POWER MAINTENANCE REDUCTION — A MIXED BLESSING

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Abstract

There has been much interest expressed regarding the reduction of the expense incurred with the maintenance of telecommunications power plants.

Technological advances in the Telcom business have drastically reduced the numbers of technicians in the central office. Since the smaller switches used less power, smaller plants were needed, and offices with a dedicated power room technician found that he was the first to be eliminated when the budget for technicians was cut. The switch technician must now maintain the power plant.

In similar fashion, when the office workload is high, power maintenance is a lower priority and is usually postponed, sometimes indefinitely. Frequently, this leads to catastrophic failures. Our most sophisticated electronic systems are capable of very little without power.

Accordingly, there is a cost to be incurred by maintenance, or by the lack of it. Non-functioning switches are very expensive when one considers possible hardware and software damage, the interrupted revenue streams, the restoral efforts of technical savants, and the administrative cost of failure analysis, and fault correction. These impressive expenses are only part of the picture. Sometimes neglected equipment suffers a shortened life, or becomes less efficient in the conversion of energy, thus, the lifecycle cost increases.

Balancing the cost of maintenance with the cost of neglect is a very unstable equation. Modern equipment and tooling is capable of taking some of the risk out of the seldom visited power plant whether it is remote, or in the next room. The purpose of this paper is to explore products and techniques which may reduce the need (or frequency) for periodic maintenance, while reducing the risk of plant failure.

Battery Maintenance

Batteries have traditionally required a high degree of maintenance. Conventional flooded electrolyte battery cells require periodic watering, and cleaning / tightening of the electrical connectors. Although several manufacturers have brought improved batteries to the marketplace, and called them "Maintenance Free", they still require periodic maintenance. Gas recombinant batteries simply aren't watered, and a diminished service life is tolerated in the name of reduced maintenance.

Some of the flooded electrolyte designs, such as AT&T's popular "Round Cell" (T.M. - AT&T) requires very little watering due to the low charge current required to maintain float.

Such designs, may well reduce the hours of maintenance, but do not present the entire battery maintenance picture. The connections must be retorqued, at least annually, and the battery stand may require service.

One might think that a totally maintenance free battery would endear itself to the technicians who must otherwise do the work. Perhaps, the most cheerful recipient of such a technology is the corporate officer who needs to reduce operating costs to compete in an aggressive telecommunications marketplace.

About the only realistic way I see of eliminating the retorquing of battery connections is to eliminate the mechanical conection. Present state of the art is still fairly old technology. Because copper has such an affinity for sulfuric acid, lead must be plated onto the battery posts and intercell connectors. Unfortunately, lead is a very soft metal which, over time, is squeezed out loosening the connection.

An annual recheck of the connecting bolt torque essentially tightens the bolt to fill the gap where the lead ran out by cold flow. To date, there has been little of value offered in the energy marketplace to deal with this problem. Belleville washers might help keep the connection tight by holding spring tension on the bolted joint, however, this might only extend the retorque interval by a year or so.

Eliminating the bolted connection might be possible by extending the post enough to accommodate an integral compression type lug barrel. The following figures offer some possibilities.

The first figure is a simple post extension which is machined round at the top, and bored to accept a cable. The bore would be factory treated with an anti-oxidation compound at the time of manufacture, and a hydraulic crimper would be used to produce a gas-tight crimp at the time of installation. The bolting surfaces below the crimp would be used for discharge capacity testing, single cell boost charging, or as a standard intercell connection point in the unlikely event that a crimped connection failed.

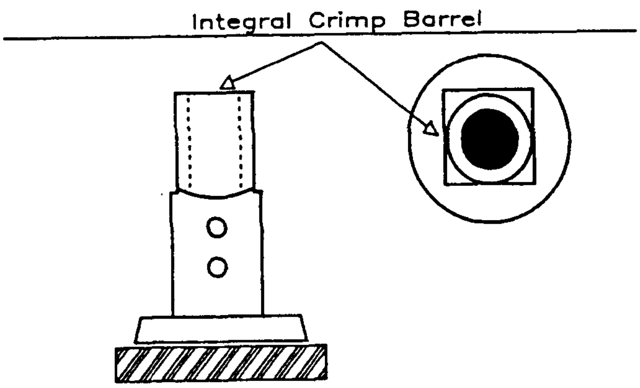

Figure1
Crimp Post - Vertical Barrel

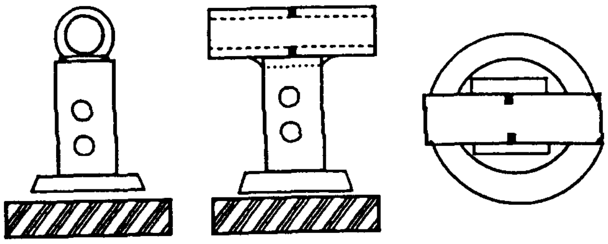

Figure 2
Welded Horizontal Lug

The second figure incorporates a lug barrel which is laser-welded on top of the post after the jar seals are installed. This design has the advantage of reducing the overall battery height. Also, the connector barrel could be crimped at either end. This design could accommodate two cables if high currents were anticipated, such as found with Uninterruptible Power Supply (UPS) systems.

Some battery designs incorporate a copper post embedded within the lead post. With this type of design, it might be simpler to fashion the copper element by making a cable "Prform" of copper cable to copper post, formed in a molding process, perhaps a casting or an exothermic mold. The preform would be embedded in the lead post and the connecting cable would protrude from the post, and would be conected to the next cable with a crimped parallel connector. Such cables could be routed out of the top of the post or the side as shown.

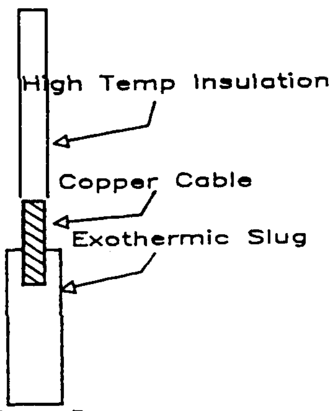

Figure 3
Post cable preform

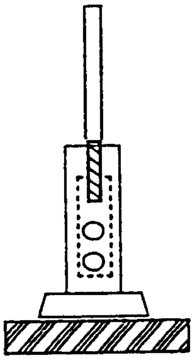

Figure 4
Preform embedded in post
(vertical orientation)

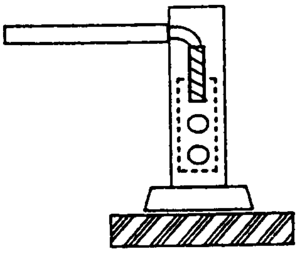

Figure 5
Preform embedded in post
(Right Algle)

It is recognized that all of the designs presented might make servicing the post seal more difficult. However, modern seal designs have proven to be very reliable.

It may be possible to weld intercell connectors to the battery posts in the field and, thus establish a permenant connection. Perhaps a technique similar to spotwelding could be employed, and a post head used to automate the process. The head would be slightly larger than a hydraulic crimp die.

Microprocessor governed controls would ascertain that the resistance was within acceptable limits before the welds were made. Air pressure or a screw type linier actuator would apply the proper pressure to the electrodes, and clamp the intercell connectors to the battery post for measurement and welding. Once the resistance was found to be within limits, the microprocessor would start the spotwelds one at a time. The process would only take a few seconds, and could ensure a lifetime of maintenance-free service.

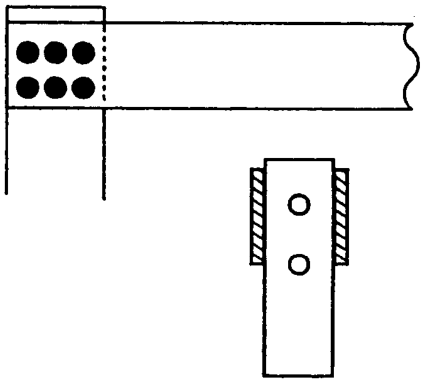

Figure 6
Spot welded intercell connection

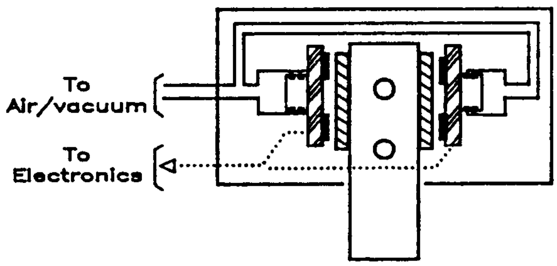

Figure 7
Functional sketch - weld head

Battery Stand

Eliminating the bolted connection leaves only the bolts on the battery stand to be tightened periodically. This is usually a manufacturer's recommendation which experience and prudence might supercede. On the other hand, there are stand designs which could eliminate this problem. AT&T Microsystems has fiberglass reinforced plastic stands for their "Round Cells". The stands are interlocked by means of keyways where driven wedges lock the stands together. American Bell Telephone Companies have been using these stands for approximately ten years and have enjoyed excellent service from them.

Aside from not having bolts, the stands are factory finished, and painting is not required, so electrolyte problems or scratches need no attention. The stands are an insulating material so safety is maximized. There are no bus to stand short circuits which can be dangerous in a telephone battery, and lethal in an UPS battery. Though designed for Round Cells, there is no reason why stands for other batteries could not be designed with these qualities.

Since the battery is so critical to telecommunications service, it might be a good idea to monitor the strings. In Eastern Pennsylvania, we are field trialing the addition of ammeter shunts to individual battery strings. The voltage drop across the shunts are monitored by analog points on a microprocessor power plant controller. Part of the design algorithm is a feature which identifies strings which are not contributing their share of energy to the load. Serious imbalances would exceed an alarm threshold and alert technicians who would attempt to isolate and correct the problem. Obviously, it is much better to fix a poor connection before the office fails. In this case knowledge really is power. Battery midpoint voltage is another tool which might help in the performance monitoring of an office. This isn't something I'd want to buy a bigger system for, but if a few analog points were left over in a monitor system, this might be a good way to use them, as the cabling costs would be minimal.

Increasingly, UPS systems are being deployed to protect the power which serves minicomputers used as operational support systems. There is a trend to use large molded case circuit breakers as the feed to the UPS system. Unfortunately, such circuit breakers require "Multi-Amp" or load testing every three to five years. Such testing takes the system off line, and generally is expensive. Perhaps it is time to rediscover an old friend; the fused safety switch does a credible job of protecting UPS equipment, yet requires no periodic testing.

Engine Sets

Standby engine sets require a fairly high amount of maintenance effort, however this can be reduced to manageable levels with some planning. Smaller systems enjoy greatly reduced maintenance if the fuel tank can be located in the building. There is a severe penalty to be paid for buried tanks, in terms of water contamination, dirt, etc. These problems all but vanish with indoor tanks.

Some designs incorporate a fuel tank mounted below the engine in a sound attenuated package. This design allows the delivery of the entire system as a module. Some additional benefits include the fact that the cooling system is a meter or so above the floor line. Usually, this keeps leaves and other debris out of the system at the wall penetration. The prudent use of such designs should include double walled tanks to reduce a possible fire risk.

Modern control systems are able to perform routine engine runs without the need of a technician hovering over the gauges. Sometimes called "Hospital packages", these systems automatically run the engine when commercial power is lost.

These systems are also capable of performing routine exercise runs saving valuable technician manhours.

Another useful tool is the microprocessor monitor in the telecommunications power plant. Often, spare analog points can be used to monitor the condition of the engine start battery. A threshold can be set to alarm if the voltage drops to that point, and the battery can be serviced or replaced. The processor can also be programmed to 'Watch' for a certain voltage sequence at the start battery. For example, it may normally 'See' the float voltage from the trickle charger. This voltage should drop to open circuit just prior to a routine start. This item would identify offices where the technician forgets to turn off the trickle charger for a routine run, and avoids the embarrassment of learning that much of the engine start potential had been supplied by a charger which, of couse, is inoperative during a power failure (it really happens). Next, the voltage should drop, but stay above a threshold as the engine is cranked. Recharge is the next voltage, and finally, trickle is reapplied. The monitor would indicate any deviation from the normal pattern, and thus reduce the service risk of a poor starting system.

Telephone companies and fleet managers have long known the value of fuel and lubricant analysis. Properly used, these tools can greatly reduce unnecessary maintenance without risk. Care must be taken, however, to be consistent in the purchase of fuel and oil types so that the 'Benchmark' established by the laboratory isn't compromised by unknown additives.

There are limits to maintenance reduction however, even with all of these systems and maintenance aids in place, it would be very foolish to ignore mechanical machinery. There are still belts to tighten, coolant to add, etcetera. Neglecting these items can lead to the catastrophic loss of an expensiveengine system.

Summary

Maintenance expenses are here to stay. The challenge to the engineer is how to minimize these expenses within the constraints of jealously guarded capital money. Certainly, the time to consider new maintenance saving features on new work, or major replacements. At other times, system upgrades are driven in the wake of major failures when power is a fresh, if not burning issue. Hopefully, as technology develops, the cost of deploying labor saving power equipment will be reduced by mass production and competition. Controlling operational costs while ensuring system qualityand reliability is one of the key items contributing to a telephone company's bottom line.