

VLA Test Memo 221

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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 seconds to minutes, 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, but is designed to recover from power failure reliably and in a known state. Recovery in these cases need only deal with antenna based problems. Power outages lasting longer than a few minutes are protected against by the diesel generators which start automatically when commercial power is interrupted for more than 20 SECONDS. The generators have sufficient capacity to power the entire VLA allowing observing to continue essentially uninterrupted except for the antenna-based transient outage between the loss of commercial power and the availability of local generator power. The function of the UPS in this strategy is primarily that of a power conditioner, and in the case of the computer system allows the system to function long enough for the operator to shut it down gracefully in case of an unrecoverable power outage. In the case that neither commercial or local generator power is available at the control building, the state of the system should be considered terminal. The correlator will shut itself down in a few minutes because of lack of cooling and the operator should prepare to shutdown the rest of the correlator and computer systems before the UPSs are exhausted.

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 turned on shortly after the Control Building went completely dark. The initial course of action 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 for operators and janitors. 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: An interim procedure prepared, but it is imbedded in a 10 page power down/up procedure. A simplified 1 page checksheet, as mentioned further on, may help.

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 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 and outlets in Operator Break Area, PCs in Ruff's, Rice's, and Oberver'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.

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. Green LED blinking on off-line IAT clock but not on on-line. Annex not responding. Keyboards not responding.

1033 Array restored to normal operation.

Candidate action items as a result of test:

1. Should we swap UPS loads so that correlator UPS goes down first? Correlator draws more current than computer load but cannot be operated because HVAC is down. Alternate solution: backup cooling for correlator on UPS. Putting the existing cooling pump on the UPS correlator will extend correlator time for only 5 minutes at the most.
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 battery for the on-line IAT clock was dead. 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. Individual power switches on each of the Modcomp terminals did not function properly until power switch to Modcomps was cycled. Procedural problem?

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 power shedding procedures be put in to effect 5 minutes after loss of utility power, and that shutdown procedures for equipment begin 30 minutes after loss of utility power regardless of 5 minute warnings.

10. Lights powered by a UPS or at least a flashlight must be provided in the UPS room.

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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.