AN END-USER'S EXPERIENCE WITH A COMPREHENSIVE PREVENTATIVE MAINTENANCE PROGRAM AND THE IOVR PROCESS

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ABSTRACT

XO Communications has always valued the benefits of dc power plant preventative maintenance. Inspections have been completed by in-house personnel as well as outsourced to service providers. In the past preventative maintenance inspections varied in frequency and quality. In September 2005, XO Communications began a regiment of semi-annual preventative maintenance inspections of our dc power plants and related batteries with an independent testing company. The method of procedure developed by XO Communications incorporated recommendations as set forth by the IEEE standards and recommended practices, and our own experiences with switched-mode rectifiers, ferroresonant rectifiers and valve regulated batteries. XO Communications primarily uses battery strings with 2 volt jars to support our 48-volt equipment. This paper does not try to determine the causes of low battery capacity, thermal conditions/runaway, or low/high internal ohmic values. Rather it examines the value of a comprehensive preventative maintenance program and the ability to correct these issues in the field. The dc plants are installed in temperature controlled environments with rectifiers approved for telecom applications. While it has been our experience that some batteries have attributes making them more desirable than others, this paper makes no endorsement of any battery technology or manufacturer.

RECENT EXPERIENCE

In an effort to maintain network reliability, XO Communications contracted a service vendor to perform inspections on our dc power equipment. Battery inspections included, but were not limited to: inter-cell connection resistance, ac ripple voltage, individual cell internal ohmic readings, individual cell temperature taken at the negative post, torque at connection verification, charge/float current, string and individual cell voltages, current on frame grounds, dc voltage from most positive cell to ground, dc voltage of most negative cell to ground, and a host of other data including cable/disconnect sizing, settings and sizing related to the rectification equipment. Infrared thermography was also used to scan the dc and ac power equipment and dc distribution.

In addition to the data captured in the field during the inspections there was a second important step in the process; report review and summary by the service vendor. The inability to analyze the readings taken in the field can negate the value of the inspection. Using data supplied by field service technicians, a service manager reviewed disconnect and shunt sizing, calculated an estimated reserve time (based on total battery ampere-hour and plant load), reviewed rectifier capacity and battery recharge capabilities, and battery condition. Battery recommendations were based on battery age, physical appearance, internal ohmic values, float current, operating temperature, and individual cell voltages.

In conjunction with the preventative maintenance program, battery recovery was also incorporated as a cost effective method to maintain network reliability. The process is referred to as Internal Ohmic Valve Recovery (IOVR). It has been XO Communications experience that the IOVR process can increase the service life of VRLA batteries.

#1 CASE STUDY OF BATTERY STABILIZATION AND RECOVERY

Battery: 24 cell XYZ (1,450 ampere-hour @ 8hr rate to 1.75 vpc)

One of the first plants identified with high float current and temperatures was located in the Washington DC area. The first inspection took place in October 2005. The vendor responsible for completing the inspections made an argument based on the age of the batteries (mfg 1998) and relativity good condition of the cell's exterior (no post seal leaks were evident and relatively low evidence of excessive positive plate growth), that they be allowed to attempt to recover and stabilize the battery.

The battery was immediately taken offline when the condition was discovered. The vendor returned two days later and performed a load test to determine the capacity of the battery. The battery was tested at the three hour rate to 1.75 vpc; constant current discharge of 369 amperes dc. The battery tested at 63% of rated capacity (see figure 1).

Using the internal resistance readings, a prescribed amount of distilled water was introduced to each cell. The pressure relief valves were replaced with valves with a catalyst attached. The battery was placed back online. Approximately two months later the battery was retested. The battery tested at 94% of rated capacity (see figure 1).

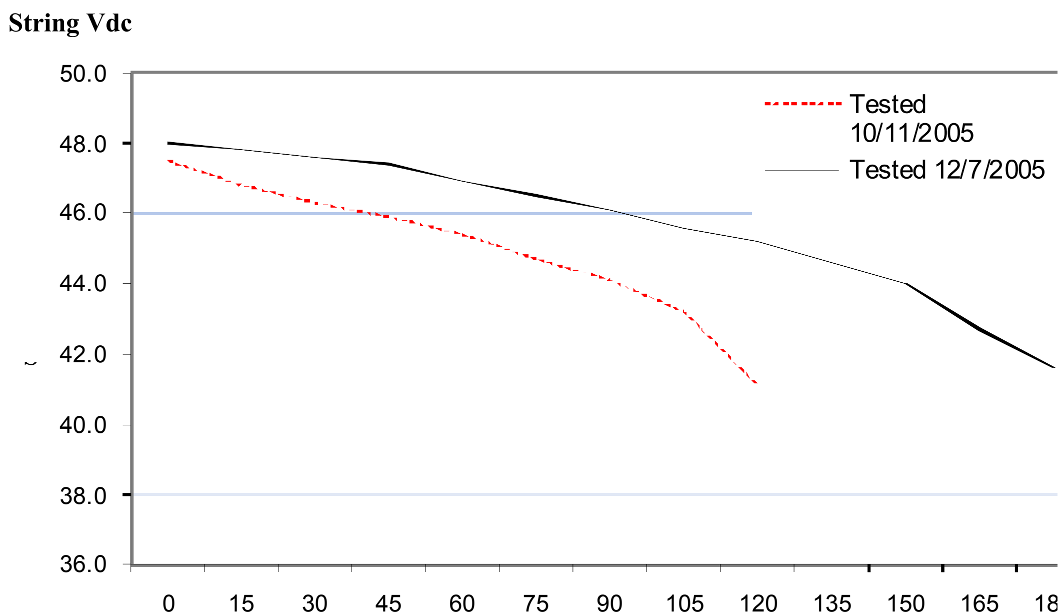

Figure 1

While additional load testing is planned for the battery, float current and conductance readings were being metered and recorded as part of the preventative maintenance program. The operating temperature and float current remained constant. While newly installed 1,450 AH 48 volt VRLA battery strings typically have a float current less than 2.1 adc (<149 mA/100Ahr of rated capacity), the float current was a marked improvement from the time of the thermal condition and did not to appear to impact operating temperature (see figure2). While not always getting float current down to the levels of a newly installed VRLA string, we have not experienced a thermal condition in any battery that has had the process completed.

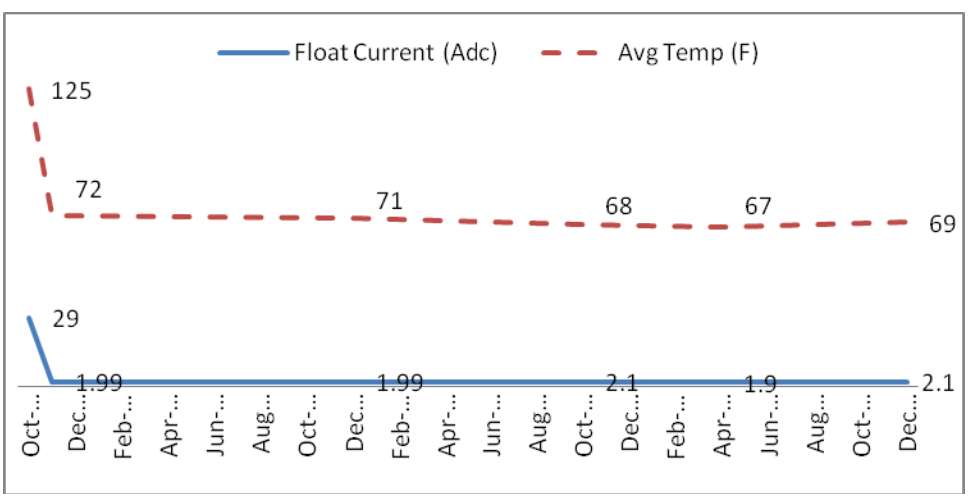

Figure 2

#2 CASE STUDY OF BATTERY STABILIZATION AND RECOVERY

Battery: 24 cell XYZ (4,800 ampere-hour @ 8hr rate to 1.75 vpc)

Some of our locations have installed series/parallel batteries (72 cell string). While we no longer install new VRLA batteries of this orientation there are still some in our network. Two 100A99 strings installed at a location in Boston, MA (manufactured October 2000) were under the preventative maintenance program when the float currents were observed trending higher. The cell temperatures remained constant, between 72-76°F (22-25°C). Because the batteries were under a maintenance program the condition could be identified and corrected before becoming a critical event. Again, due to the relatively good physical condition of the battery at the time of inspection, we elected to try and lower the float current and increase average cell conductance via the IOVR process. Figure 3 represents the string float current at 54.0 vdc The IOVR process was completed October 2007. These strings are still in service.

#3 CASE STUDY OF BATTERY INTERNAL OHMIC VALUES PRE AND POST-IOVR

Battery: 24 cell ABC (785 ampere-hour @ 8hr rate to 1.75 vpc)

Not all battery issues identified in the field exhibited high float current or operating temperature, but rather low conductance / high impedance values. XO Communications regards internal ohmic measurement as a valuable tool in determining the health of a battery. When possible, readings are trended from the time of installation and recommendations are made based on consecutive inspections. In other instances, recommendations are made by our service provider based on deviation from a nominal value. The battery in this example was manufactured June 1997. Based on the internal ohmic readings and the physical condition of the cells, IOVR was recommended and completed on the string in September 2007. There was an immediate increase in average cell conductance.

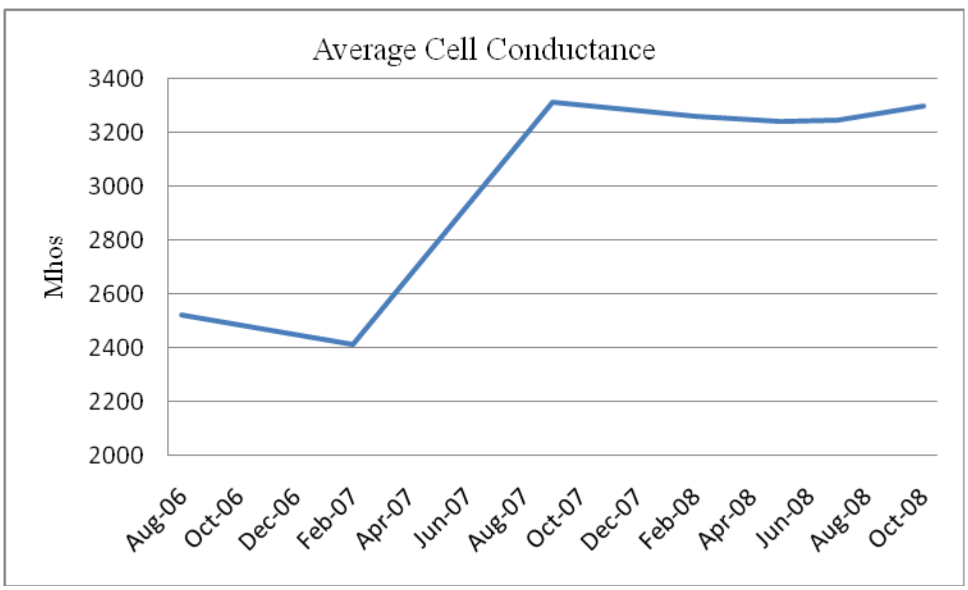

Figure 3

SUMMARY

Unplanned dc power related events decreased over the term of the preventative maintenance agreement (See figure 4). The events referred to in the graph do not represent outages, but rather events related to the dc plant and batteries. While the previous three examples relate to battery recovery and stabilization, there have been instances where the condition and age of the battery made it impractical to pursue field repair. Those battery strings were either removed from service or replaced. To date over 7,600 cells have received the IOVR process in our network. It is our estimation, based upon conservative replacement pricing, that XO Communications has reduced our battery replacement expenditures by over $3.8M by the deferral or elimination of replacement of these battery strings.

Column on left: Number of times tech were called to site.

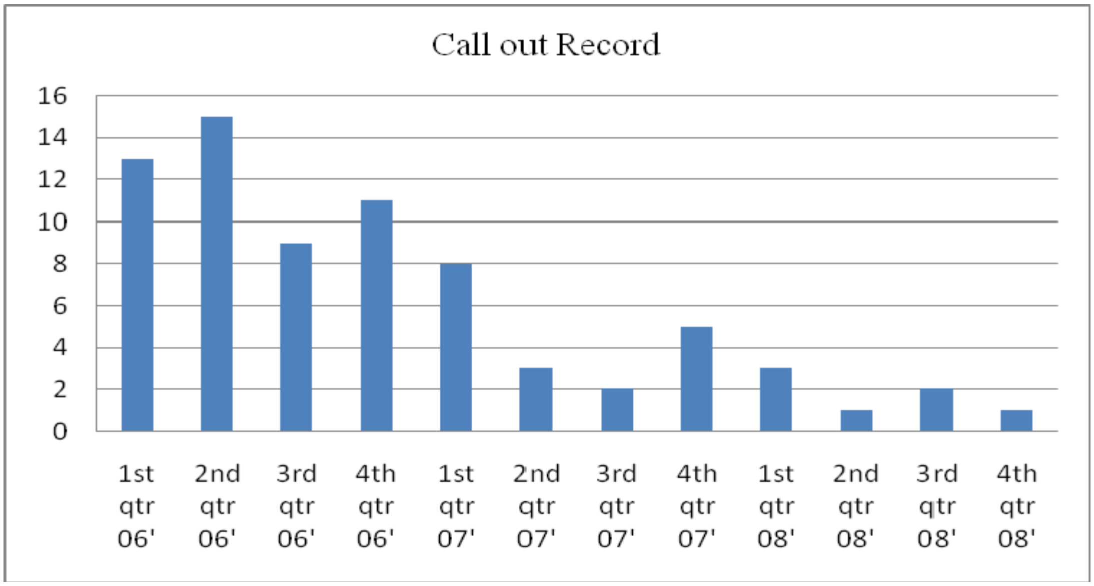

Figure 4

CONCLUSION

Regularly scheduled preventative maintenance inspections, completed by qualified dc power technicians can greatly improve network reliability. Preventative maintenance inspections can also identify cells that would be high-quality candidates for the IOVR recovery process. The process has successfully reversed and stabilized float current, increased capacity, improved internal ohmic values, and prolonged service life. Ultimately an effective preventative maintenance program is dependent upon three factors. First, accurate and reliable data recorded in the field. Second, is having the ability to analyze the data and generate practical recommendations. Third, follow through on implementation of the recommendations.