OPERATING AN 8750 DRAGLINE ON DIESEL GENERATORS

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INTRODUCTION

Drummond LTD owns and operates Pribbenow Mine located in Colombia S.A., about 125 miles from the northern coast. This area has a limited infrastructure, which means commercial electric power is not readily available or is it a dependable system. As a result, the mine must have the capability of operating without incoming commercial power.

At the present time, the mine diesel generator system is the only electrical power source available to operate the mine equipment. As a result, the mine is being operated 100% of the time with the diesel generator plant providing 100% of the electric power. The total power plant is split into two separate systems. This was done to prevent pit-loading fluctuations from affecting the office facilities. One system is the surface facilities, which includes the train load-out and all buildings such as offices, living quarters, warehouse, and repair shops. The second system is pit operations, which includes the Marion 8750 dragline, Gardner Denver GD70 blast hole drill, DeMag H655E shovel, and many pumps. This paper covers only the pit operations system.

The design goals for the generator plant include the following.

- Fully automatic (no system operator required)
- Add generators automatically when the system requires additional power
- Capability to service any generator set when needed without effecting operations
- Capacity to start and run any load at any time
- Capability to synchronize and co-generate with commercial power
- Prevent pit power fluctuations, typical of those caused by excavators, from effecting surface facilities
- Prevent diesel under loading for extended periods
- Automatically adjust pit voltage to number preset with the operator interface unit
- All pit equipment is to operate without any detrimental effects or any de-rating
- The generator plant can operate without the need for a stored energy device

PIT EQUIIPMENT OPERATING CHARACTERISTICS

- Marion 8750 dragline – 21,575 KW at peak motoring with synchronous motor rotor control and MG set soft start
- Gardner Denver GD70 drill – 600 KW at peak motoring with 0.86 power factor
- DeMag H655E shovel – 2 X 1800 HP induction motors with onboard, fixed power factor correction capacitors switched with the motor contactors
- Pit pumps range from 95 HP to 450 HP with 0.85 power factor. Total pump connected HP is 2400.

GENERATOR PLANT CAPACITY

A total of fourteen generator sets are connected in parallel to provide sufficient peak power for the pit and provide extra capacity for generator maintenance. Each generator set has a CAT 3515B engine with a CAT 827 frame generator, and each generator set is dual rated at 1825 KW prime plus 10% (2000 KW standby). This design enables the system to run twelve generators with 24,000 KW peak rating and have two standby generators for maintenance.

Because the 8750 dragline is capable of regenerating up to 60% of peak motoring power, a six-stage resistive load bank was installed to absorb regenerative power, which is not being utilized by other mine equipment. The diesel generators can absorb a small amount of regenerative power, but the load bank is required to absorb larger amounts of regenerative power. When the generators are required to absorb an excessive amount of regenerative power, the excessive power is reflected in the system frequency increasing to an unacceptable value.

Generator control is accomplished by using a combination of load share modules and programmable logic controllers. The load share modules control load share (KW), and voltage control (KVAR/PF) between generators as well as provide synchronizing control for oncoming generators. The programmable logic controllers serve as the system master control and provide controls for the following areas.

- Control the number generators are running. This includes keeping the minimum number of generators on line and increasing the minimum number when pit conditions require more than the preset number.
- Control the load bank to prevent excessive frequency resulting from regenerative power that cannot be absorbed by the engines
- Provide an alarm system for maintenance to locate problems
- Monitor and take automatic action on all controls such as service switches, fault relays, alarm relays, analog power data, etc.

RESULTS

Figure 1 is a ten-minute time graph of the total pit operation showing pit voltage, pit power (KW), pit reactive power (KVAR), and pit frequency (X100 where 6000 = 60 HZ), with data being taken with a one second sample rate.

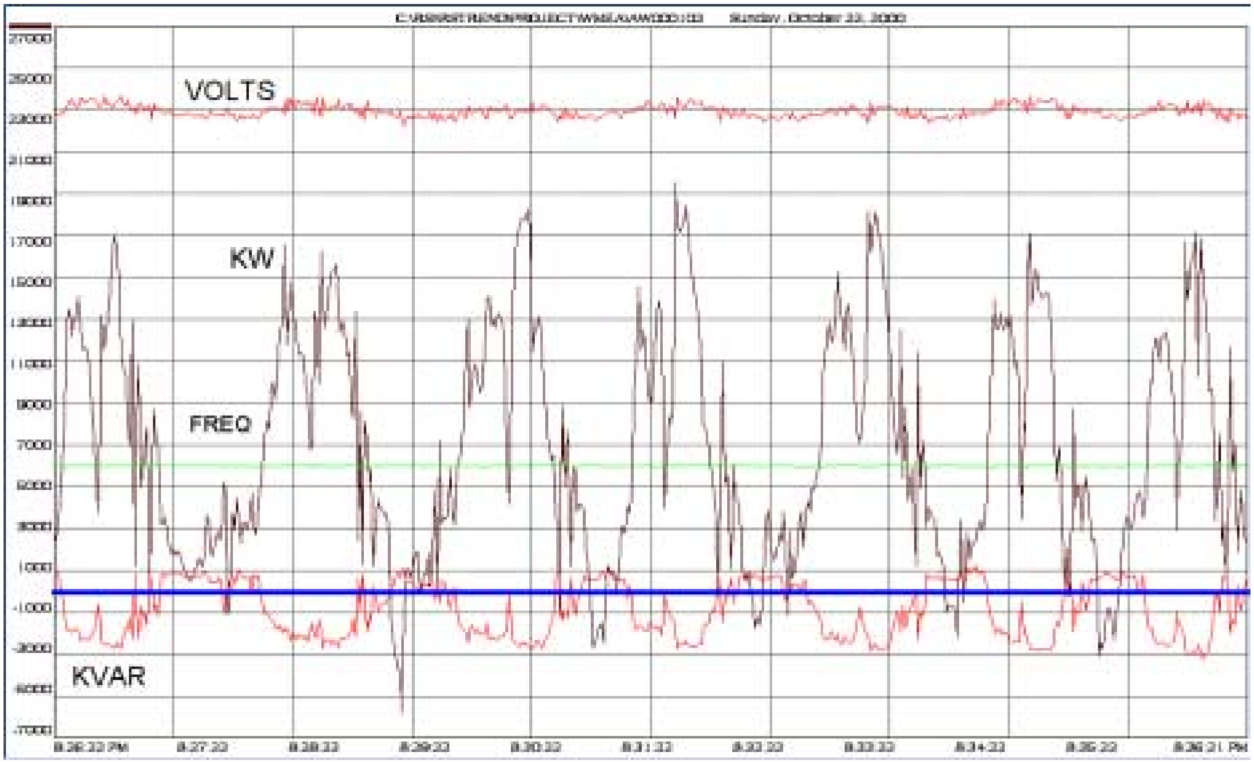

Figure 1


Figure 2. This is the same time base as Figure 1 with the frequency scale expanded.

The two numbers that must be maintained to make a successful pit system is a stable voltage and a stable frequency. The voltage variation, as shown in figure 1, is small and provides satisfactory operation and can be trimmed to give better results by adjusting the 8750 power-factor controls.

As shown in figure 2 the frequency range is between 59 and 61 HZ during this time period. The frequency variation is due to the combination of sudden load changes and response time of the generator engine.

OTHER CONSIDERATIONS

Operation of excavators, with their cyclic power usage, requires a case-by-case evaluation of electrical system design. The use of a stored energy method must be considered because it will smooth out the system power fluctuations created by the excavators and result in an energy savings.

Fuel consumption is the major cost for producing electrical energy with diesel generators and it can be viewed as gallons-per-KWH (input divided by output). Figure 3 is a graph showing how fuel consumption increases with a partially loaded CAT 3516B engine. Because of the high peak power requirement by draglines, as compared to average power, the percent loading will be about 30%. From the graph, the 30% loading consumes 0.076 gallon-per-KWH compared to the 100% loading consumption of 0.066 gallon-per-KWH. This is an increase of 15% over the best engine performance. A design goal should be closer to 70% loading to provide good engine life and to provide some extra power capacity with a fuel consumption of 0.069 gallon-per-KWH.

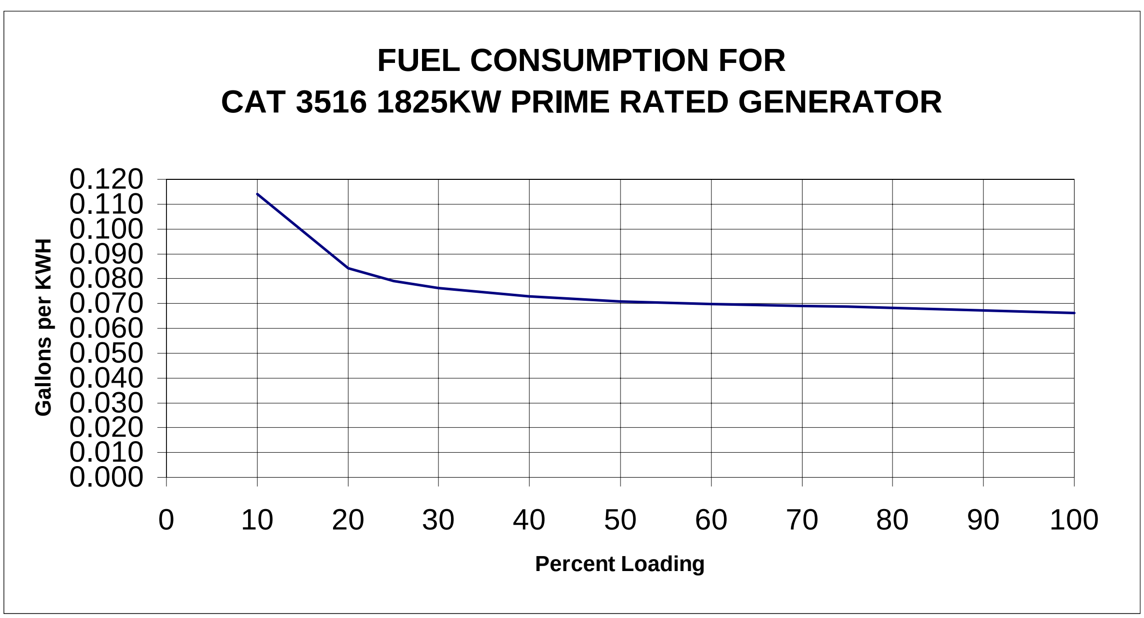

Figure 3.

In addition to fuel consumption being increased by a partially loaded engine, the constant power changes made on the diesel engines increase fuel consumption. The combination of partially loaded engines and cyclic power will make the fuel consumption considerably higher than the numbers provided by the generator manufacturer and must be considered over time to determine if a stored energy device should be used.

CONCLUSION

With the proper selection of generators and other associated equipment, large draglines can be operated directly with generators without detrimental operating effects along with other electric pit equipment. A direct drive system, as described in this paper, is cost effective when used for a short period of time or as a backup system.