

VLA Test Memo No. 221

Recovery from Power Outages at VLA

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C. Janes, L. Serna, and K. Sowinski

Summary:

A 2 hour power outage in April 1999, resulted in 22 hours of lost observing time. Various improvements in equipment and procedures are being implemented to reduce disruption introduced by power failures; a test was conducted on August 10, 1999, to measure progress of the corrective action.

Overview of VLA site power:

We have two levels of defense against power problems at the VLA. Short term outages or disturbances, from single cycle to several seconds, are dealt with by three UPSs which protect the three systems critical to the VLA: the Master LO system, the correlator, and the computer system. Antenna-based equipment is not protected by UPS, but is designed to recover from power failure reliably and in a known state. Recovery for the short-term outages need only deal with antenna-based problems. Longer power outages are protected against by diesel generators which start automatically when commercial power is interrupted for more than 20 seconds and take up the load after a few minutes. The generators have sufficient capacity to power the entire VLA allowing observing to continue except for the few moments it takes for the generators to warm up after loss of commercial power. The function of the UPS for the longer outages is to allow time for the operator to shut the system down gracefully if the generator does not come up or fails and commercial power is not available.

The Failure:

On Wednesday April 21, 1999, a few minutes after the bus had left for the day, the SEC electrical power at the VLA failed. The operator tried to call up the generator, but a switch on the generator control had been left in the manual position. Thinking that a repairman would be able to return to the site before the CB UPSs went down, the operator did not follow emergency shut down procedures. The generators were started up shortly after the Control Building went completely dark. The response to the problem agreed on by heads of the Computer, Operations, Electronics, and Engineering Services Divisions is as follows:

1. Add the status of the manual/automatic switch to the generator parameters already on display at the operator's console. Other additions could be certain temperatures and voltages that are not currently available. In addition, a warning is being considered at the generator for certain disabling conditions.

Status: To be scheduled.

2. The ES Division electrician will continue to check the generator, but with a better defined schedule of doing so under load for a minimum of 1 hour per month, typically on VLA double maintenance days starting May 4th. The Auto Shop will continue to check oil level and other static engine maintenance indicators. Service work will be entered in a log sheet to be kept at the generator.

Status: Done.

3. Better recovery procedures for circuit breakers and fire alarms will be defined. In addition, "shunt trip" circuit breakers that lock off on power fail will be replaced with normal circuit breakers that trip with load fault only. Improvements to the fire alarm system are being studied.

Status: Shunt trip breakers have been replaced; fire alarm improvements designed and scheduled for September. A 1 page checksheet for the janitors needs to be prepared, but after the fire alarm improvements.

4. The Computer Division will review and document the procedure for powering down and powering up the DDS, Modcomp computer, and correlator computer to reduce the problem in restoring communication handshakes when power is restored.

Status: An interim procedure prepared, but further work needed in this area. The existing procedure is 10 pages long; a simplified 1 page checksheet is recommended.

5. A problem with the Spectre communication switch will be studied and the procedure improved. Electronics Division will investigate displaying the status of this and other key switches.

Status: An interim procedure was prepared, but not followed in test of August 10. The communication switch referred to here is used to switch an RS232 serial port for Spectre from DDS (operational use) to a terminal in the screen room (for checkout and diagnostics). There is currently large lettering under the Spectre terminal in the operator's area warning to check the switch in the event the terminal fails to respond. A similar sign will be affixed to the Spectre terminal in the screen room. This switch is also referred to in the interim procedure for power down/up. Remote indication is not planned.

6. The Computer and Electronics Division will develop procedures to shed load on the UPSs to extend the battery time; this includes shutting down non-vital systems that drain unnecessary power. The UPSs are designed for riding through power glitches and bridging the time from commercial power fail to generator, but can last only a limited time.

Status: Power shedding doesn't buy much and may not be worth the effort. A goal must be stated if shedding is used.

7. The IAT clock also coincidentally failed but the problem was exacerbated by the power failure. To reduce future problems, the Electronics Division will move the L35 time box 1PPS synchronization to the hydrogen maser UPS. An indication of the presence of the external sync is being studied. Procedures for switching from standard to backup clocks and associated GPS receivers and 1PPS synchronization will be studied and improved where possible.

Status: The L35 time box receives its 1 PPS synchronization from the GPS receiver. The GPS receiver is backed up by the maser (central electronics room) UPS, and the L35 by

its internal batteries. The 5 MHz reference for the L35 module comes from the L28 module. A problem in April was absence of backup voltages for the L28 module. Some backup voltages have already been provided, but provision for all backup voltages will be included in the spare L28 module under construction. The indication for external sync is scheduled for October.

8. The array operators will be instructed to be less conservative in starting up the generators on windy or stormy days when power glitches are occurring.
Status: Done.

The Test of August 10, 1999:

- 0800 The CB main breaker was turned off. Three UPSs provided power to the correlator, the computer equipment, and the maser oscillator equipment rack. Equipment noted on UPS power: Control Room equipment, D. VanHorn's office lights, first floor copier and FAX, incandescent fixtures in upstairs restrooms, range, refrigerator, and outlets in Operator Break Area, PCs in Ruff's, Rice's, and Observer's offices, both VLBI racks and recorders, chart recorder rack, all maser racks, correlator equipment, blower fans, and room lights, and Modcomp. Without power were the SLC rack in the MLO row, the D-racks, and lights in the UPS room.
- 0805 Correlator sensed over-temperature and turned itself off initiating an alarm. Operators switched correlator power from "auto" to "off."
- 0838 Computer UPS shutdown. 5 minute warning did not sound. Shutdown occurred with 5 minutes remaining on UPS status display panel. No radio communications available at console. Phone OK. Green LED blinking on off-line IAT clock but not on on-line clock.
- 0843 Maser UPS shutdown.
- 0848 Wyecom computer equipment shutdown; wyecom voice commo remained powered.
- 0907 Correlator UPS shutdown. 5 minute alarm seemed more like 3 minutes; UPS alarm not observable at console because of wyecom equipment shutdown earlier.
- 0912 Power restored to CB. Zone 8 and correlator (digital) room plenum fire alarms sounded and were reset manually. Correlator plenum alarm must be reset in plenum on first floor. Annex not responding. Keyboards not responding.
- 1033 Array restored to normal operation.

Candidate action items as a result of test:

1. The correlator UPS lasts much longer than the computer UPS because the correlator overheats and shuts down in 5 minutes. The correlator could be kept going for another 5 minutes, 10

minutes total, if the chiller pump were added to the correlator UPS. Since the correlator shuts down so soon, the additional battery capacity is available for the pump without impacting correlator shutdown time. A second note on UPS usage, the computer up time could be increased by re-configuring UPS battery banks. Since overheating shuts down the correlator so soon, the battery bank for the correlator UPS could be made smaller and the bank for the computer UPS larger. All that said, an extra few minutes of up time for the correlator and computer systems do not buy that much. As a result, no action is planned.

2. Wyecom equipment stayed up for only 10 minutes after computer UPS went down, should wyecom have stayed up longer? Some say the Wyecom UPS should have stayed up for hours. Power for Wyecom equipment and wyecom paging does not seem to be understood; need documentation?
3. The backup battery for the on-line IAT clock was dead, which is why the green LED was not blinking on this clock but was blinking on the backup. The battery was replaced and a maintenance procedure will be established to replace the batteries every 5 years. Since the IAT battery was dead, the number of leap seconds was reset to zero, IAT was wrong, and the clock had to be reset. Checking the IAT - UTC offset will be added to the power up sequence.
4. Annex cannot respond until Miranda brought up. Procedure calls for Annex (and computer peripherals) to be turned off when power fails and not to be turned back on until Miranda completely brought up. Banshee and Cyclops also should not be brought up until Miranda completely booted. Perhaps shortening computer power down/up procedures to simple check sheet would help insure procedure is followed correctly.
5. The OP3 terminal failed during exercise. Do we have a problem with transients that is causing equipment to fail when power cycled?
6. The Modcomp console device terminals do not always return to a normal state after a power outage if they are not switched off. Need to add an item to cover this problem in the "restore to operation" check list.
7. Power to Spectre and system controller rack had to be cycled to get Spectre to boot. This happened because Spectre and system controller were not powered down during shutdown and came up out of sequence. Again, a simplified check sheet may reduce errors in performing shut down/power up sequence.
8. Fire alarm resets can be made more graceful during improvements scheduled for September.
9. The 5 minute warnings for UPS power down need to be defined/fixed. In addition, the writers recommend that shutdown procedures for equipment begin some set period of time, say 20 minutes, after loss of utility power regardless of 5 minute warnings.
10. Emergency lights or at least a flashlight must be provided in the UPS room.

11. Moving the telephone switch to batteries solved the problem with no phones, but we still have a problem with radio communication. The radio needs to be on power backup that will last 24 hours. If power backup is currently available, it needs to be repaired and regular checks included in MAINT.

12. The UPS load includes unnecessary auxiliary equipment. Rewiring may be scheduled when the site Electrical Shop is staffed sufficiently.

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Conclusions:

The power fail test demonstrated progress in improving response to power outages, but some items remain to be done. Each Division should sort out action items for its area and add the items to the VLA/VLBA Coordination meeting or to MAINT. Another test should be scheduled for double maintenance time in November.

