Lightning Damage at Los Alamos

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Sept. 25, 1989

A presumed lightning strike hit the Los Alamos antenna on Saturday, August 19th, 1989, at about 1:30 p.m. The antenna fire alarm malfunctioned, causing the sensaphone to dial out. There was no weather station or pedestal room UPS installed at the time. The UPS in the station building did not record any problems with the A.C. power.

The following problems have been found:

Vertex Room:

1) The RFI filter for the critical A.C. power at the vertex room bulkhead had shorted two of the phases to ground. This tripped the vertex room critical power breaker in the pedestal room.

2) The standard interface board in synthesizer #3 was defective.
* Problem unknown.

3) The 80 hz receiver IC, 5A, was defective in all four Front-end Interface modules.

Pedestal Room:

4) The circuit breaker for the antenna cryo compressor was tripped.

5) The three diodes that feed power from the A.C. lines to the 3 phase dropout detector in the pedestal room non-critical power panel were vaporized. These diodes are rated at 400 volts p.i.v.

ACU problems: (The power to the ACU was turned off at the time.)

* 6) The standard interface board in the ACU was defective. Problem unknown.

7) A defective op amp in the ACU caused an incorrect reading of the ACU power supply sum voltage on the computer screen. The op amp is U30 on the ESI interface board.

Drive Cabinet problems: (The power to the Drive Cabinet was off at the time.)

8) When the azimuth axis was enabled the antenna would always move at a slow speed in one direction. The speed and direction command actually being sent to the drive cabinet had no affect. Also the drive cabinet sum voltage was incorrect on the computer screen. These problems were caused by a defective dual op amp, C8, on the azimuth interface board.

9) None of the emergency stops would work. The ACU display would indicate that the stop had been pushed, but it would not prevent the antenna from moving. As a test of the final limits I opened the pintle bearing room door which engages a final limit switch. The antenna would still operate even though the ACU displayed a cw limit. This door does not engage a brake interlock switch, which is part of the final limit switches on the antenna. I tested the pre-limits and they operated properly. No test was done of the 1 st limit prior to repairing the problems. These problems where due to two defective OR gates, A23 on the elevation interface board, and A23 on the azimuth interface board. Also inverter A19 on the Azimuth interface board was defective. Since replacing these parts all limits and emergency stops have been tested for proper operation.

FR problems: The power to the FR electronics was on at the time.

10) The standard interface card in the FR interface was defective. The line driver and receiver, U8 and U9, were defective, as was the CPU U1.

11) The rotation display was blank on the Apex Interface module due to a defective OR gate, D20.

12) The subreflector would not move in focus or rotation due to a defective OR gate, B25, in the Apex Interface module. Also causing focus drive problems were D6, a hex inverter that buffers the focus limit switches, and F20, a shift register that sends the limit switch status to the F-R Controller.

13) After getting the subreflector to run, all the limit switches were tested. None of the focus limits worked. This was due to all the inputs of U1 being shorted to ground. U1 is an inverter that sends the limit switch status to the bar graph LED. U1 is also in the Apex Interface module.

14) The second screw sensor was defective.

15) The antenna fire alarm shunt tripped all power in the antenna. The alarm panel gives a constant alarm. A quick check found six defective semiconductors in the input circuit from the smoke detectors. The smoke detectors checked ok. No schematic is available for a more detailed analysis.

16) The LCD display on the telephone in the pedestal room was blank. The phone would produce a dial tone but would not dial out. Also the earpiece was quite warm. I unplugged the phone on Saturday. On Monday I plugged the phone back in and it functioned normally.

Antenna:

17) An Az gearbox error message was displayed on the front of the ACU. This was caused by a shorted capacitor, C2, in the azimuth data gear box. The gear box is mounted on one of the azimuth wheels. The capacitor is across the 400 hz drive to the synchros.

Control Building:

18) The circuit breaker for the building cryo compressor was tripped. The compressors internal breaker was also tripped.

19) The station computers RS232 port that is connected to the RS232 ports in the antenna was inoperative. U59, a line driver on the MVME 050 board, was defective. Three weeks later the receiver IC, U58, also failed.

20) There was no 80 hz from the Station Timing module. The line driver IC, 1D, was defective.

Lightning experts from Los Alamos National Laboratory were given a tour and asked for their recommendations. Some of their recommendations included the following:

1) Use a larger ground wire in all A.C. power circuits to reduce the ground impedance between various pieces of equipment.

2) Use TransZorbs instead of MOV's on signal lines. TransZorbs have a faster response time.

3) Put as much inductance or resistance as can be tolerated in series with each signal line. Install a TransZorb to ground on the equipment side of the added impedance.

4) Tie all boards in the weather station together with a low impedance ground bus.

Los Alamos National Laboratory personnel measured the resistance to earth ground from the rail, cable wrap ground cable, and the A.C. power ground in the pintle bearing room. They all measured approximately 1.75 ohms. I measured the resistance from the back up structure, vertex room bulk head and both lightning rods to the rail. They all measured less then 0.1 ohm.

Transient voltage suppressors have been installed in the pedestal room critical and non-critical power panels. I would recommend that additional transient voltage protection be installed at the following locations:

A) RS232 line from the antenna. Install at the computer.
B) Monitor and control bus. At the ACU rack and at the vertex room bulkhead.
C) 80 Hz line. At the vertex room bulkhead and the control building bulkhead
D) Second screw sensor.
E) FRM limit switch lines. These presently have MOV's in the pedestal room junction box. TransZorbs with some series inductance might be more effective.
F) Fire alarm at smoke detector input.

* NOTE: **Items marked problems unknown were modules or boards sent to AOC for repair.**