# PowerCentre's; an Engineering Solution for the Next Generation

**(By permission from Author)**

## 1. Executive Summary

Historically, the coal mining industry has been using Explosion Protected Apparatus (EPA) based on concepts that are 30 to 40 years old (flame proof equipment). This older generation concept is also based on skilled labour that greatly rely on actual skill levels of artisans, and should someone not follow correct procedures, high risks are introduced. Pre-installation of conventional equipment is labour intensive and exposes labour to high risks based on:

- High labour hours to install.
- Large weights involved.
- Exposure to medium voltage and low voltages present when all interconnections are done between the different equipment.

Hence a change is required in the industry, "how we did things to date" is not good enough anymore and a complete rationalisation's required for EPA for the next 30 to 40 years in the coal mining industry. The coal mining industry has made a giant leap and is currently the leading end-user to actively contribute to optimise innovation for the next generation.

The PowerCentre concept combines improved safety focus, best practice, highest equipment specifications, limited skill resources and best cost into one package. This adds value, and in this case, with an "extreme high" impact.

## 2. Introduction

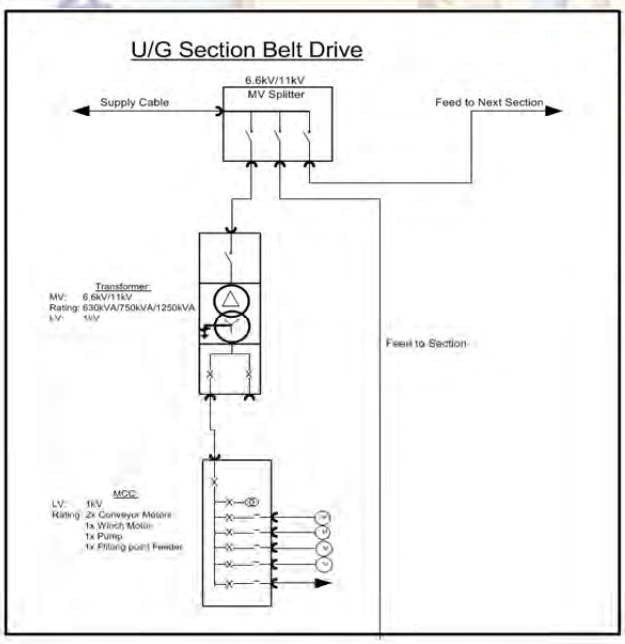
EPA for a typical underground section in a coal mine consists out of the following:

- Section belt drive:
  - Medium Voltage (MV) switchgear also known as underground splitters.
  - Section belt drive transformer complete with MV switchgear and Low Voltage (LV) switchgear.
  - Motor Control Centre (MCC) or Gate End Box (GEB) to stop/start the conveyor motors.
  - Program Logic Controller (PLC) or outstation (microprocessor based dedicated belt drive unit) to control the section belt drive. All safety devices and communication systems are routed through this node.

Installation of the equipment requires high labour hours and with the amount of work required, exposes high risk. Movement and placement in the normally tight space dedicated for the substation underground also poses a significant high risk based on the general weight of the equipment.

The concept of the general belt drive layout based on an aged technology has also contributed to the cause of concern and in general does not meet today's demanding safety focus to try and mitigate all risks present.

Through an innovational approach, a fresh view to understand what the actual needs were, had to be introduced and this was




Typical U/G Section Belt Drive Layout

- All equipment is either mounted on trailer or skid.
- Actual installation poses high risk due to all interconnections required.
- 3 x Trailer or Skid installation. Requires large machines to move in small space.

the birth of the PowerCentre concept:

- To mitigate all risks.
- To address all issues relating to artisan skill level.
- To minimise possibility to open equipment live.
- To reduce failures and extend Mean Time Before Failure (MTBF).
- To reduce installation time requirement.
- To optimise costs.
- To include all Mine Health and Safety Act requirements.
- To comply with all directives issued by the Department of Mineral Resources (DMR).
- To reduce certification requirements of equipment as dictated by regulation.

This was by no means an easy task as the industry is "set in its ways" and perception of how "things are done", needed change.
It took a lot of man hours to persuade any buy-in.

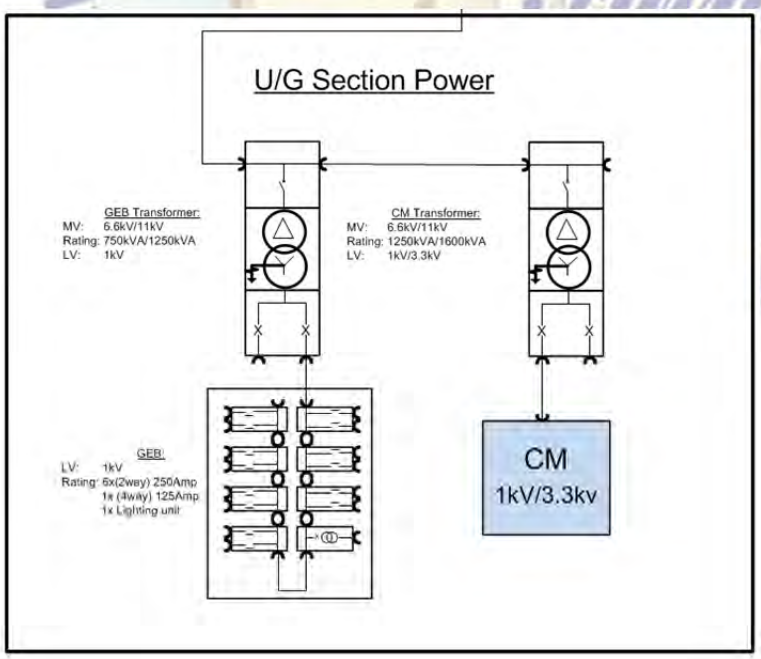
No standard or any specification existed and had to be generated to ensure correct designs and concepts are followed to achieve the expected results. A safety performance specification was generated and this was also different in terms of how things were done. To achieve the needs listed, equipment specification had to be good and the actual concept dictated a complete new equipment requirement that does not yet exist. Underlying concepts were outlined as a "must" and no compromises were to be acceptable:

- "Safe by design".
- Incorporate "state of the art" technology.
- Best practices followed.
- Comply with all available standards.
- Ensure all practical aspects are incorporated.
- Add value on all aspects (safety, reliability, functionality and costs).
- Multi-functional design. Must be easily expandable.
- Must be multi-application based.
- Must cater for the ever needed higher power demands.
- Include environmental equipment, PLC and communication systems as a total package.

Section power requirements inside the hazardous location must also be included into the concept. Conventional section power that powers the Continuous Miner (CM) and other machines are as follows:

- Underground Section:
  - GEB transformer MV Switchgear (6.6kV/11kV).
  - GEB transformer (750kVA/1250kVA).
  - GEB transformer LV switchgear (1kV).
  - GEB trailer with GEB's installed to power all 1kV machines.
  - CM transformer MV Switchgear (6.6kV/11kV).
  - CM transformer MV/LV secondary switchgear (1kV/3.3kV).

Equipment in the section can also be trailer or skid mounted depending on the specific standards used by the operation.

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## 3. PowerCentre Concept

*What is this? Why is it different?.....*

The PowerCentre concept in terms of a definition is nothing new. Current transformers that have a MV primary side, transformer and LV secondary side is already classed as one PowerCentre configuration.

***Definition:*** A PowerCentre consists out of;

- Primary switchgear.
- Transformer.
- Secondary switchgear.
- All combined as one unit.

*Note: LoadCentres must not be confused with PowerCentre's. A load centre is supplied via a feeding cable and not directly from a transformer.*

Differences are based on how the three main components are put together, this is what is new.

*Why must we have three separate trailers/skid mounted equipment whereas all can be combined into one unit?*

To add value, the concept must be expandable and to control costs, enclosures and lay-outs must be multifunctional. This means that the configurations used at the section belt drive must be similar with the section switchgear. All cables connected to the PowerCentre are now protected. This is a major improvement over the conventional way of providing power to underground sections.

Training of mine personnel is also made easy as the interface and display have been kept standard by utilising existing equipment, thereby improving "system overview understanding" and acceptance of the PowerCentre concept.

To understand the concept, the following drawing will shed better understanding to grasp the concept.

### 3.1 Conventional section layout vs PowerCentre layout (see Figure 3)

The design is also extremely compact as that the Power Centre units must fit all operational requirements especially where size and height limitations are mandatory. Current conventional non- EPA belt drives are alone > 6 meters. The complete PowerCentre length is limited to 6 meters.

- MV switchgear can be configured from one to three way.
- Transformer combinations can vary from single to dual wound transformers with different secondary voltages.
- Secondary switchgear can vary from 1 to 12 circuits @ 250 Amp for belt drives and 1 to 16 circuits @ 450 Amp for the section.
- Due to the possibility of using 1600kVA transformers, fault levels are very high and all options are based on 31kA fault levels to ensure correct operation for a considerable number of years. This is a 200% improvement on current equipment.

### 3.2 Other uses

Although the PowerCentre concept was initially developed for section and belt drive switchgear, applications are not limited and the concept can be used for all points of supply and even on surface installations.

Current conventional trunk conveyor installations are based on fixed substation layouts. Based on annual electrical audit results, these installations are always a concern due to the arduous conditions equipment are exposed to and the fact that "fit for purpose" equipment are not available. Buildings of fixed U/G substations are very expensive and the timeline to build the substations are not acceptable.

PowerCentre's are also the answer for this seeing that EPA specifications are more suitably rated for the arduous conditions encountered at these installations.

Non-EPA PowerCentre's can also be designed to reduce the initial costs compared with EPA certified PowerCentre's. However, ingress protection must be rated at an IP 65 level. (Please take note that EPA equipment is generally in a better state compared with Non-EPA equipment).

## 4. Conclusion

The first PowerCentre is currently installed and in operation at a coal mine in the Witbank area. Feedback from mine personnel is in favour of the new design and the introduction of the first unit went extremely well.

As the new concept gets a wider acceptance in the industry, more configurations and options will be introduced to cater for all operational needs. However, it is important to rationalise on standard best practice options to ensure spares and standby units will be able to operate should a problem arise.

Equipment used inside the PowerCentre's were specifically rated and specified to ensuring high safe operating hours over the expected life is achievable.

The need to prevent a person from opening any equipment is very high to prevent unnecessary "fiddling"/tamper with components that is functioning as intended, this will extend the reliability of equipment and again special focus was placed on this aspect of the specifications and design (finger problems).

Equipment must withstand all types of electrical and mechanical abuse and faults during its operating life. Special focus was put on "fit for purpose" equipment thereby eliminating all risks experienced to date on conventional equipment.

At this stage, it is clear that a winning solution for the coal mining Industry is on the table and it will be discussion points for a number of forums based on the value add that PowerCentre's brings to the industry.

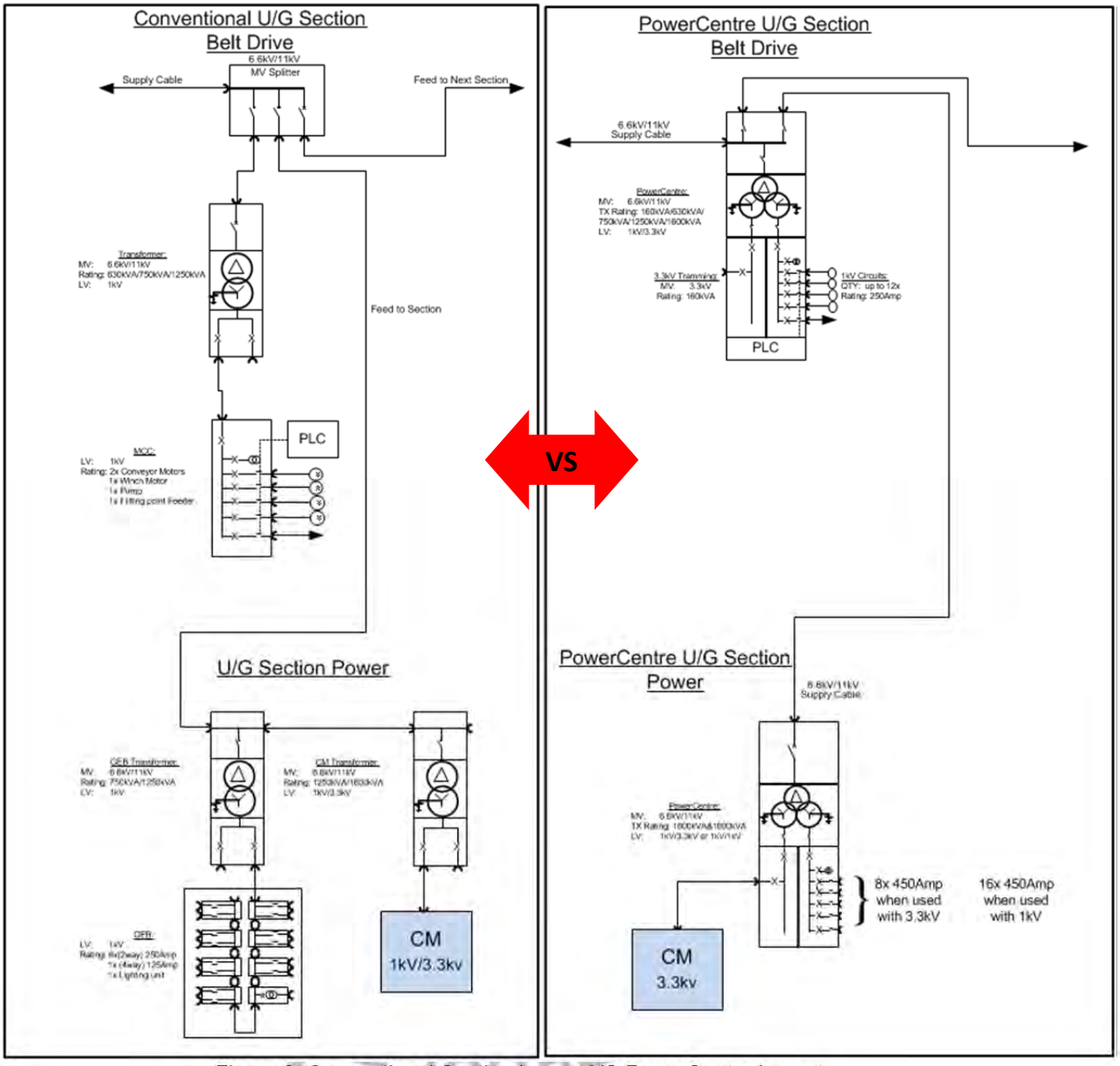


*Figure 3: Conventional Section Layout VS PowerCentre Layout*

**5. Image library - Current belt drive switchgear**

Current belt drive switchgear installed consists out of:

- MV splitter unit.
- Belt drive transformer.
- MCC or GEB belt starter and;
- PLC.

*Figure 4. Photo of splitter*

*Figure 5. Photo of transformer*


*Figure 6. Photo of MCC*

*Figure 6. GEB units used at belt drives*

**6. Image library - PowerCentre**

The following photos are based on a Single MV primary supply breaker, dual 1600kVA (11kV/1kV/1kV) and 16 Secondary circuits for a complete production section:

- MV primary.
- Dual wound transformer.
- Secondary circuits.

*Figure 7. Photo of complete PowerCentre*