ATCD-RP (ATNA-NU/1 DEC 98) 1st End Mr. O'Malley/lwb/DSN 680-3478
SUBJECT: Final Report on Computer Test Data

5 Feb 99

CDR, USATRADOC, ATTN: ATCD-ZA, FORT MONROE, VA 23651-1046

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1. References:

a. AR 71-9, Materiel Requirements, 30 Apr 97.

b. AR 70-75, Survivability of Army Personnel and Materiel, 10 Jan 95.

c. TP 71-9, Requirements Determination, 1 Aug 98.

2. Enclosed test results indicate unprotected COTS electronic equipment may not function after High-Altitude Electromagnetic Pulse (HEMP) environments, a condition that is not acceptable in our Force XXI Information Based Army.

3. Many threat countries currently have the capability to launch and detonate a small, crudely built nuclear device in the atmosphere. The resulting yield is field strengths well in excess of 5 kilovolts per meter for a radius of hundreds of miles.

4. The bottom line from the test: COTS computers EMP vulnerability is not predictable. The only way to measure the vulnerability of a given system is to test the system in its operational configuration. If the system is mission essential, it must be tested to ensure the required level of protection has been met.

5. HEMP survivability is mandatory for mission essential equipment (ref 1a. paragraph 6-9a; and 1b, paragraph 1-5I). If the system is mission essential, the HEMP requirements will be stated in the ORD IAW ref 1b and Appendix S of ref 1c. If the system is not mission essential, this must be stated in the ORD IAW ref 1b, paragraph 1-5.d. Doctrine and TTPs for a system, which is not HEMP survivable, must provide contingencies for the theater wide loss of the system.

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6. Point of Contact this office is Mr. Sean O'Malley, DSN 680-3478.

FOR THE DEPUTY CHIEF OF STAFF FOR COMBAT DEVELOPMENTS:

ALLAN M. RESNICK
Assistant Deputy Chief of Staff
for Combat Developments

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SPRINGFIELD, VIRGINIA 22150-3198

REPLY TO
ATTENTION OF:

ATNA-NU

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MEMORANDUM FOR HEADQUARTERS TRAINING AND DOCTRINE COMMAND, ASSISTANT DEPUTY CHIEF OF STAFF FOR COMBAT DEVELOPMENTS (ADCSCD), ATTN: ATCD-ZC MR. RESNICK, FORT MONROE, VA 23651-5000

SUBJECT: Final Report on Computer Test Data

1. Reference: ATNA-NU memorandum, subject: Interim Report on Computer Test Data, dated 23 Oct 98 (herewith superseded).

2. At our request in response to your query on commercial-off-the-shelf (COTS) computer vulnerability to high-altitude electromagnetic pulse (HEMP), the Test and Evaluation Command at White Sands Missile Range (WSMR) and the Defense Threat Reduction Agency (DTRA) tested six computer-type systems in September and November 1998. The tests were intended to identify the onset of anomalous system behavior due to exposure to HEMP.

3. Constraints in the HEMP field-source generator limited the output levels to discrete field strengths of 0.5, 1, 2, 4, 8, 16, and 32 kV/m (+/- 20%). The system behavior was noted as the peak E–fields were stepped up. Because of the discrete levels tested, if anomalous behavior was noted, the actual onset of that behavior could have occurred anywhere between the level where the behavior was first noted and the next lower level tested.

4. In the November 1998 tests, to demonstrate mitigation afforded using the common techniques of turning-off or unplugging the systems, each system was tested at each E-field strength unplugged, plugged in but not powered, and plugged in with power on. After each test where system power was off, the system was powered up and the status of the system evaluated.

5. Four system/subsystem behaviors are noted: (1) no noticeable effect – no impact on functional operation or mission; (2) temporary upset that self-recovers – mission impact dependent upon subsystem function and mission; (3) latchup requiring human intervention – mission impact dependent upon subsystem function and mission; and (4) permanent damage – mission impact dependent upon mission. A summary of the

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equipment tested and the results is on the enclosed graph. Systems 1 and 2 were tested in September 1998 at JAYCOR in Colorado Springs (under contract to DTRA). Systems 3 through 6 were tested in November 1998 at WSMR. Results may be compared.

a. System 1 consisted of a 29" Mitsubishi RGB monitor, RGB 109+ VGA interface, ADA-2-300HV distribution amplifier, VICON video camera, videocassette recorder (VCR), and 386 computer. The following system behavior was noted as peak E–fields were stepped up: at 1 kV/m, the RGB monitor experienced temporary upset; at 2 kV/m, the VCR and 386 computer experienced latchup that required operator intervention; and at 8 kV/m and 4 kV/m, respectively, the VCR and 386 computer experienced permanent damage. Other system components (RGB 109, amplifier, video camera) experienced no effect from levels up to and including 32 kV/m.

b. System 2 consisted of a CISCO Catalyst 300 router, a Pentium 75 (P-75) computer, a 486 computer, and a 386 computer used as a controller. The computers were each initially tested with the cables detached and then hooked together in a LAN configuration using the CISCO router to evaluate the effect of HEMP on the router and the operation of the overall LAN. The peak E-field output levels were stepped up consistent with system 1 testing: at 1 kV/m, the 386 experienced upset that required operator intervention to correct; at 4 kV/m, the P-75 experienced temporary upset that self-corrected; at 8 kV/m, the P-75 and the 486 experienced upsets that required operator intervention to correct; and at approximately 16 kV/m, the CISCO router and P-75 experienced permanent damage. The system, as a whole, experienced upsets in flow of information in the LAN at or before 8 kV/m; the system was not tested between 4 and 8 kV/m output levels.

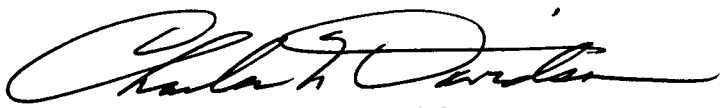
c. System 3 consisted of a Zenith 486 Desktop Computer, Zenith Keyboard, Logitech Mouse, and Orchestra Color Monitor. Up to 32 kV/m there were no noticeable effects. At 32 kV/m, while unplugged, or plugged in and not powered, there were no noticeable effects. At 32 kV/m, while powered, the CPU and monitor experienced permanent damage. The CPU was repairable.

d. System 4 consisted of a Positive 386 Desktop Computer, Positive Supertron Monitor, Positive Keyboard, Logitech Mouse, Motorola Universal Data Systems Modem, and Kodack Dieconix 180 SI Ink Jet Printer. Up to 16 kV/m and with no power at 16 kV/m, there were no noticeable effects. Powered at 16 kV/m, the computer and printer experienced upsets that required operator intervention to correct. Powered at 32 kV/m, the modem experienced upsets that required operator intervention to correct. With no power at 32 kV/m, there were no noticeable effects.

e. System 5 consisted of a Commodore Amiga Desktop with a Motorola 6800 (7.16 MHz) processor, and Commodore Color Monitor. No noticeable effects were observed at any level or power configuration.

f. System 6 consisted of a Texas Instrument 386 Laptop and power supply. While unplugged at 2 kV/m, the system experienced permanent damage. The system would not boot, the low battery light flashed, and the monitor burned out.

6. These test results demonstrate that COTS computer systems' vulnerability to HEMP cannot be categorically stated. Some systems and components survived up to 32 kV/m, while others experienced upsets and failures at very low levels. Tests 3 through 6 show that turning power off does increase a system's ability to survive a HEMP event. Vulnerability to HEMP is also highly configuration dependent. Without testing a specific system in an intended operational configuration, it would be extremely difficult to determine its vulnerability to HEMP.



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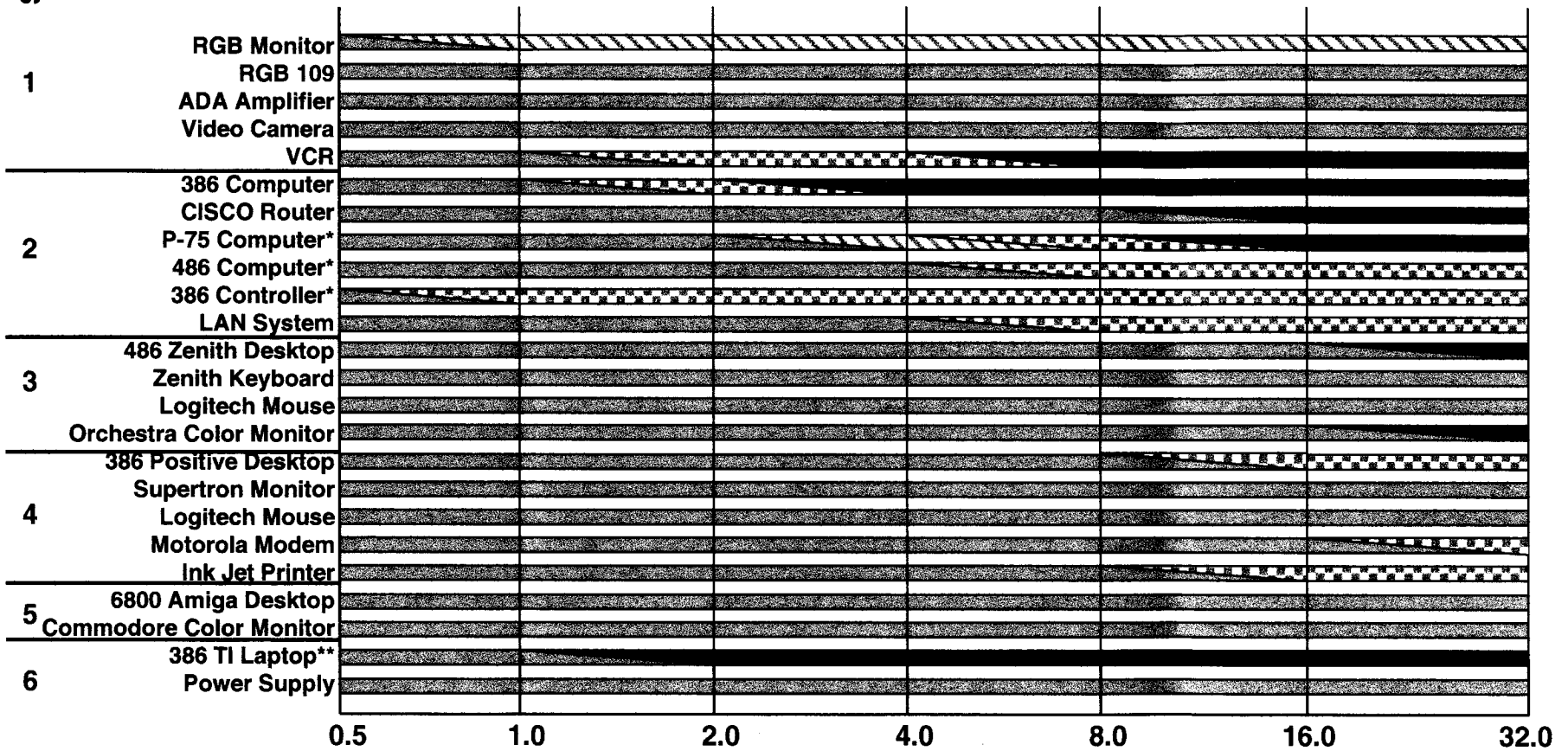
CHARLES N. DAVIDSON
Director

Test Results



Indicate that the specified behavior could have occurred at these levels

NOTES: Systems were tested at the approximate 0.5, 1, 2, 4, 8, 16, and 32 kV/m levels only.
System changes were noted at the tested levels.
Unless indicated, results are shown are with power supplied to the system
* Testing done without cables connected
** Power was off, system was unplugged