7-Star Engineering

SVCs FOR EFFECTIVE MINING

Mining requires electric power. Power for coal cleaning and coal preparation. Power for offices and washroom facilities. Power for battery charging. But the largest and most critical power requirement is for underground mining operations.

Effective mining operations means safely extracting the coal from the coal seam and bringing it to the surface as quickly and efficiently as possible. Underground power requirements quickly become a limiting factor at three different points during mining.


SVC Serves Entire Site

Power first becomes the limiting factor when a mine portal is being planned. Mine entrances need to be located where the seam is close to the surface and space exists to build and operate the portal infrastructure. The existence of power company infrastructure is afforded limited consideration during the siting process. Subsequent requests to a utility to serve a planned mine portal are often met with expensive utility construction charges, extended times, and limitations on the size of the motor loads allowed.

Available power also has a direct impact on underground production at the mine portal. Often, rural locations mean “soft” power circuits. The “softer” a circuit, the more voltage will dip in response to a conveyor starting or continuous miner motor loading up as it bears into the coal seam. This has a compounding effect: first, as the motors try to apply more torque, the current will increase, causing the voltage to drop. Then the torque supplied by the motor drops in proportion to the square of the voltage sag (V^2). Typical in-mine electrical systems are set to trip at 80% voltage: by the time a trip occurs, the cutter head motors are providing 64% of rated horsepower—or less. All this happens so fast that conventional voltage regulators and cap banks don’t help.

As mining continues, the distance from the entrance to the coal seam increases. Power delivery to the underground equipment is limited by both the utility power (to the mine entrance) and the underground cables (from the mine entrance to the face of the coal seam). Frequently, power availability at the face becomes a limiting factor. This presents two expensive options: opening either a new portal or a new power entrance, closer to the face.

Mine operators have come to accept decreasing productivity and increased costs due to “soft” power systems and extended underground cabling. But an alternative is available to offset initial service, voltage dip, and long power cable issues.

SVCs

SVCs (Static VAR compensators) keep motor voltages constant by analyzing the amount of power a “load” (mine motors) is drawing, and adjusting at a rate of 60 times per second. In addition to avoiding under-voltage circuit breaker trips, an SVC also effectively increases shredder motor horsepower. Because, while mitigating utility flicker and in-mine voltage sags, the SVC prevents loss of motor horsepower (torque).

Utility benefits

- Stop flicker.
- Lower service cost.
- More site power.

⬅ SVC Advantages ➡

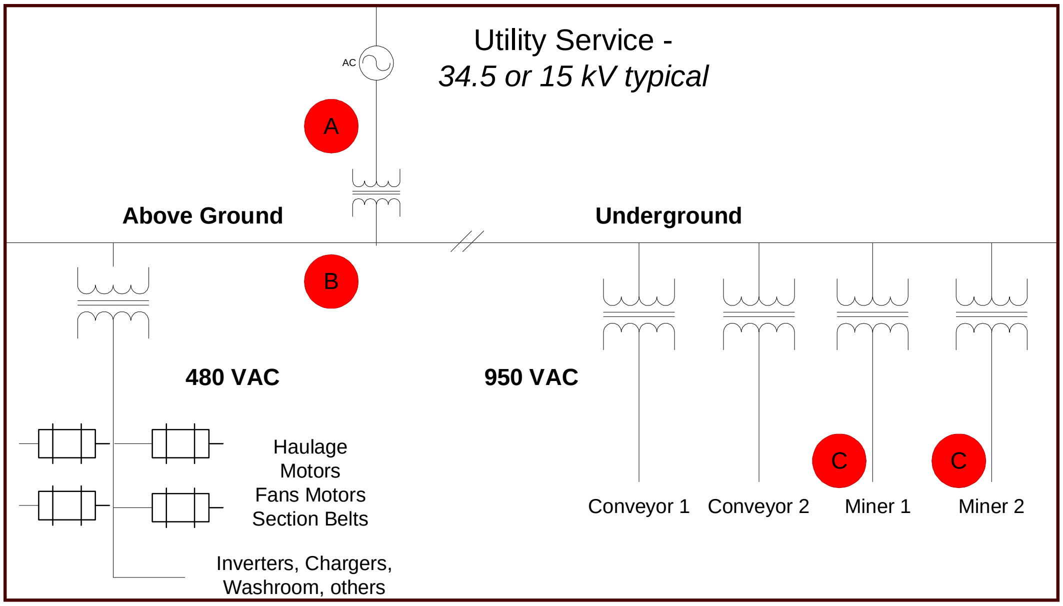
Mine benefits

- Stable voltage.
- Higher effective HP.
- Faster site build.

SVC Placement and Benefits

The electrical layout of a typical mine shown below. Distribution voltage electric service is taken from the local power company. Power is then transformed onto a medium voltage customer bus. Above ground facilities (fans, pumps, haulage motors) are served from a secondary transformer that steps power down to 480 VAC. Other aboveground services—inverters, chargers, day office, washrooms - are served at lower voltages, stepped down from either the 480 volt bus or directly from the main customer bus.

Underground power is supplied directly from the customer secondary bus to load centers located close to the in-mine loads. There voltage is stepped down further for use by the major underground loads, primarily miners and conveyors.



SVCs can be placed in several locations, with varying impacts.

When placed at “A” above, an SVC protects the utility service from voltage flicker, but has the least ability to hold the voltage stable on the mine-wide customer bus. This is frequently the location requested by utility when an SVC is required.

Substituting an SVC at “B” for one at “A”, improves a mine’s ability to keep plant-wide bus voltage stable. “B” results in improved power factor (Decreasing transformer loading and possibly power bills) and results in better voltage flicker control than an SVC located at “A”.

If the locations of all large motor loads in a mine were fixed, “B” is normally the best location for a mining SVC. But as mining continues, the cable length between the surface and the underground equipment steadily increases. Cable impedance increases with length: eventually, even with an SVC-provided stable surface voltage (“B”), the voltage drop through the cable becomes so large that it becomes impossible to run miners at the coal face.

By placing additional small SVCs at “C” the impact of the cable impedance can be reduced significantly. Located this far underground, (“C”), these SVCs do not entirely eliminate the need for an SVC at “B” (although they will reduce its size): but they provide nearly constant voltage at the coal face. Mine operators achieve two benefits from these SVCs:

- Voltage (and productivity) remains as high as it was when mining near the portal.
- Mining is possible farther from existing portals before creating new portals or building new surface substations.

Power Considerations for New Mining Sites:

1. What quality of electrical service is presently available at the site? (*voltage, fault current, X/R*)
2. What power company flicker standards must be met?
3. What's the largest allowable motor without additional utility investment? (*What's the largest an SVC would allow?*)
4. What would utility investment cost and how long would it take? (*Without an SVC*) If done, what is the largest allowable motor? How much does the mine bus sag during operations?
5. What does an SVC cost? (*Typical 20 week delivery*) What is the largest allowable motor after SVC installation? How much does the mine bus sag during operations?

T-Star Engineering, based outside Pittsburgh, Pennsylvania specializes in helping power grid operators and power user-clients who need to place large "problem" loads on to power grids. Mine operators often find themselves in exactly this situation.

Mining SVC at Site Entrance.

T-Star is most effective when our involvement begins starting in the planning stages for a new mine. Involving T-Star later, when a facility is already designed, or when an operating facility encounters problems still provides real benefit to the operator, but "late stage" involvement sometimes results in higher costs and lower performance compared with early involvement.

Clients deserve a single entity willing to take "end-to-end" responsibility for power system planning and analysis, beginning with a "needs analysis" including a study of the utility power system and ending only when the mine is operating as designed and without complication. T-Star can perform all "end-to-end" functions required including power system analysis, solution development, manufacturing, commissioning, and training.

Substation SVC suitable for mining .

T-Star focuses on meeting the needs of the end-customer. Clients include power grid operators and end-user customers, as well as Architect/Engineering firms, and System Integrators. T-Star tailors client engagement ensuring that end-customer personnel are involved, familiar, and comfortable with the installed solutions. T-Star field service and support are only a phone call—an an internet connection—away.

If the problem proves to be flicker or voltage instability the solution may include designing, providing, com-

SVCs FOR EFFECTIVE MINING

Transient Power Problems

Over in a second, repairs can last for weeks

Power systems at mines are constantly changing. Inside the mine, motors turn on and off, cutter heads load and unload, and systems like battery chargers turn on and off. On the utility side, other customers, transmission activity, and cap banks affect the power system at the mine.

Sometimes the right combination of conditions spells disaster in the form of sudden power trips, damaged equipment, and unplanned downtime. Often there is no warning, and no "smoking gun" explaining what happened. The operator is left to absorb the downtime, repair the equipment, and wonder when it will happen again.

T-Star's extensive practical experience and power system modeling expertise can help. Modeling can identify probable problem causes. Practical experience can help interpret the model, then recommend and implement effective ways to prevent recurrence. For difficult or recurrent problems, T-Star can also install and maintain monitoring systems capable of actually catching transient events

missioning, and maintaining a T-Star Medium Voltage Static VAR compensator. If other issues arise, including steady-state power factor, current or voltage harmonics, T-Star will analyze, specify, and if requested, design, deliver, and commission the necessary solutions.

Since it's development in the 1990's, over 100 Medium Voltage SVCs have been installed at customer sites throughout North America. T-Star's principals have been involved in virtually all MV SVC projects. Customers and grid operators alike benefit from our extensive experience gained from dozens of installations and hundreds of application analyses.

T-Star designs undergo constant review to ensure that years of applications experience are translated into improving SVC performance and reliability while continually simplifying customer requirements.

WWW.TSTAR-ENG.COM

Road-Side Mining SVC

Steady-State Power Problems

"Mining's our business...Power is a necessary nuisance."

True, but it's a nuisance that affects the initial cost, recurring fixed costs and daily tonnage. No power, no mining. That makes it pretty important.

T-Star's expertise can be employed during the planning stages for a new mine to provide a robust, low-operating cost power system while reducing the chances—and severity of—future transient problems.

During exploratory and development stages of a mine, T-Star can evaluate the adequacy of the utility power and the help assess the options for mine-side equipment. Performing harmonic analyses during final equipment selection can minimize future transient harmonic issues, while concurrent load flow studies can ensure high operating power factors and stable steady-state voltages.

Finally, T-Star can automate power system operations to levels like mining operations, identifying problems before they become critical and eliminating the mysteries of transient failures.