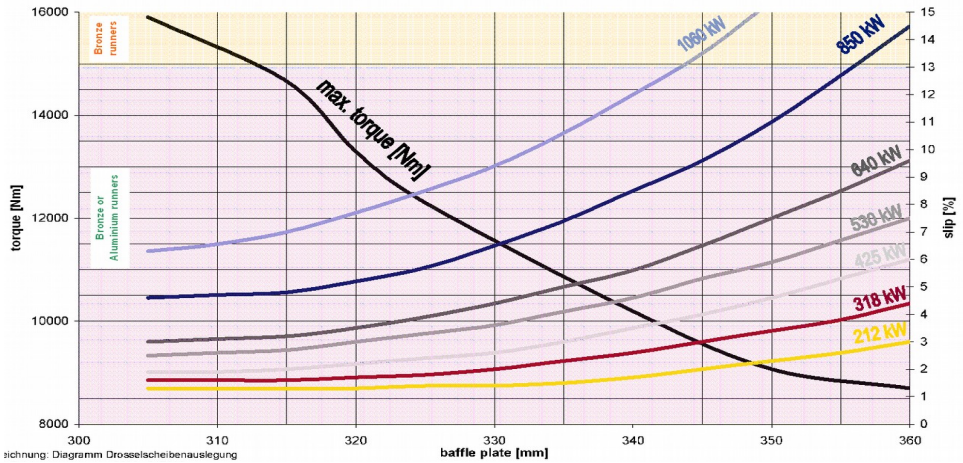
# Efficiency Improvement

- No requirement for active slip couplings within the drive system.
- Overall efficiency improvements of over 20% are possible.
- No heat build up in couplings therefore lower cooling water requirement.



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# Further Benefits

- Full torque availability throughout the speed range.
- System overload protection.
- Longwall output flow metering.
- Low maintenance requirements.

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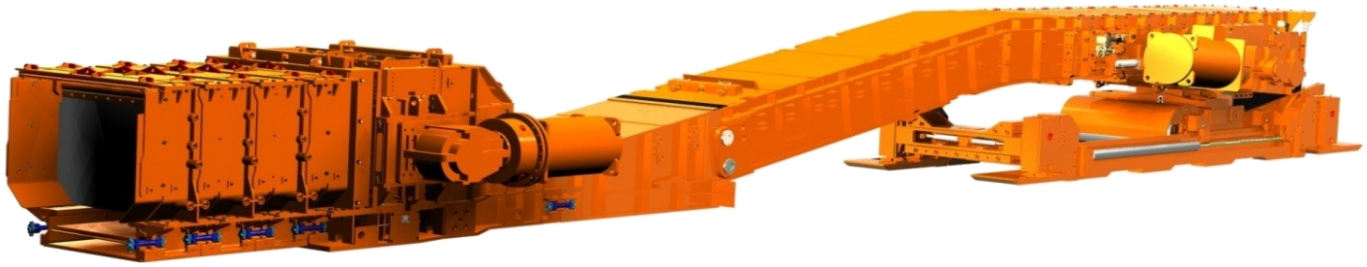
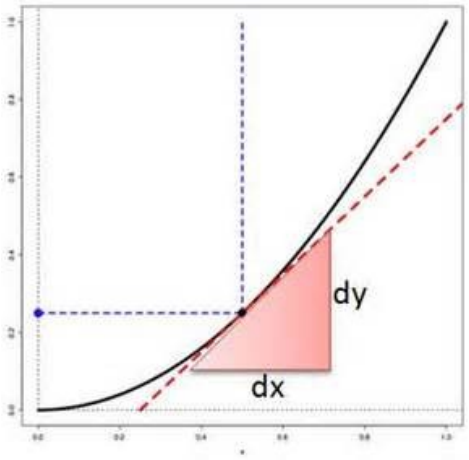
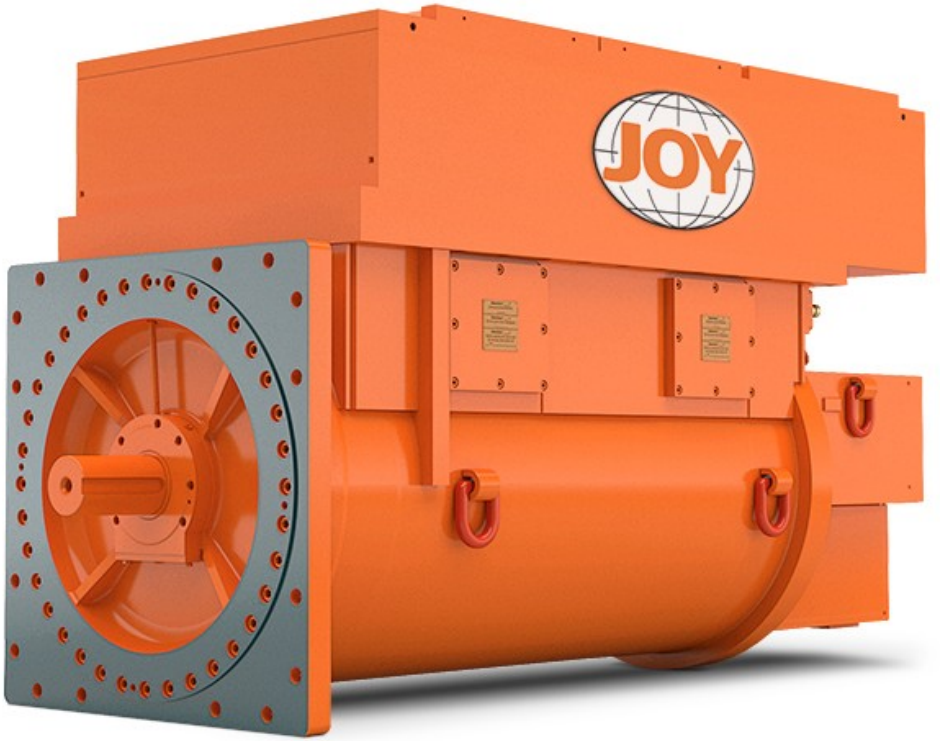
Armored Face Conveyor
OptiDrive Technology



# Monitoring



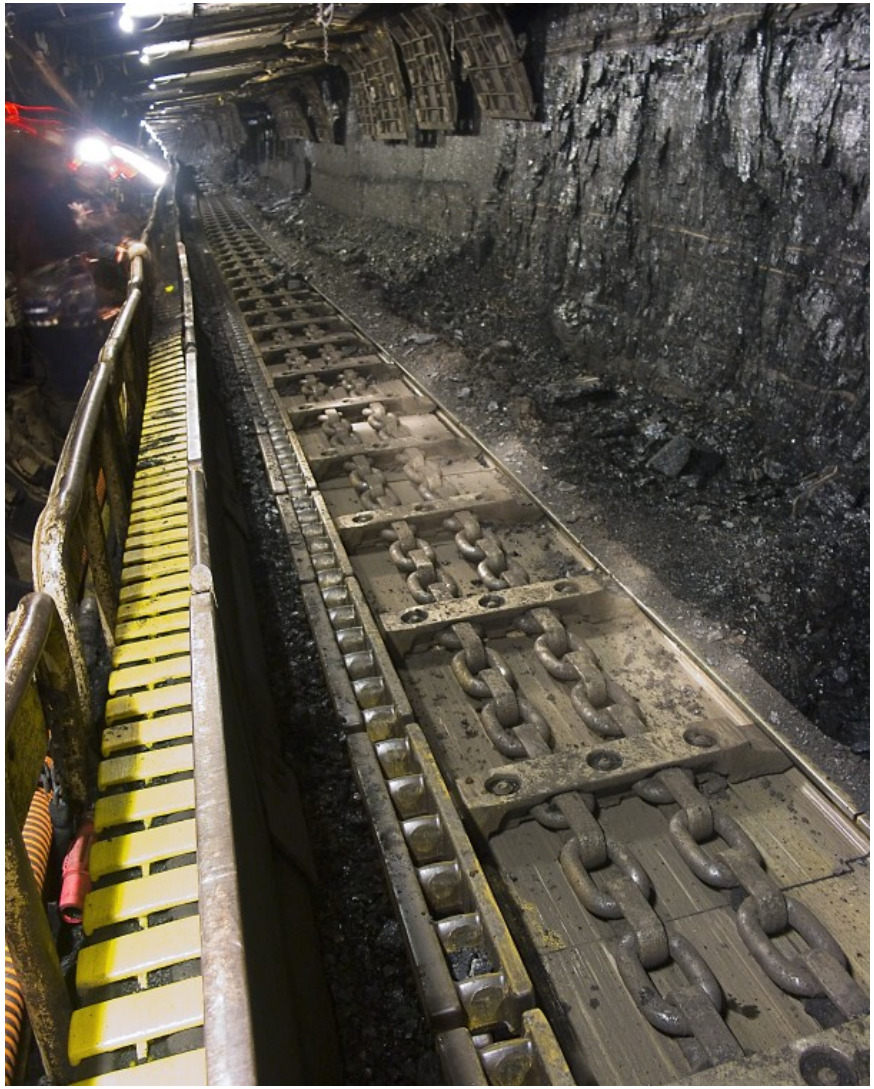

- Integrated Type = Closed loop control & High degree of speed and torque accuracy.
- Independent Type = Open loop control, Estimated speed & torque.




- Torque rate of change monitoring used to detect jammed or broken chain.
- Rapid fault intervention and removal of power within 300 Milliseconds.

# Maintenance

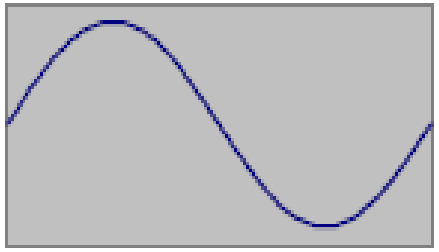
- Continuous run chain inspections made possible.
- Touch positioning of AFC Chain.
- Instant reversibility of AFC Chain.
- Live interactive AFC Chain mapping.
- AFC Chain positional awareness making selective chain parking a reality.
- High torque 'Event' capture.



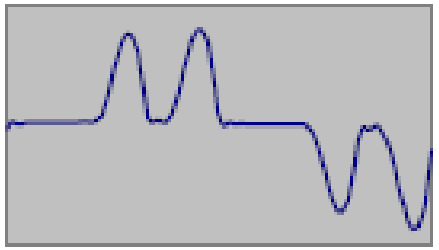
# Challenges associated with VSD's

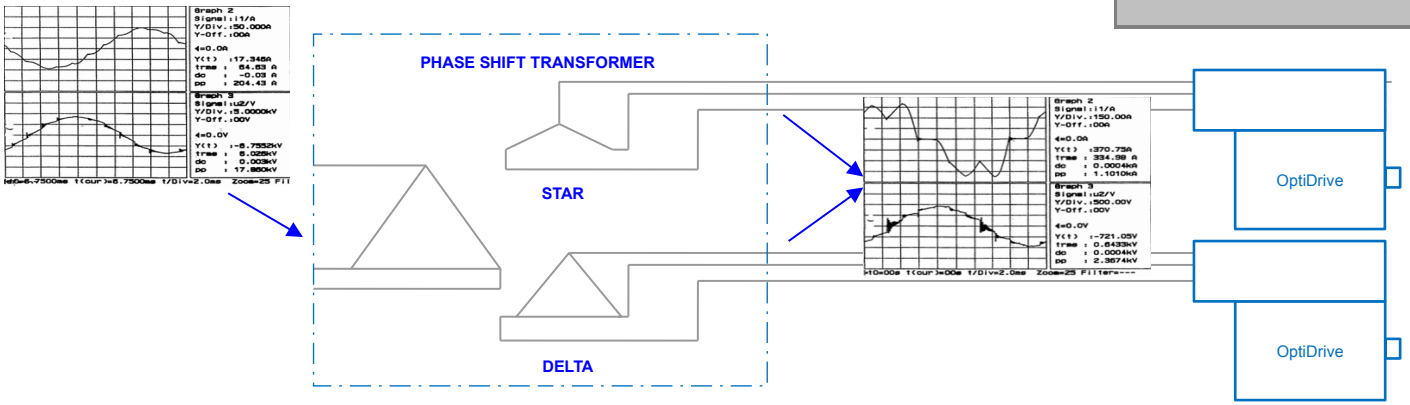
- Non-Linear loads sometimes require power conditioning by use of 30° Phase Shift transformers.
- Independent systems may need special motor cables to prevent over voltages breaking down insulation.
- Independent systems may require additional screening of their motor cables to prevent electromagnetic Interference with communication systems.

**Supply Current - Linear Load**



**Supply Current – Non-linear Load**





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# Summary

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**Presentation by;**

**Gareth Rimmington**

*Thank you*

*"A Thing of Beauty is a Joy Forever"*

'Endymion' – John Keats