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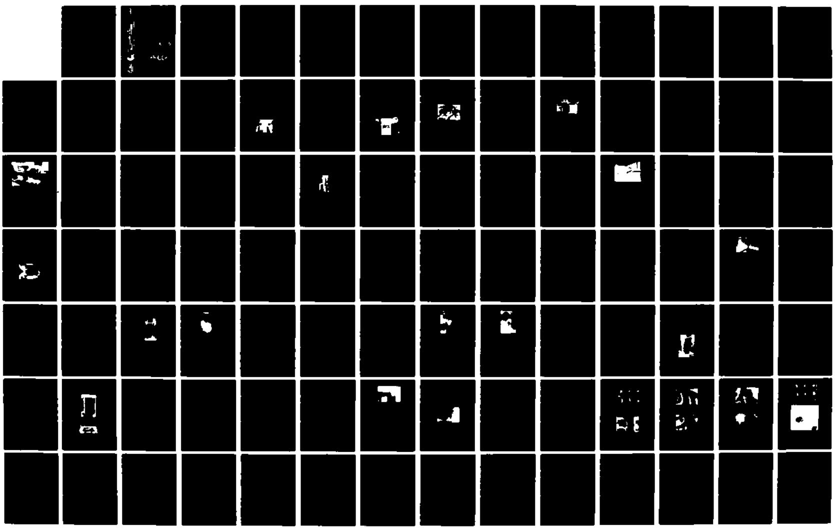

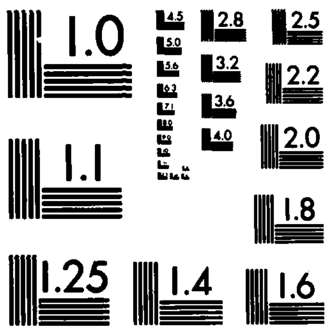

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REPORT OF TEST RESULTS: HALON 1301 VS WATER SPRINKLER FIRE PROTECTION FOR ESSENTIAL ELECTRONIC EQUIPMENT

ERIC F. REICHELT
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JULY 1982

FINAL REPORT
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This report describes results of testing two contending extinguishants, Halon 1301 and water, for fire protection of essential electronic equipment. A series of controlled fires in a facility housing an operational electronic data processing system sought to establish immediate and long term effects of exposure of sensitive electronic equipment and stored data to fire extinguishment atmospheres. Test results lead to the conclusion

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that Halon 1301 is superior to water as an extinguishant for fires occurring in essential electronic equipment installations.

PREFACE

This report was prepared by the Air Force Engineering and Services Center, Engineering and Services Laboratory at Tyndall AFB, Florida, 32403, under Job Order Number 2505-1006, Fire Protection for Essential Electronic Equipment. The efforts were sponsored by Air Force Systems Command (AFSC/SDNE), Andrews AFB, Maryland.

The work was performed between November 1980 and June 1982. The Project Officer was Joseph L. Walker.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

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SECTION I

INTRODUCTION

1. BACKGROUND

a. General

U. S. Air Force interest and involvement in providing adequate fire protection for essential electronic equipment date back to 1960. The tremendous technological advances made in electronic data processing (EDP) in the years since 1960 have resulted in significant monetary investment by the U.S. Air Force in this type of equipment. The ability of EDP equipment to perform complex, vital and high volume functions led to the widespread use, installation and concentration of very costly computer systems in single locations. As the Air Force increasingly relied upon EDP systems in its daily operations and abandoned traditional data processing and record keeping methods, the continuing, uninterrupted availability of these systems became a matter of great concern. According to AFM 88-15: "The protection of the large investment often is less important than the continuity of operations."[1] Much of the Air Force's electronic equipment became essential to carrying out vital military tactical or supporting missions and any loss of this equipment could adversely affect mission performance. Recognizing the criticality, the Air Force considers electronic equipment essential when it:

- Is necessary to national security
- Performs an operation that must be continued to completion without interruption
- Requires a long leadtime to replace[1]

Because of this dependence on essential electronic equipment, fire protection of these systems must be assured to the utmost degree practicable.

b. Halon Versus Water

Unfortunately, the question of what type of fire protection system is best suited for essential electronic equipment has raised considerable controversy. In essence, the debate centers on water versus Halon 1301 as the most effective agent. Water,

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[1]Department of the Air Force, Air Force Design Manual - Criteria and Standards for Air Force Construction, AFM 88-15 (C3), Washington, DC, 20 August 1976.

of course, has been used successfully as an effective fire extinguishing agent for centuries. Halon 1301, on the other hand, has proven itself in the last decade to be extremely effective in extinguishing all types of fires where the combustion is not deep seated. Additionally, Halon is especially effective in fires involving energized electrical and electronic equipment without danger of high voltage arcing and shorting. The major criticism brought against Halon systems is that, although competitive with other chemical fire protection systems such as CO2 and foam systems, the cost of a Halon system is considerably higher than a water sprinkler system. Another major concern is the high cost associated with the inadvertent discharge of Halon extinguishant. However, the devastating effect of accidental water discharge is exemplified by the dramatic $12 million loss experienced by the Bureau of the Census in Washington, DC.

c. Extinguishant Effectiveness and Limitations

(1) Halon 1301. Various fire suppressing agents have been developed which are capable of extinguishing electronic equipment related fires.[2,3,4] Because of its superior extinguishing characteristics and low toxicity, the most widely used and generally recommended agent is Bromotrifluoromethane (Halon 1301). Unlike other extinguishing agents which suppress the fire by either cooling (water), oxygen exclusion or smothering (carbon dioxide), or mechanical separation of fuel from the oxidizer (foam and powder), Halon extinguishes by reacting with the combustion products which are responsible for rapid and violent flame propagation. Once the flaming combustion is stopped, radiant heat feedback to the fuel is also stopped, thus curtailing the production of flammable vapors from the material, and causing surface combustion to die out.

Numerous tests have shown that this reaction will be effective for fully curtailing most fires with a 5 to 7 percent by volume concentration of Halon 1301. In general, such a concentration is attained by the discharge of one pound of Halon for

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[2] J. K. Musick and F. W. Williams, The Use of Halons as Fire Suppressants, Report 8161, Washington, DC, 5 October 1977.

[3] Roger R. Cholin, "Testing the Performance of Halon 1301 on Real Computer Installations, Fire Protection by Halons, National Fire Protection Association, Boston, MA, 1975.

[4] W. M. Carey and W. A. Haas, Extinguishment of Class A and B Fires in Electronic Computer Rooms with Halon 1301, Report, File NC535 (Elmsford, NY: Safety First Products Corporation, Elmsford, NY, 17 January 1972.

every 50 cubic feet of enclosed space.[5] Over twenty years of medical research on both test animals and humans have shown that Halon 1301 in concentrations up to seven percent by volume could be used with a high degree of safety. In the very unlikely event of a Halon extinguishment of a deep-seated fire, two potential problems may result. If, during the fire extinguishment process, the Halon 1301 is taken to 900°F, it will decompose into the corrosive compounds of hydrogen fluoride (HF) and hydrogen bromide (HBr) gas. In normal fire extinguishment situations, local concentrations of these compounds have been extremely low, generally below 20 parts per million (ppm). However, long duration contact of Halon with the 900°F combustion area causes extended decomposition of the agent and localized levels may increase to as much as 300 ppm. Although not nearly fatal, 300 ppm concentrations may be harmful to personnel or equipment if exposure to such an atmosphere is prolonged.[6]

(2) Water Sprinkler System. Water has had an uncertain role in the protection of essential electronic equipment. Early detection of a fire and discharge of extinguishant is paramount for the protection of high cost EDP systems from smoke and heat damage. With water sprinkler systems, fire extinguishment is usually withheld until considerable damage or loss has been caused by the heat rise necessary to activate the water system. Even if discharged at the fire's incipient stage, the water itself can cause unacceptable levels of damage or downtime of electronic equipment. Numerous studies and analyses indicate that minimal protection is realized with a water sprinkler system, because both hardware and software may be destroyed or rendered inoperative for prolonged periods whether the system discharges early or not.[7]

d. Policy and Literature Review

The theory of fire protection for essential electronic equipment and the roles of both Halon 1301 and water as contending extinguishing agents have been interpreted by Government agencies with a wide margin of difference. Differences in policy

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[5]National Fire Protection Association, Standard for Halogenated Fire Extinguishing Agent Systems, NFPA 12A-1977, Boston, MA, 1977 .

[6]J. W. Seastrom, Fire Protection Methods for Spacecraft and Related Mission Critical Electronic Equipment Vulnerable to Water Damage, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 1980.

[7]The Ansul Company, Fire Protection for Electronic Data Processing and Computer Systems Marinette, WI, February, 1973 .

may well be attributable to the unique requirements of individual agencies. However, our literature survey suggests that the proponents of water sprinkler systems have taken the traditional and "safe" approach, while advocates of Halon 1301 have, on occasion, overstated their fear of water damage by disregarding the reduced moisture problem of advanced, solid state technology.

(1) National Fire Prevention and Control Administration. The "Standard Practice for the Protection of Essential Electronic Equipment Operations (RP-1)," issued by the National Fire Prevention and Control Administration (NFPCA) in August 1978, is used by federal agencies as the guide for fire protection of essential electronic equipment and was "promulgated for use by all agencies at the discretion of their management."[8] Unequivocally, RP-1 states:

> Automatic sprinkler protection is required for all electronic equipment and record storage areas and shall be installed in accordance with NFPA No. 13, "Sprinkler System."

Halon 1301 fire protection systems are allowed for optional use in a supplementary capacity for extraordinary situations.

(2) National Fire Protection Association (NFPA). In its capacity as a national standard setting body, the NFPA has issued design specifications for both water sprinkler and Halon 1301 systems. While citing electronic equipment installations as being suitable for Halon 1301 fire protection, the NFPA does not take a position on the Halon 1301 versus water sprinkler issue.[9]

(3) U.S. Air Force Standards. The general U.S. Air Force policy concerning fire protection systems and features is contained in Chapter 13 of AFM 88-15, "Air Force Design Manual - Criteria and Standards for Air Force Construction."[1] The primary emphasis rests on water sprinkler systems through most of Chapter 13. Some indecision as to the proper choice of systems seems to result from the following statement: "Halon 1301 Fire Suppression Systems. These systems, installed only where required and approved, will follow criteria in Attachment 18." Attachment 18, entitled "Halon 1301 Suppression Systems for Essential Electronic

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[8]National Fire Prevention and Control Administration, Standard Practice for Fire Protection of Essential Electronic Equipment Operations, RP-1, U.S. Department of Commerce, Washington D.C., 1978.

[9]National Fire Protection Association, Standard for the Protection of Electronic Computer/Data Processing Equipment, NFPA 75-1976, Boston, MA, 1976.

Facilities of Type N Construction," can be interpreted that Halon 1301 must be installed in essential electronic equipment facilities. As a consequence, Halon 1301 systems predominate at U.S. Air Force essential electronic installations, although some feature both Halon 1301 and water sprinkler systems.

Review of applicable literature and governmental policies relating to fire protection of essential electronic equipment points out the controversy surrounding the Halon 1301 versus water issue. While both agents are effective, rapidly advancing state-of-the-art in electronic data processing technology requires that effective fire protection of electronic equipment be tailored to enhance the U.S. Air Force mission performance.

2. OBJECTIVE

The objective was to assess damage to an operational electronic computer system by activation of two contending fire suppression systems in response to a series of controlled fires. Derived data serve as the basis for recommendations concerning the design of optimal, yet cost-effective, fire protection for Air Force essential electronic equipment installations.

SECTION II

TEST DESCRIPTION

1. INTRODUCTION

The purpose of this section is to describe the test facility and equipment. Detailed descriptions are provided for the permanent building constructed to house the test vehicle, installed fire protection systems, the GE 115/2 computer system that served as the test vehicle, and the test equipment used for monitoring and data collection.

2. COMPUTER TEST FACILITY

a. Test Site

(1) Building. A permanent building (Figure 1) was constructed at Tyndall Air Force Base, Florida, by the Air Force Civil Engineering Center to house the computer system used as the test vehicle during the series of tests. The structure was designed to meet all requirements of a typical, operational computer facility.

Figure 1. AFESC Computer Test Facility.

(2) Construction. The building was constructed of reinforced concrete blocks, and features a reinforced concrete roof and floor. A raised floor of vinyl covered plywood was placed 17 inches above the concrete slab. An automatic sump pump was installed to remove any excess moisture accumulation. Double metal doors and framing were installed for the main entrance. A suspended ceiling, made of fiberglass panels and metal framing, was installed 6 inches below the roof. The building measures 26'5" x 16' x 7". An 18" x 20" plexiglass observation window was installed in the entrance door. Doors were sealed. Essential building dimensions are shown below:

(3) Building Dimensions:

Ceiling -	203.33 ft^3
Room -	3100.83 ft^3
Floor -	546.86 ft^3
Total Vol.	3851.02 ft^3
Plenum -	2.0 ft^2
Return -	2.0 ft^2
Openings -	2.6 ft^2

(4) Climate Controls. A closed system, 5-ton air conditioning/heating unit was installed near the outside south wall. A double-filtered air return 17" x 16" was installed in the south wall. A plenum 17" x 16" was installed in the south wall and dumps the conditioned air into the subflooring. Four screened openings 8" x 12" were placed in the raised floor near the north wall. The unit is capable of maintaining temperature at a preset level ranging from 60°F to 85°F. The computer equipment is located between the air outlets and the return. The system is capable of moving 2000 cfm, thus exchanging the air approximately every two minutes. A portable dehumidifier maintains specified humidity levels.

b. Fire Protection Systems

(1) Water Sprinkler System. A sprinkler system was installed and is fed by a 1-1/4" main line; 3/4" branch lines feed four sprinkler heads that protrude 6 inches below the suspended ceiling. The system is capable of 100 psi water pressure at the main feed line. The sprinkler head seals are set to activate when the heat rise reaches 212°F. Manual shutoff valves are located inside and outside the computer facility.

(2) Halon 1301 System. An installed automatic Halon 1301 fire extinguishing system consists of the following:

(a) Discharge Nozzle. One discharge nozzle protrudes 1.5 inches from the suspended ceiling. One discharge nozzle extends 6 inches beneath the raised floor. Both nozzles are fed from a single Halon cylinder on a common feed pipe.

(b) Cylinder. The cylinder and Halon were supplied by Ansul Company. The cylinder has a total weight of 165 pounds 6 ounces with a charge of 85 pounds. The content of bromotrifluoromethane was superpressurized to 360 psi and 70°F with dry nitrogen gas. When activated, the cylinder completely discharged in 10 minutes and was designed to provide a 5.3 percent Halon 1301 concentration.

(c) Smoke Detectors. Two 3040RC Series photoelectric smoke detectors and two PID-B ionization sensors were mounted on the suspended ceiling and extend into the room. One photoelectric smoke detector and one ionization sensor were located in the subfloor space.

(d) Control Panel. The C-1024 Cross-Zoned Detection Control Unit (Figure 2) provides detection, supervision, control, and actuation signals required for the automatic operation of the Halon 1301 fire extinguishing system. Power was furnished by an AC line with a built-in battery backup system. Input from either of the six sensors caused an alarm to be sounded and, 30 seconds later, a signal was sent to open the Halon cylinder valve. A manual abort station could be activated by computer room personnel to abort the Halon dump within the 30-second delay after the alarm had sounded. A manual fire alarm station provided for an immediate dump of the Halon, should the criticality of the situation demand it.

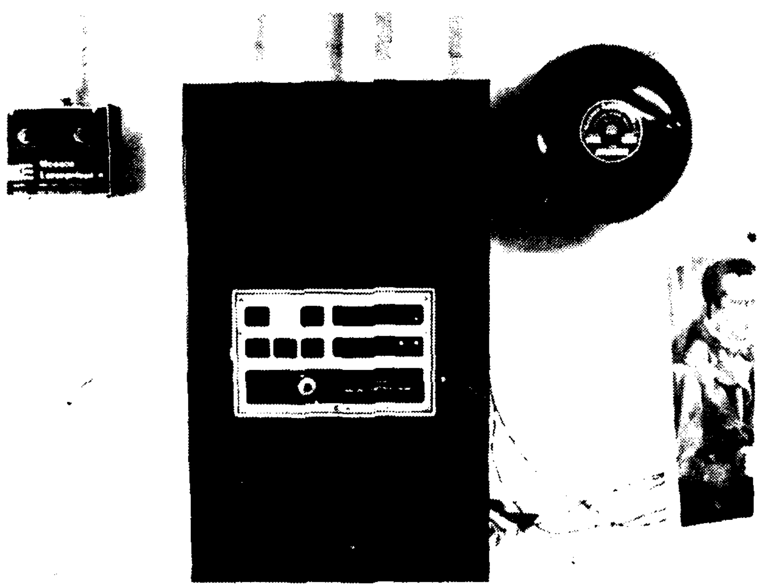


Figure 2. C-1024 Halon Control Panel Assembly.

3. ELECTRONIC DATA PROCESSING TEST SYSTEM

a. Description

A General Electric 115/2 Central Processor Unit (CPU), a second generation type basic computer system, was chosen as the test vehicle (Figure 3). A surplus item, although still in use at various Air Force installations, the GE 115/2 system contains discrete components of transistors, capacitors, and resistors. An advantage of choosing this computer for a test vehicle was the construction of logic circuits on individual printed circuit cards and the assurance of tracing equipment failure down to specific components.

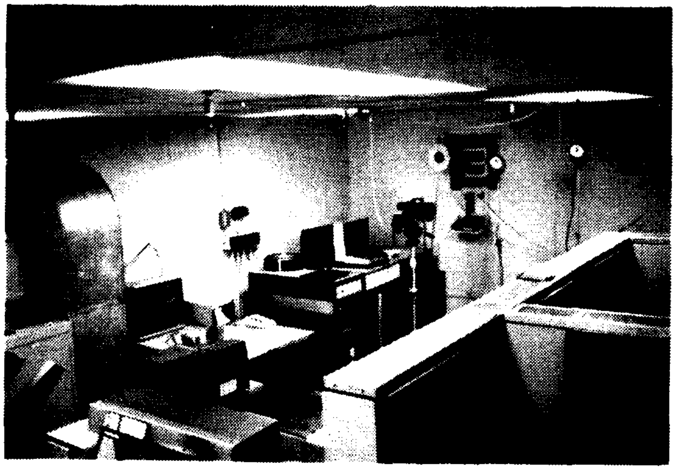


Figure 3. Test Vehicle - GE 115/2 Computer System.

b. System Components (Figure 4)

Components included in the GE 115/2 System were:

(1) GE 115/2 CPU with an eight-kilobyte magnetic core memory and associated power supplies

(2) GE MZ4, 300 LPM line printer, controller, and power supplies

(3) GE CR-10, card reader and controller

(4) GE LP-300 BT1 card reader/punch and controller

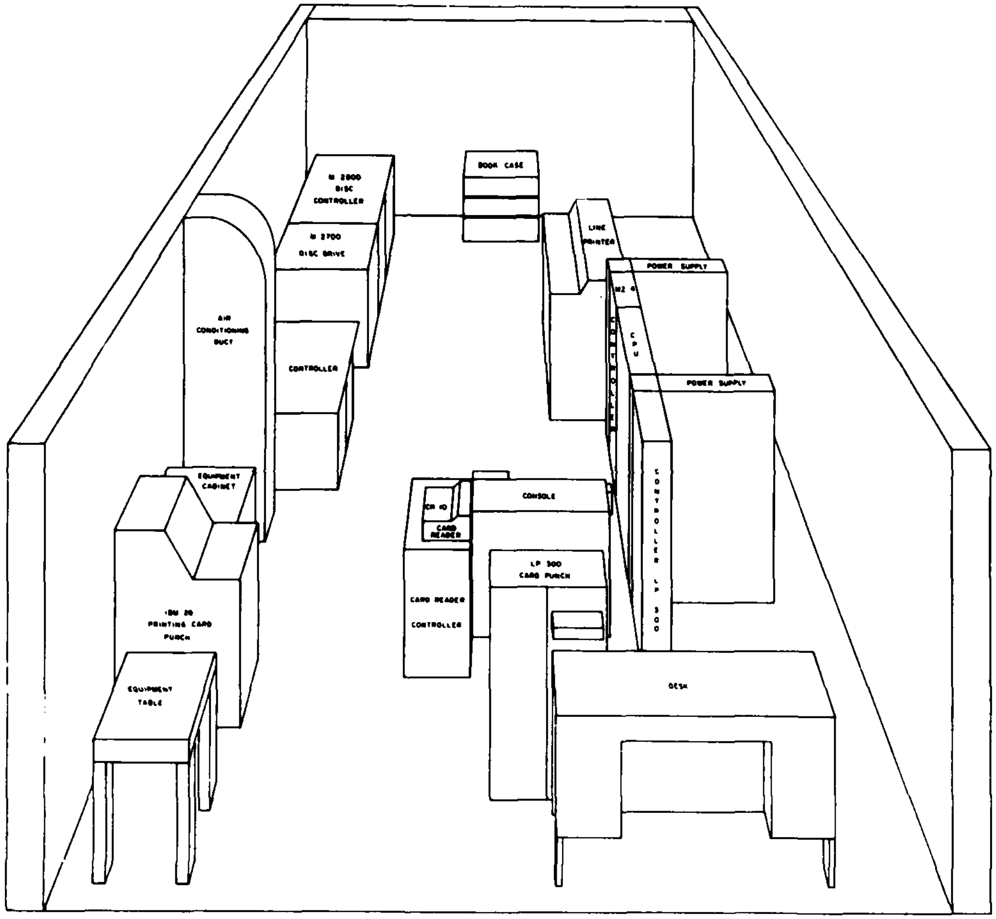


Figure 4. Components of the GE 115/2 Test Computer System.

(5) IBM 26 printing card punch

c. Third generation type of computer equipment (Figure 5) included in the installation consisted of:

(1) A Marshall Data Systems disc controller, type M-2800 and disc drive unit, type M-2700

(2) Control Data Corporation Cathode-Ray Tube (CRT) display 211 and controller 217

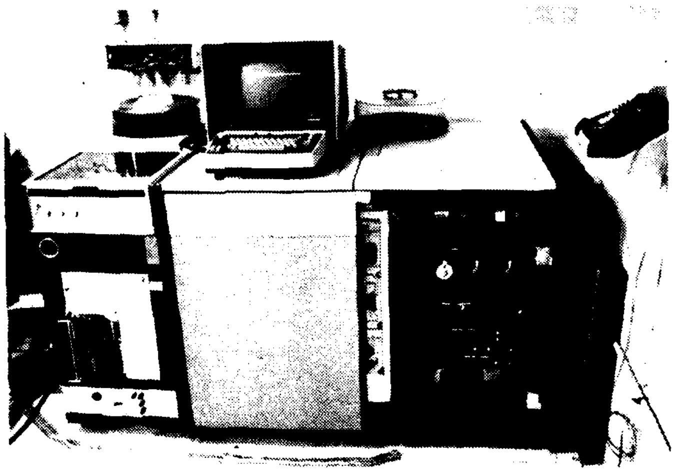


Figure 5. Third Generation EDP Equipment Included in Test.

4. TEST INSTRUMENTATION

a. General

The Computer and peripheral equipment were contained in 17 separate cabinets, each with its own system of heat removal. Each cooling system was similar in that filtered air was extracted from the atmosphere by fans and flowed over the electronic components; the heated air was expelled back into the atmosphere. The GE 115/2 system included thousands of discrete components, integrated circuits, plug-in printed circuit boards (PCBs), various voltages and branch currents. Each was susceptible to failure through corrosion or changes in contact resistance, electrical values, or in magnetic strength. Chosen for instrumentation and monitoring of the system were component test points that were representative, more susceptible to failure under environmental changes, and had the ability of system shutdown when their individual parameters were exceeded. The ability to trace failures to individual components, time-related to test conditions, was considered basic to the series of planned tests.

b. Test Points

The test points selected are summarized in Table 1 below and portrayed graphically in Figure 6.

TABLE 1. TEST POINTS.

EQUIPMENT MONITORED	TEMPERATURE	VOLTAGE	HUMIDITY
CRT Controller	X	X	X
Disk Drive	X		
DisK Control			
Card Reader			
Card Reader Controller			
Console			
Card Punch			
Printer Power Supply	X	X	
Printer Controller			
CPU	X		X
CPU Power Supply	X	X	
Card Punch Controller			
Printer			
Atmosphere	X		X
Outside	X		X
Line Voltage		X	

NOTE: Test points were chosen based on their criticality and the number of test input channels available (16 channels).

c. Component Description

(1) CRT Controller. The CRT controller has a self-contained power supply that furnishes the required voltage of +5V, +20V, and -20V for operation of the electronic modules. The input power is rated at a nominal value of 110 VAC single phase. The "+" and "-" 20V power supply does not furnish voltages to all modules of the controller. However, all modules require power from the +5V source for operation. A $\pm$ 10 percent change in the +5V supply may cause a failure in the data flow by injecting erroneous bits of data or dropping bits of data in the data chain. A test point for monitoring the +5V source was included.

The CRT controller has a temperature operating range from +60°F to +85°F. A built-in sensing device shuts down the controller power after reaching 110°F. A temperature sensing device was placed near the electronic package of the controller to monitor the possible temperature change.

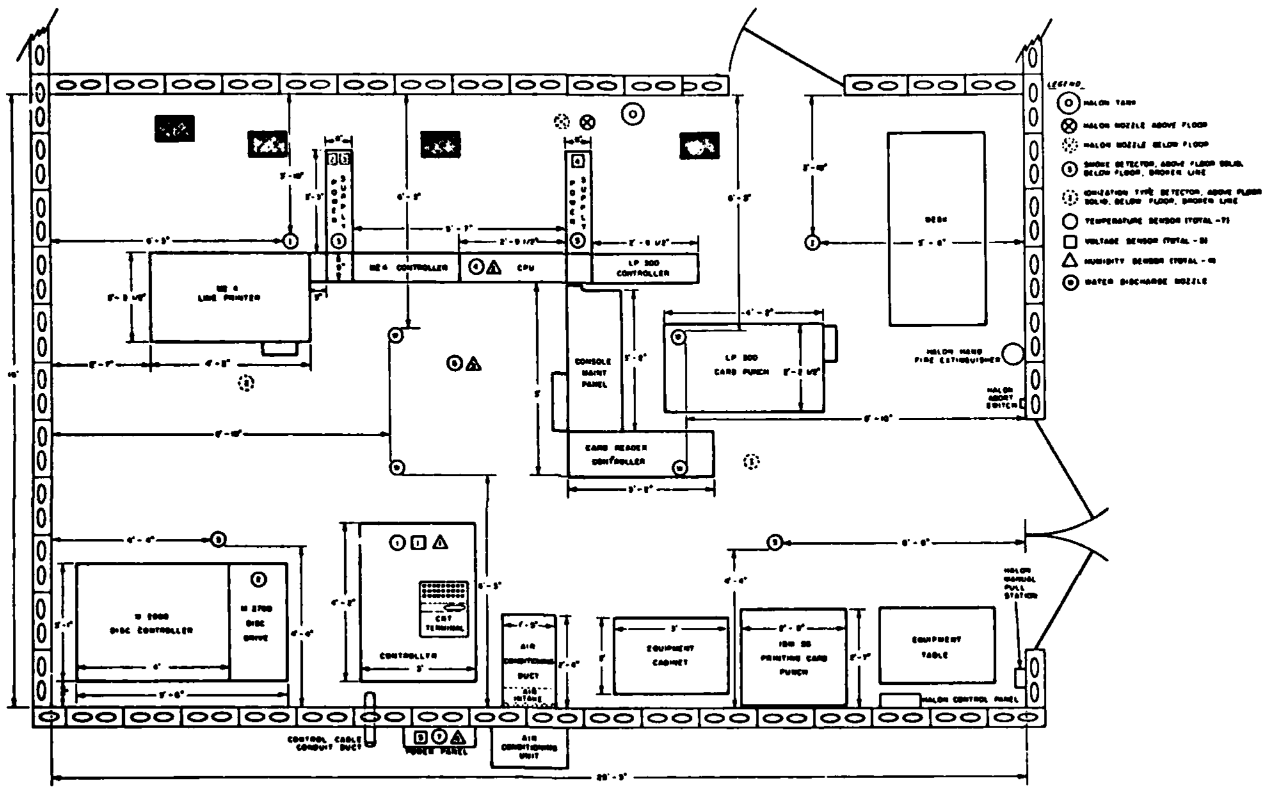


Figure 6. Test Points.

(2) Disk Drive. The disk drive operated in a stand-alone mode. The disk pack was tested by formatting it with known data and checking its contents before and after each test for losses or degradation. Normal disk drive operating temperature may vary between +60°F and +90°F with a maximum variation of 15°F. A temperature sensing device was placed near the electronic package of the disk drive to monitor temperature changes.

(3) MZ4 Printer, Controller and Power Supplies. The output of a computer installation is central to its purpose. This installation includes a printer for a hard-copy result of data reception. Failures in the operation of the printer with an input of valid data may be traced to failures in PCBs caused by their operating parameters being exceeded in either voltage, temperature, or humidity. The printer and its controller logic and memory circuits require stable voltages for error-free operation. Two electronically regulated power supplies are located in a separate cabinet to furnish the -15V and -46.5V required. When the voltage out varies more than $\pm$ 10 percent from their nominal value, internal protection devices de-energize a relay, thus removing input power.

Thermal conditions, line voltage, or electronic parts failure may cause a resultant change in the output voltage and, consequently, activate the protection devices. Data errors may appear before the protection devices activate. Voltage test points were installed to monitor the -15V and -46.5V source. The free air temperature was also monitored near the heat producing power supply semiconductors. This temperature could vary from 80°F to 135°F before failures in components or data flow could be expected.

(4) Central Processing Unit (CPU). The CPU used a magnetic core memory ranging from one to four modules of four kilobytes each. The test configuration consisted of two modules, a total of eight kilobytes of memory capacity. The operation characteristics of magnetic core type of memory use minute read/write currents and a stable voltage in order to magnetize a specific core in a specific direction to constitute data for manipulation or retrieval.

Temperature and voltage were parameters that had considerable influence on memory operating margins. For instance, if the temperature increases, the point of correct operation moves toward the lower read/write currents. At these lower read/write currents, the memory is more susceptible to random spikes of noise. The value of the read/write currents is dependent on two factors: (1) the emitter resistance of the power transistor and (2) the voltage variation on the power transistor base. Current calibration is affected by the emitter resistance, so that the base voltage variations are in the order of 6V. A 14V generator maintains a constant 6V difference between the +20V source and the 14V generator.

A thermistor is mounted on the memory module to compensate for variations in temperature and maintains a constant memory operating voltage with a nominal temperature of 81.5°F. Two resistors compensate for thermistor resistance variations. Two other resistors were used for calibration purposes to obtain 510 ohms (± 0.5 percent) between their terminals to the memory module. As the temperature changed, the thermistor resistance varied and, consequently, the equivalent circuit resistance, thus determining the +14V variation. This, in turn, caused a variation of the read/write current. A temperature sensing device was placed near the memory module to monitor variations from the 81.5°F desired and corresponding incidence of errors or failures.

(5) CPU Power Supply. The CPU is dependent upon a stable voltage of +20V for its proper operation. An electronic regulated power supply is contained in a separate cabinet that provides this stabilized voltage. In the event of a voltage fluctuation of ± 10 percent, voltage protection circuits shut it down. Other protection circuits shut down power in the event the wiggle effect riding on the 20V exceeds 50 millivolts. A device to monitor the power supply voltage and temperature was placed in the power supply cabinet. A resolution of 5 millivolts change was required.

(6) Line Voltage. Monitors of the 208 VAC three-phase line voltage were installed for comparison.

(7) Humidity Detection. All components of the computer installation were sensitive to change in the relative humidity of their environment. A 50-percent relative humidity was recommended for their continued proper operation by the equipment manufacturer. Unpredictable results may occur when the relative humidity approaches the outside limits of either 10 or 90 percent.

A total of four humidity detection devices were installed. Two were installed in the more sensitive components, the CPU memory and the CRT controller. These components also represent the second and third generation computer family. The other two detectors monitored the humidity inside and outside the building. A dehumidifier was installed to maintain the level of humidity called for by the test design.

d. Data Collection

(1) Data Recording System. An Intel MDS-80 microcomputer was installed in a separate, adjacent structure to monitor all tests (Figure 7). The Intel system was comprised of a CPU with 65-kilobyte memory, a dual minidisk unit, CRT terminal, and a printer.

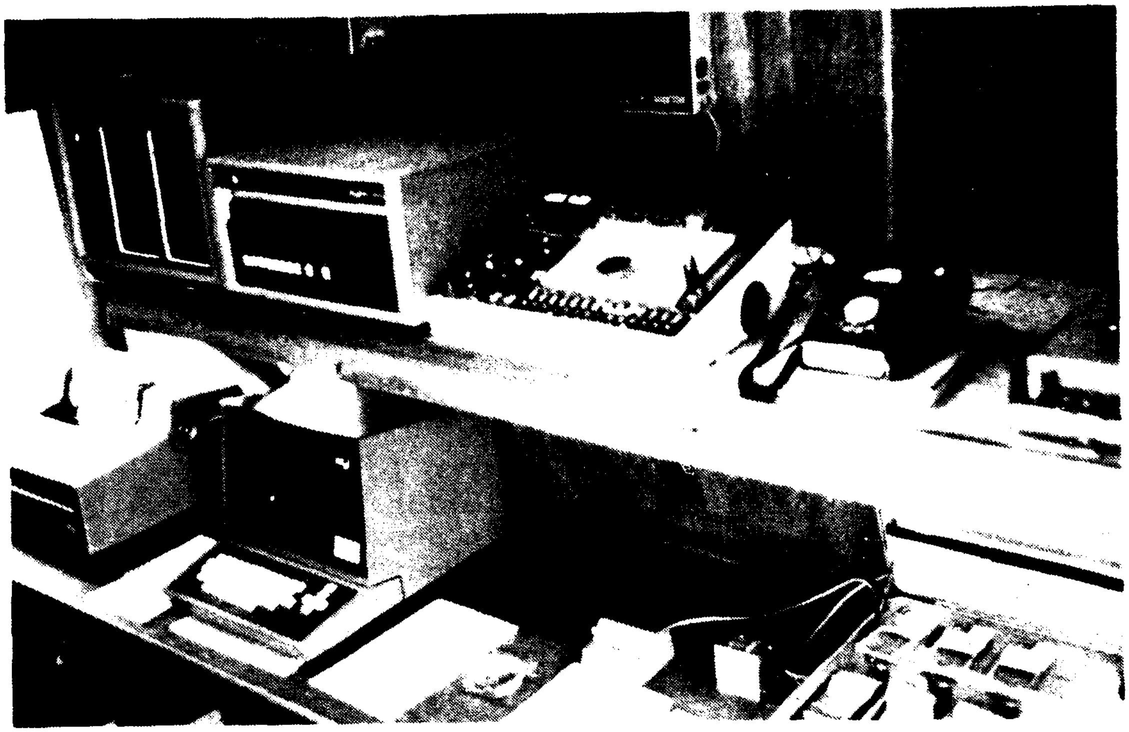


Figure 7. Intel MDS-80 Test Data Recording System.

An analog-to-digital converter board was installed in the computer to receive the differentiated input from the 16 test points of the GE 115/2 system test vehicle. This test data formed the basis for a detailed analysis and final evaluation of the test effort.

(2) Back-Up Systems. Strip chart recorders were installed to provide redundancy in test data collection.

(3) Computer Function for Tests

(a) General. With the exception of the disc test, CTR test, and tape test, all tests required the printing of beginning and ending messages. When each test was completed, the program performed the next test. When the last test was completed, the program branched to the beginning and repeated the tests. Thus, the program continued until the machine failed or the program was terminated by the operator.

(b) Memory Test. On the first run of this test, memory area not used to store the program was loaded with known patterns. The memory area was then checked against the known pattern. If the pattern did not match an error message, consisting of the address and pattern found, it was then printed and the original pattern reloaded into that portion of memory which failed. This test served as a check against the loss of data in memory.

(c) Arithmetic Test. This test checked the add decimal, subtract decimal, add binary, and subtract binary logic. The test performed operations on ten numbers in each mode and then compared the result to a known result. If an error occurred, an error message was printed consisting of the operation mode, the expected result, and actual result.

(d) Move Test. This test moved ten numbers and then ascertained that the moves were performed properly. When an error occurred. a message, consisting of the expected value and the actual value moved, was printed. This test verified the move logic.

(e) Printer and Card Reader Test. This test was designed to check printer mechanics and card reader transformation logic from IBM code to internal code. A card containing all the printable characters was read and then printed 216 times. Characters were shifted one place to the right each print so that each character was printed in every print position.

(f) Pack and Unpack Test. This test checked the pack and unpack logic; ten numbers were packed, ten numbers unpacked. The results were then compared with known values. If an error occurred, a message consisting of the operation, expected result, and actual result was printed.

(g) Compare and Branch Test. This test checked the condition code logic for each type of instruction that affected the condition codes. An operation with results known to the condition codes was then performed and a branch executed. If the branch did not occur, a message was printed consisting of the operation, the expected condition code, and the actual condition code. The program then branched to execute a Memory Test.

(h) Disk Test. This test served as an additional check against the loss of data. Two disks, preformatted at an outside computer facility, were used. One disk was inserted in the disk drive unit and run during the test exposure. The other disk was exposed to the atmosphere. After each test the disks were checked for damage and data loss.

(i) Cathode-Ray Tube (CRT) Test. The CRT operated as a stand-alone system and was both visually and electrically inspected before and after each test sequence to assess damage resulting from exposure to fire extinguishants.

(j) Tape Test. A number of tapes were preformatted at an outside facility. Several tapes were unreeled and exposed to the atmosphere, while others remained in their case during each test sequence. After each test, tapes were checked for damage and data loss.

(4) Halon Sampling. Using the thermal conductivity properties of Halon in air, a PERCO Halon Analyzer (Model 113A200) was used to sample agent concentration in the computer test facility. Three 50 ft sampling lines led from the analyzer and electrical recorder (located in the data collection enclosure) into the computer test facility. One Halon sampling point at the end of these lines was in the plenum above the suspended ceiling, another was 4 feet above the raised floor, and the third sampling point was located in the subfloor area. Three 0-50-millivolt direct current recorders charted the measurements obtained from the three independent gas detectors located within the common housing of the analyzer. Accuracy of the instrument was ±2 percent of full scale.

(5) Sampling and Analysis of HF and HBr. A two-stage scrubber was installed to collect gas samples for analysis of hydrogen fluoride and hydrogen bromide present in the planned series of tests. A schematic diagram of the gas sampling arrangement is shown in Figure 8.

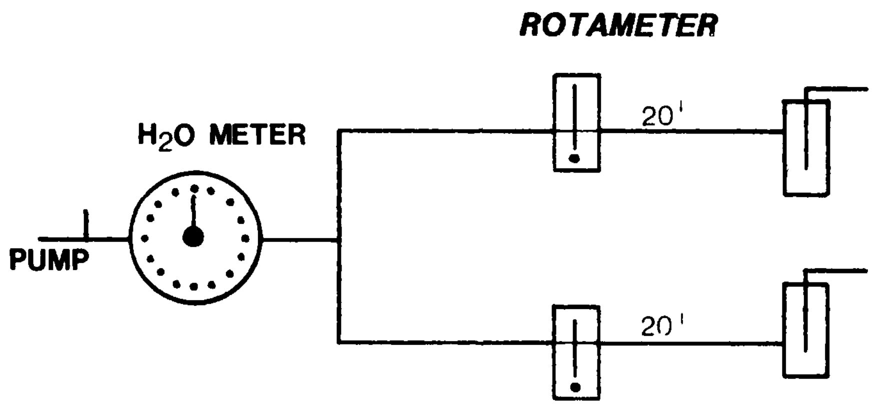


Figure 8. Gas Sampling Arrangement.

Sampling to determine HF and HBr concentrations began at the time of actuation of the fire suppression system. Once the vacuum pump was turned on, a constant flow rate of 1.17 Liters/minute was maintained throughout the fire suppression and subsequent soak period. At the end of each test, pumps were turned off and sample containers removed for laboratory analysis by the Environics Division, Air Force Engineering and Services Center.

(6) Procedure for Analysis of Printed Circuit Boards. The procedure for pretest establishment of baseline data and post-test analvsis of the immediate, intermediate (90 to 120 days) and long term (18 months) effects of the test exposure on selected printed circuit boards (PCBs) is given in Appendix B.

(7) Video Recording of Selected Test Events. Recorded inside the computer test facility, the edited video tape of the test program provides effective evidence of actual conditions of the fire scene in a computer facility.

SECTION III

TEST RESULTS

1. ORGANIZATION OF DATA

a. General

This section describes the results of the series of controlled tests conducted during the period November 1980 through February 1981 and documents the post-test analyses of the long term effects of induced fire exposure of electronic equipment components. The latter evaluations concluded in June 1982.

b. Chronology and Numbering of Tests

Ten test evolutions were planned for each of the contending fire suppression systems. While all Halon 1301 tests (numbered A-1 through A-10) were accomplished, water sprinkler tests (identified by prefix B) actually saw only one replication of the planned identical test conditions to which both systems were to be subjected. Test B-1, the first application of the water sprinkler system, resulted in a complete breakdown of the computer test vehicle. As a consequence, continued testing of the water sprinkler systems had to be accomplished in an adjacent room, without the use of on-line computer equipment. This limited the evaluation to the use of a computer cabinet replica, and exposure of computer software (tape and disks) and computer-associated paper products (printouts and cards).

2. HALON 1301 FIRE EXTINGUISHMENT TESTS

Appendix A provides initial and post-test recordings of data from selected printed circuit boards monitored during the tests. Individual tests are discussed in detail below.

a. Test Item A-1. Halon 1301 Against Plastics Fire

(1) Objectives

(a) Determine whether Halon 1301 with a design concentration of 5.6 percent in air would extinguish fires of common wire insulation materials (polyvinyl chloride-jacketed cabling) when the EDP and air exchange systems remained operational during fire extinguishment.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 68°F with a relative humidity of 44 percent. A metal cabinet (Figure 9), identical in dimension to a wing of the GE 115/2 computer, was loaded with polyvinyl chloride (PVC)-jacketed, multistrand computer cabling. The fuel array inside the test cabinet was representative of normal installation of computer cabling. Weight of the PVC, the fuel source for this test, was 250 grams. The Halon system-activated electrical power shunt was bypassed to allow the computer to continue to function during the test. A nichrome igniter in the bottom of the cabinet was wired for remote ignition.

Figure 9. Computer Cabinet Replica and PVC-Jacketed Cabling.

(3) Results

(a) Timed Events. Smoke became visible at 57 seconds after ignition. The first detection alarm occurred in Zone 1 at 1 minute 30 seconds. The second detection occurred in Zone 2 at 1 minute 45 seconds. The Halon system discharged at 2 minutes 15 seconds. The fire was extinguished after 4 minutes 45 seconds. Total soaking time was 30 minutes from time of Halon system discharge.

(b) Fuel Comsumption: 90 percent at end of test.

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 10)

a. Room. Peaked at 4.2 percent by time of fire extinguishment and remained at that level until 11 minutes of soaking time, thereafter falling gradually to 3.3 percent at the conclusion of the test.

b. Subfloor. Exceeded 10 percent (off scale) 10 seconds after Halon system activation. At time of extinguishment (4 minutes 45 seconds), the level had fallen steadily to 5.4 percent, gradually diminishing to 3.3 percent by end of test.

c. Ceiling. Rose rapidly, peaked at 7.2 percent by 1 minute 35 seconds after activation and was 7.2 percent at fire extinquishment. After 5 minutes soaking time, the concentration dropped to 6.9 percent. The Halon 1301 concentration leveled off at 5.2 percent at 13 minutes soaking time and remained there until end of test.

2. Room Temperatures (Figure 10)

a. Computer room temperature (stabilized at 68°F at start of test) rose to 69°F by the time of the fire extinguishment; thereafter, it gradually declined to a low of 67°F at 10 minutes, then rose again gradually to 71°F at the end of the test.

b. Floor temperature (60°F at start) dropped to 53°F at Halon discharge and within 5 minutes rose to ambient room temperature.

c. Temperature at ceiling level (65°F at start) reached a maximum of 72°F when Halon was discharged, then dropped to 66°F within 5 minutes, remained there for 10 minutes, and gradually increased to 70°F at end of test.

3. Relative Humidity. Relative Humidity, stabilized at the start at 44 percent, gradually rose to 46 percent at fire extinguishment; it then fell gradually during soaking back to 44 percent, declining during the last 5 minutes to 41 percent.

4. Visibility. The room was almost completely obscured from time of Halon system activation to 2 minutes after extinguishment. Visibility gradually improved until at 17 minutes 13 seconds it had cleared to 25 feet. At 26 minutes 15 seconds, total visibilty had been restored. The room environmental conditioning system continued operating during the test.

5. Ambient Temperature and Barometric Pressure

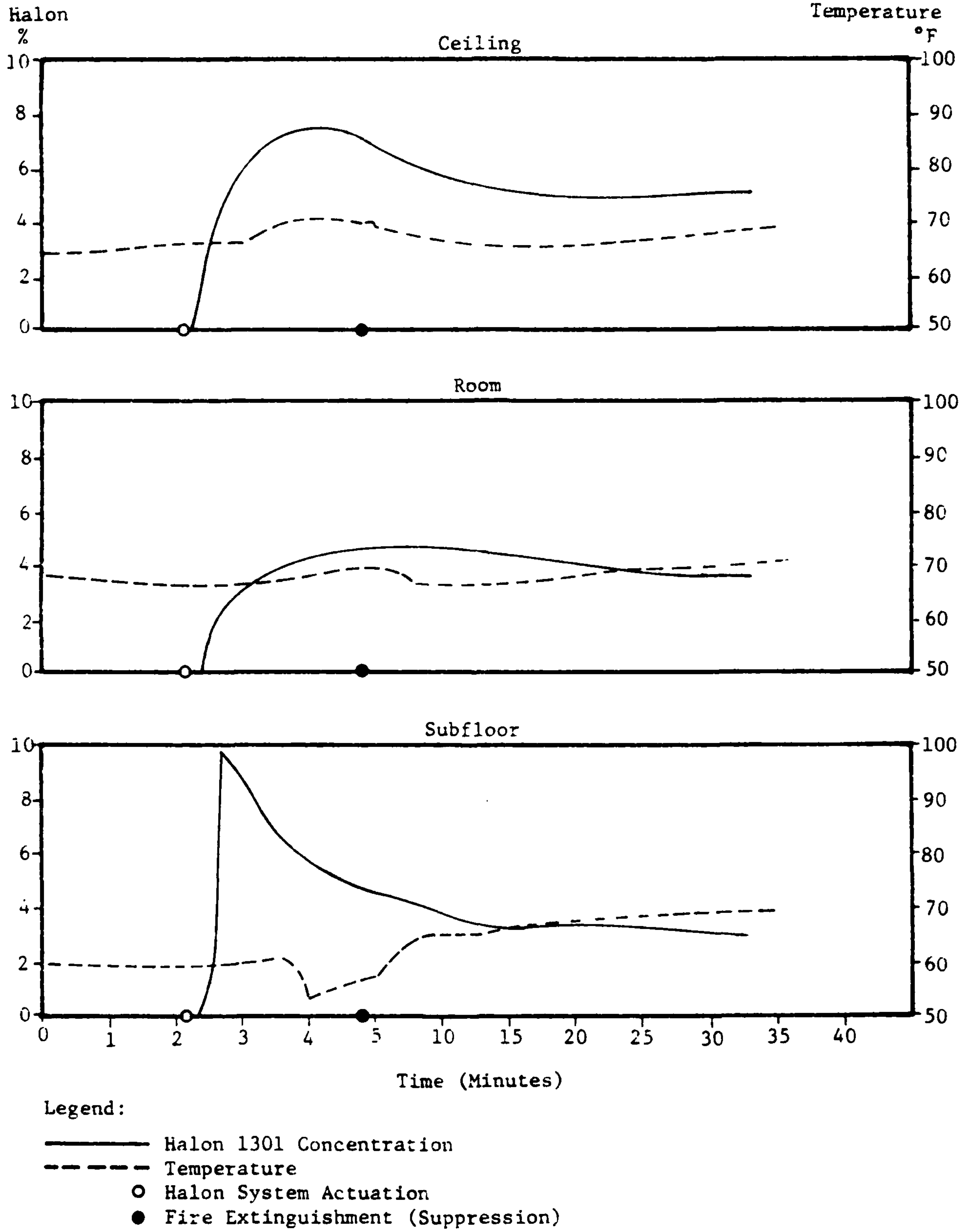


Figure 10. Halon Concentration and Temperature Versus Time, Test A-1.

a. During the test, the ambient temperature increased from 68°F at beginning to 71°F at end of test.

b. Barometric pressure during the test was 30.11 inches Hg.

6. Post-Test Analysis of Gas Samples. The computer facility attained a concentration of 2.4 ppm of HF and 6.5 ppm of HBr as indicated by a sample size of 32 liters taken over 33 minutes.

(d) Structural Effects. Several ceiling panels had been blown out of their ceiling grids by the force of the Halon discharge, and one of the overhead lights had been dislodged.

(e) Impact on EDP Equipment. During the test, the printer had stopped due to a minor mechanical malfunction not attributable to the test fire or the extinguishing system. All computer system components functioned normally after restart.

1. Equipment Temperature. Sensors monitoring computer equipment indicated that equipment modules remained within normal operating ranges.

2. Test Cabinet Temperature. Two thermocouples located in the test cabinet indicated between 69°F and 72°F during the entire test. It was concluded that these sensors were faulty, since they were located inches from the fire. A temperature tab located on the test cabinet indicated that the temperature reached 465°F. The latter temperature must be assumed to reflect the actual result of the fuel consumed inside the test cabinet.

3. Room, ceiling, and subfloor temperatures are shown in Appendix A.

4. Analysis of Intel Voltage Recordings. The fire and extinguishant had no significant effect on CRT control temperature, CRT control logic, printer controller print logic, and printer controller power supply control voltages. Voltage change effects on the remaining Intel monitored equipment, although slightly out of tolerance (as defined by a 95-percent confidence interval of mean normal operating condition), had no adverse effects on the EDP system's continued operation.

5. Static Resistance Variances. Pretest and post-test readings showed an average increase of 36.78mΩ in computer board resistance measurements and an average increase of 2.16mΩ per computer board terminal (Appendix A).

6. Static Voltage Variances. Before and after test readings showed an average decrease of 0.473 volt per computer board and an average decrease of 0.028 volt per computer terminal (Appendix A).

7. Long Term Effect on PCBs. When aged and tested 137 days after exposure to Halon 1301 extinguishment, PCBs showed no deterioration; tested again 18 months after Test A-1 exposure, no adverse effects were discernible.

(f) Software

1. The computer program printout was normal, showing no effects of fire or extinguishant on the test computer software.

2. Peripherally placed test tapes, diskettes, cards and printed circuit boards showed no adverse effects when data recovery was attempted immediately after Test A-1.

b. Test Item A-2. Halon Against Plastics Fire

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in extinguishing a computer facility plastics fire while the computer and air exchange systems were deactivated.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 70°F with a relative humidity of 50 percent. The metal cabinet (Figure 9), used for Test A-1, was again loaded with PVC-jacketed, multistrand computer cabling. The fuel array inside the test cabinet was representative of normal installation of computer cabling. Weight of the PVC, the fuel source for this test, was 224 grams. The Halon system-activated electrical power shunt was allowed to function normally so that the electrical power to the computer and air exchange would be automatically interrupted upon Halon system activation. A nichrome igniter in the bottom of the cabinet was wired for remote ignition.

(3) Results

(a) Timed Events. Smoke became visible at 52 seconds after ignition. Flame was visible at 1 minute 7 seconds. The first detection alarm occurred in Zone 1 at 1 minute 22 seconds. The second detection occurred in Zone 2 at 1 minute 51 seconds. The Halon system discharged at 3 minutes 33 seconds. The fire was extinguished at 4 minutes 14 seconds. Total soaking time was 60 minutes from time of fire extinguishment.

(b) Fuel Comsumption. At end of test it was found that 75 percent (by weight of PVC cable insulation) of the fuel had been consumed (Figure 11).

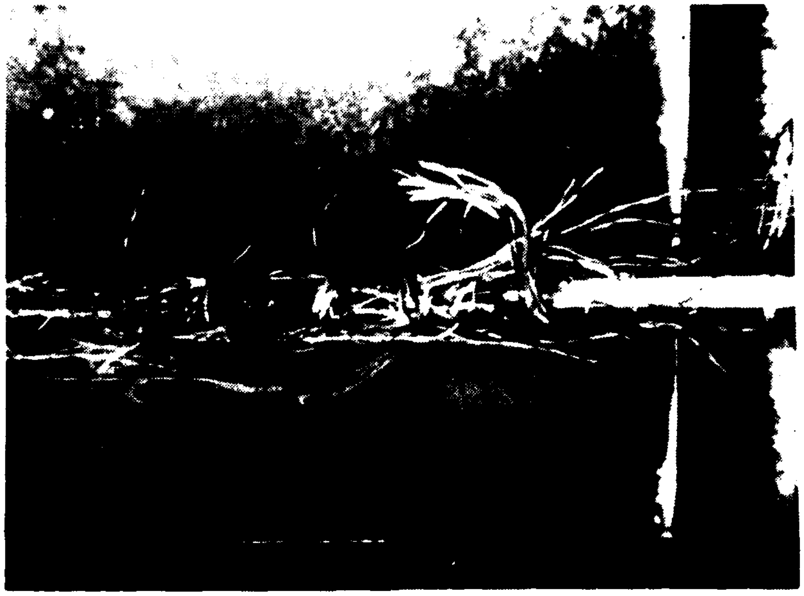


Figure 11. PVC Fuel Source 75-Percent Consumed After Test A-2.

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 12)

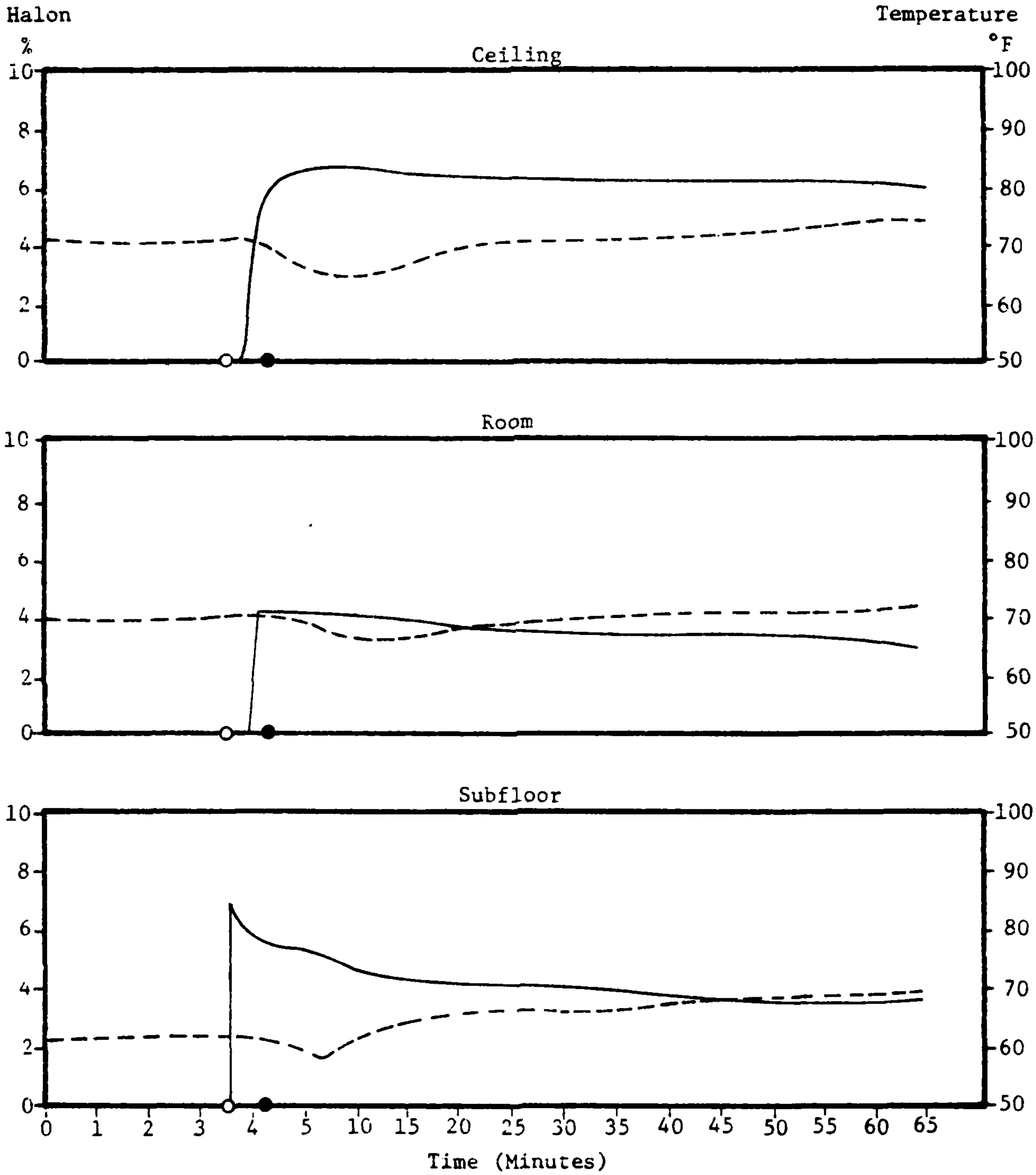
a. Room. Peaked at 4.3 percent 27 seconds after system activation. Halon concentration was 4.2 percent at extinguishment and remained at that level until 4 minutes of soaking time, thereafter falling gradually to 3.0 percent by end of test.

b. Subfloor. Peaked at 6.9 percent, 12 seconds after Halon system activation. By extinguishment (4 minutes 14 seconds), the level had fallen steadily to 5.3 percent, gradually diminished to 3.8 percent by 40 minutes of soaking time and remained there until end of test.

c. Ceiling. Rose rapidly to 6.2 percent by fire extinguishment. After peaking at 6.9 percent 1 minute 15 seconds of soaking time, the Halon 1301 concentration gradually fell to 6.2 percent by end of test.

2. Room Temperatures (Figure 12)

a. Computer room temperature stabilized at 70°F at the start of the test; the temperature began falling at 2 minutes soaking time and reached 67°F by 4 minutes soaking time, beginning to rise again after 10 minutes soaking time and stabilizing at 72°F by end of test.



Legend:

Halon 1301 Concentration
Temperature
Halon System Actuation
Fire Extinguishant

Figure 12. Halon Concentration and Temperature Versus Time, Test A-2.

b. Floor temperature (62°F at start) dropped to 58°F 3 minutes after fire extinguishment, rose to 66°F by 15 minutes soaking time and gradually reached 70°F by end of test.

c. Temperature at the ceiling (71°F at start) fell to 65°F 4 minutes after extinguishment, rose to 70°F after 15 minutes soaking time, and gradually increased to 75°F at end of test.

3. Relative Humidity. Relative humidity (stabilized at the start at 50 percent) was 49 percent at Halon system activation and remained there until 1 minute of soak time, declining to 47 percent by 5 minutes soaking time. The humidity then rose to 58 percent by 10 minutes soaking time, gradually declining to 52 percent by end of test.

4. Ambient Temperature and Barometric Pressure. During the test, the outside temperature remained at 76°F until 1 minute of soaking time, when it fell to 73°F by 5 minutes soaking time. At end of test the outside temperature had risen to 75°F. Barometric pressure during the test was 29.99 inches Hg.

5. Post-Test Analysis of Gas Samples. The computer facility attained a concentration of 6.6 ppm of HF and 9.2 ppm of HBr as indicated by a sample of 76.8 liters taken over a 60-minute sampling period.

(d) Structural Effects. Similar to Test A-1, several ceiling panels were dislodged from their ceiling grids by the force of the Halon discharge.

(e) Effects on EDP Equipment

1. The computer system and air exchange system operated normally when restarted after the test.

2. Equipment Temperatures. Thermocouples monitoring computer equipment temperatures indicated that equipment modules remained within normal operation ranges, with the following exception: CR10 Card Reader Controller. A temperature indicating tab on the side of the cabinet 4 feet from the fire and 4 feet above the floor reached 140°F, exceeding allowed operating temperature (85°F) by 55 degrees.

3. Test Cabinet Temperatures. The thermocouple located on the lower portion of test cabinet indicated a temperature of 98°F at time of Halon discharge. Temperature indicating tabs located on the upper portion of the cabinet indicated a maximum temperature of 465°F.

4. Room Temperatures

a. A temperature indicating tab located on the test facility door, some 4 feet from the test cabinet, indicated 140°F.

b. A sensor mounted on the wall 12 inches behind the test cabinet read 465°F (par. 2 b.(3)(e)3., above).

5. Analysis of Intel Voltage Recordings. The fire and extinguishant had no significant effect on CRT Control temperature tolerance, CRT control logic, printer controller print logic, and printer controller power supply control voltages. Voltage change effects on the remaining Intel monitored equipment, although slightly out of tolerance, had no impact on subsequent operation of the system (Appendix A).

6. Static Resistance Variances. Pretest and post-test readings showed an average increase of 23.22mΩ in computer board resistance measurements and an average increase of 1.37mΩ per computer board terminal (Appendix A).

7. Static Voltage Variances. Showed an average increase of 0.126 volt per PCB and an average increase of 0.007 volt per computer terminal (Appendix A).

8. Post-Test Analysis of Printed Circuit Boards. PCBs showed no change in voltage signal and resistance parameters when tested 137 days after exposure to byproducts of the fire and decomposition of the extinguishant. No degradation of performance was noticed when again tested in June 1982.

(f) Software

1. The computer program printout was normal, showing no effects of fire or extinguishant on the test computer software.

2. Peripherally placed cards were not affected as to data recovery and further use as program input.

c. Test Item A-3. Halon 1301 Against Cellulosic Materials Fire

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in extinguishing a computer facility cellulosic materials fire while the computer and air exchange systems were deactivated.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 70°F with a relative humidity of 49 percent. A metal waste container of the type common to EDP facilities was loaded with cellulosic materials. Randomly placed inside the container were 1000 grams tabulating cards, 250 grams carbon paper and 550 grams printout paper. The Halon system-activated electrical power shunt was allowed to function normally so that the electrical power to the computer and air exchange would be automatically interrupted upon actuation of the fire protection sytem. A nichrome igniter in the bottom of the container was wired for remote ignition.

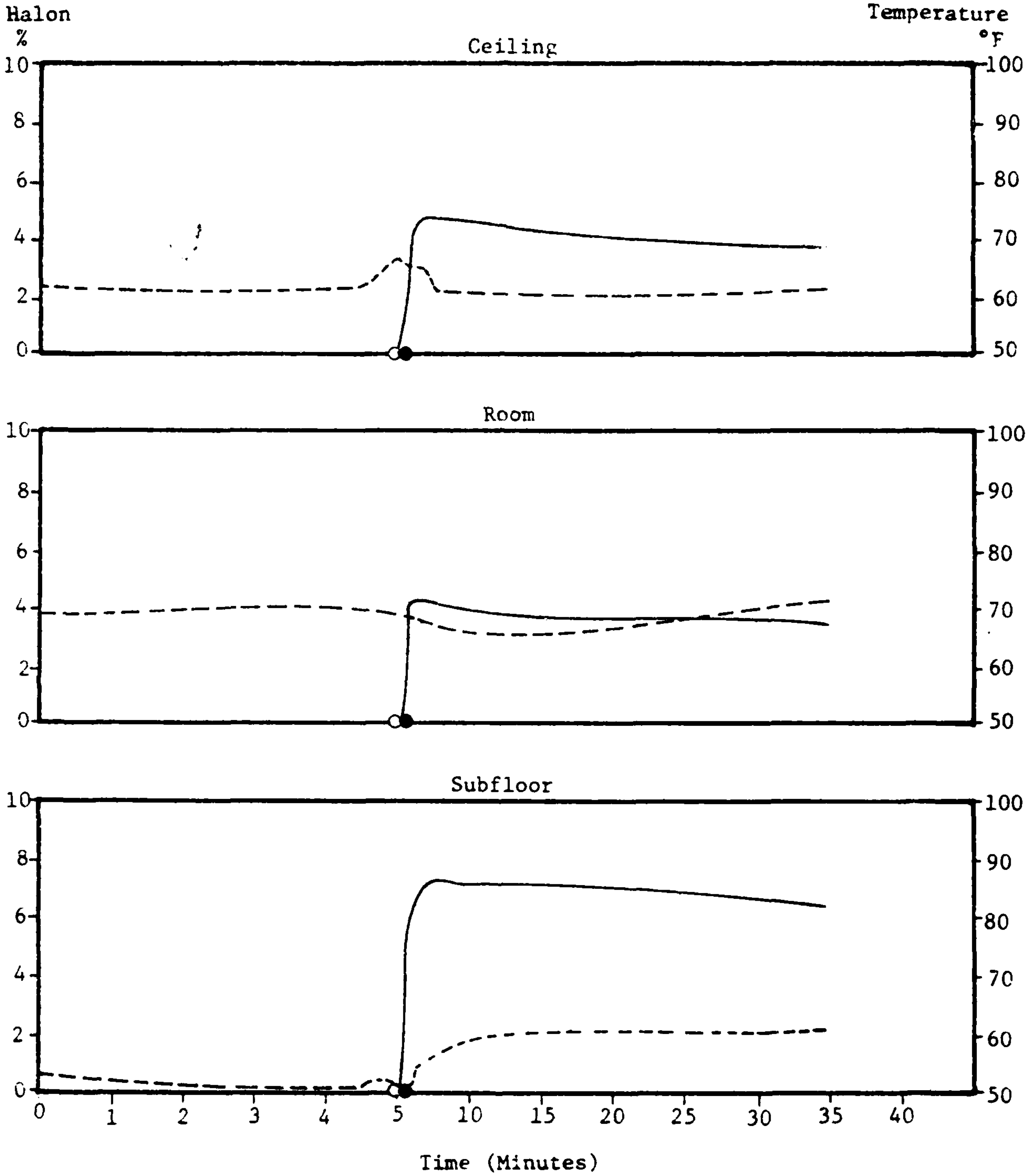
(a) Timed Events. Smoke became visible at 40 seconds after ignition. The first detection alarm occurred in Zone 1 at 2 minutes 18 seconds. Flame became visible at 2 minutes 28 seconds. The second detection occurred in Zone 2 at 4 minutes 20 seconds. The Halon system discharged at 5 minutes 11 seconds. The fire was extinguished at 5 minutes 30 seconds. Total soaking time was 30 minutes from time of fire extinguishment.

(b) Fuel Consumption. Approximately 30 percent of the paper products had been consumed when the waste container fire was extinguished. Figure 13 shows the remnants of the fuel array after conclusion of the test.

Figure 13. Unconsumed Fuel from Waste Container, Test A-3.

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 14)



Legend:

——— Halon 1301 Concentration
– – – Temperature
○ Halon System Actuation
● Fire Extinguishment (Suppression)

Figure 14. Halon Concentration and Temperature Versus Time, Test A-3.

a. Room. Temperature rose to 4.2 percent by time of fire extinguishment, peaked at 4.3 percent 5 seconds later, thereafter falling gradually to 3.7 percent by end of test.

b. Subfloor. Temperature rose to 5.6 percent by fire extinguishment, peaked at 7.3 percent by 1 minute, 20 seconds soaking time, then gradually diminished to 6.7 percent by end of test.

c. Ceiling. Temperature rose to 4.2 percent by fire extinguishment. After peaking at 4.4 percent 30 seconds after extinguishment, the Halon 1301 concentration gradually dropped to 3.8 percent by end of test.

2. Room Temperatures (Figure 14)

a. Computer room temperature stablized at 70°F at the start of the test. The temperature remained there until fire extinguishment, thereafter dropping to a low of 66°F at 3 minutes soaking time, then rose gradually to 71°F at the end of the test.

b. The floor temperature (53°F at start) dropped to 52°F at Halon discharge; within 6 minutes it rose to 61°F and remained there until end of test.

c. The ceiling temperature (62°F at start) reached a maximum of 57°F at time of Halon release. Ceiling temperature dropped to 62°F within 2 minutes and continued at that level to end of test.

3. Relative Humidity. Relative humidity (stabilized at the start at 49 percent) dropped to 46 percent at Halon activation, rose to 47 percent immediately after activation and remained there until 30 seconds after extinguishment; it gradually increased to 54 percent at 20 minutes soaking time, then increased to 66 percent at end of test.

4. Ambient Temperature and Barometric Pressure. During the test, the outside temperature dropped from 69°F at beginning to 68°F at end. Barometric pressure during test was 29.99 inches Hg.

5. Post-Test Analysis of Gas Samples. The computer facility attained a concentration of 1.9 ppm of HF and 5.2 ppm of HBr as indicated by a sample size of 51.2 liters taken over 36 minutes.

(d) As in preceding tests, several ceiling panels had been lifted slightly above ceiling grids by the force of the Halon discharge.

(e) Effect on EDP Equipment

1. The computer system equipment and peripherals functioned normally after restart.

2. Equipment Temperatures. Thermocouples monitoring computer equipment temperatures indicated that equipment modules remained generally within normal operation ranges.

3. Test Cabinet Temperatures

a. A thermocouple located on the test cabinet indicated between 63°F and 70°F. It was concluded that this thermocouple was faulty, since it was located inches from the fire. A temperature indicating tab located on the test cabinet showed that it had reached its maximum recording temperature of 260°F.

4. Room Temperatures

a. A thermocouple above the test vehicle measured a maximum temperature of 112°F.

b. Temperature on the wall behind the waste container reached approximately 200°F.

c. Room, ceiling, and subfloor temperatures are shown in Figure 14.

5. Analysis of Intel Voltage Recordings. Monitoring of voltages throughout the GE 115/2 system showed no adverse results from this test evolution.

6. Static Resistance Variances. Pretest and post-test readings showed an average increase of 41.22mΩ in computer board resistance measurements and an average increase of 2.42mΩ per computer board terminal (Appendix A).

7. Static Voltage Variances. Before and after test readings showed an average decrease of 0.025 volt per computer board and average decrease of 0.002 volt per computer terminal (Appendix A).

8. Post-Test Analysis of Printed Circuit Boards. Prolonged aging of PCBs had no noticable effect on voltage, signal strength and resistance paramaters even 18 months after exposure.

(f) Software

1. Upon restart of the computer, five memory errors were noted. Two were due to program reload, one had data inserted, and two had been erased. The program then had to be

reloaded and no further errors were noted. The minor problem was not attributable to the test-induced conditions.

d. Test Item A-4. Halon 1301 Against Cellulosic Materials Fire

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in extinguishing a computer facility cellulosic materials fire without interrupting the data processing function or the computer and without shutting off the air handling equipment.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 63°F with a relative humidity of 44 percent. A wire waste container, similar to those found in computer installation, was loaded with cellulosic materials. The fuel array was randomly placed in the container in a manner normally found in computer room waste containers. Weight and composition of the fuel was identical to Test A-3. The Halon system-activated electrical power shunt was bypassed to allow the computer to continue to function during the test. A nichrome igniter in the bottom of the container was wired for remote ignition.

(3) Results

(a) Timed Events. Smoke became visible at 35 seconds after ignition. The first detection alarm occurred in Zone 2 at 2 minutes 51 seconds. The second detection occurred in Zone 1 at 3 minutes 53 seconds. Flame became visible at 4 minutes 25 seconds; the Halon system discharged at 4 minutes 27 seconds, suppressing the fire in 4 minutes 37 seconds. After 16 minutes, extreme smoke and smoldering were noted. At 19 minutes into the test, flames were again visible. At 22 minutes 30 seconds the fire died out completely.

(b) Fuel Consumption: 33 percent

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 15)

a. Room. Halon concentration was only 1.9 percent at time of fire suppression, peaked at 4.3 percent within 1 minute 18 seconds, then gradually dropped to 4.0 percent at 5 minutes of soaking time; concentration fell rapidly to 2.0 percent at 20 minutes soaking (at this point flames were again visible) and then gradually diminished to 1.6 percent at the conclusion of the test.

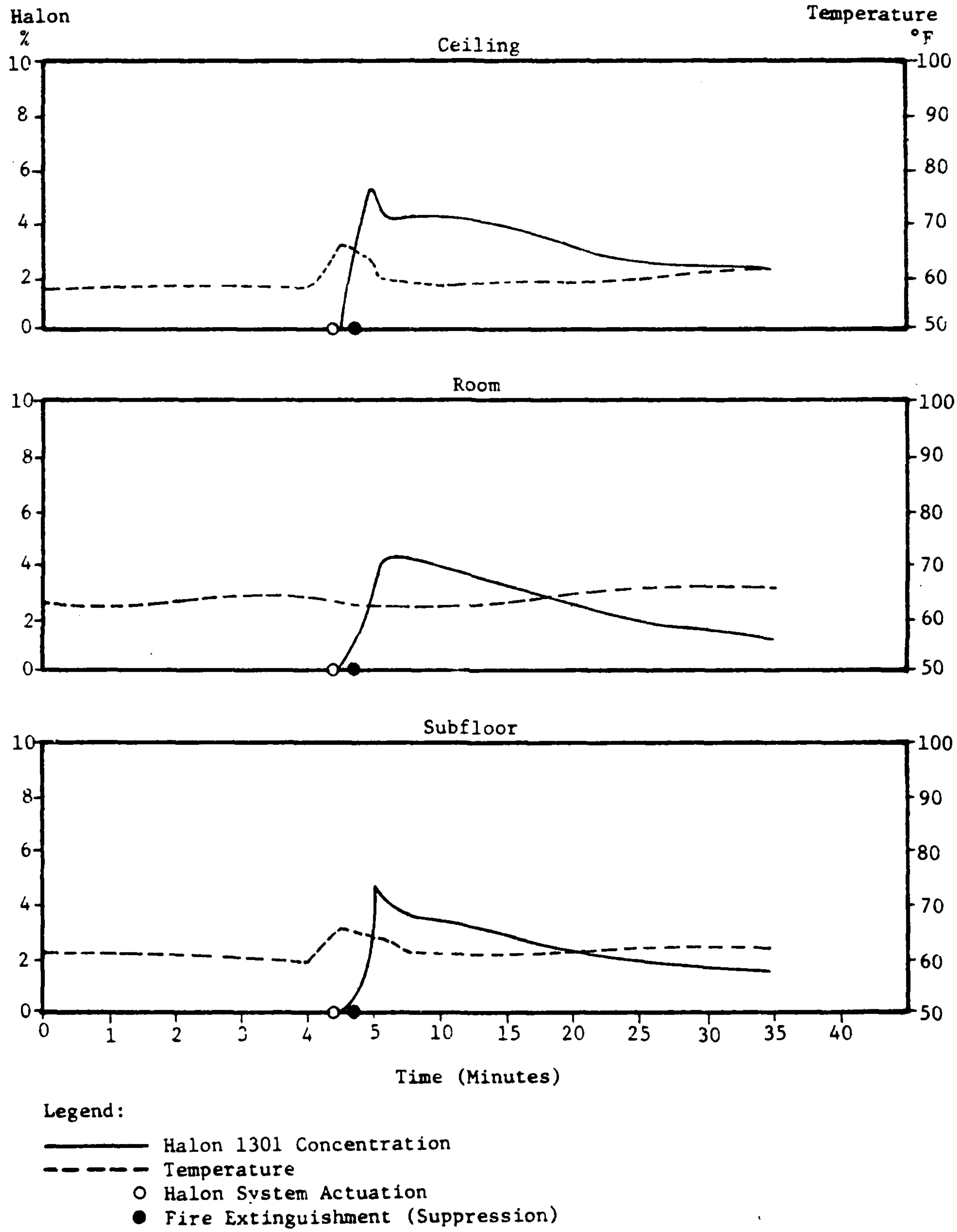


Figure 15. Halon Concentration and Temperature Versus Time, Test A-4.

b. In the floor, the Halon concentration was only 1.0 percent when the fire was suppressed. Peak concentration of 4.4 percent was achieved 26 seconds later, then gradually dropped to 3.6 percent at 5 minutes soaking time, 2.0 percent at 20 minutes soaking time, and 1.6 percent by end of test.

c. Ceiling. Halon concentration rose to 3.0 percent by fire suppression. After peaking at 5.2 percent 20 seconds after suppression, the Halon 1301 concentration gradually dropped to 4.3 percent at 5 minutes soaking time, 2.8 percent at 20 minutes soaking time, and 2.2 percent at end of test.

2. Room Temperatures (Figure 15)

a. The temperature (63°F at start) rose to 65°F at the time of Halon activation, dropped to 63°F at suppression, remained there until 5 minutes 3 seconds after suppression, and gradually rose to 67°F at end of test.

b. The floor (61°F at start) rose to 66°F when flames were visible; temperature dropped to 62°F by 1 minute 23 seconds after suppression, remained there though 15 minutes soaking time, rose to 63°F, and remained there until end of test.

c. The ceiling (58°F at start) reached a maximum of 66°F, which occurred when flames were visible; the temperature remained there until suppression, dropped to 58°F by 5 minutes soaking time, and gradually increased to 62°F at end of test.

3. Relative Humidity. Relative humidity, stabilized at the start at 44 percent, gradually rose to 46 percent when flames were visible; humidity remained at 46 percent through 25 minutes soaking time and increased to 47 percent at end of tests.

4. Ambient Temperature and Barometric Pressure. During the test, the outside temperature increased from 52°F at beginning to 56°F during the first 5 minutes 30 seconds; it dropped to 52°F at 14 minutes 40 seconds into test and increased to 54°F at end of test. Barometric pressure during the test was 30.02 inches Hg.

5. Post-Test Analysis of Gas Samples. The computer facility attained a concentration of 1.3 ppm of HF and 177 ppm of HBr as indicated by a sample size of 44 liters taken over 34 minutes.

(d) EDP Facility. No adverse effects noted.

(e) Effect on EDP Equipment

1. Computer system equipment functioned normally throughout the test.

2. Equipment temperatures remained within tolerable limits throughout the tests.

3. Temperatures at Fuel Source

a. A thermocouple located on the wire container indicated temperatures up to 138°F until initial suppression, remaining at 133°F until the fire restarted, when the temperature in the waste basket increased to 468°F.

4. Room Temperatures

a. A thermocouple on the ceiling 4 feet above the wire basket recorded temperatures up to 80°F until activation of the Halon system, then dropped to 66°F until it again increased to 170°F 15 minutes after initial suppression; thereafter, temperature dropped to 120°F at end of test.

b. Room, ceiling, and subfloor temperatures during Test A-4 are also shown in Figure 15, above.

5. Analysis of Intel voltage recordings showed that no adverse effects resulted from this test.

6. Static Resistance Variances. Pretest and post-test readings showed an average increase of 24.67mΩ in computer board resistance measurements and an average increase of 1.45mΩ per computer board terminal (Appendix A).

7. Static Voltage Variances. Before and after test readings showed an average decrease of 7.254 volt per PCB and an average decrease of 0.427 volt per computer terminal (Appendix A).

8. Post-Test Analysis of Printed Circuit Boards. PCBs showed no change in voltage, signal, and resistance parameters when tested 128 days after exposure to Test A-4 and were still unaffected when tested again in June 1982.

(f) Software

1. The computer program printout was normal despite some slight omissions of characters. Missing print was traced to a partially blocked optical aperture.

2. Peripherally placed test tapes, diskettes and cards remained unaffected and performed normally after the test exposure.

e. Test Item A-5. Halon 1301 Against Plastics Fire

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in extinguishing a computer facility plastics fire while the computer remained in operation and air exchange systems were turned off.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 75°F with a relative humidity of 46 percent. The metal test cabinet used in Tests A-1 and A-2 (Figure 9) was loaded with PVC-jacketed, multistrand computer cabling. The fuel array inside the test cabinet was representative of normal installation of computer cabling with respect to weight (240 grams) and configuration. The Halon system-activated electrical power shunt was bypassed to allow the computer to function normally during the test. A nichrome igniter in the bottom of the cabinet was wired for remote ignition.

(3) Results

(a) Timed Events. The first detection alarm occurred in Zone 1 at 54 seconds. The second detection occurred in Zone 2 at 1 minute 22 seconds. The Halon system discharged at 1 minute 52 seconds; fire was extinguished at 2 minutes 22 seconds. Total soaking time was 10 minutes from time of Halon system discharge. Test was terminated prematurely due to an external power failure.

(b) Fuel Consumption: 90 percent.

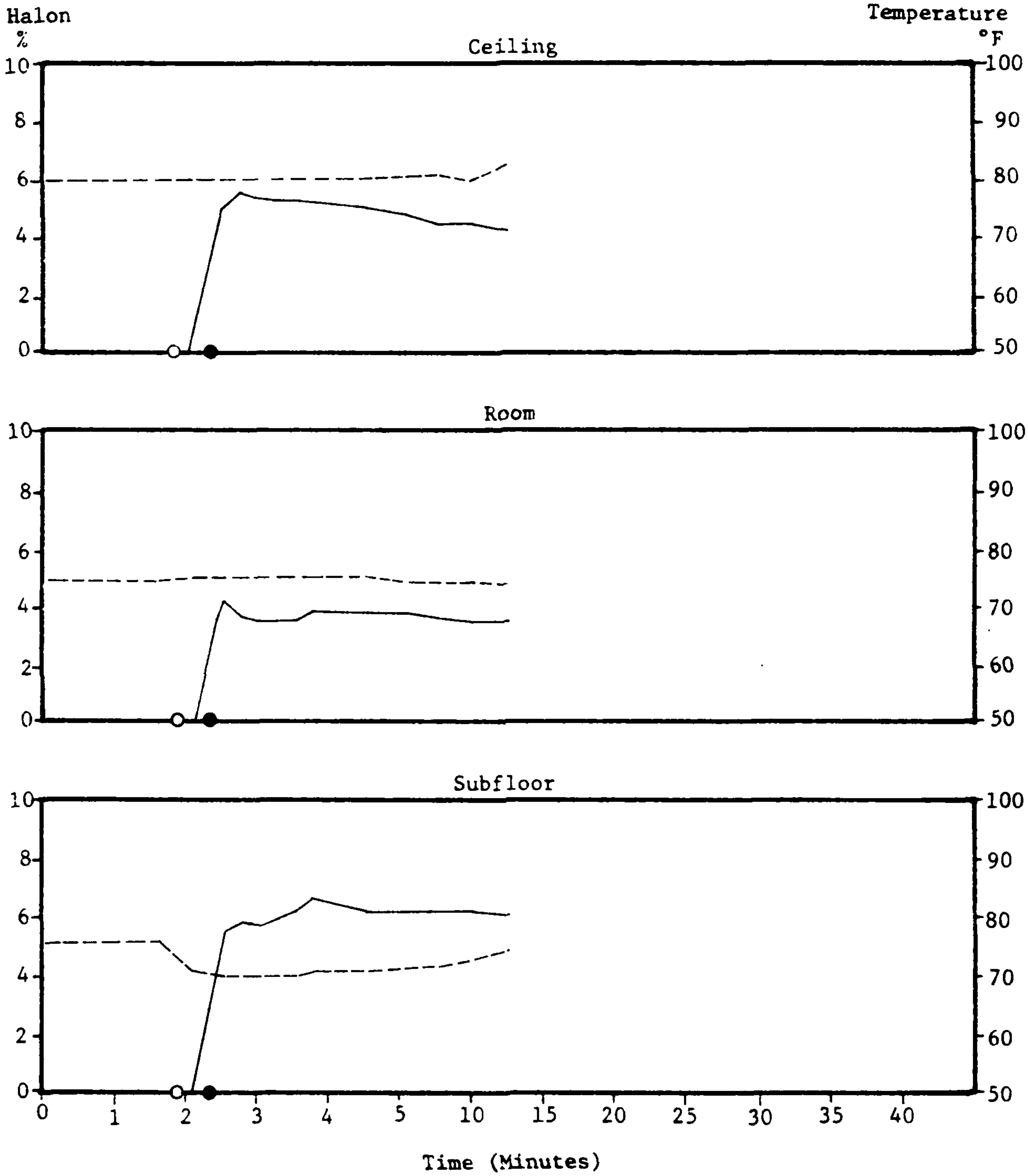
(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 16)

a. Room. Halon concentration peaked at 4.1 percent 20 seconds after discharge. Dropped to 3.9 percent at time of fire extinguishment, thereafter falling gradually to 3.7 percent at end of test.

b. Subfloor. Halon concentration rose to 5.9 percent initially, then peaked at 6.3 percent after 1 minute 5 seconds soaking time, then gradually dropped to 6.0 percent at test conclusion.

c. Ceiling. Halon concentration was 5.1 percent when the fire was extinguished. Peak concentration of 5.6 percent was achieved during the test.



Legend:

——— Halon 1301 Concentration
– – – Temperature
○ Halon System Actuation
● Fire Extinguishment (Suppression)

Figure 16. Halon Concentration and Temperature Versus Time, Test A-5.

2. Room Temperatures (Figure 16)

a. Computer room temperature fluctuated between 75°F at the start and 77°F at Halon discharge to 74°F at the termination of the test.

b. Floor temperature (76°F at start) dropped to 71°F at Halon discharge and dropped to 70°F at extinguishment; it remained there for 1 minute, then rose to 74°F at end of test.

c. Ceiling temperature (80°F at start) remained at 80°F until 5 minutes soak time, at which time it began to increase to 83°F at end of test.

3. Relative Humidity. Relative humidity, stabilized at the start at 46 percent, dropped to 43 percent at Halon discharge, and increased to 44 percent at end of test.

4. Ambient Temperature and Barometric Pressure

a. During the test, the outside temperature increased from 64°F to 65°F during the test.

b. The barometric pressure during the test was 30.13 inches Hg.

5. Post-Test Analysis of Gas Samples. The computer facility attained a concentration of less then 5 ppm of HF and less then 5.6 ppm of HBr as indicated by a sample size of 8.6 liters taken over 9.6 minutes. Due to the small sample taken as a result of premature test termination, these samples should be disregarded.

(d) EDP Equipment. With the exception of the printer which jammed due to a minor mechanical malfunction, all other system elements performed normally throughout the test. Temperature within the equipment enclosures did not exceed tolerable levels.

1. Test Cabinet Temperatures. A thermocouple located on the test cabinet indicated a maximum temperature of 171°F during the test.

2. Room Temperatures

a. A thermocouple mounted on the ceiling above the cabinet containing the fuel reached a maximum temperature of 336°F.

b. Room, ceiling, and subfloor temperatures are shown in Figure 16.

3. Analysis of Intel voltage recordings showed no variances from the norm.

4. Static Resistance Variances. Pretest and post-test readings showed an average increase of 22.33mΩ in computer board resistance measurements and an average increase of 1.31mΩ per computer board terminal (Appendix A).

5. Static Voltage Variances. Before and after test readings showed an average decrease of 8.450 volts per computer terminal (Appendix A).

6. Post-Test Analysis of Printed Circuit Boards. PCBs showed no adverse effects when tested 123 days and again 8 months after test exposure.

(e) Software remained totally unaffected by the test.

f. Test Item A-6. Halon 1301 Against Plastics Fire

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in extinguishing a computer facility plastics fire occurring in a subfloor cable duct; EDP system remained in operation (to simulate uninterrupted acquisition of essential data) and air exchange systems were shut off.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 68°F with a relative humidity of 40 percent. A metal cabinet (Figure 17), simulating a cabling duct, was loaded with the PVC-jacketed cabling and placed in the subfloor area. Weight of the PVC cable insulation was 250 grams. The Halon system-activated electrical power shunt was bypassed to allow the computer to continue to function during the test; the air exchange system was turned off. A nichrome igniter provided remote ignition.

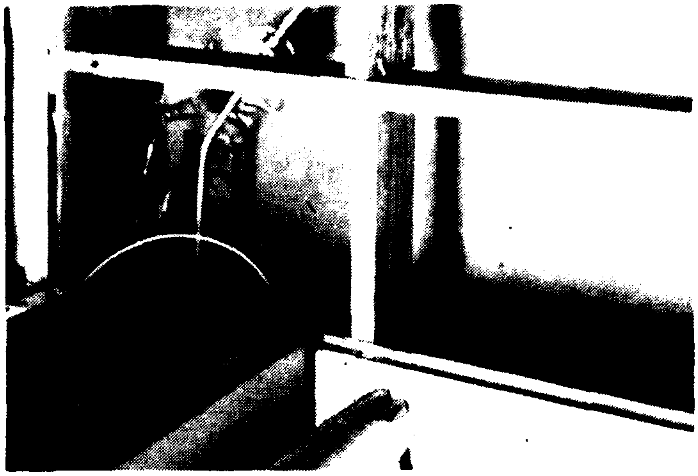


Figure 17. Fuel Array for Subfloor Cable Fire, Test A-6.

(3) Results

(a) Timed Events. The first detection alarm occurred in Zone 1 at 1 minute 37 seconds. Smoke became visible at 2 minutes 55 seconds. The second detection occurred in Zone 2 at 6 minutes 21 seconds. The Halon system discharged at 6 minutes 51 seconds. The fire was extinguished at 8 minutes 20 seconds. Total soaking time was 30 minutes from time of Halon system discharge.

(b) Fuel Consumption: 90 percent.

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 18)

a. Room. Halon concentration peaked at 3.2 percent 29 seconds after Halon discharge; it dropped to 3.0 percent when fire was fully extinguished and remained at that level until 11 minutes of soaking time, thereafter falling gradually to 2.7 percent by end of test.

b. Subfloor. Halon concentration rose to 5.4 percent at time of extinguishment. It peaked at 5.5 percent 10 seconds later, then gradually diminished to 5.2 percent by end of test.

c. Ceiling. Halon concentration peaked at 7.7 percent, 29 seconds after activation.

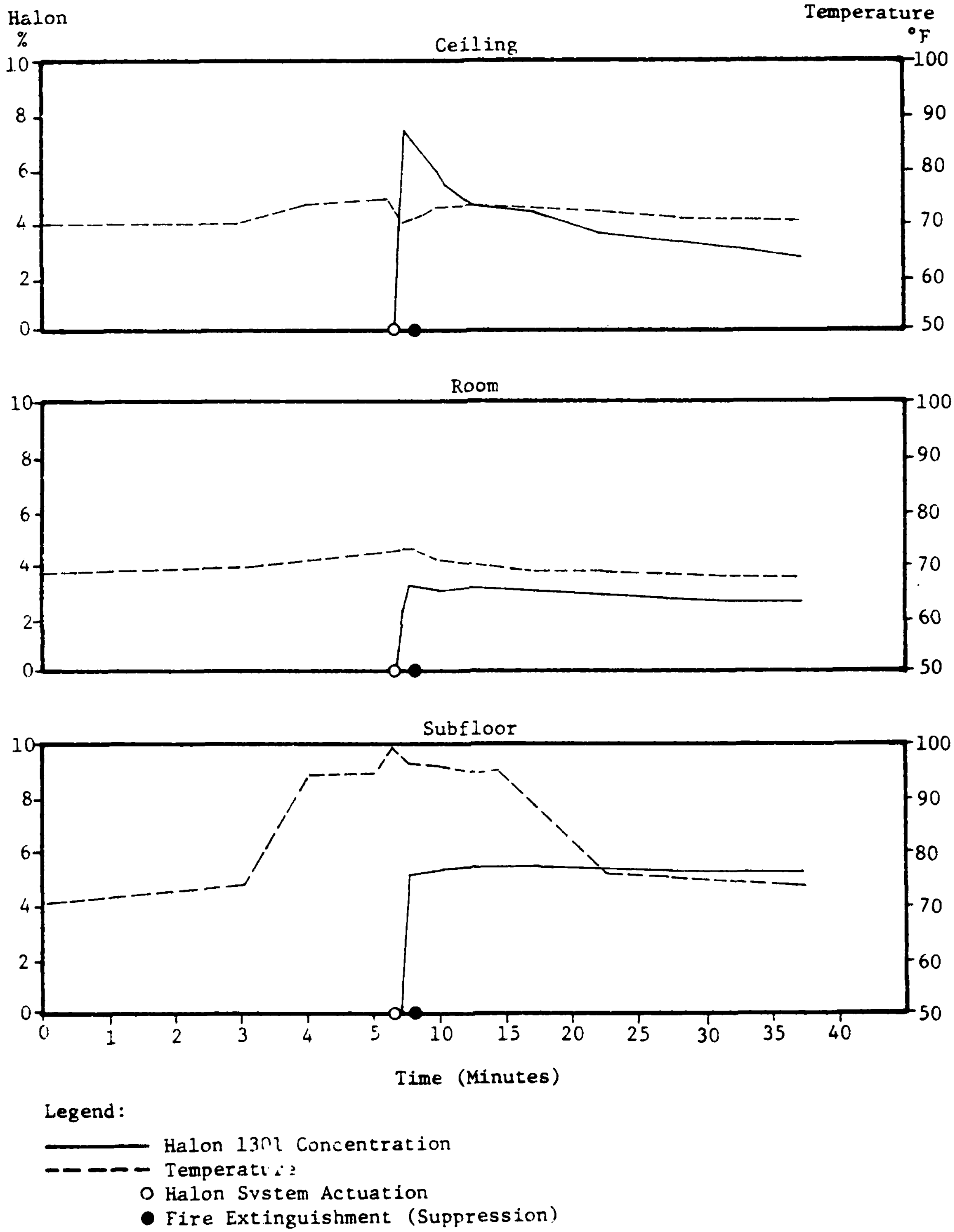


Figure 18. Halon Concentration and Temperature Versus Time, Test A-6.

2. Room Temperatures (Figure 18)

a. Computer room temperature (68°F at start) rose to 74°F at time of extinguisher discharge and thereafter gradually declined to 68°F at the end of the test.

b. Temperature in the subfloor area was 71°F at start, then rose to 101°F 30 seconds prior to Halon discharge when it dropped to 97°F. At the end of the soaking period the subfloor temperature had fallen to 74°F.

c. The ceiling (70°F at start) reached a maximum of 75°F, which occurred at Zone 2 detection. Ceiling temperature dropped to 70°F at Halon activation, rose to 75°F at end of 5 minutes soaking time, and gradually decreased to 71°F at end of test.

3. Relative humidity fluctuated between 40 and 38 percent during the test.

4. Ambient temperature increased 1 degree during the test (69°F to 70°F). Barometric pressure was 30.34 inches Hg.

5. Post-Test Analysis of Gas samples

a. The room attained a concentration of 0.41 ppm HF and 2.6 ppm HBr as indicated by a sample size of 31.6 liters taken over a 32-minute period.

b. Subfloor concentrations of HF and HBr were 1.1 and 3.4, ppm respectively, for the 32-minute, 31.6-liter gas sample collected.

c. Concentrations of HF and HBr collected near the ceiling of the test facility were 0.47 ppm and 3.0 ppm, respectively. These were measured from a gas sample size of 27.9 liters.

(d) EDP Facility. Two ceiling panels had been lifted slightly above the ceiling grid by the force of the Halon discharge.

(e) EDP Equipment

1. The computer system equipment functioned normally throughout the test. Internal temperatures remained within tolerance levels.

2. Test Cabinet Temperatures

a. Two sensors located on the test cabinet indicated a maximum temperature of 94°F during the entire test and were assumed to be faulty.

4. Room Temperatures

a. A thermocouple 4 inches above the test cabinet and on the underside of flooring recorded a maximum of 591°F.

b. Room, ceiling, and subfloor temperatures are shown in Figure 18.

5. Analysis of Intel voltage recordings indicated normal functioning of the test computer system.

6. Static Resistance Variances. Pretest and post-test readings showed an average increase of 9.33mΩ in computer board resistance measurements and an average increase of 0.55mΩ per computer board terminal (Appendix A).

7. Static Voltage Variances. Before and after test readings showed an average decreas of 3.87 volt per computer board and an average decrease of 0.228 volt per computer terminal (Appendix A).

8. Post-test analysis of PCBs 115 days and then 8 months after the test showed no change in voltage, signal and resistance parameters.

(f) Software in use during the test and items placed in the vicinity of the fire box showed no degradation of data retrieval after the test.

g. Test Item A-7. Halon 1301 Against Plastics Fire

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in extinguishing a computer facility plastics fire while the computer remained on and air exchange systems were turned off.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 65°F with a relative humidity of 52 percent. An open wire basket (Figure 19) was loaded with 7200 feet of wound polyester-base tape, polystyrene tape cores and reels of polyethylene tape bands. The fuel array inside the wire basket was representative of normal installation storage of tape reels. The Halon system-activated electrical power shunt was bypassed to allow the computer to continue to function during

the test. Fifty ml of isopropyl alcohol were used to ignite the fuel.

Figure 19. Polyester, Polyethylene and Polystyrene as Fuel Sources.

(3) Results

(a) Timed Events. Smoke became visible within 3 seconds after ignition. The first detection alarm sounded in Zone 1 within 7 seconds; flames became visible at the same time. Zone 2 detection occurred after 31 seconds. The Halon system discharged at 1 minute 6 seconds. The fire was extinguished at 1 minute 26 seconds. Total soaking time was 30 minutes from time of Halon system discharge.

(b) Fuel Consumption: 75 percent (Figure 20)

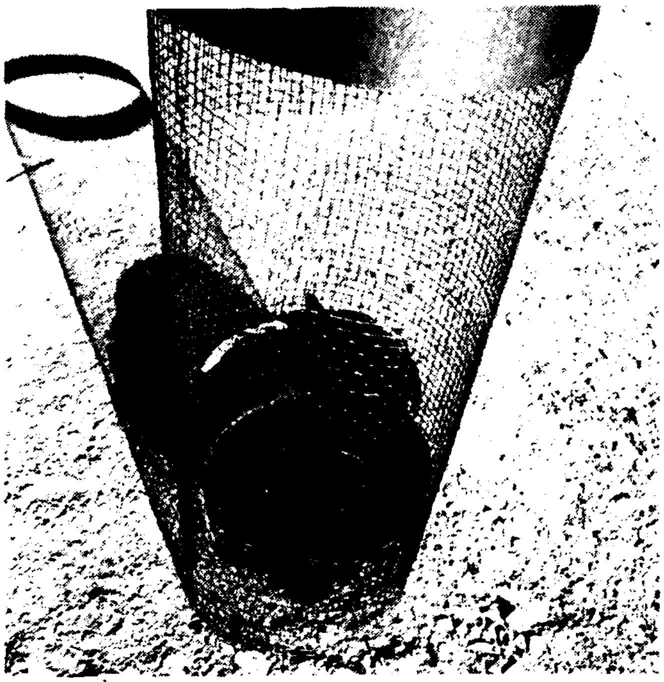


Figure 20. Fuel Remaining from Test A-7.

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 21)

a. Room. Halon concentration rose to 3.9 percent by time of fire estinguishment. It peaked at 4.3 percent 10 seconds later, gradually dropped to 3.9 percent after 5 minutes of soaking time, and thereafter fell gradually to 3.2 percent by end of test.

b. Subfloor. Highest concentration was 6.4 percent at 8 minutes 35 seconds.

c. Ceiling. Halon concentration rose rapidly to 6.6 percent at fire extingushment. After peaking at 6.9 percent 10 seconds after extinguishment, the Halon 1301 concentration gradually fell to 3.7 percent at end of test.

2. Room Temperature (Figure 21)

a. Computer room temperature was stabilized at 65°F at the start of the test, then rose to 66°F at Zone 2 detection and dropped lower to 65°F after Halon discharge, remaining there through end of test.

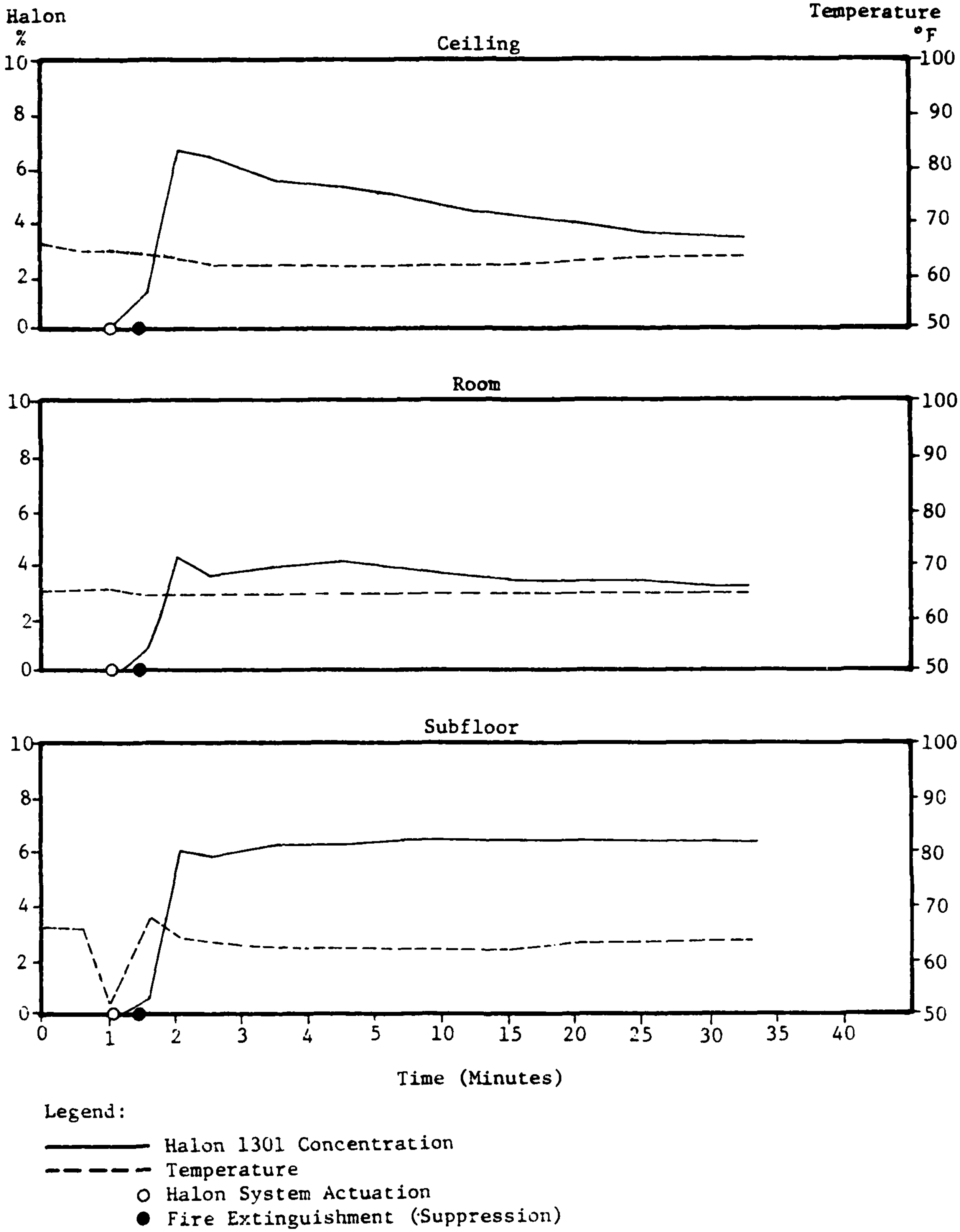


Figure 21. Halon Concentration and Temperature Versus Time, Test A-7.

b. Floor temperature (66°F at start) dropped to 51°F at Halon discharge, increased to 68°F at extinguishment, dropped to 63°F and maintained that level throughout the soaking period.

c. The ceiling (67°F at start) reached a maximum of 76°F, which occurred when Halon was released.

3. Relative humidity was 52 percent at start and dropped to 50 percent at end of test.

4. Ambient Temperature and Barometric Pressure

a. During the test, ambient temperature remained at 73°F.

b. The barometric pressure during the test was 30.16 inches Hg.

5. Post-Test Analysis of Gas Samples

a. The room of the computer facility attained concentrations of 2.1 ppm HF and 4.4 ppm HBr. Total gas sample was 31.1 liters taken over a 31-minute period.

b. Subfloor area saw concentrations of 0.42 ppm and 2.6 ppm of HF and HBr, respectively.

c. Concentrations near the ceiling were 0.48 ppm HF and 3.0 ppm HBr.

(d) EDP Facility. Several ceiling panels had been lifted above their ceiling grids by the force of the Halon discharge.

(e) EDP Equipment

1. The computer system equipment functioned normally thoughout the test.

2. Temperatures within the equipment remained within operational parameters.

3. Temperature measured at the wire basket containing the fuel was measured at 275°F; at the ceiling above the basket the temperature reached 265°F. Figure 20 shows recorded temperatures in the computer room, at the ceiling and in the subfloor area during Test A-7.

4. Equipment voltages recorded with the Intel system indicated no abnormal fluctuations.

5. Static Resistance Variances

a. Pretest and post-test readings showed an average increase of 22.33m Ω in computer board resistance measurements and an average increase of 1.31m Ω per computer board terminal (Appendix A)

6. Static Voltage Variances. Before and after test readings showed an average increase of 0.561 volt per computer and an average increase of 0.033 volt per computer terminal (Appendix A)

7. Post-test analysis of PCBs 110 days after exposure revealed no adverse effects on voltage, signal, and resistance parameters. Similar findings were obtained 18 months after the test.

(f) Software functioned normally both during and subsequent to test exposure.

h. Test Item A-8. Halon 1301 Against Plastics Fire

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in extinguishing a deep-seated fire while the computer remained operational and air exchange systems were turned off.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 66°F with a relative humidity of 46 percent. Polyester-base magnetic tape was unwound and placed in an open wire basket, similar to tape being discarded in typical operations. Weight of the tape was 640 grams and measured 4,800 feet unwound. The power shunt was bypassed to allow the computer to continue to function during the test. Fifty ml of isopropyl alcohol were used to ignite the fuel (Figure 22).

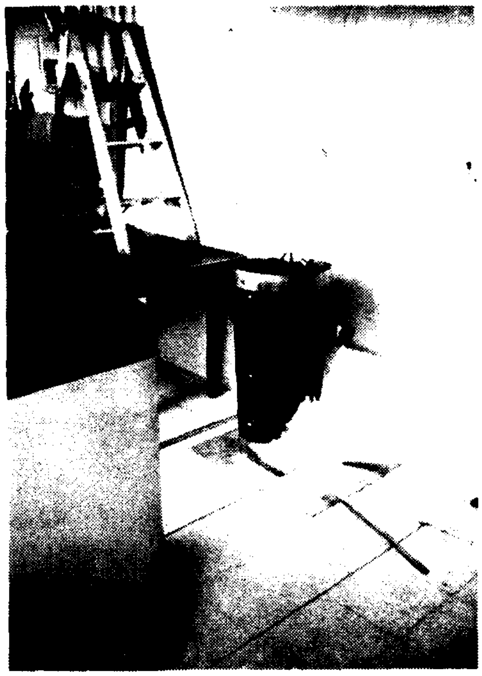


Figure 22. Ignition of 4,800 Feet of Unwound Magnetic Tape.

(3) Results

(a) Timed Events. The first detection occurred in Zone 1 at 9 seconds. The second detection occurred in Zone 2 at 18 seconds. The Halon system discharged at 1 minute. The fire appeared suppressed within seconds of the Halon discharge, but smoldering indicated that it was deep seated. The planned soaking period of 30 minutes had to be curtailed by 20 minutes when excessive soot threatened video recording equipment located inside the test facility.

(b) When the doors to the test facility were opened at the premature conclusion of the test, the 25 percent of fuel remaining immediately reignited, confirming the deep-seated aspects of the fire (Figure 23).

Figure 23. Reignition of Smoldering Magnetic Tape.

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 24)

a. Room. Halon concentration rose to 3.5 percent by time of fire suppression, peaked at 4.3 percent 40 seconds later and fell gradually to 4.1 percent by end of test.

b. Subfloor. Halon concentration rose to 5.9 percent by fire suppression, peaked at 7.3 percent 1 minute 15 seconds later and gradually fell to 7.1 percent by end of test.

c. Ceiling. Halon concentration rose to 5.2 percent by fire suppression. After peaking at 5.7 percent 15 seconds after suppression, the Halon 1301 concentration leveled off at 4.0 percent at 3 minutes soaking time and remained there until end of test.

2. Room Temperatures (Figure 24). Computer room temperature was stabilized at 66°F at the start of the test, then rose to 70°F at the time of fire suppression, and thereafter gradually dropped to 67°F at 1 minute 15 seconds soaking time and remained there until end of test.

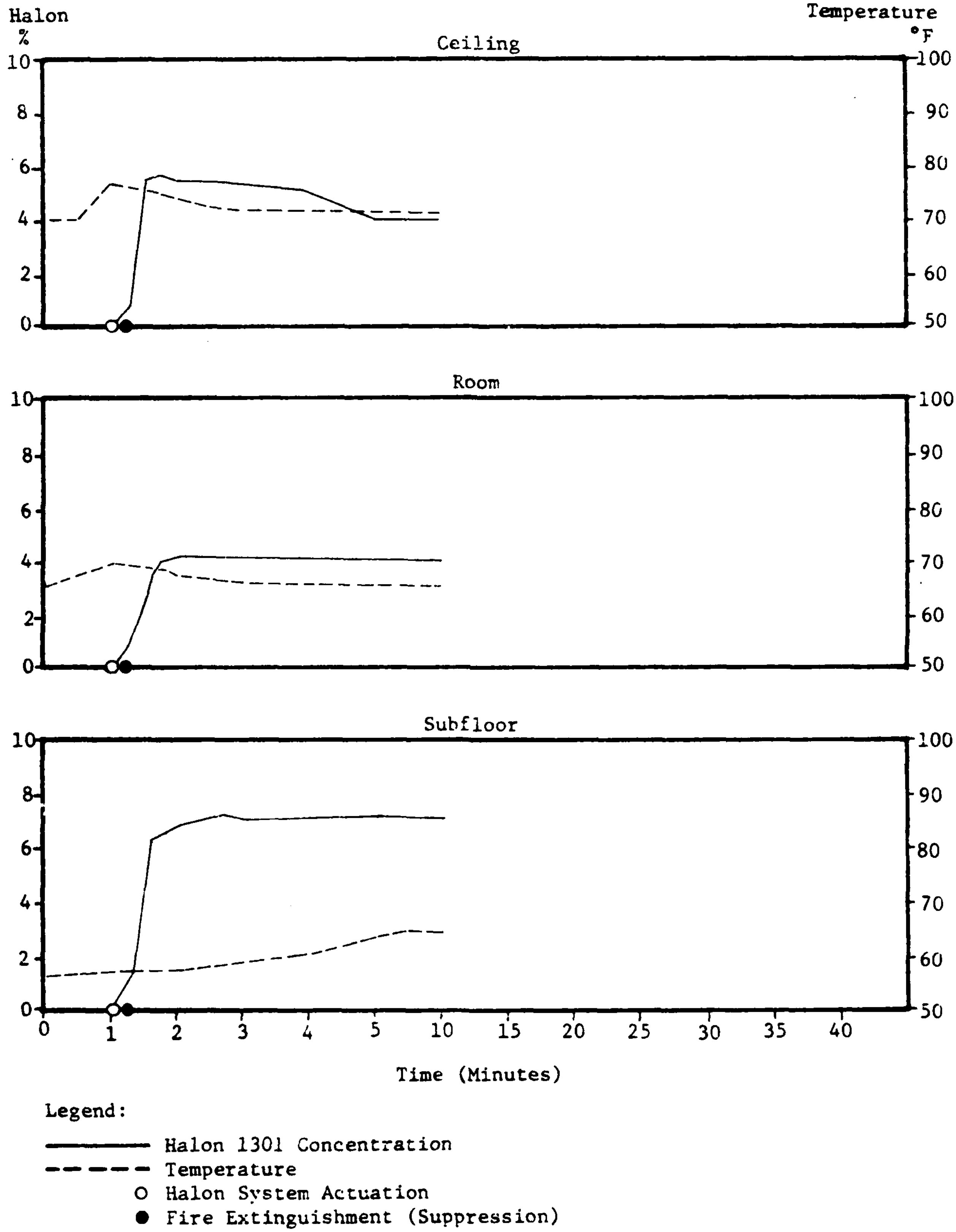


Figure 24. Halon Concentration and Temperature Versus Time, Test A-8.

3. Relative Humidity. Relative humidity, stabilized at the start at 46 percent, rapidly rose to 50 percent at Halon dump, then increased to 54 percent at suppression. The humidity then increased to 58 percent at Halon sensing. The humidity reached 62 percent at 55 seconds soaking time and remained there until end of test.

4. Ambient temperature and barometric pressure were 63°F and 30.04 inches Hg, respectively.

5. Post-Test Analysis of Gas Samples

a. The computer facility room attained concentrations of 27.4 ppm HF and 30.2 ppm HBr. Sample size was 10 liters collected during a 10-minute period.

b. 2.6 ppm HF and 1.8 ppm HBr were measured at floor level.

c. At ceiling level, 18.3 ppm HF and 18.5 ppm HBr were measured.

(d) EDP Facility. As in many previous tests, several ceiling panels had been lifted above their ceiling grids by the force of the Halon discharge; two lights were dislodged.

(e) Despite the damage sustained by the optics of the video camera, EDP equipment suffered no similar ill effects. The system processed data normally throughout and subsequent to the test. As in previous test evolutions, none of the temperature paramaters inside equipment enclosures were exceeded.

1. Static Resistance Variances

Pretest and post-test readings showed an average increase of 12.67mΩ in computer board resistance measurements and an average increase of 0.75mΩ per computer board terminal (Appendix A).

2. Static Voltage Variances. Before and after test readings showed an average decrease of 0.448 volt per computer board and an average decrease of 0.026 volt per computer terminal (Appendix A).

3. Tests of PCBs 108 days after exposure showed no measurable changes in voltage, signal strength and resistance. The same results were obtained nearly 18 months after the test.

(f) Software, as in all previous tests preceding A-8, was totally unaffected by this exposure, even though the heavy accumulation of soot was feared to have deleterious consequences.

i. Test Item A-9. Halon 1301 Against Cellulosic Material Fire

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in combatting a deep-seated fire of cellulosic materials while the computer remained on and air exchange systems were turned off.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. An open metal wire basket was filled with shredded computer room paper products (printout paper and tabulating cards) (Figure 25). The Halon system-activated electrical power shunt was bypassed to allow the computer to continue to function during the test. Fifty ml of alcohol were used to ignite the fuel.

Figure 25. Attempt to Create Deep-Seated Fire with Shredded Paper.

(3) Results

(a) Timed Events. First detection alarm occurred in Zone 1 at 11 seconds. The second detection occurred in Zone 2 at 22 seconds. The Halon system discharged at 1 minute 11 seconds. The fire was suppressed at 1 minutes 30 seconds. However, smoldering continued throughout the 30-minute soaking period, although no flames became visible. The fire appeared to be deep seated. This was confirmed when the remnants of the shredded paper reignited upon removal from the Halon atmosphere inside the test facility.

(b) Fuel Consumption: 75 percent.

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 26)

a. Room. Halon concentration peaked at 4.1 percent by time of fire suppression. It dropped to 3.9 percent 30 seconds later and remained at that level until 10 minutes of soaking time, thereafter falling gradually to 3.4 percent by end of test.

b. Subfloor. Halon concentration rose to 6.5 percent by the time the fire was suppressed and gradually diminished to 6.2 percent.

c. Ceiling. Halon concentration peaked at 6.5 percent.

2. Room Temperatures (Figure 26)

3. Relative humidity rose from 53 to 61 percent during the course of the test.

4. Ambient temperature was between 67 and 70°F during the test; barometric pressure indicated 30.22 inches Hg.

5. Post-Test Analysis of Gas Samples

a. The computer facility room attained concentrations of 6.1 ppm and 14.9 ppm of HF and HBr, respectively, as indicated by a sample size of 30 liters taken over 30 minutes.

b. The subfloor showed 0.44 ppm HF and 1.1 ppm HBr.

c. Concentrations near the ceiling were 33.9 ppm HF and 25.2 ppm HBr.

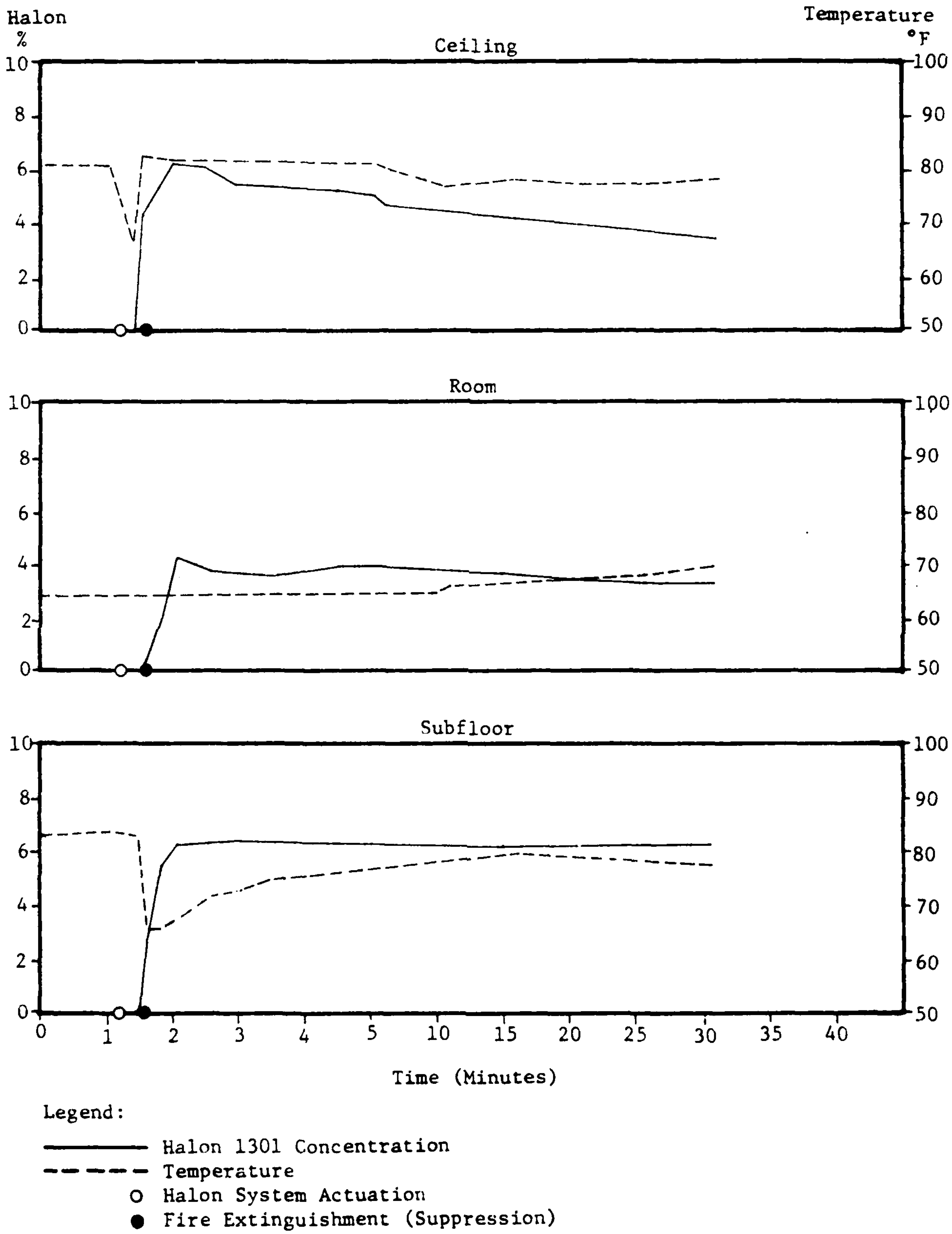


Figure 26. Halon Concentration and Temperature Versus Time, Test A-9.

(d) EDP Facility. No adverse effects were noted.

(e) EDP Equipment functioned normally with the exception of a feed mechanism jam in the printer which was not related to the test conditions.

1. Temperature inside equipment enclosures was within normal range.

2. A thermocouple on the wire basket recorded a maximum of 580°F prior to suppression of the fire.

3. Room temperature reached a high of 198°F on the ceiling immediately above the wire basket (Figure 26).

4. Voltages monitored on the GE 115/2 system showed no irregularities.

5. Static Resistance Variances. Pretest and post-test readings showed an average increase of 24.11mΩ in computer board resistance measurements and an average increase of 1.42mΩ per computer board terminal (Appendix A).

6. Static Voltage Variances. Before and after test readings showed an average decrease of 7.728 volt per computer board and an average decrease of 0.455 volt per computer terminal (Appendix A)

7. Long term aging of PCBs had produced no adverse effects when checked nearly 18 months after exposure.

(f) Software. Aside from the unrelated paper jam mentioned above, no degradation of software performance was noted.

k. Test Item A-10. Halon 1301 Against Plastics Fire in Multiple Locations

(1) Objectives

(a) Measure the effectiveness of Halon 1301 in defeating cable fires located in a typical component cabinet and in the subfloor area of the facililty. Operation of the EDP system was continued during the fire episode; however, air exchange was shut off.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 66°F with a relative humidity of 52 percent. A metal cabinet (Figure 27), identical in

dimension to a wing of the GE 115/2 computer, was loaded with PVC-jacketed, multistrand cabling. Similar cabling was placed in smaller metal box, simulating a cabling duct, and positioned in the subfloor space (Figure 28). The subfloor fire was started remotely with a nichrome igniter. When smoke became visible, the fuel in the metal cabinet was ignited manually with 50 ml isopropyl alcohol.

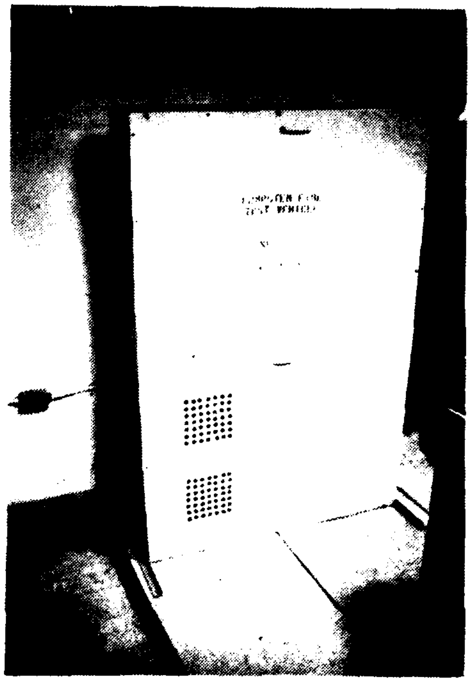


Figure 27. Computer Cabinet Replica.

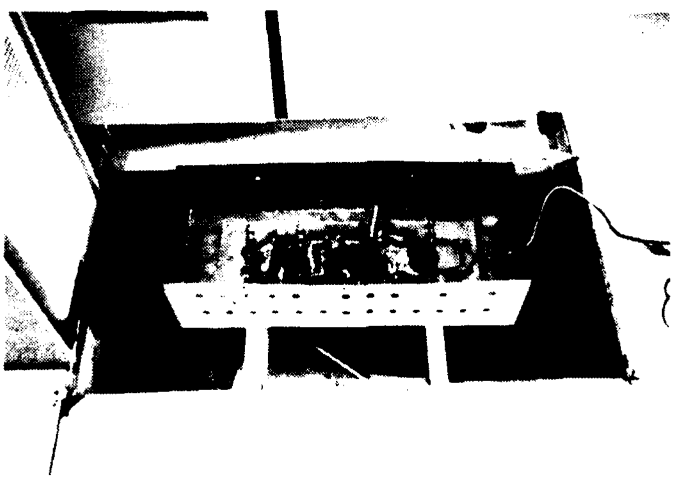


Figure 28. Test Setup for Subfloor Cable Fire.

(3) Results

(a) Timed Events. The first detection alarm was sounded in Zone 1 after 1 minute 1 second. Smoke was observed coming up from the floor at 2 minutes 10 seconds. Cross-zoning occurred at 2 minutes 25 seconds. The Halon system discharged at 2 minutes 55 seconds. Both fires were extinguished at 3 minutes 20 seconds. Total soaking time was 30 minutes from time of fire extinguishment.

(b) Fuel Consumption

1. The PVC material in the power unit cabinet was 99 percent consumed at end of test.

2. The fuel in the subfloor unit was found to be 50-percent consumed at end of test.

(c) Test Atmosphere Variables

1. Halon 1301 Concentration (Figure 29)

a. Room. Halon concentration rose to 3.8 percent by time of fire extinguishment, peaked at 4.0 percent 5 seconds later, then gradually dropped to 3.2 percent by end of test.

b. Subfloor. Halon concentration rose to 5.8 percent at time of fire extinguishment and peaked at 6.5 percent at 1 minute soaking time; the level had fallen to 6.2 percent by 2 minutes soaking time and remained there until end of test.

c. Ceiling. Halon concentration peaked at 5.2 percent, diminishing to 3.4 percent at the end of the soaking period.

2. Room Temperatures (Figure 29)

3. Relative humidity rose from 52 to 66 percent during the 33-minute test.

4. Ambient temperature varied from 65°F to 67°F. Barometric pressure was 29.70 inches Hg.

5. Post-Test Analysis of Gas Samples

a. The room of the computer test facility attained concentrations of 4.47 ppm and 37.1 ppm of HF and HBr, respectively, as indicated by a sample size of 30 liters taken over 30 minutes.

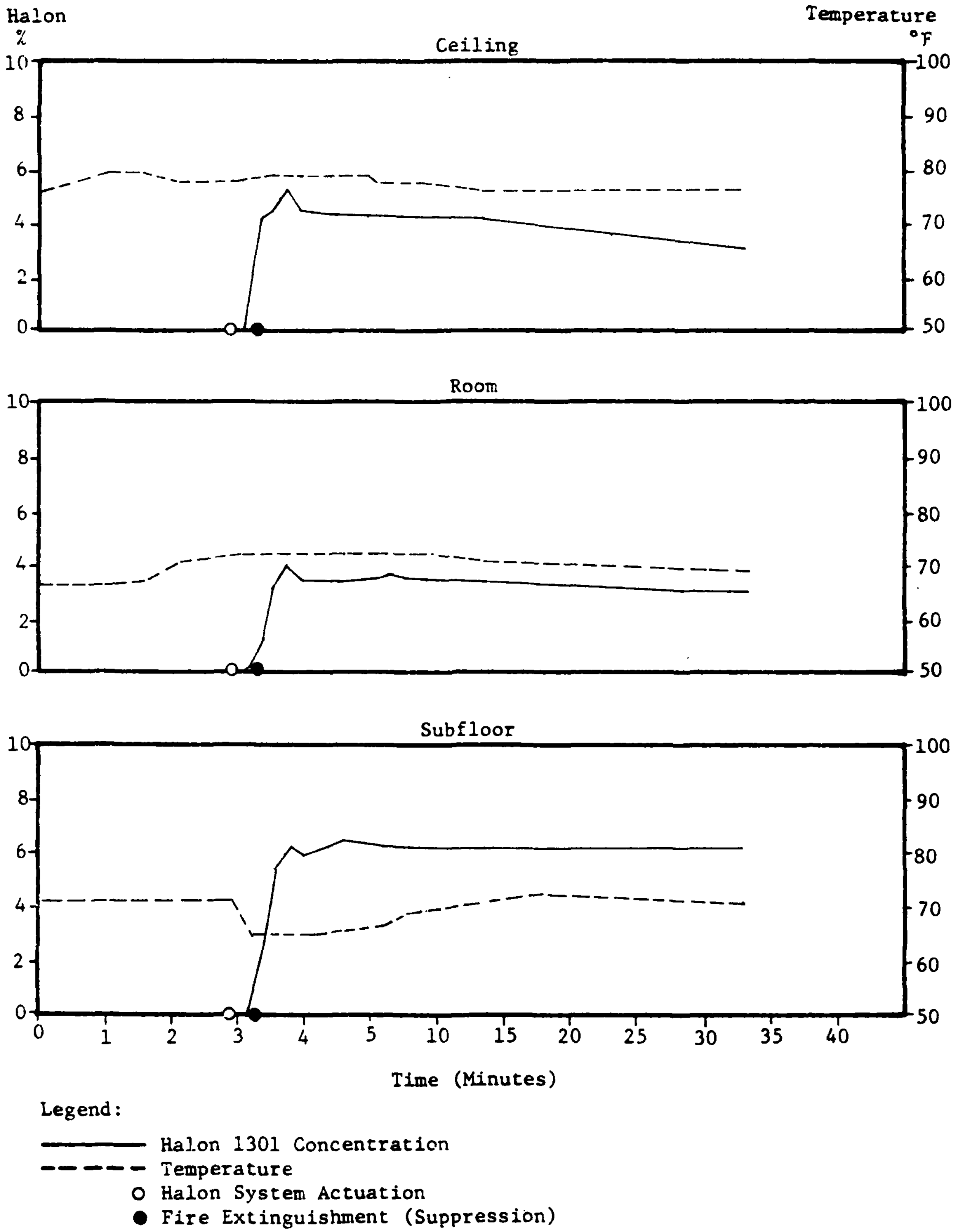


Figure 29. Halon Concentration and Temperature Versus Time, Test A-10.

b. The subfloor showed 0.46 ppm HF and 7.2 ppm HBr.

c. Concentrations of 2.98 ppm HF and 3.3 ppm HBr were measured at ceiling level.

(d) EDP Facility. No damage was sustained as a result of the test.

(e) EDP Equipment

1. The computer system equipment functioned normally throughout the test with the exception of some missing print which was due to particulate matter partially blocking the optical aperture of the printer.

2. Temperatures experienced inside system enclosures posed no problems.

3. Room Temperatures

a. A thermocouple mounted on the ceiling above the power unit test cabinet recorded a maximum temperature of 84°F.

b. A thermocouple mounted above the subfloor unit recorded a maximum of 81°F.

c. Room, ceiling, and subfloor temperatures are shown in Figure 29.

4. Post-Test analysis of voltage recordings showed that the multiple fires had no adverse effect on the computer system.

5. Static Resistance Variances

Pretest and post-test readings showed an average increase of 21.44mΩ in computer board resistance measurements and an average increase of 1.26mΩ per computer board terminal (Appendix A).

6. Static Voltage Variances. Before and after test readings showed an average decrease of 0.473 volt per PCB and an average decrease of 0.028 volt per computer terminal (Appendix A).

7. Analysis of PCBs conducted 102 days and then 18 months after the test failed to show any long term degradation of performance characteristics.

(f) Software Effects

1. The computer program printout was normal with the exception of the above mentioned print, showing no effects of fire or extinguishant on the test computer software.

2. Peripherally placed test tapes, diskettes, and cards provided normal program input and data recovery after the test.

3. WATER EXTINGUISHMENT TESTS

Water extinguishment tests were designed to replicate the test conditions used during the series of Halon 1301 experiments.

a. Test Item B-1. Water Against Plastics Fire

(1) Objectives

(a) Measure the effectiveness of a water sprinkler system in extinguishing a computer facility plastics fire.

(b) Determine the immediate and long term effects of the extinguishant on electronic and peripheral equipment and stored data.

(2) Procedure. Prior to the test, the temperature in the computer facility was stabilized at 62°F with a relative humidity of 50 percent. The metal cabinet used for the series of Halon fire extinguishments preceding Test B-1 was loaded with PVC-jacketed, multistrand computer cabling. The fuel array inside the test cabinet was representative of normal installation of computer cabling. The electrical power was to be turned off at first alarm of the automatic Halon system. Fifty ml of alcohol were to be used for ignition of fuel.

(3) Results

(a) Timed Events. The first detection alarm sounded 22 seconds after fuel ignition. The second detection occurred in Zone 2 after 40 seconds. The sprinkler system discharged 5 minutes 30 seconds after fuel ignition, when the heat rise reached the intensity required to actuate the 212°F sprinkler head. Total soaking time was 10 minutes from time of sprinkler discharge; however, the fire was still not extinguished when the water supply was shut off, to prevent further damage to the test equipment (Figure 30). The fire had to be extinguished with a portable Halon 1211 extinguisher.

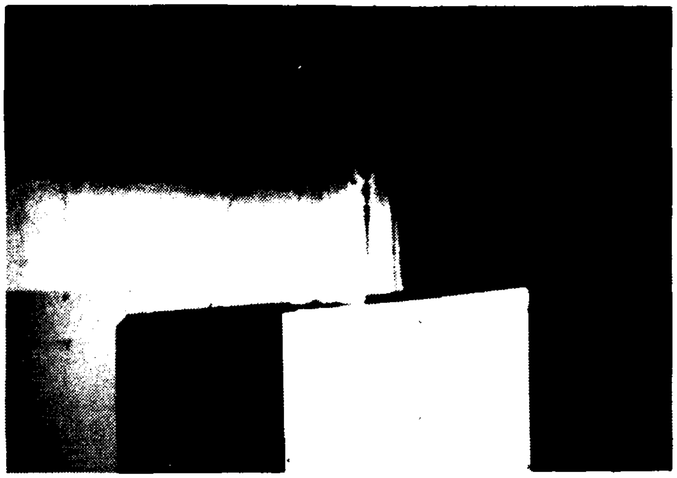


Figure 30. Flaming Computer Cabinet During Water Sprinkler Discharge.

(b) Fuel Consumption: 90 percent

(c) Test Atmosphere Variables

1. Room temperature was 62°F at the start of the test and rose to 67°F by the time the water sprinkler system discharged. Temperature at floor level was 71°F at start, increased to 74°F at first warning and remained there through 1 minute 30 seconds soaking time, at which time only fire box temperature was recorded. The ceiling, 59°F at start, reached a maximum of 77°F one minute after ignition of the fuel. The thermocouple nearest to the sprinkler head and directly above the burning computer cabinet, malfunctioned at that point in time.

2. Relative humidity rose from 50 to 62 percent during the test.

3. Ambient temperature was 66°F; barometric pressure measured 30.28 inches Hg.

4. Post-Test Analysis of Gas Samples

a. The computer facility room attained concentrations of less than 1.29 ppm HF and 28.0 ppm of HBr; sample consisted of 10 liters collected over a period of 10 minutes.

b. The subfloor attained concentrations of less than 1.29 ppm HF and 35.1 ppm HBr.

c. The ceiling concentrations were less than 1.44 ppm and 12.0 ppm of HF and HBr, respectively.

(d) EDP Facility. Heavy accumulation of sticky soot particles had settled on everything out of range of the sprinkler. Standing water covered the front half of the test facility nearest to the sprinkler head which had discharged.

(e) EDP Equipment. Water spray had extended from those components nearest the sprinkler head (Figure 6) in the NE corner of the room outward to a radius of 15 feet. The LP300 Controller cabinet and CPU sustained the heaviest exposure to water, being completely inundated with water accumulations in the base of the cabinets. The operating console and maintenance panel (Figure 31), located 10 feet from the discharging water sprinkler, experienced 1/4 inch of standing water, penetrating all switches and lamp sockets.

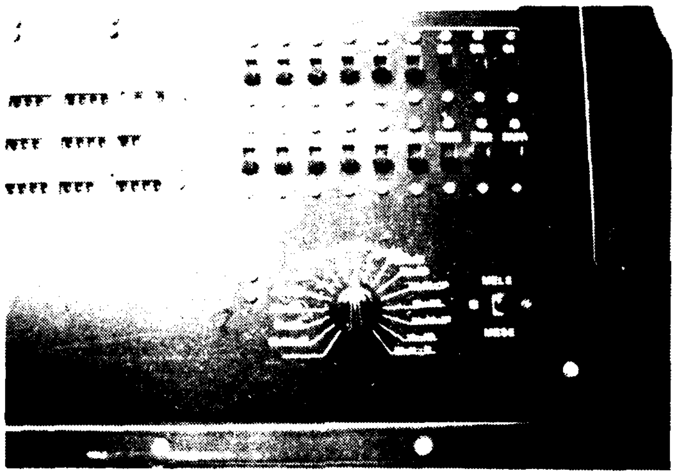


Figure 31. Water Damage Sustained by Computer Console.

Immediate post-test examination of other computer system components is summarized below:

1. Card Reader. Water accumulations in card track and on control switches. Tabulating cards in hopper and collection bin were soaked and coated with soot. Standing water in bottom of cabinet enclosure.

2. Wing "H" was waterlogged through all rows of PCBs down to the fan assembly. Water and soot had collected in all cross assemblies and in bottom of cabinet.

3. Wing "D" showed water in upper regulator assembly with moisture on components in lower rack.

4. Wing "C" revealed water penetration down to the 5th row of the PCB assembly. Moisture and soot had collected on the memory pack and fan assembly.

5. Wing "A" appeared to have suffered the least amount of water penetration with only the upper row of PCBs exposed to water.

6. Wing "B" had water accumulation at all levels of the power supply assembly.

7. MZ-4 Printer. Most distant from the sprinkler head actuated during the test, the printer showed mainly exterior water accumulations. Printing paper was moist and appeared of questionable future use.

(f) Sensors monitoring computer equipment temperatures indicated that equipment modules remained within normal operating ranges during Test B-1.

(g) Test cabinet maximum temperature recorded was 151°F. A thermocouple mounted on the ceiling directly above the test fire and in proximity to the sprinkler head recorded a maximum temperature of 214°F.

(h) Static Resistance Variances

Pretest and post-test readings showed an average increase of 50.44mΩ in computer board resistance measurements and an average increase of 2.97mΩ per computer board terminal (Appendix A).

(i) Static Voltage Variances. Before and after test readings showed an average decrease of 0.543 volt per PCB and an average decrease of 0.032 volt per computer board terminal (Appendix A).

(4) Post-Test Evaluation

(a) The computer test program had been loaded into the computer prior to the test; as planned, power was removed just prior to ignition of the test fire. Due to possible safety hazards, power was not restored to the system until the day following the water sprinkler discharge and after all accumulations of water had been removed. Power-up was accomplished without any major incident. Test routines were initiated and made three passes, running for 2 minutes, when errors started to appear in the printouts. When errors rapidly increased in frequency, the system was powered down and troubleshooting routines were initiated.

(b) Fault Analyses

1. CPU Power Supply (Wing "D") suffered two (out of six) inoperative SCRs due to being shorted out. SCRs are protected by 75-ampere fuse links in the anode lead; however, these appeared not to have reacted in time to protect the SCRs.

2. The Central Processer Unit revealed three inoperative PCBs, two NOR circuits in the "F" register showed faulty resistors, and one flip-flop board was disabled by a resistor that had become separated from its solder lead.

3. The Printer Controller had suffered the greatest amount of damage with as many as nine resistors burnt out on each of its 14 double-size SPA (hammerdriver) boards. A pulse timing, one-slot multivibrator board suffered a burnt resistor and one shorted transistor. Two photo lamp amplifiers were inoperative due to faulty transistors. Another amplifier board revealed a burnt resistor. One skip selection flip-flop had a faulty transistor.

4. The MZ-4 Printer operates on a principle of sending GECO Code signals to the printer controller and comparing these signals with those coming from the CPU. The printer was sending faulty comparative GECO Code signals to the controller as a result of soot particles partially blocking the apertures of the code wheel and the photoelectric read head.

5. Printer power supplies were inoperative. Faults were traced to two PCBs in the control panel which had suffered defunct transistors and a blown protective fuse. The power transistor and diode bank incorporates a separate cooling fan which has 1/8 inch clearance between blade tips and protective shroud. The blades would not turn when power was applied; an accumulation of wet soot had hardened and formed on the shroud and blade tips, fusing them together.

(b) Post-test analyses of PCBs exposed to the water sprinkler discharge can best be illustrated through closeup photographs taken the day after (Figures 32-34) and then 103 days after Test B-1 (Figures 35-39).

Figure 32. Closeup View of PCB One Day After Test B-1.

Figure 33. Closeup View of Soot on PCB One Day After Test B-1.

Figure 34. Corrosion Forming on PCB One Day After Test B-1.

Figure 35. Severe Corrosion on PCB 103 Days After Test B-1.

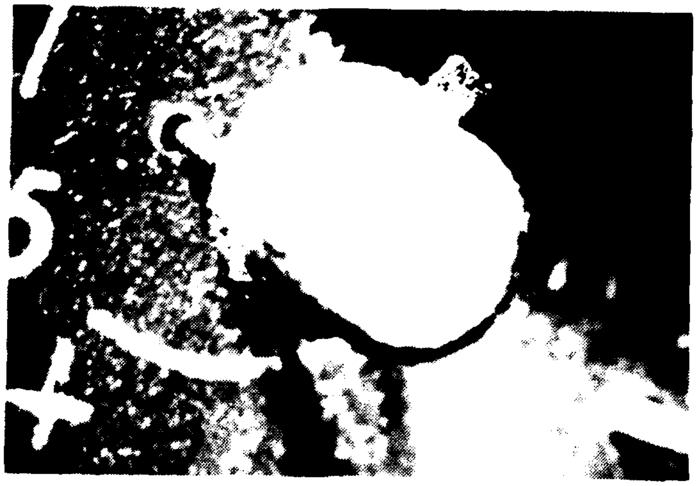


Figure 36. Severe Corrosion on PCB 103 Days After Test B-1.

Figure 37. Corrosion Has Disabled PCB 103 Days After Test B-1.

Figure 38. Closeup of Disabled PCB 103 Days After Test B-1.

Figure 39. Shorted PCB 103 Days After Test B-1.

(c) Software exposed to the water discharge also suffered considerable damage. One diskette suffered an immediate loss of 55 of 30,000 data items with 4 changes of data. Twenty-four hours later the system programs could not be loaded from the diskette. Data recovery was attempted by loading a program from another diskette, resulting in a loss rate of 366/30,000 data item with 14 changes of data. Punch cards were found to be unfit for program input due to warping after moisture had dried out.

SECTION IV

ANALYSIS OF TEST RESULTS

1. DISCUSSION

The primary objectives of this test program were to evaluate the effects on an operational computer system resulting from extinguishment of fires with (1) an automatic Halon 1301 total flooding system and (2) a water sprinkler sytem. Test conditions were created to specifically achieve fires of materials normally found in EDP installation, i.e., plastic and cellulosic materials. The conditions of these tests varied widely, but central to the preponderance of tests was continued operation of the EDP system during the test sequence. In addition, several tests were run in an attempt to generate high concentrations of HF and HBr to measure the immediate and long term effects of the fire extinguishment atmosphere on EDP hardware and stored data.

2. HALON 1301 FIRE EXTINGUISHMENT TESTS

Analysis of results of the 10 tests of Halon 1301 clearly showed that a design concentration of 5.6 percent was adequate to completely extinguish all surface fires and that Halon 1301 was capable of suppressing deep-seated Class A fires even for prolonged periods of time.

Extinguishment time for most Class A fuels was extremely short, in some cases almost instantaneous. When radiant heat feedback from the flame to the solid was stopped in Class A fuels, flammable gases were no longer produced and surface combustion died out quickly (Tests A-3,4,5, and 7). When Class A fuel had been burning for a longer time, e.g., shredded paper used in Test A-9, smoldering combustion that was well insulated from heat loss continued even after 30 minutes of soaking time. In contrast, several tests involving plastics never experienced deep-seated combustion, no matter how long they burned.

Halon extinguishment of a deep-seated fire, if it involves temperatures in excess of 900°F, will decompose Halon into the corrosive compounds of HF and HBr gas. Throughout the ten Halon tests, local concentrations of these compounds remained extremely low, generally below 30 parts per million. During one of two tests where the air exchange system continued to operate during fire extinguishment and soaking period (Test A-4), the Halon concentration dropped below 4 percent within 2 minutes of fire suppression. Although not visibly observed, it must be assumed that a rekindling ot the fire occurred, since the HBr concentration of

177 ppm measured during Test A-4 was significantly higher than all other gas samples recorded during the entire series of tests. Although a 177 ppm concentration is not nearly fatal, it may be harmful if human exposure to such an atmosphere is prolonged.

Another item of concern was the effect of long exposure to postextinguishment atmospheres on electronic components and software. It was found in all cases that the EDP equipment and associated software was not harmed in any way by these atmospheres. During most of the Halon fire situations, the concentrations of HF and HBr were below 30 ppm and even much lower when fires had been extinguished in incipient stages.

3. WATER SPRINKLER TEST

Analysis of the results of water extinguishment tests showed that fire extinguishment was withheld until the building itself was in danger of being lost. Had the fire occurred in the actual EDP equipment, it would have been destroyed or extensively damaged. Despite many precautionary measures to protect the test computer system from the water spray, water damage was so extensive that the system was barred from further exposure to water sprinkler tests. In contrast to the Halon series of tests, where 8 out of 10 tests were run with the EDP system in an operational mode performing critical data processing functions, the full-scale sprinkler test saw the computer shut down as an additional precautionary measure.

Immediate and long term water damage occurred from such mechanisms as corrosion and staining of delicate electronic system components due to chemical reaction, as well as galvanic action and contamination from solids in impure water. Other resultant damage from the one-time water deluge involved the system's optical and instrument sensors, lubrication points, and corrosion of mechanisms and other moving parts.

In sum, it took a fairly large fire burning for some time before the sprinkler head opened and released the water, failing to extinguish the fire in the computer cabinet replica, and disabling the EDP system for a considerable period of time.

SECTION V

CONCLUSIONS

1. GENERAL

Analysis of results of the technical test and evaluation program of Halon 1301 and water sprinkler fire protection systems leads to the conclusion that Halon 1301 is superior to water as an extinguishant for fires occurring in essential electronic equipment installations.

2. CONCLUSIONS OF HALON 1301 FIRE EXTINGUISHMENT TESTS

a. Halon 1301 is highly effective as an extinguishant for fires in electronic equipment installations, being easily distributed throughout congested enclosures and leaving no residue harmful to delicate and expensive electronic components.

b. Automatic fire extinguishment, with a Halon 1301 total flooding system designed to provide a 5.6 percent (volume) concentration, does not produce atmospheres that will interfere with EDP operations.

c. Most combustibles in EDP facilities do not produce deep-seated fires.

d. Data recorded on magnetic tape were unaffected by exposure to these tests.

e. Printed circuit boards (PCBs) subjected to atmospheres produced in these tests showed no degradation in performance immediately after the tests and when checked at intervals up to 18 months after exposure.

3. CONCLUSIONS OF WATER SPRINKLER TEST

a. A single sprinkler discharge resulted in considerable downtime to dry out the electronic equipment and repair water-damaged components.

b. The heat rise required to activate the sprinkler head withheld the water discharge until the test facility was in danger of loss; once activated, the water discharge was ineffective against a fire that had nearly consumed all combustibles inside a computer cabinet replica.

c. The water discharge produced many deleterious side effects, primarily through corrosion and staining of sensitive electronic components.

SECTION VI

RECOMMENDATIONS

1. Continued development of a cost-effective, capsulized Halon 1301 fire suppression system for Air Force electronic data processing installations is recommended. Placement of independent, automatic extinguishing capsules near potential ignition sources could reduce by as much as 90 percent the current average cost of $11.00 per square foot of Halon 1301 total flooding fire protection.

2. Until such a development becomes commercially available, it is recommended that new installations of Air Force essential electronic equipment continue to be protected by automatic Halon 1301 total flooding systems.

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APPENDIX A

RECORDED TEST DATA

PCB PRETEST AND POST-TEST READINGS

TEST DATA ANALYSIS

TEST A1 DATE 11-7-80

BOARD # 0511500F FUNCTION PRINTER CONTROLLER

COMPUTER WING. A ROW. A POSITION 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.400	107	6.400	101	0.000	0
2	0.160	102	0.160	101	0.000	-1
3	6.300	106	6.300	101	0.000	1
4	0.200	107	0.200	101	0.000	0
5	6.000	111	6.000	101	0.000	-4
6	0.000	103	0.000	102	0.000	0
7	0.100	106	0.100	101	0.000	1
8	20.000	102	20.000	107	0.000	11
9	0.000	107	0.000	101	0.000	0
10	6.250	106	6.200	101	-0.050	-1
11	6.300	106	6.300	101	0.000	1
12	6.300	107	6.300	101	0.000	0
13	6.300	106	6.200	102	-0.100	2
14	6.650	106	6.600	103	-0.050	1
15	6.000	107	6.000	101	0.000	0
16	6.000	107	6.000	102	0.000	1
17	0.000	102	0.000	109	0.000	13
CALIBRATION		100		94		

COMMENTS.

TEST DATA ANALYSIS

TEST A1 DATE 11-7-80

BOARD # 0613230Y FUNCTION. PRINTER CONTROLLER

COMPUTER WING. A ROW. 6 POSITION 07

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.130	104	0.130	101	0.000	5
2	0.000	102	0.000	110	0.000	16
3	18.200	110	18.000	101	-0.200	-1
4	0.600	104	0.600	102	0.000	6
5	0.000	105	0.000	105	0.000	8
6	0.150	104	0.140	102	-0.010	6
7	0.600	103	0.600	101	0.000	6
8	19.900	102	19.900	110	0.000	16
9	10.000	109	10.000	102	0.000	1
10	11.100	106	11.000	102	-0.100	4
11	0.150	110	0.150	102	0.000	0
12	0.600	104	0.600	102	0.000	6
13	17.000	107	17.000	102	0.000	3
14	0.600	102	0.600	100	0.000	6
15	0.000	102	0.000	103	0.000	9
16	0.140	106	0.140	101	0.000	3
17	0.000	102	0.000	110	0.000	16
CALIBRATION		100		92		

COMMENTS.

TEST DATA ANALYSIS

TEST A1 DATE 11-7-88

BOARD # 0613230Y FUNCTION. PRINTER CONTROLLER

COMPUTER WING: A ROW: G POSITION: 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	7.000	106	7.000	99	0.000	0
2	0.000	102	0.000	106	0.000	11
3	17.100	106	17.000	99	-0.100	-2
4	0.600	106	0.600	100	0.000	1
5	0.000	102	0.000	103	0.000	8
6	0.000	107	0.000	99	0.000	-1
7	0.700	111	0.650	100	-0.050	-4
8	20.000	102	20.000	106	0.000	11
9	14.000	107	14.000	99	0.000	-1
10	17.100	107	17.000	106	-0.100	0
11	0.000	107	0.000	99	0.000	-1
12	[illegible].600	105	6.600	101	0.000	3
13	16.000	110	16.000	99	0.000	-4
14	0.700	108	0.700	100	0.000	-1
15	0.000	102	0.000	103	0.000	8
16	6.300	106	6.300	101	0.000	2
17	0.000	102	0.000	104	0.000	9
CALIBRATION		100		93		

COMMENTS:

TEST DATA ANALYSIS

TEST A1 DATE 11-7-80

BOARD # 0611511V FUNCTION: CPU

COMPUTER WING: C ROW: 6 POSITION: 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.500	101	6.500	100	0.000	4
2	6.600	100	6.600	100	0.000	5
3	6.100	104	6.000	98	-0.100	-1
4	5.600	103	5.700	102	-0.100	4
5	5.800	102	5.700	101	-0.100	4
6	5.500	105	5.400	100	-0.100	0
7	5.600	103	5.800	99	0.000	1
8	13.500	101	13.500	101	0.000	5
9	0.170	104	0.170	96	0.000	-1
10	7.000	105	7.000	99	0.000	-1
11	5.800	106	5.800	99	0.000	-2
12	5.800	106	5.800	99	6.000	-2
13	0.200	105	0.200	98	0.000	-2
14	0.200	106	0.200	99	0.000	-2
15	0.000	105	0.000	98	0.000	-2
16	0.000	106	0.000	99	0.000	-2
17	0.000	103	0.000	100	0.000	2
CALIBRATION		94		89		

COMMENTS:

TEST DATA ANALYSIS

TEST A1 DATE 11-7-80

BOARD # 0611509A FUNCTION: CPU

COMPUTER WING: C ROW: C POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	101	0.000	97	0.000	0
2	0.130	101	0.125	99	-0.005	2
3	7.900	101	7.900	98	0.000	1
4	0.010	102	0.010	102	0.000	4
5	6.500	101	6.400	101	-0.100	4
6	6.000	102	6.000	101	0.000	3
7	0.000	103	0.000	100	0.000	1
8	19.600	102	19.600	110	0.000	12
9	6.800	103	6.800	99	0.000	0
10	5.900	104	5.900	100	0.000	0
11	0.120	103	0.100	99	-0.020	0
12	6.700	102	6.600	100	-0.100	2
13	6.200	102	6.200	100	0.000	2
14	6.300	102	6.300	102	0.000	4
15	5.900	101	5.800	98	-0.100	1
16	1.500	101	0.150	99	-1.350	2
17	0.000	103	0.000	100	0.000	1
CALIBRATION		94		90		

COMMENTS:

TEST DATA ANALYSIS

TEST A1 DATE 11-7-80

BOARD # 0614129M FUNCTION CPU

COMPUTER WING: C ROW: T POSITION: 20

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	20.000	102	20.000	100	0.000	2
2	16.000	101	16.000	101	0.000	4
3	5.900	100	5.900	98	0.000	2
4	0.000	102	0.000	102	0.000	4
5	0.000	101	0.000	102	0.000	5
6	0.000	102	0.000	104	0.000	6
7	0.000	105	0.000	98	0.000	-3
8	20.000	102	20.000	102	0.000	4
9	0.000	105	0.000	98	0.000	-3
10	0.000	105	0.000	99	0.000	-2
11	0.000	106	0.000	98	0.000	-4
12	0.000	102	0.000	106	0.000	8
13	0.000	102	0.000	102	0.000	4
14	1.000	105	1.000	99	0.000	-2
15	0.000	102	0.000	102	0.000	4
16	0.000	110	0.000	99	0.000	-7
17	0.000	102	0.000	106	0.000	8
CALIBRATION		96		92		

COMMENTS:

TEST DATA ANALYSIS

TEST A1 DATE 11-7-80

BOARD # 0611500F FUNCTION. PUNCH CONTROLLER

COMPUTER WING: H ROW. A POSITION: - 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	103	0.000	102	0.000	1
2	0.000	106	0.000	103	0.000	-1
3	0.000	104	0.000	101	0.000	-1
4	0.000	102	0.000	107	0.000	7
5	0.000	108	0.000	101	0.000	-5
6	0.000	106	0.000	102	0.000	-2
7	0.000	103	0.000	104	0.000	3
8	0.000	103	0.000	105	0.000	4
9	0.000	106	0.000	101	0.000	-3
10	0.000	103	0.000	104	0.000	3
11	0.000	104	0.000	105	0.000	3
12	0.000	108	0.000	102	0.000	-4
13	0.000	107	0.000	104	0.000	-1
14	0.000	103	0.000	102	0.000	1
15	0.000	104	0.000	100	0.000	-2
16	0.000	102	0.000	101	0.000	1
17	0.000	102	0.000	105	0.000	5
CALIBRATION		96		94		

COMMENTS. VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED

AD-A122 602 REPORT OF TEST RESULTS: HALON 1301 VERSUS WATER SPRINKLER FIRE PROTECTION..(U) AIR FORCE ENGINEERING AND SERVICES CENTER TYNDALL AFB FL ENGI.. 2/2

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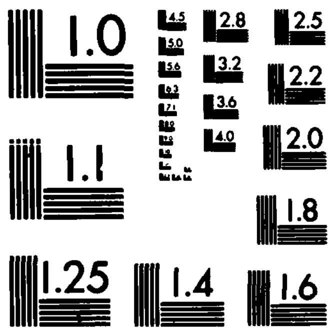

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TEST DATA ANALYSIS

TEST A1 DATE 11-7-80

BOARD # 0611420T FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	0.000	104	0.000	100	0.000	0
2	0.000	104	0.000	105	0.000	5
3	0.000	102	0.000	101	0.000	3
4	0.000	107	0.000	105	0.000	2
5	0.000	106	0.000	105	0.000	3
6	0.000	108	0.000	104	0.000	0
7	0.000	105	0.000	100	0.000	-1
8	0.000	104	0.000	104	0.000	4
9	0.000	104	0.000	106	0.000	0
10	0.000	106	0.000	102	0.000	-2
11	0.000	103	0.000	100	0.000	-4
12	0.000	104	0.000	104	0.000	4
13	0.000	103	0.000	101	0.000	2
14	0.000	102	0.000	102	0.000	4
15	0.000	105	0.000	101	0.000	6
16	0.000	106	0.000	100	0.000	-2
17	0.000	106	0.000	115	0.000	13
CALIBRATION		96		94		

COMMENTS: VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED.

TEST DATA ANALYSIS

TEST A1 DATE 11-7-80

BOARD # 0611500E FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 10

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	100	0.000	103	0.000	-1
2	0.000	107	0.000	102	0.000	-1
3	0.000	104	0.000	101	0.000	1
4	0.000	100	0.000	104	0.000	0
5	0.000	106	0.000	103	0.000	1
6	0.000	104	0.000	106	0.000	6
7	0.000	104	0.000	105	0.000	5
8	0.000	103	0.000	100	0.000	9
9	0.000	105	0.000	103	0.000	2
10	0.000	103	0.000	104	0.000	5
11	0.000	100	0.000	102	0.000	-2
12	0.000	109	0.000	104	0.000	-1
13	0.000	110	0.000	103	0.000	-3
14	0.000	103	0.000	102	0.000	3
15	0.000	103	0.000	101	0.000	2
16	0.000	105	0.000	104	0.000	3
17	0.000	104	0.000	109	0.000	9
CALIBRATION		99		95		

COMMENTS: VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED.

TEST DATA ANALYSIS

TEST A2 DATE 11-10-80

BOARD # 06115500F FUNCTION. PRINTER CONTROLLER

COMPUTER WING. A ROW. A POSITION: 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	7.000	107	7.000	107	0.000	-2
2	0.200	103	0.200	104	0.000	-1
3	7.000	102	7.000	104	0.000	0
4	0.000	105	0.000	110	0.000	3
5	6.000	100	6.000	103	0.000	1
6	0.200	105	0.200	108	0.000	1
7	0.120	101	0.100	102	-0.020	-1
8	20.000	101	20.000	108	0.000	5
9	0.000	100	0.000	103	0.000	1
10	7.000	99	-7.000	104	0.000	3
11	7.000	100	7.000	102	0.000	0
12	6.000	102	6.000	104	0.000	0
13	6.100	99	6.000	102	-0.100	1
14	7.000	103	7.000	104	0.000	-1
15	0.000	100	0.000	102	0.000	0
16	6.000	102	6.000	104	0.000	0
17	0.000	101	0.000	106	0.000	3
CALIBRATION		91		93		

COMMENTS.

TEST DATA ANALYSIS

TEST A2 DATE 11-10-80

BOARD # 0613230Y FUNCTION. PRINTER CONTROLLER

COMPUTER WING. A ROW. B POSITION: 07

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.130	105	0.130	104	0.000	0
2	0.000	103	0.000	105	0.000	3
3	18.000	100	18.000	102	0.000	3
4	0.620	99	0.600	100	-0.020	2
5	0.000	102	0.000	108	0.000	7
6	0.160	105	0.150	112	-0.010	8
7	0.600	100	0.600	101	0.000	2
8	20.000	102	20.000	105	0.000	4
9	12.000	103	12.000	104	0.000	2
10	12.000	101	12.000	102	0.000	2
11	0.170	101	0.150	101	-0.020	1
12	0.600	97	0.600	99	0.000	3
13	18.000	99	18.000	100	0.000	2
14	0.620	96	0.600	98	-0.020	3
15	0.000	99	0.000	104	0.000	6
16	0.170	98	0.150	99	-0.020	2
17	0.000	102	0.000	105	0.000	4
CALIBRATION		91		90		

COMMENTS.

TEST DATA ANALYSIS

TEST A2 DATE 11-10-80

BOARD # 0613230Y FUNCTION. PRINTER CONTROLLER

COMPUTER WING: A ROW. G POSITION: 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.600	105	6.600	105	0.000	-1
2	0.000	106	0.000	113	0.000	6
3	17.000	106	17.000	107	0.000	0
4	0.610	107	0.600	110	-0.010	2
5	0.000	111	0.000	114	0.000	2
6	0.000	105	0.000	106	0.000	2
7	0.700	103	0.700	105	0.000	1
8	20.000	109	20.000	113	0.000	3
9	14.000	105	14.000	106	0.000	0
10	13.000	108	13.000	109	0.000	0
11	0.000	109	0.000	112	0.000	2
12	0.650	111	0.600	116	-0.050	4
13	18.000	102	18.000	105	0.000	2
14	0.600	103	0.600	105	0.000	1
15	0.000	110	0.000	112	0.000	1
16	7.100	106	7.000	107	-0.100	0
17	0.000	106	0.000	109	0.000	2
CALIBRATION		90		91		

COMMENTS:

TEST DATA ANALYSIS

TEST A2 DATE 11-10-80

BOARD # 0611511V FUNCTION: CPU

COMPUTER WING: C ROW: B POSITION: 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	7.000	100	7.000	97	0.000	-2
2	7.000	101	7.000	97	0.000	-3
3	-2.000	100	-2.000	97	0.000	-2
4	6.000	99	6.000	98	0.000	0
5	6.000	99	6.000	98	0.000	0
6	6.000	101	6.000	100	0.000	9
7	6.000	98	6.000	98	0.000	1
8	20.000	99	20.000	104	0.000	6
9	0.170	98	0.150	99	-0.020	2
10	0.000	100	0.000	103	0.000	4
11	6.000	100	6.000	101	0.000	2
12	0.000	100	0.000	101	0.000	2
13	0.200	96	0.200	98	0.000	3
14	0.200	97	0.200	98	0.000	2
15	0.000	96	0.000	98	0.000	3
16	0.200	96	0.200	98	0.000	3
17	0.000	99	0.000	101	0.000	3
CALIBRATION		90		89		

COMMENTS:

TEST DATA ANALYSIS

TEST A2 DATE 11-10-80

BOARD # 0611509A FUNCTION: CPU

COMPUTER WING: C ROW: C POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.100	97	0.100	97	0.000	-1
2	0.100	97	0.100	98	0.000	0
3	0.000	97	0.000	97	0.000	-1
4	0.000	98	0.000	104	0.000	5
5	7.000	99	7.000	99	0.000	-1
6	6.000	100	6.000	99	0.000	-2
7	0.250	97	0.200	98	-0.050	0
8	20.000	101	20.000	106	0.000	4
9	6.900	101	6.800	101	-0.100	-1
10	6.000	105	5.900	104	-0.100	-2
11	0.160	98	0.150	98	-0.010	-1
12	6.800	96	6.800	99	0.000	2
13	6.300	98	6.300	97	0.000	-2
14	6.300	99	6.300	99	0.000	-1
15	5.900	98	5.900	97	0.000	-2
16	1.600	100	1.500	99	-0.100	-2
17	0.000	100	0.000	102	0.000	1
CALIBRATION		90		91		

COMMENTS:

TEST DATA ANALYSIS

TEST A2 DATE 11-10-80

BOARD # 0614129M FUNCTION: CPU

COMPUTER WING: C ROW. T POSITION: 20

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	20.000	108	20.000	109	0.000	1
2	13.000	101	13.000	101	0.000	0
3	6.000	100	6.000	100	0.000	0
4	0.000	102	0.000	105	0.000	3
5	0.000	102	0.000	108	0.000	6
6	0.000	104	0.000	107	0.000	3
7	0.000	104	0.000	104	0.000	0
8	20.000	106	20.000	110	0.000	4
9	0.000	104	0.000	105	0.000	1
10	0.000	101	0.000	103	0.000	2
11	0.000	102	0.000	102	0.000	0
12	0.000	106	0.000	108	0.000	2
13	0.000	104	0.000	105	0.000	1
14	1.000	105	1.000	105	0.000	0
15	0.000	106	0.000	109	0.000	3
16	0.000	101	0.000	101	0.000	0
17	0.000	106	0.000	106	0.000	0
CALIBRATION		90		90		

COMMENTS:

TEST DATA ANALYSIS

TEST 02 DATE 11-10-80

BOARD # 0611500F FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	99	0.000	99	0.000	-1
2	0.000	98	0.000	100	0.000	1
3	0.000	99	0.000	102	0.000	2
4	0.000	101	0.000	102	0.000	0
5	0.000	101	0.000	103	0.000	1
6	0.000	99	0.000	99	0.000	-1
7	0.000	99	0.000	101	0.000	1
8	0.000	101	0.000	100	0.000	-2
9	0.000	101	0.000	101	0.000	-1
10	0.000	101	0.000	103	0.000	1
11	0.000	102	0.000	104	0.000	1
12	0.000	101	0.000	105	0.000	3
13	0.000	103	0.000	103	0.000	-1
14	0.000	103	0.000	107	0.000	3
15	0.000	99	0.000	98	0.000	-2
16	0.000	100	0.000	99	0.000	-2
17	0.000	99	0.000	98	0.000	-2
CALIBRATION		90		91		

COMMENTS: VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED.

TEST DATA ANALYSIS

TEST A2 DATE 11-10-80

BOARD # 0611420T FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	0.000	97	0.000	97	0.000	0
2	0.000	96	0.000	97	0.000	1
3	0.000	95	0.000	96	0.000	1
4	0.000	96	0.000	98	0.000	2
5	0.000	95	0.000	99	0.000	4
6	0.000	96	0.000	99	0.000	3
7	0.000	98	0.000	103	0.000	5
8	0.000	98	0.000	102	0.000	4
9	0.000	98	0.000	101	0.000	3
10	0.000	96	0.000	100	0.000	4
11	0.000	99	0.000	104	0.000	5
12	0.000	98	0.000	98	0.000	0
13	0.000	98	0.000	98	0.000	0
14	0.000	98	0.000	100	0.000	2
15	0.000	100	0.000	103	0.000	3
16	0.000	100	0.000	100	0.000	0
17	0.000	100	0.000	101	0.000	1
CALIBRATION		90		90		

COMMENTS: VOLLTAGES NO TAK. EQUIPMENT FUNCTION NOT USED.

TEST DATA ANALYSIS

TEST A2 DATE 11-10-80

BOARD # 0611500E FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	97	0.000	97	0.000	0
2	0.000	100	0.000	103	0.000	3
3	0.000	101	0.000	104	0.000	3
4	0.000	98	0.000	98	0.000	0
5	0.000	98	0.000	99	0.000	1
6	0.000	99	0.000	103	0.000	4
7	0.000	99	0.000	100	0.000	1
8	0.000	100	0.000	102	0.000	2
9	0.000	100	0.000	104	0.000	4
10	0.000	100	0.000	100	0.000	0
11	0.000	100	0.000	100	0.000	0
12	0.000	98	0.000	99	0.000	1
13	0.000	99	0.000	106	0.000	7
14	0.000	102	0.000	103	0.000	1
15	0.000	101	0.000	101	0.000	0
16	0.000	101	0.000	102	0.000	1
17	0.000	102	0.000	104	0.000	2
CALIBRATION		90		90		

COMMENTS: VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED.

TEST DATA ANALYSIS

TEST A4 DATE 11-19-80

BOARD # 0611500F FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: A POSITION: 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	7.000	81	6.800	87	-0.200	1
2	0.160	80	0.150	78	-0.010	-7
3	7.000	79	7.000	89	0.000	5
4	7.000	79	7.000	88	0.000	4
5	6.000	79	[illegible]	86	-0.100	2
6	0.200	80	0.170	87	-0.030	2
7	0.100	78	0.100	89	0.000	6
8	20.000	82	20.000	90	0.000	3
9	7.000	80	6.500	88	-0.500	3
10	7.000	81	6.500	86	-0.500	0
11	7.000	80	6.500	85	-0.500	0
12	5.900	80	5.800	88	-0.100	3
13	6.500	81	6.200	89	-0.300	3
14	7.000	81	7.000	89	0.000	3
15	6.000	79	5.800	90	-0.200	6
16	6.000	79	5.800	86	-0.200	2
17	0.000	85	0.000	94	0.000	4
CALIBRATION		70		75		

COMMENTS:

TEST DATA ANALYSIS

TEST A4 DATE 11-19-80

BOARD # 0613230V FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: B POSITION: 7

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.130	78	0.130	86	0.000	3
2	0.000	79	0.000	86	0.000	2
3	10.000	78	10.000	88	0.000	5
4	0.600	80	0.600	85	0.000	0
5	0.000	80	0.000	88	0.000	3
6	0.130	80	0.130	89	0.000	4
7	0.600	77	0.700	85	0.100	3
8	20.000	81	20.300	90	0.000	4
9	10.000	79	11.000	88	1.000	4
10	11.000	80	12.000	85	1.000	0
11	0.150	80	0.140	84	-0.010	-1
12	0.700	78	0.700	88	0.000	5
13	17.000	79	18.000	88	1.000	4
14	0.700	79	0.700	89	0.000	5
15	0.000	79	0.000	89	0.000	5
16	0.150	80	0.150	89	0.000	4
17	0.000	84	0.000	90	0.000	1
CALIBRATION		70		75		

COMMENTS:

TEST DATA ANALYSIS

TEST A4 DATE 11-19-80

BOARD # 0613230V FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: G POSITION: 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	7.000	78	6.800	86	-0.200	3
2	0.000	79	0.000	86	0.000	2
3	18.000	78	18.000	87	0.000	4
4	0.700	80	0.700	85	0.000	0
5	0.000	80	0.000	86	0.000	1
6	0.000	81	0.000	88	0.000	2
7	0.700	77	0.700	88	0.000	6
8	20.000	82	20.000	89	0.000	2
9	14.000	79	14.000	86	0.000	2
10	12.500	78	13.000	85	0.500	2
11	0.000	80	0.000	87	0.000	2
12	0.600	80	0.600	88	0.000	3
13	17.500	78	17.000	88	-0.500	5
14	0.700	78	0.600	89	-0.100	6
15	0.000	78	0.000	87	0.000	4
16	7.000	81	7.000	87	0.000	1
17	0.000	83	0.000	91	0.000	3
CALIBRATION		70		75		

COMMENTS:

TEST DATA ANALYSIS

TEST A4 DATE 11-19-80

BOARD # 0611511V FUNCTION: CPU

COMPUTER WING: C ROW: B POSITION: 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	7.000	80	6.800	85	-0.200	0
2	7.000	80	6.800	85	-0.200	0
3	0.000	80	6.000	86	6.000	1
4	5.500	78	5.800	87	0.300	4
5	5.500	79	5.800	85	0.300	1
6	5.500	80	5.800	88	0.300	3
7	5.500	79	5.900	88	0.400	4
8	20.000	79	20.000	87	0.000	3
9	0.100	79	0.100	85	0.000	1
10	7.000	78	0.000	86	-7.000	3
11	5.500	79	5.900	86	0.400	2
12	5.500	80	0.300	87	-5.200	2
13	0.200	82	0.400	87	0.200	0
14	0.150	78	0.400	87	0.250	4
15	6.500	78	0.400	85	-6.100	2
16	0.150	79	0.150	86	0.000	2
17	0.000	81	0.000	89	0.000	3
CALIBRATION		70		75		

COMMENTS:

TEST DATA ANALYSIS

TEST A4 DATE 11-19-88

BOARD # 0611509A FUNCTION: CPU

COMPUTER WING: C ROW: C POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.150	77	0.150	83	0.000	1
2	0.150	78	0.150	83	0.000	0
3	5.500	78	5.800	84	0.300	1
4	0.000	78	0.000	86	0.000	3
5	6.500	77	6.400	85	-0.100	3
6	6.000	79	5.900	84	-0.100	0
7	5.500	78	0.200	84	-5.300	1
8	20.000	80	20.000	88	0.000	3
9	6.500	78	6.600	85	0.100	2
10	5.500	79	5.800	85	0.300	1
11	0.150	79	0.200	84	0.050	0
12	6.500	79	6.600	84	0.100	0
13	6.500	80	6.500	84	0.000	-1
14	6.500	77	6.500	85	0.000	3
15	5.500	78	5.800	84	0.300	1
16	0.150	78	0.150	86	0.000	3
17	0.000	80	0.000	87	0.000	2
CALIBRATION		70		75		

COMMENTS:

TEST DATA ANALYSIS

TEST A4 DATE 11-19-80

BOARD # 0614129M FUNCTION: CPU

COMPUTER WING: C ROW: T POSITION: 20

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	19.500	77	20.000	82	0.500	0
2	13.000	78	13.000	83	0.000	0
3	5.500	77	6.000	83	0.500	1
4	0.000	79	0.000	84	0.000	0
5	0.000	80	0.000	86	0.000	1
6	0.000	78	0.000	85	0.000	2
7	~~0.025~~	~~78~~	~~0.000~~	~~85~~	~~-0.025~~	~~2~~
8	20.000	81	20.000	88	0.000	2
9	0.200	80	0.000	85	-0.200	0
10	0.300	80	0.000	84	-0.300	-1
11	0.200	79	0.000	84	-0.200	0
12	0.050	79	0.000	84	-0.050	0
13	0.000	77	0.000	83	0.000	1
14	1.000	78	1.000	86	0.000	3
15	0.000	79	0.000	86	0.000	2
16	35.000	79	0.000	85	-35.000	1
17	0.000	80	0.000	88	0.000	3
CALIBRATION		70		75		

COMMENTS:

TEST DATA ANALYSIS

TEST A4 DATE 11-19-88

BOARD # 0611500F FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	83	0.000	87	0.000	2
2	0.000	86	0.000	83	0.000	-5
3	0.000	81	0.000	83	0.000	0
4	0.000	84	0.000	84	0.000	-2
5	0.000	82	0.000	90	0.000	6
6	0.000	82	0.000	85	0.000	1
7	0.000	80	0.000	81	0.000	-1
8	0.000	86	0.000	89	0.000	1
9	0.000	82	0.000	83	0.000	-1
10	0.000	84	0.000	84	0.000	-2
11	0.000	80	0.000	82	0.000	0
12	0.000	81	0.000	85	0.000	2
13	0.000	80	0.000	83	0.000	1
14	0.000	83	0.000	84	0.000	-1
15	0.000	82	0.000	85	0.000	1
16	0.000	79	0.000	84	0.000	3
17	0.000	85	0.000	90	0.000	3
CALIBRATION		69		71		

COMMENTS:

TEST DATA ANALYSIS

TEST A4 DATE 11-19-80

BOARD # 0611420T FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	81	0.000	87	0.000	2
2	0.000	82	0.000	90	0.000	4
3	0.000	80	0.000	86	0.000	4
4	0.000	84	0.000	83	0.000	-5
5	0.000	79	0.000	83	0.000	0
6	0.000	84	0.000	84	0.000	-4
~~7~~	~~0.000~~	~~82~~	~~0.000~~	~~87~~	~~0.000~~	1
8	0.000	85	0.000	92	0.000	3
9	0.000	83	0.000	86	0.000	-1
10	0.000	82	0.000	91	0.000	5
11	0.000	82	0.000	83	0.000	-3
12	0.000	81	0.000	88	0.000	3
13	0.000	82	0.000	84	0.000	-2
14	0.000	84	0.000	84	0.000	-4
15	0.000	81	0.000	82	0.000	-3
16	0.000	83	0.000	82	0.000	-5
17	0.000	87	0.000	89	0.000	-2
CALIBRATION		68		72		

COMMENTS:

TEST DATA ANALYSIS

TEST A4 DATE 11-19-80

BOARD # 0611500E FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	85	0.000	89	0.000	2
2	0.000	81	0.000	86	0.000	3
3	0.000	83	0.000	85	0.000	0
4	0.000	82	0.000	84	0.000	0
5	0.000	84	0.000	83	0.000	-3
6	0.000	89	0.000	85	0.000	-6
7	0.000	83	0.000	84	0.000	-1
8	0.000	83	0.000	88	0.000	3
9	0.000	81	0.000	84	0.000	1
10	0.000	85	0.000	89	0.000	2
11	0.000	82	0.000	86	0.000	2
12	0.000	84	0.000	89	0.000	3
13	0.000	83	0.000	85	0.000	0
14	0.000	84	0.000	85	0.000	-1
15	0.000	83	0.000	86	0.000	1
16	0.000	84	0.000	86	0.000	0
17	0.000	85	0.000	88	0.000	1
CALIBRATION		69		71		

COMMENTS:

TEST DATA ANALYSIS

TEST AS DATE 11-25-88

BOARD # 0611500F FUNCTION. PRINTER CONTROLLER

COMPUTER WING: A ROW. A POSITION. 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	6.800	79	6.600	84	-0.200	0
2	0.170	79	0.160	84	-0.010	0
3	7.000	79	6.600	84	-0.400	0
4	7.000	78	0.000	86	-7.000	3
5	6.000	80	5.900	85	-0.100	0
6	0.150	80	0.180	84	0.030	-1
~~7~~	~~0.100~~	~~79~~	~~0.100~~	~~85~~	~~0.000~~	~~1~~
8	20.000	81	20.000	88	0.000	2
9	6.500	78	0.000	86	-6.500	3
10	6.500	79	6.600	83	0.100	-1
11	6.500	79	6.600	84	0.100	0
12	5.800	78	5.900	83	0.100	0
13	6.500	78	0.000	86	-6.500	3
14	7.000	80	7.000	86	0.000	1
15	6.000	79	6.000	88	0.000	4
16	5.800	80	5.900	85	0.100	0
17	0.000	81	0.000	87	0.000	1
CALIBRATION		78		75		

COMMENTS

TEST DATA ANALYSIS

TEST A5 DATE 11-25-80

BOARD # 0613230Y FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: B POSITION: 7

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.150	78	0.140	85	-0.010	2
2	0.000	81	0.000	85	0.000	-1
3	17.000	80	17.000	85	0.000	0
4	0.600	77	0.600	86	0.000	4
5	3.900	78	[illegible]	84	0.000	1
6	0.130	79	5.600	86	5.470	2
7	0.700	79	0.600	87	-0.100	3
8	20.000	80	20.000	84	0.000	-1
9	10.000	79	10.000	86	0.000	2
10	11.000	79	11.000	86	0.000	2
11	0.150	81	0.140	87	-0.010	1
12	0.600	80	0.600	85	0.000	0
13	17.000	78	17.500	84	0.500	1
14	0.700	79	0.600	85	-0.100	1
15	0.000	81	0.000	86	0.000	0
16	0.130	79	0.140	86	0.010	2
17	0.000	80	0.000	87	0.000	2
CALIBRATION		70		75		

COMMENTS:

TEST DATA ANALYSIS

TEST A5 DATE 11-25-86

BOARD # 0613230Y FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: G POSITION: 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	7.000	79	6.600	83	-0.400	0
2	0.000	79	0.000	84	0.000	1
3	18.000	78	17.500	84	-0.500	2
4	0.700	79	0.600	83	-0.100	0
5	0.000	80	0.000	85	0.000	1
6	0.000	78	0.000	86	0.000	4
7	0.700	77	0.600	85	-0.100	4
8	20.000	82	20.000	84	0.000	-2
9	14.000	78	14.000	83	0.000	1
10	13.000	78	12.500	84	-0.500	2
11	0.000	77	0.000	84	0.000	3
12	0.700	77	0.600	86	-0.100	5
13	18.000	79	17.500	85	-0.500	2
14	0.700	79	0.600	83	-0.100	0
15	0.000	78	0.000	84	0.000	2
16	6.500	78	6.500	85	0.000	3
17	0.000	81	0.000	86	0.000	1
CALIBRATION		69		73		

COMMENTS.

TEST DATA ANALYSIS

TEST A5 DATE 11-25-80

BOARD # 0611511V FUNCTION: CPU

COMPUTER WING: C ROW: 6 POSITION: 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	6.700	80	6.600	87	-0.100	1
2	6.700	78	6.500	86	-0.200	2
3	6.000	78	5.900	88	-0.100	4
4	5.900	80	5.800	88	-0.100	2
5	5.800	78	5.800	88	0.000	4
6	5.900	77	5.800	89	-0.100	6
7	5.800	80	5.700	90	-0.100	4
8	20.000	80	19.500	91	-0.500	5
9	0.150	79	0.150	85	0.000	0
10	6.800	77	0.300	84	-6.500	1
11	5.800	78	5.700	87	-0.100	3
12	5.800	79	0.000	87	-5.800	2
13	0.200	79	0.200	88	0.000	3
14	0.200	80	0.200	90	0.000	4
15	6.600	78	0.000	85	-6.600	1
16	1.200	78	0.100	86	-1.100	2
17	0.000	80	0.000	86	0.000	2
CALIBRATION		69		75		

COMMENTS:

TEST DATA ANALYSIS

TEST A5 DATE 11-25-80

BOARD # 0611509A FUNCTION: CPU

COMPUTER WING: C ROW. C POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.180	80	0.150	86	-0.030	0
2	0.180	78	0.150	85	-0.030	1
3	6.900	77	0.000	83	-6.900	0
4	0.000	80	0.000	86	0.000	0
5	6.400	78	6.400	84	0.000	0
6	6.800	79	6.000	86	-0.800	1
7	0.160	80	0.200	85	0.040	-1
8	20.000	81	19.900	88	-0.100	1
9	6.600	80	6.600	86	0.000	0
10	5.600	77	5.600	87	0.000	4
11	0.160	76	0.150	88	-0.010	6
12	6.700	78	6.600	86	-0.100	2
13	6.700	78	6.400	85	-0.300	1
14	6.500	78	6.600	88	0.100	4
15	5.700	81	0.000	89	-5.700	2
16	0.140	79	0.150	86	0.010	1
17	0.000	82	0.000	89	0.000	1
CALIBRATION		79		76		

COMMENTS

TEST DATA ANALYSIS

TEST A5 DATE 11-25-80

BOARD # 0614129M FUNCTION. CPU

COMPUTER WING: C ROW: T POSITION: 20

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	19.000	83	19.900	85	0.900	1
2	13.000	83	13.500	84	0.500	0
3	6.000	86	6.000	87	0.000	0
4	0.000	84	0.000	85	0.000	0
5	0.000	85	0.000	86	0.000	0
6	0.000	85	0.000	86	0.000	0
7	0.000	85	0.000	86	0.000	0
8	20.000	87	19.900	89	-0.100	1
9	0.000	85	0.000	86	0.000	0
10	0.000	85	0.000	86	0.000	0
11	0.000	85	0.000	86	0.000	0
12	0.000	83	0.000	85	0.000	1
13	0.000	82	0.000	84	0.000	1
14	1.000	82	1.000	84	0.000	1
15	0.000	86	0.000	86	0.000	-1
16	0.000	86	0.000	88	0.000	1
17	0.000	86	0.000	88	0.000	1
CALIBRATION		75		76		

COMMENTS:

TEST DATA ANALYSIS

TEST A5 DATE 11-25-80

BOARD # 0611500F FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	82	0.000	84	0.000	0
2	0.000	83	0.000	83	0.000	-2
3	0.000	81	0.000	90	0.000	7
4	0.000	87	0.000	86	0.000	-3
5	0.000	85	0.000	95	0.000	8
6	0.000	82	0.000	87	0.000	3
7	~~0.000~~	~~80~~	~~0.000~~	~~82~~	~~0.000~~	[illegible]
8	0.000	81	0.000	95	0.000	12
9	0.000	82	0.000	82	0.000	-2
10	0.000	82	0.000	84	0.000	0
11	0.000	80	0.000	83	0.000	1
12	0.000	81	0.000	85	0.000	2
13	0.000	80	0.000	83	0.000	1
14	0.000	82	0.000	83	0.000	-1
15	0.000	80	0.000	94	0.000	12
16	0.000	82	0.000	82	0.000	-2
17	0.000	91	0.000	95	0.000	2
CALIBRATION		69		71		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A5 DATE 11-25-80

BOARD # 0611420T FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	82	0.000	84	0.000	-1
2	0.000	83	0.000	86	0.000	0
3	0.000	86	0.000	82	0.000	-7
4	0.000	86	0.000	81	0.000	-8
5	0.000	85	[illegible]	81	0.000	-7
6	0.000	83	0.000	83	0.000	-3
7	0.000	84	0.000	84	0.000	-3
8	0.000	91	0.000	94	0.000	0
9	0.000	82	0.000	90	0.000	5
10	0.000	84	0.000	89	0.000	2
11	0.000	84	0.000	92	0.000	5
12	0.000	82	0.000	89	0.000	4
13	0.000	84	0.000	89	0.000	2
14	0.000	83	0.000	85	0.000	-1
15	0.000	81	0.000	84	0.000	0
16	0.000	80	0.000	86	0.000	3
17	0.000	85	0.000	94	0.000	6
CALIBRATION		69		72		

COMMENTS VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A5 DATE 11-25-80

BOARD # 0611500E FUNCTION PUNCH CONTROLLER

COMPUTER WING. H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	82	0.000	86	0.000	1
2	0.000	81	0.000	85	0.000	1
3	0.000	84	0.000	87	0.000	6
4	0.000	83	0.000	85	0.000	-1
5	0.000	80	0.000	84	0.000	1
6	0.000	85	0.000	87	0.000	-1
7	0.000	82	0.000	86	0.000	1
8	0.000	82	0.000	98	0.000	13
9	0.000	83	0.000	86	0.000	0
10	0.000	86	0.000	91	0.000	2
11	0.000	85	0.000	85	0.000	-3
12	0.000	83	0.000	86	0.000	0
13	0.000	82	0.000	89	0.000	4
14	0.000	83	0.000	92	0.000	6
15	0.000	84	0.000	88	0.000	1
16	0.000	86	0.000	86	0.000	-3
17	0.000	86	0.000	92	0.000	3
CALIBRATION		70		73		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A6 DATE 12-3-88

BOARD # 0611500F FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: A POSITION: 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.600	80	6.500	78	-0.100	0
2	0.160	81	0.150	79	-0.010	0
3	6.500	80	6.500	79	0.000	1
4	0.000	81	0.000	80	0.000	1
5	5.800	81	5.7[illegible]	80	-0.100	1
6	0.160	79	0.160	81	0.000	4
7	0.100	79	0.100	80	0.000	3
8	20.000	80	19.900	82	-0.100	4
9	6.500	79	6.400	79	-0.100	2
10	6.500	79	6.500	78	0.000	1
11	6.500	80	6.500	78	0.000	0
12	5.600	81	6.500	78	0.900	-1
13	6.400	79	0.000	80	-6.400	3
14	7.000	79	6.800	79	-0.200	2
15	6.000	80	5.800	79	-0.200	1
16	5.800	81	5.600	80	-0.200	1
17	0.000	82	0.000	82	0.000	2
CALIBRATION		72		70		

COMMENTS.

TEST DATA ANALYSIS

TEST A6 DATE 12-3-80

BOARD # 0613230V FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: B POSITION: 7

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.130	80	0.130	78	0.000	0
2	0.000	80	0.000	80	0.000	2
3	17.000	80	17.000	80	0.000	2
4	0.600	78	0.600	79	0.000	3
5	0.000	80	0.000	80	0.000	2
6	0.130	79	0.130	79	0.000	2
7	0.600	81	0.600	80	0.000	1
8	20.000	81	19.900	78	-0.100	-1
9	10.500	79	10.000	78	-0.500	1
10	10.500	79	10.500	79	0.000	2
11	0.140	81	0.140	80	0.000	1
12	0.600	80	0.600	81	0.000	3
13	17.500	80	17.000	81	-0.500	3
14	0.600	79	0.600	79	0.000	2
15	0.000	81	0.000	78	0.000	-1
16	5.800	81	0.140	80	-5.660	1
17	0.000	81	0.000	80	0.000	1
CALIBRATION		72		70		

COMMENTS:

TEST DATA ANALYSIS

TEST A6 DATE 12-3-80

BOARD # 0613230Y FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: G POSITION: 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.600	77	6.600	76	0.000	1
2	0.000	78	0.000	77	0.000	1
3	17.000	79	17.000	78	0.000	1
4	0.500	79	0.600	80	0.100	3
5	0.000	79	[illegible]	79	0.000	2
6	0.000	78	0.000	79	0.000	3
7	~~0.600~~	~~81~~	~~0.600~~	~~79~~	~~0.000~~	~~-1~~
8	20.000	81	19.900	79	-0.100	0
9	14.000	82	14.000	79	0.000	-1
10	12.000	80	12.000	80	0.000	2
11	0.000	80	0.000	81	0.000	3
12	0.600	82	0.600	79	0.000	-1
13	17.000	79	17.000	77	0.000	0
14	0.600	82	0.600	79	0.000	-1
15	0.000	81	0.000	80	0.000	1
16	6.400	79	6.400	79	0.000	2
17	0.000	82	0.000	81	0.000	1
CALIBRATION		72		70		

COMMENTS:

TEST DATA ANALYSIS

TEST A6 DATE 12-3-80

BOARD # 0611511V FUNCTION: CPU

COMPUTER WING: C ROW: B POSITION: 32

CONNECTOR	PRETEST VOLTAGE (VOLTS)	PRETEST RESISTANCE (MILLIOHMS)	POST TEST VOLTAGE (VOLTS)	POST TEST RESISTANCE (MILLIOHMS)	RESULTS VOLTAGE DIFFERENCE (VOLTS)	RESULTS RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.600	81	6.600	79	0.000	0
2	6.600	81	6.500	79	-0.100	0
3	6.000	81	0.000	79	-6.000	0
4	5.700	80	5.600	82	-0.100	4
5	5.700	82	5.600	79	-0.100	-1
6	5.800	78	5.600	80	-0.200	4
7	5.900	79	5.600	80	-0.300	3
8	20.090	80	19.900	83	-0.100	5
9	0.150	79	0.130	79	-0.020	2
10	0.190	82	0.000	80	-0.190	0
11	5.800	80	5.700	78	-0.100	0
12	0.000	80	0.000	80	0.000	2
13	0.130	81	0.140	78	0.010	-1
14	0.130	79	0.140	76	0.010	-1
15	0.000	82	0.000	79	0.000	-1
16	0.090	80	0.100	79	0.010	1
17	0.000	82	0.000	81	0.000	1
CALIBRATION		72		70		

COMMENTS:

TEST DATA ANALYSIS

TEST A6 DATE 12-3-80

BOARD # 0611509A FUNCTION: CPU

COMPUTER WING: C ROW: C POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.140	78	0.120	77	-0.020	1
2	0.130	79	0.100	77	-0.030	0
3	0.000	82	0.000	80	0.000	0
4	0.000	78	0.000	80	0.000	4
5	6.500	80	6.400	78	-0.100	0
6	5.700	80	5.700	77	0.000	-1
7	0.120	29	0.000	80	-0.120	2
8	20.000	83	20.000	84	0.000	3
9	6.700	79	6.700	80	0.000	3
10	5.600	81	5.700	79	0.100	0
11	0.160	80	0.160	78	0.000	0
12	6.600	80	6.700	79	0.100	1
13	6.400	82	6.400	80	0.000	0
14	6.500	82	6.500	79	0.000	-1
15	0.000	83	0.000	81	0.000	0
16	0.150	80	0.140	81	-0.010	3
17	0.000	83	0.000	83	0.000	2
CALIBRATION		72		70		

COMMENTS:

TEST DATA ANALYSIS

TEST A6 DATE 12-3-80

BOARD # 0614129M FUNCTION: CPU

COMPUTER WING: C ROW: T POSITION: 20

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	19.500	79	19.000	77	-0.500	0
2	13.000	78	13.000	78	0.000	2
3	5.800	78	5.700	80	-0.100	4
4	0.000	82	0.000	79	0.000	-1
5	0.000	79	0.000	81	0.000	4
6	0.000	80	0.000	84	0.000	6
7	0.000	79	0.000	79	0.000	2
8	20.000	82	19.900	85	-0.100	5
9	0.000	81	0.000	80	0.000	1
10	0.000	83	0.000	79	0.000	-2
11	0.000	80	0.000	80	0.000	2
12	0.000	79	0.000	81	0.000	4
13	0.000	79	0.000	79	0.000	2
14	1.000	82	0.000	76	-1.000	-4
15	0.000	82	0.000	80	0.000	0
16	0.000	81	0.000	83	0.000	4
17	0.000	80	0.000	83	0.000	5
CALIBRATION		72		70		

COMMENTS:

TEST DATA ANALYSIS

TEST A6 DATE 12-3-80

BOARD # 0611500F FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	90	0.000	82	0.000	-6
2	0.000	84	0.000	83	0.000	1
3	0.000	86	0.000	90	0.000	6
4	0.000	88	0.000	88	0.000	2
5	0.000	87	0.[illegible]	83	0.000	-2
[illegible]	0.000	84	0.000	83	0.000	1
7	0.000	85	0.000	83	0.000	0
8	0.000	95	0.000	86	0.000	-5
9	0.000	84	0.000	83	0.000	1
10	0.000	85	0.000	82	0.000	-1
11	0.000	84	0.000	83	0.000	1
12	0.000	84	0.000	83	0.000	1
13	0.000	84	0.000	84	0.000	2
14	0.000	86	0.000	82	0.000	-2
15	0.000	87	0.000	83	0.000	-2
16	0.000	83	0.000	83	0.000	2
17	0.000	95	0.000	90	0.000	-3
CALIBRATION		73		71		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A6 DATE 12-3-80

BOARD # 0611420T FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	85	0.000	85	0.000	2
2	0.000	88	0.000	87	0.000	1
3	0.000	86	0.000	88	0.000	4
4	0.000	91	0.000	82	0.000	-7
5	0.000	92	0.000	83	0.000	-7
6	0.000	85	0.000	83	0.000	0
7	0.000	85	0.000	89	0.000	6
8	0.000	95	0.000	88	0.000	-5
9	0.000	87	0.000	84	0.000	-1
10	0.000	96	0.000	85	0.000	-9
11	0.000	86	0.000	84	0.000	0
12	0.000	93	0.000	86	0.000	-5
13	0.000	88	0.000	88	0.000	2
14	0.000	85	0.000	84	0.000	1
15	0.000	85	0.000	83	0.000	0
16	0.000	84	0.000	84	0.000	2
17	0.000	95	0.000	90	0.000	-3
CALIBRATION		73		71		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A6 DATE 12-3-80

BOARD # 0611500E FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 10

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	85	0.000	83	0.000	-2
2	0.000	83	0.000	82	0.000	-1
3	0.000	86	0.000	85	0.000	-1
4	0.000	83	0.000	84	0.000	1
5	0.000	88	0.000	85	0.000	-3
6	0.000	88	0.000	85	0.000	-3
7	0.000	89	0.000	89	0.000	0
8	0.000	95	0.000	88	0.000	-7
9	0.000	86	0.000	87	0.000	1
10	0.000	91	0.000	87	0.000	-4
11	0.000	88	0.000	90	0.000	2
12	0.000	87	0.000	87	0.000	0
13	0.000	96	0.000	90	0.000	-6
14	0.000	84	0.000	84	0.000	0
15	0.000	86	0.000	84	0.000	-2
16	0.000	85	0.000	83	0.000	-2
17	0.000	95	0.000	95	0.000	0
CALIBRATION		72		72		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A7 DATE 12-8-80

BOARD # 0611500F FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: A POSITION: 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.500	80	6.500	82	0.000	0
2	0.160	80	0.150	82	-0.010	0
3	6.500	82	6.500	84	0.000	0
4	0.000	84	0.000	86	0.000	0
5	5.000	80	5.000	84	0.000	2
6	0.170	79	0.170	82	0.000	1
7	~~0.100~~	~~79~~	~~0.100~~	~~82~~	~~0.000~~	~~1~~
8	20.000	84	20.000	88	0.000	2
9	6.500	79	6.500	84	0.000	3
10	6.500	76	6.500	85	0.000	7
11	6.500	79	6.500	82	0.000	1
12	5.600	80	5.600	82	0.000	0
13	0.000	80	0.000	82	0.000	0
14	7.000	78	7.000	80	0.000	0
15	6.000	79	6.000	84	0.000	3
16	5.000	79	5.000	82	0.000	1
17	0.000	82	0.000	86	0.000	2
CALIBRATION		69		71		

COMMENTS:

TEST DATA ANALYSIS

TEST A7 DATE 12-8-88

BOARD # 8613230Y FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: B POSITION: 7

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.130	79	0.130	81	0.000	0
2	0.000	80	0.000	82	0.000	0
3	17.000	78	17.000	80	0.000	0
4	0.600	76	0.6[illegible]	80	0.000	2
5	0.000	80	0.000	81	9.999	-1
6	5.900	81	5.850	83	-0.050	0
7	0.600	78	0.600	80	0.000	0
8	20.000	84	20.000	89	0.000	3
9	10.200	78	10.100	84	-0.100	4
10	10.500	78	10.500	80	0.000	0
11	0.140	78	0.140	80	0.000	0
12	0.600	8[illegible]	0.600	85	0.000	1
13	17.500	79	17.500	81	0.000	0
14	0.650	78	0.640	81	-0.010	1
15	0.9[illegible]0	81	0.900	82	0.000	-1
16	0.140	80	0.140	84	0.000	2
17	0.000	84	0.000	89	0.000	3
CALIBRATION		69		71		

COMMENTS:

TEST DATA ANALYSIS

TEST A7 DATE 12-8-80

BOARD # 0613230Y FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: G POSITION: 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.500	79	6.500	79	0.000	0
2	0.000	78	0.000	82	0.000	4
3	17.500	76	17.500	81	0.000	5
4	0.600	82	6.000	86	5.400	4
5	0.000	80	0.000	89	0.000	9
6	0.000	78	0.000	78	0.000	0
~~7~~	~~0.650~~	~~79~~	~~0.650~~	~~79~~	~~0.000~~	~~0~~
8	20.000	79	20.000	79	0.000	0
9	14.000	80	14.000	80	0.000	0
10	12.500	81	12.500	83	0.000	2
11	0.000	77	0.000	78	0.000	1
12	0.600	78	0.600	78	0.000	0
13	17.500	80	17.500	79	0.000	-1
14	0.650	78	0.650	76	0.000	0
15	0.000	84	0.000	88	0.000	4
16	6.500	80	6.500	80	0.000	0
17	0.000	78	0.000	82	0.000	4
CALIBRATION		78		78		

COMMENTS:

TEST DATA ANALYSIS

TEST A7 DATE 12-8-80

BOARD # 0611511V FUNCTION: CPU

COMPUTER WING: C ROW: B POSITION: 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.600	76	6.600	81	0.000	6
2	6.600	79	6.600	80	0.000	2
3	0.000	79	0.000	78	0.000	0
4	5.800	79	5.800	78	0.000	0
5	5.800	80	5.800	79	0.000	0
6	5.800	78	5.800	79	0.000	2
7	5.800	85	5.800	83	0.000	4
8	19.900	85	19.900	84	0.000	0
9	0.150	80	0.150	80	0.000	1
10	0.000	76	0.000	79	0.000	4
11	5.800	80	5.800	79	0.000	0
12	0.000	81	0.000	79	0.000	-1
13	0.130	78	0.130	83	0.000	6
14	0.130	79	0.130	79	0.000	1
15	0.100	82	0.100	81	0.000	0
16	0.000	76	0.000	81	0.000	6
17	0.000	82	0.000	82	0.000	1
CALIBRATION		70		69		

COMMENTS:

TEST DATA ANALYSIS

TEST A7 DATE 12-8-80

BOARD # 0611509A FUNCTION: CPU

COMPUTER WING: C ROW: C POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.140	80	0.140	83	0.000	2
2	0.130	76	0.130	80	0.000	3
3	0.000	80	0.000	82	0.000	1
4	0.000	79	0.000	80	0.000	0
5	6.500	78	6.500	79	0.000	0
6	5.800	82	5.800	85	0.000	2
7	0.000	76	0.000	81	0.000	4
8	19.900	81	19.900	82	0.000	0
9	6.600	79	6.600	80	0.000	0
10	5.600	79	5.600	80	0.000	0
11	0.120	79	0.120	80	0.000	0
12	6.700	82	6.700	85	0.000	2
13	6.500	78	6.500	80	0.000	1
14	6.500	78	6.500	79	0.000	0
15	0.000	81	0.000	82	0.000	0
16	0.140	81	0.140	82	0.000	0
17	0.000	81	0.000	86	0.000	4
CALIBRATION		69		70		

COMMENTS:

TEST DATA ANALYSIS

TEST A7 DATE 12-8-80

BOARD # 0614129M FUNCTION: CPU

COMPUTER WING: C ROW: T POSITION: 20

CONNECTOR	PRETEST VOLTAGE (VOLTS)	PRETEST RESISTANCE (MILLIOHMS)	POST TEST VOLTAGE (VOLTS)	POST TEST RESISTANCE (MILLIOHMS)	RESULTS VOLTAGE DIFFERENCE (VOLTS)	RESULTS RESISTANCE DIFFERENCE (MILLIOHMS)
1	20.000	82	20.000	84	0.000	2
2	13.500	89	13.500	88	0.000	-1
3	5.900	80	5.900	86	0.000	6
4	0.000	80	0.000	80	0.000	0
5	0.000	81	[illegible]	81	0.000	0
6	0.900	78	0.000	81	0.000	3
7	0.000	82	0.000	83	0.000	1
8	19.900	81	19.900	86	0.000	5
9	0.000	78	0.000	78	0.000	0
10	0.000	78	0.000	78	0.000	0
11	0.000	82	3.000	84	0.000	2
12	0.000	80	0.000	81	0.000	1
13	0.000	80	0.000	80	0.000	0
14	1.000	80	1.000	79	0.000	-1
15	0.000	81	0.000	83	0.000	2
16	0.000	78	0.000	82	0.000	4
17	0.000	83	0.000	88	0.000	5
CALIBRATION		70		70		

COMMENTS:

TEST DATA ANALYSIS

TEST A7 DATE 12-8-80

BOARD # 0611500F FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	82	0.000	91	0.000	8
2	0.000	86	0.000	91	0.000	4
3	0.000	91	0.000	87	0.000	-5
4	0.000	82	0.000	92	0.000	9
5	0.000	86	0.000	90	0.000	3
6	0.000	85	0.000	90	0.000	4
7	0.000	83	0.000	89	0.000	5
8	0.000	86	0.000	92	0.000	5
9	0.000	86	0.000	86	0.000	-1
10	0.000	83	0.000	87	0.000	3
11	0.000	89	0.000	88	0.000	-2
12	0.000	83	0.000	87	0.000	3
13	0.000	85	0.000	87	0.000	1
14	0.000	84	0.000	88	0.000	3
15	0.000	85	0.000	88	0.000	2
16	0.000	83	0.000	86	0.000	2
17	0.000	86	0.000	95	0.000	8
CALIBRATION		69		78		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A7 DATE 12-8-88

BOARD # 06114420T FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	81	0.000	89	0.000	1
2	0.000	83	0.000	89	0.000	-1
3	0.000	84	0.000	89	0.000	-2
4	0.000	81	0.000	90	0.000	2
5	0.000	81	0.000	89	0.000	1
6	0.000	[illegible]	0.000	92	0.000	3
7	0.000	82	0.000	89	0.000	0
8	0.000	85	0.000	92	0.000	0
9	0.000	88	0.000	94	0.000	-1
10	0.000	84	0.000	92	0.000	1
11	0.000	90	0.000	94	0.000	-3
12	0.000	85	0.000	88	0.000	-4
13	0.000	86	0.000	91	0.000	-2
14	0.000	83	0.000	90	0.000	0
15	0.000	85	0.000	89	0.000	-3
16	0.000	85	0.000	89	0.000	-3
17	0.000	88	0.000	92	0.000	-3
CALIBRATION		71		78		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A7 DATE 12-8-80

BOARD # 0611500E FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	87	0.000	88	0.000	-4
2	0.000	85	0.000	91	0.000	1
3	0.000	88	0.000	89	0.000	-4
4	0.000	85	0.000	89	0.000	-1
5	0.000	85	0.000	94	0.000	4
6	0.000	85	0.000	89	0.000	-1
7	0.000	89	0.000	97	0.000	3
8	0.000	91	0.000	98	0.000	2
9	0.000	87	0.000	98	0.000	6
10	0.000	88	0.000	89	0.000	-4
11	0.000	85	0.000	101	0.000	11
12	0.000	86	0.000	93	0.000	2
13	0.000	86	0.000	90	0.000	-1
14	0.000	88	0.000	89	0.000	-4
15	0.000	87	0.000	95	0.000	3
16	0.000	86	0.000	90	0.000	-1
17	0.000	91	0.000	98	0.000	2
CALIBRATION		73		78		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A7 DATE 12-8-80

BOARD # 0611500F FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	82	0.000	91	0.000	8
2	0.000	86	0.000	91	0.000	4
3	0.000	91	0.000	87	0.000	-5
4	0.000	82	0.000	92	0.000	9
5	0.000	86	0.000	90	0.000	3
6	0.000	85	0.000	90	0.000	4
7	0.000	83	0.000	89	0.000	5
8	0.000	86	0.000	92	0.000	5
9	0.000	86	0.000	86	0.000	-1
10	0.000	83	0.000	87	0.000	3
11	0.000	89	0.000	88	0.000	-2
12	0.000	83	0.000	87	0.000	3
13	0.000	85	0.000	87	0.000	1
14	0.000	84	0.000	88	0.000	3
15	0.000	85	0.000	88	0.000	2
16	0.000	83	0.000	86	0.000	2
17	0.000	86	0.000	95	0.000	8
CALIBRATION		69		70		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A7 DATE 12-8-88

BOARD # 0611512H FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 13

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	91	0.000	14
2	0.000	0	0.000	91	0.000	14
3	0.000	0	0.000	91	0.000	14
4	0.000	0	0.000	92	0.000	15
5	0.000	0	0.000	95	0.000	18
6	0.000	0	0.000	95	0.000	18
7	0.000	0	0.000	95	0.000	18
8	0.000	0	0.000	102	0.000	25
9	0.000	0	0.000	90	0.000	13
10	0.000	0	0.000	94	0.000	17
11	0.000	0	0.000	101	0.000	24
12	0.000	0	0.000	92	0.000	15
13	0.000	0	0.000	89	0.000	12
14	0.000	0	0.000	92	0.000	15
15	0.000	0	0.000	89	0.000	12
16	0.000	0	0.000	90	0.000	13
17	0.000	0	0.000	97	0.000	20
CALIBRATION		0		77		

COMMENTS: EXPOSED TO 7 HALON DUMPS

TEST DATA ANALYSIS

TEST A7 DATE 12-8-88

BOARD # 0612027J FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 14

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	94	0.000	17
2	0.000	0	0.000	93	0.000	16
3	0.000	0	0.000	93	0.000	16
4	0.000	0	0.000	92	0.000	15
5	0.000	0	0.000	93	0.000	16
6	0.000	0	0.000	91	0.000	14
7	0.000	0	0.000	91	0.000	14
8	0.000	0	0.000	98	0.000	21
9	0.000	0	0.000	92	0.000	15
10	0.000	0	0.000	91	0.000	14
11	0.000	0	0.000	91	0.000	14
12	0.000	0	0.000	92	0.000	15
13	0.000	0	0.000	91	0.000	14
14	0.000	0	0.000	94	0.000	17
15	0.000	0	0.000	93	0.000	16
16	0.000	0	0.000	96	0.000	19
17	0.000	0	0.000	96	0.000	19
CALIBRATION		0		77		

COMMENTS: EXPOSED TO 7 HALON DUMPS

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 0611500F FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW: A POSITION: 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.400	87	6.400	78	0.000	-1
2	0.160	86	0.150	79	-0.010	1
3	6.400	87	6.400	79	0.000	0
4	6.200	87	6.400	79	0.200	0
5	5.900	86	5.900	78	0.000	0
6	0.160	87	0.160	79	0.000	0
7	0.100	85	0.100	79	0.000	2
8	20.000	86	20.000	80	0.000	2
9	6.400	85	6.400	79	0.000	2
10	6.400	86	6.400	80	0.000	2
11	6.400	85	6.400	78	0.000	1
12	5.900	85	5.900	79	0.000	2
13	6.200	84	6.200	78	0.000	2
14	6.400	85	6.500	79	0.100	2
15	5.900	85	5.900	79	0.000	2
16	5.900	85	5.900	79	0.000	2
17	0.000	86	0.000	64	0.000	6
CALIBRATION		77		69		

COMMENTS

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 0613238V FUNCTION: PRINTER CONTROLLER

COMPUTER WING: A ROW. 6 POSITION 07

CONNECTOR	PRETEST VOLTAGE (VOLTS)	PRETEST RESISTANCE (MILLIOHMS)	POST TEST VOLTAGE (VOLTS)	POST TEST RESISTANCE (MILLIOHMS)	RESULTS VOLTAGE DIFFERENCE (VOLTS)	RESULTS RESISTANCE DIFFERENCE (MILLIOHMS)
1	5.600	81	0.140	79	-5.460	1
2	0.000	82	0.000	80	0.000	1
3	1.700	81	17.500	80	15.800	2
4	0.400	81	0.620	82	0.220	4
5	0.000	83	0.	85	0.000	5
6	5.700	83	0.140	80	-5.560	0
7	0.620	81	0.620	79	0.000	1
8	20.000	83	20.000	85	0.000	5
9	10.500	84	11.000	81	0.500	0
10	12.000	83	12.000	80	0.000	0
11	0.220	84	0.140	82	-0.080	1
12	0.580	84	0.600	79	0.020	-2
13	17.500	83	17.500	79	0.000	-1
14	0.620	83	0.620	76	0.000	-4
15	0.000	84 *	0.000	85	0.000	4
16	0.140	83	0.140	78	0.000	-2
17	0.000	85	0.000	85	0.000	3
CALIBRATION		74		71		

COMMENTS:

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 0613230V FUNCTION PRINTER CONTROLLER

COMPUTER WING. A ROW G POSITION. 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.500	84	6.400	78	-0.100	0
2	0.000	85	0.000	79	0.000	0
3	17.500	85	17.000	78	-0.500	-1
4	0.600	87	0.600	79	0.000	-2
5	0.000	86	0.000	87	0.000	7
6	0.000	81	0.000	76	0.000	1
7	0.620	81	0.640	75	0.020	0
8	20.000	85	20.000	85	0.000	6
9	14.500	81	14.000	76	-0.500	1
10	12.500	82	12.500	79	0.000	3
11	0.000	81	0.000	77	0.000	2
12	0.600	81	0.600	78	0.000	3
13	17.500	80	17.500	77	0.000	3
14	0.620	81	0.620	78	0.000	3
15	0.000	84	0.000	80	0.000	2
16	6.600	82	6.400	78	-0.200	2
17	0.000	85	0.000	80	0.000	1
CALIBRATION		73		57		

COMMENTS

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 0611511V FUNCTION: CPU

COMPUTER WING: C ROW B POSITION: 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.700	79	6.200	77	-0.500	1
2	6.600	80	6.400	78	-0.200	1
3	6.000	81	6.000	78	0.000	0
4	5.600	81	5.900	79	0.300	1
5	5.600	81	5.900	78	0.300	0
6	5.600	81	5.900	79	0.300	1
7	5.200	80	5.900	78	0.200	1
8	20.000	82	19.900	84	-0.100	5
9	0.160	80	0.100	78	-0.060	1
10	6.800	82	6.400	82	-0.400	3
11	5.800	80	5.900	78	0.100	1
12	5.600	82	5.600	81	0.000	2
13	0.180	80	0.180	79	0.000	2
14	0.180	81	0.180	80	0.000	2
15	6.700	81	0.300	80	-6.400	2
16	0.120	81	0.100	81	-0.020	3
17	0.300	83	0.000	81	0.000	1
CALIBRATION		74		71		

COMMENTS:

TEST DATA ANALYSIS

TEST A9 DATE 12-12-88

BOARD # 8611509A FUNCTION CPU

COMPUTER WING C ROW C POSITION 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.140	86	0.120	76	-0.020	0
2	0.140	85	0.120	76	-0.020	1
3	5.900	86	5.900	76	0.000	0
4	0.000	85	0.000	85	0.000	10
5	6.500	86	6.200	76	-0.300	0
6	5.900	88	5.900	85	0.000	7
7	5.800	86	0.100	76	-5.700	0
8	20.000	86	19.900	78	-0.100	2
9	6.600	86	6.200	76	-0.400	0
10	5.700	88	5.900	77	0.200	-1
11	0.170	86	0.100	76	-0.070	0
12	6.800	87	6.400	77	-0.400	0
13	6.600	86	6.200	76	-0.400	0
14	6.600	87	6.200	78	-0.400	1
15	5.800	86	5.800	76	0.000	0
16	0.150	87	0.000	77	-0.150	0
17	0.000	88	0.000	80	0.000	2
CALIBRATION		78		68		

COMMENTS

TEST DATA ANALYSIS

TEST: A9 DATE 12-12-88

BOARD # 06141234 FUNCTION: CPU

COMPUTER WING: C ROW T POSITION: 20

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	19.900	89	19.900	78	0.000	1
2	13.500	89	13.000	80	-0.500	3
3	5.800	87	5.900	78	0.100	3
4	0.000	91	0.000	92	0.000	13
5	0.000	92	0.000	83	0.000	3
6	0.000	96	[illegible]	82	0.000	-4
7	0.000	88	0.000	74	-0.000	-2
8	20.000	91	19.900	84	-0.100	5
9	0.130	89	0.000	76	-0.130	-1
10	0.250	90	0.000	76	-0.250	-2
11	0.100	90	0.000	76	-0.100	-2
12	0.150	89	0.000	83	-0.150	6
13	0.000	87	0.000	76	0.000	1
14	1.000	91	0.750	77	-0.250	-2
15	0.120	91	0.000	76	-0.120	-3
16	35.000	93	0.000	75	-35.000	-6
17	0.000	92	0.000	76	0.000	-4
CALIBRATION		80		68		

COMMENTS:

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 0611500F FUNCTION PUNCH CONTROLLER

COMPUTER WING H ROW A POSITION 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	82	0.000	79	0.000	2
2	0.000	83	0.000	79	0.000	1
3	0.000	82	0.000	77	0.000	0
4	0.000	82	0.000	78	0.000	1
5	0.000	81	0.000	78	0.000	2
6	0.000	83	0.000	77	0.000	-1
7	0.000	80	0.000	77	0.000	2
8	0.000	85	0.000	79	0.000	-1
9	0.000	83	0.000	77	0.000	-1
10	0.000	84	0.000	77	0.000	-2
11	0.000	84	0.000	77	0.000	-2
12	0.000	83	0.000	77	0.000	-1
13	0.000	82	0.000	77	0.000	0
14	0.000	87	0.000	79	0.000	-3
15	0.000	83	0.000	77	0.000	-1
16	0.000	82	0.000	76	0.000	-1
17	0.000	85	0.000	84	0.000	4
CALIBRATION		72		67		

COMMENTS. VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 8611420T FUNCTION PUNCH CONTROLLER

COMPUTER WING: H ROW A POSITION: 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	80	0.000	79	0.000	6
2	0.000	82	0.000	80	0.000	5
3	0.000	79	0.000	76	0.000	6
4	0.000	80	0.000	77	0.000	4
5	0.000	79	000	77	0.000	5
6	0.000	82	0.000	78	0.000	3
7	0.000	81	0.000	78	0.000	4
8	0.000	85	0.000	79	0.000	1
9	0.000	82	0.000	78	0.000	3
10	0.000	82	0.000	79	0.000	4
11	0.000	84	0.000	78	0.000	1
12	0.000	81	0.000	79	0.000	5
13	0.000	83	0.000	79	0.000	3
14	0.000	82	0.000	79	0.000	4
15	0.000	81	0.000	78	0.000	4
16	0.000	82	0.000	78	0.000	3
17	0.000	86	0.000	81	0.000	2
CALIBRATION		76		69		

COMMENTS: VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 0611580E FUNCTION. PUNCH CONTROLLER

COMPUTER WING. H ROW. A POSITION 16

CONNECTOR	PRETEST VOLTAGE (VOLTS)	PRETEST RESISTANCE (MILLIOHMS)	POST TEST VOLTAGE (VOLTS)	POST TEST RESISTANCE (MILLIOHMS)	RESULTS VOLTAGE DIFFERENCE (VOLTS)	RESULTS RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	85	0.000	81	0.000	1
2	0.000	84	0.000	80	0.000	1
3	0.000	84	0.000	80	0.000	1
4	0.000	83	0.000	80	0.000	2
5	0.000	84	0.000	79	0.000	0
6	0.000	84	0.000	80	0.000	1
~~7~~	~~0.000~~	~~84~~	~~0.000~~	~~81~~	~~0.000~~	~~2~~
8	0.000	86	0.000	82	0.000	1
9	0.000	83	0.000	80	0.000	2
10	0.000	83	0.005	82	0.000	4
11	0.000	84	0.000	80	0.000	1
12	0.000	85	0.000	81	0.000	1
13	0.000	83	0.000	79	0.000	1
14	0.000	83	0.000	80	0.000	2
15	0.000	83	0.000	79	0.000	1
16	0.000	84	0.000	81	0.000	2
17	0.000	87	0.000	82	0.000	0
CALIBRATION		76		71		

COMMENTS: VOLTAGES NOT TAKEN EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 0611510U FUNCTION PUNCH CONTROLLER

COMPUTER WING: H ROW K POSITION 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	78	0.000	8
2	0.000	0	0.000	78	0.000	8
3	0.000	0	0.000	76	0.000	6
4	0.000	0	0.000	78	0.000	8
5	0.000	0	0.000	76	0.000	6
6	0.000	0	0.000	76	0.000	6
7	0.000	0	0.000	76	0.000	6
8	0.000	0	0.000	78	0.000	8
9	0.000	0	0.000	76	0.000	6
10	0.000	0	0.000	77	0.000	7
11	0.000	0	0.000	76	0.000	6
12	0.000	0	0.000	77	0.000	7
13	0.000	0	0.000	76	0.000	6
14	0.000	0	0.000	78	0.000	8
15	0.000	0	0.000	76	0.000	6
16	0.000	0	0.000	77	0.000	7
17	0.000	0	0.000	78	0.000	8
CALIBRATION		0		70		

COMMENTS: EXPOSED TO 9 HALON DUMPS.

TEST DATA ANALYSIS

TEST AS DATE 12-12-80

BOARD # 0611509A FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: K POSITION: 33

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	78	0.000	7
2	0.000	0	0.000	78	0.000	7
3	0.000	0	0.000	78	0.000	7
4	0.000	0	0.000	78	0.000	7
5	0.000	0	0.000	77	0.000	6
6	0.000	0	0.000	78	0.000	7
7	~~0.000~~	~~0~~	~~0.000~~	~~79~~	~~0.000~~	~~8~~
8	0.000	0	0.000	86	0.000	15
9	0.000	0	0.000	77	0.000	6
10	0.000	0	0.000	77	0.000	6
11	0.000	0	0.000	77	0.000	6
12	0.000	0	0.000	78	0.000	7
13	0.000	0	0.000	78	0.000	7
14	0.000	0	0.000	77	0.000	6
15	0.000	0	0.000	78	0.000	7
16	0.000	0	0.000	78	0.000	7
17	0.000	0	0.000	79	0.000	8
CALIBRATION		0		71		

COMMENTS EXPOSED TO 9 HALON DUMPS

TEST DATA ANALYSIS

TEST A9 DATE 12-12-80

BOARD # 06152172 FUNCTION PUNCH CONTROLLER

COMPUTER WING H ROW K POSITION 34

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	79	0.000	8
2	0.000	0	0.000	80	0.000	9
3	0.000	0	0.000	79	0.000	8
4	0.000	0	0.000	80	0.000	9
5	0.000	0	0.000	78	0.000	7
6	0.000	0	[illegible]	79	0.000	8
7	0.000	0	0.000	78	0.000	7
8	0.000	0	0.000	83	0.000	12
9	0.000	0	0.000	78	0.000	7
10	0.000	0	0.000	79	0.000	8
11	0.000	0	0.000	79	0.000	8
12	0.000	0	0.000	78	0.000	7
13	0.000	0	0.000	77	0.000	6
14	0.000	0	0.000	78	0.000	7
15	0.000	0	0.000	77	0.000	6
16	0.000	0	0.000	79	0.000	8
17	0.000	0	0.000	76	0.000	5
CALIBRATION		0		71		

COMMENTS EXPOSED TO 9 HALON DUMPS

TEST DATA ANALYSIS

TEST 81 DATE 12-18-80

BOARD # 0611500F FUNCTION PRINTER CONTROLLER

COMPUTER WING A ROW A POSITION 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.700	84	6.600	84	-0.100	5
2	0.160	86	0.160	85	0.000	2
3	6.700	88	6.600	84	-0.100	1
4	6.600	87	6.800	86	0.200	4
5	5.800	86	5.800	85	0.000	4
6	0.165	87	0.165	86	0.000	4
7	0.110	86	0.120	85	0.010	4
8	20.000	89	19.600	93	-0.400	9
9	6.700	86	6.600	85	-0.100	4
10	6.800	87	6.600	85	-0.200	3
11	6.800	87	6.600	84	-0.200	2
12	5.700	88	5.600	85	-0.100	2
13	6.600	87	6.500	84	-0.100	2
14	7.000	86	7.000	84	0.000	1
15	5.900	88	5.900	84	0.000	1
16	5.800	89	5.800	84	0.000	0
17	0.000	91	0.000	93	0.000	7
CALIBRATION		76		71		

COMMENTS

TEST DATA ANALYSIS

TEST 81 DATE 12-16-80

BOARD # 0613230Y FUNCTION PRINTER CONTROLLER

COMPUTER WING. A ROW. 5 POSITION 7

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.130	81	0.000	89	-0.130	9
2	0.000	65	0.000	93	0.000	9
3	17.500	82	17.000	82	-0.500	1
4	0.620	83	0.600	83	-0.020	1
5	0.000	90	[illegible]	93	0.000	4
6	0.130	84	0.000	83	-0.130	0
7	0.640	82	0.000	82	-0.640	1
8	20.000	89	19.600	92	-0.400	4
9	10.500	81	10.500	84	0.000	4
10	10.800	80	10.600	84	-0.200	5
11	0.140	83	0.140	84	0.000	2
12	0.620	84	0.620	85	0.000	2
13	17.300	83	17.000	83	-0.300	1
14	0.620	82	0.620	83	0.000	2
15	0.000	82	0.000	95	0.000	14
16	0.140	86	0.140	85	0.000	0
17	0.000	88	0.000	93	0.000	6
CALIBRATION		73		72		

COMMENTS

TEST DATA ANALYSIS

TEST 61 DATE 12-16-80

BOARD # 0613230Y FUNCTION. PRINTER CONTROLLER

COMPUTER WING. A ROW. G POSITION. 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	6.700	83	6.600	83	-0.100	4
2	0.000	89	0.000	86	0.000	1
3	7.000	85	17.000	85	10.000	4
4	0.600	85	0.600	83	0.000	2
5	0.000	89	0.000	86	0.000	1
6	0.000	85	0.000	83	0.000	2
7	~~0.640~~	~~86~~	~~0.620~~	~~84~~	~~-0.020~~	~~2~~
8	20.000	86	19.600	87	-0.400	5
9	14.500	85	14.000	84	-0.500	3
10	13.000	86	12.500	83	-0.500	1
11	0.000	86	0.000	83	0.000	1
12	0.600	86	0.600	84	0.000	2
13	17.500	85	17.000	83	-0.500	2
14	0.630	85	0.620	84	-0.010	3
15	0.000	93	0.000	92	0.000	3
16	6.600	86	6.400	84	-0.200	2
17	0.000	89	0.000	93	0.000	8
CALIBRATION		77		72		

COMMENTS.

TEST DATA ANALYSIS

TEST 61 DATE 12-16-80

BOARD # 0611511V FUNCTION CPU

COMPUTER WING C ROW 6 POSITION 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.700	81	6.500	85	-0.200	2
2	6.800	82	6.500	86	-0.300	2
3	6.200	81	6.000	85	-0.200	2
4	5.800	83	5.800	86	0.000	1
5	5.800	81	5.800	86	0.000	3
6	5.900	[illegible]	[illegible]	86	0.000	1
7	5.800	82	5.800	86	0.000	2
8	20.000	90	19.600	93	-0.400	1
9	0.160	82	0.000	86	-0.160	2
10	6.900	84	6.800	88	-0.100	2
11	5.900	82	5.800	87	-0.100	3
12	5.700	83	5.600	89	-0.100	4
13	0.180	82	0.000	87	-0.180	3
14	0.170	84	0.000	88	-0.170	2
15	6.800	83	6.800	88	0.000	3
16	0.120	84	0.000	88	-0.120	2
17	0.000	88	0.000	90	0.000	0
CALIBRATION		74		76		

COMMENTS

TEST DATA ANALYSIS

TEST B1 DATE 12-18-80

BOARD # 0611509A FUNCTION CPU

COMPUTER WING. C ROW. C POSITION 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.145	80	0.000	86	-0.145	1
2	0.150	81	0.000	89	-0.150	3
3	6.000	80	5.600	87	-0.400	2
4	0.000	80	0.000	88	0.000	3
5	6.400	80	6.400	87	0.000	2
6	6.000	83	6.000	89	0.000	1
7	~~5.800~~	~~81~~	~~5.200~~	~~86~~	~~-0.600~~	~~0~~
8	20.000	86	19.600	93	-0.400	2
9	6.700	80	6.500	86	-0.200	1
10	5.700	82	5.500	88	-0.200	1
11	0.160	81	0.000	87	-0.160	1
12	6.800	82	6.500	88	-0.300	1
13	6.600	81	6.200	88	-0.400	2
14	6.600	83	6.300	89	-0.300	1
15	5.800	83	5.500	88	-0.300	0
16	0.140	83	0.000	88	-0.140	0
17	0.000	85	0.000	91	0.000	1
CALIBRATION		72		77		

COMMENTS:

TEST DATA ANALYSIS

TEST 61 DATE 12-18-88

BOARD # 0614129M FUNCTION CPU

COMPUTER WING: C ROW: T POSITION 20

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	20.000	86	19.600	82	-0.400	1
2	13.400	86	13.500	81	0.100	0
3	5.800	85	5.800	83	0.000	3
4	0.000	86	0.000	82	0.000	-1
5	0.000	88	[illegible]	88	0.000	5
6	0.000	[illegible]	0.000	86	0.000	2
7	0.120	85	0.120	84	0.000	4
8	20.000	88	19.600	85	-0.400	2
9	0.230	84	0.210	83	-0.020	4
10	0.320	85	0.360	83	0.040	3
11	0.200	85	0.220	82	0.020	3
12	0.150	93	0.000	93	-0.150	5
13	0.000	92	0.000	88	0.000	1
14	0.900	88	0.120	[illegible]	-0.780	0
15	0.000	87	0.000	93	0.000	11
16	35.000	85	35.000	83	0.000	3
17	0.000	86	0.000	92	0.000	11
CALIBRATION		77		72		

COMMENTS:

TEST DATA ANALYSIS

TEST 81 DATE 12-18-80

BOARD # 0611500F FUNCTION PUNCH CONTROLLER

COMPUTER WING H ROW A POSITION 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	85	0.000	85	0.000	4
2	0.000	85	0.000	85	0.000	4
3	0.000	85	0.000	82	0.000	1
4	0.000	88	0.000	83	0.000	-1
5	0.000	83	0.000	83	0.000	4
6	0.000	86	0.000	83	0.000	1
7	0.000	85	0.000	84	0.000	3
8	0.000	83	0.000	92	0.000	13
9	0.000	83	0.000	87	0.000	8
10	0.000	86	0.000	88	0.000	6
11	0.000	86	0.000	84	0.000	2
12	0.000	85	0.000	85	0.000	4
13	0.000	88	0.000	85	0.000	1
14	0.000	86	0.000	86	0.000	4
15	0.000	85	0.006	83	0.000	2
16	0.000	85	0.00C	84	0.000	3
17	0.000	83	0.000	89	0.000	10
CALIBRATION		77		73		

COMMENTS

TEST DATA ANALYSIS

TEST B1 DATE 12-16-80

BOARD # 0611420T FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	0.000	85	0.000	83	0.000	1
2	0.000	88	0.000	91	0.000	6
3	0.000	85	0.000	86	0.000	4
4	0.000	83	0.000	83	0.000	3
5	0.000	83	0.000	84	0.000	4
6	0.000	85	0.000	86	0.000	4
7	0.000	86	0.000	85	0.000	2
8	0.000	89	0.000	92	0.000	6
9	0.000	85	0.000	86	0.000	4
10	0.000	86	0.000	89	0.000	6
11	0.000	86	0.000	85	0.000	0
12	0.000	89	0.000	90	0.000	4
13	0.000	86	0.000	83	0.000	0
14	0.000	85	0.000	85	0.000	3
15	0.000	85	0.000	84	0.000	2
16	0.000	85	0.000	84	0.000	2
17	0.000	88	0.000	89	0.000	4
CALIBRATION		76		73		

COMMENTS:

TEST DATA ANALYSIS

TEST 81 DATE 12-16-80

BOARD # 0611580E FUNCTION PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	87	0.000	86	0.000	3
2	0.000	85	0.000	85	0.000	4
3	0.000	85	0.000	85	0.000	4
4	0.000	85	0.000	84	0.000	3
5	0.000	85	0.000	83	0.000	2
6	0.000	87	0.000	86	0.000	3
7	~~0.000~~	~~86~~	~~0.000~~	~~84~~	~~0.000~~	~~2~~
8	0.000	88	0.000	86	0.000	4
9	0.000	85	0.000	84	0.000	3
10	0.000	89	0.000	90	0.000	5
11	0.000	85	0.000	84	0.000	3
12	0.000	86	0.000	85	0.000	3
13	0.000	86	0.000	85	0.000	3
14	0.000	87	0.000	86	0.000	3
15	0.000	87	0.000	86	0.000	3
16	0.000	88	0.000	85	0.000	1
17	0.000	89	0.000	86	0.000	1
CALIBRATION		77		73		

COMMENTS

TEST DATA ANALYSIS

TEST B1 DATE 12-18-80

BOARD # 0611510U FUNCTION: PUNCH CONTROLLER

COMPUTER WING: H ROW 6 POSITION: 8

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	85	0.000	12
2	0.000	0	0.000	84	0.000	11
3	0.000	0	0.000	82	0.000	9
4	0.000	0	0.000	84	0.000	11
5	0.000	0	0.000	83	0.000	10
6	0.000	[illegible]	[illegible]	86	0.000	13
7	0.000	0	0.000	84	0.000	11
8	0.000	0	0.000	85	0.000	12
9	0.000	0	0.000	83	0.000	10
10	0.000	0	0.000	83	0.000	10
11	0.000	0	0.000	83	0.000	10
12	0.000	0	0.000	85	0.000	12
13	0.000	0	0.000	85	0.000	12
14	0.000	0	0.000	87	0.000	14
15	0.000	0	0.000	83	0.000	10
16	0.000	0	0.000	87	0.000	14
17	0.000	0	0.000	86	0.000	13
CALIBRATION		0		73		

COMMENTS: EXPOSED TO 10 HALON DUMPS EXPOSED TO 1 WATER DUMP

TEST DATA ANALYSIS

TEST B1 DATE 12-18-90

BOARD # 0612021H FUNCTION. PUNCH CONTROLLER

COMPUTER WING. H ROW 6 POSITION. 9

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	84	0.000	11
2	0.000	0	0.000	84	0.000	11
3	0.000	0	0.000	83	0.000	10
4	0.000	0	0.000	85	0.000	12
5	0.000	0	0.000	82	0.000	9
6	0.000	0	0.000	84	0.000	11
7	0.000	0	0.000	83	0.000	10
8	0.000	0	0.000	84	0.000	11
9	0.000	0	0.000	83	0.000	10
10	0.000	0	0.000	84	0.000	11
11	0.000	0	0.000	83	0.000	10
12	0.000	0	0.000	83	0.000	10
13	0.000	0	0.000	83	0.000	10
14	0.000	0	0.000	83	0.000	10
15	0.000	0	0.000	82	0.000	9
16	0.000	0	0.000	85	0.000	12
17	0.000	0	0.000	87	0.000	14
CALIBRATION		0		73		

COMMENTS: EXPOSED TO 10 HALON DUMPS. EXPOSED TO 1 WATER DUMP

TEST DATA ANALYSIS

TEST B1 DATE 12-16-80

BOARD # 0611511V FUNCTION PUNCH CONTROLLER

COMPUTER WING. H ROW: 6 POSITION: 10

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	0.000	0	0.000	82	0.000	8
2	0.000	0	0.000	82	0.000	8
3	0.000	0	0.000	82	0.000	8
4	0.000	0	0.000	83	0.000	9
5	0.000	0	0.000	84	0.000	10
6	0.000	0	0.000	84	0.000	10
7	0.000	0	0.000	83	0.000	9
8	0.000	0	0.000	86	0.000	12
9	0.000	0	0.000	82	0.000	8
10	0.000	0	0.000	83	0.000	9
11	0.000	0	0.000	82	0.000	8
12	0.000	0	0.000	84	0.000	10
13	0.000	0	0.000	82	0.000	8
14	0.000	0	0.000	83	0.000	9
15	0.000	0	0.000	82	0.000	8
16	0.000	0	0.000	82	0.000	8
17	0.000	0	0.000	82	0.000	8
CALIBRATION		0		74		

COMMENTS EXPOSED TO 10 HALON DUMPS EXPOSED TO 1 WATER DUMP

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 0611500F FUNCTION PRINTER CONTROLLER

COMPUTER WING A ROW A POSITION 12

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.600	80	6.800	83	0.200	3
2	0.160	79	0.160	84	0.000	5
3	6.500	78	6.700	83	0.200	5
4	6.600	81	6.700	84	0.100	3
5	5.800	81	5.800	82	0.000	1
6	0.165	82	0.165	84	0.000	2
7	0.110	81	0.125	84	0.015	3
8	20.000	82	20.000	88	0.000	6
9	6.600	79	6.500	83	-0.100	4
10	6.600	78	6.700	83	0.100	5
11	6.600	78	6.700	83	0.100	5
12	5.700	80	5.600	82	-0.100	2
13	6.400	78	6.500	82	0.100	4
14	7.000	78	7.000	83	0.000	5
15	5.900	78	5.900	82	0.000	4
16	5.800	80	5.700	85	-0.100	5
17	0.000	82	0.000	88	0.000	6
CALIBRATION		72		72		

COMMENTS

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 8613230Y FUNCTION PRINTER CONTROLLER

COMPUTER WING A ROW B POSITION 07

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.130	83	0.130	84	0.000	-1
2	0.000	85	0.000	85	0.000	-2
3	17.500	82	17.500	86	0.000	2
4	0.600	83	0.610	87	0.010	2
5	0.000	83	0.000	86	0.000	1
6	0.130	83	0.130	87	0.000	[illegible]
7	0.610	81	0.620	85	0.010	2
8	20.000	83	20.000	89	0.000	4
9	10.400	83	10.400	87	0.000	2
10	10.600	83	10.900	85	0.300	0
11	0.142	83	0.140	85	-0.002	0
12	0.600	83	0.610	85	0.010	0
13	17.500	82	17.200	84	-0.300	0
14	0.620	82	0.620	84	0.000	0
15	0.000	82	0.000	90	0.000	6
16	0.140	83	0.140	85	0.000	0
17	0.000	82	0.000	89	0.000	5
CALIBRATION		70		72		

COMMENTS:

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 8613230Y FUNCTION PRINTER CONTROLLER

COMPUTER WING: A ROW: G POSITION: 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.600	81	6.700	84	0.100	3
2	0.000	82	0.000	87	0.000	5
3	7.000	82	17.200	84	10.200	2
4	0.590	82	0.600	83	0.010	1
5	0.000	82	0.000	88	0.000	6
6	0.000	83	0.000	83	0.000	0
7	0.660	83	0.640	84	-0.020	1
8	20.000	82	20.000	88	0.000	6
9	14.000	85	14.300	83	0.300	-2
10	12.600	86	12.500	83	-0.100	-3
11	0.000	84	0.000	83	0.000	-1
12	0.600	87	0.600	84	0.000	-3
13	17.000	83	17.500	84	0.500	1
14	0.620	84	0.640	84	0.020	0
15	0.000	82	0.000	88	0.000	6
16	6.500	82	6.700	84	0.200	2
17	0.000	82	0.000	89	0.000	7
CALIBRATION		73		73		

COMMENTS.

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 0611511V FUNCTION CPU

COMPUTER WING: C ROW: B POSITION: 32

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	6.500	80	6.500	83	0.000	0
2	6.500	81	6.700	85	0.200	1
3	6.100	80	6.000	84	-0.100	1
4	5.700	81	5.800	84	0.100	0
5	5.800	80	[illegible]	84	0.000	1
6	5.800	81	5.800	84	0.000	0
7	5.800	81	5.800	84	0.000	0
8	20.000	82	20.000	89	0.000	4
9	0.160	79	0.155	83	-0.005	1
10	6.800	82	6.700	88	-0.100	3
11	5.800	80	5.700	84	-0.100	1
12	5.700	81	5.600	86	-0.100	2
13	0.180	81	0.180	84	0.000	0
14	0.170	82	0.170	85	0.000	0
15	6.600	82	6.700	84	0.100	-1
16	0.120	82	0.120	85	0.000	0
17	0.000	82	0.000	89	0.000	4
CALIBRATION		72		75		

COMMENTS

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 0611509A FUNCTION. CPU

COMPUTER WING: C ROW C POSITION: 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMNS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMNS)
1	0.140	81	0.140	83	0.000	-2
2	0.140	82	0.140	86	0.000	0
3	5.800	82	5.900	86	0.100	0
4	0.000	82	0.000	88	0.000	2
5	6.500	81	6.600	85	0.100	0
6	6.100	82	6.000	89	-0.100	3
7	5.700	84	5.700	86	0.000	-2
8	20.000	82	20.000	91	0.000	5
9	6.500	83	6.500	86	0.000	-1
10	5.600	84	5.600	87	0.000	-1
11	0.160	82	0.170	88	0.010	2
12	6.700	82	6.800	88	0.100	2
13	6.500	83	6.600	85	0.100	-2
14	6.500	83	6.600	88	0.100	1
15	6.700	83	5.800	86	-0.900	-1
16	0.140	84	0.140	88	0.000	0
17	0.000	82	0.000	89	0.000	3
CALIBRATION		72		76		

COMMENTS:

TEST DATA ANALYSIS

TEST A10 DATE 12-16-88

BOARD # 0614129M FUNCTION: CPU

COMPUTER WING. C ROW T POSITION: 20

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	19.900	80	20.000	84	0.100	1
2	13.200	81	13.500	86	0.300	2
3	5.800	81	5.900	84	0.100	0
4	0.000	83	0.000	86	0.000	0
5	0.000	85	300	91	0.000	3
6	0.000	83	0.080	89	0.080	3
7	0.120	80	0.110	84	-0.010	1
8	20.000	83	20.000	92	0.000	6
9	0.190	80	0.190	84	0.000	1
10	0.320	81	0.240	85	-0.080	1
11	0.240	81	0.220	83	-0.020	-1
12	0.150	83	0.140	88	-0.010	2
13	0.000	83	0.000	91	0.000	5
14	1.000	80	1.000	86	0.000	3
15	0.000	83	0.110	88	0.110	2
16	35.000	80	35.000	84	0.000	1
17	0.000	83	0.000	91	0.000	5
CALIBRATION		73		76		

COMMENTS

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 0611500F FUNCTION PUNCH CONTROLLER

COMPUTER WING: H ROW: A POSITION: 16

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	80	0.000	88	0.000	2
2	0.000	80	0.000	87	0.000	1
3	0.000	80	0.000	86	0.000	0
4	0.000	81	0.000	88	0.000	1
5	0.000	81	0.000	87	0.000	0
6	0.000	81	0.000	88	0.000	1
7	0.000	80	0.000	86	0.000	0
8	0.000	83	0.000	89	0.000	0
9	0.000	83	0.000	87	0.000	-2
10	0.000	83	0.000	88	0.000	-1
11	0.000	83	0.000	87	0.000	-2
12	0.000	82	0.000	87	0.000	-1
13	0.000	82	0.000	87	0.000	-1
14	0.000	84	0.000	89	0.000	-1
15	0.000	81	0.000	87	0.000	0
16	0.000	81	0.000	87	0.000	0
17	0.000	83	0.000	92	0.000	3
CALIBRATION		71		77		

COMMENTS: VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED.

TEST DATA ANALYSIS

TEST A10 DATE 12-16-88

BOARD # 86114207 FUNCTION FUNCH CONTROLLER

COMPUTER WING H ROW A POSITION 17

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	79	0.000	84	0.000	0
2	0.000	80	0.000	89	0.000	4
3	0.000	79	0.000	85	0.000	1
4	0.000	79	0.000	86	0.000	2
5	0.000	79	0.000	85	0.000	1
6	0.000	79	0.000	85	0.000	1
7	0.000	79	0.000	86	0.000	2
8	0.000	85	0.000	89	0.000	-1
9	0.000	83	0.000	86	0.000	-2
10	0.000	79	0.000	86	0.000	2
11	0.000	80	0.000	85	0.000	0
12	0.000	80	0.000	86	0.000	1
13	0.000	82	0.000	86	0.000	-1
14	0.000	81	0.000	86	0.000	0
15	0.000	80	0.000	86	0.000	1
16	0.000	81	0.000	86	0.000	0
17	0.000	83	0.000	89	0.000	1
CALIBRATION		73		78		

COMMENTS. VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED.

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 0611500E FUNCTION PUNCH CONTROLLER

COMPUTER WING. H ROW. A POSITION. 18

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	82	0.000	86	0.000	0
2	0.000	82	0.000	85	0.000	-1
3	0.000	81	0.000	85	0.000	0
4	0.000	83	0.000	86	0.000	-1
5	0.000	82	0.000	86	0.000	0
6	0.000	82	0.000	86	0.000	0
7	0.000	82	0.000	87	0.000	1
8	0.000	85	0.000	90	0.000	1
9	0.000	82	0.000	87	0.000	1
10	0.000	84	0.000	88	0.000	0
11	0.000	84	0.000	86	0.000	-2
12	0.000	86	0.000	87	0.000	-3
13	0.000	84	0.000	86	0.000	-2
14	0.000	82	0.000	87	0.000	1
15	0.000	83	0.000	87	0.000	0
16	0.000	83	0.000	88	0.000	1
17	0.000	83	0.000	89	0.000	2
CALIBRATION		72		76		

COMMENTS. VOLTAGES NOT TAKEN. EQUIPMENT FUNCTION NOT USED

TEST DATA ANALYSIS

TEST A16 DATE 12-16-80

BOARD # 0616306N FUNCTION. PUNCH CONTROLLER

COMPUTER WING. H ROW K POSITION 26

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	82	0.000	11
2	0.000	0	0.000	83	0.000	12
3	0.000	0	0.000	82	0.000	11
4	0.000	0	0.000	83	0.000	12
5	0.000	0	[illegible]	82	0.000	11
6	0.000	0	0.000	83	0.000	12
7	~~0.000~~	~~0~~	~~0.000~~	~~83~~	~~0.000~~	~~12~~
8	0.000	6	0.000	81	0.000	10
9	0.000	0	0.000	83	0.000	12
10	0.000	0	0.000	85	0.000	14
11	0.000	0	0.000	84	0.000	13
12	0.000	0	0.000	85	0.000	14
13	0.000	0	0.000	83	0.000	12
14	0.000	0	0.000	85	0.000	14
15	0.000	0	0.000	84	0.000	13
16	0.000	6	0.000	85	0.000	14
17	0.000	0	0.000	81	0.000	10
CALIBRATION		0		71		

COMMENTS EXPOSED TO 10 HALON DUMPS.

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 0616386N FUNCTION PUNCH CONTROLLER

COMPUTER WING: H ROW: K POSITION: 27

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	84	0.000	11
2	0.000	0	0.000	84	0.000	11
3	0.000	0	0.000	86	0.000	13
4	0.000	0	0.000	84	0.000	11
5	0.000	0	0.000	83	0.000	10
6	0.000	0	0.000	83	0.000	10
7	0.000	0	0.000	84	0.000	11
8	0.000	0	0.000	81	0.000	8
9	0.000	0	0.000	82	0.000	9
10	0.000	0	0.000	82	0.000	9
11	0.000	0	0.000	82	0.000	9
12	0.000	0	0.000	83	0.000	10
13	0.000	0	0.000	81	0.000	8
14	0.000	0	0.000	83	0.000	10
15	0.000	0	0.000	82	0.000	9
16	0.000	0	0.000	83	0.000	10
17	0.000	0	0.000	81	0.000	8
CALIBRATION		0		73		

COMMENTS EXPOSED TO 10 HALON DUMPS.

TEST DATA ANALYSIS

TEST A10 DATE 12-16-80

BOARD # 0616306N FUNCTION PUNCH CONTROLLER

COMPUTER WING H ROW K POSITION 28

	PRETEST		POST TEST		RESULTS	
CONNECTOR	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE (VOLTS)	RESISTANCE (MILLIOHMS)	VOLTAGE DIFFERENCE (VOLTS)	RESISTANCE DIFFERENCE (MILLIOHMS)
1	0.000	0	0.000	81	0.000	6
2	0.000	0	0.000	86	0.000	11
3	0.000	0	0.000	85	0.000	10
4	0.000	0	0.000	85	0.000	10
5	0.000	0	.00	85	0.000	10
6	0.000	0	0.000	85	0.000	10
7	0.000	0	0.000	85	0.000	10
8	0.000	0	0.000	82	0.000	7
9	0.000	0	0.000	84	0.000	9
10	0.000	0	0.000	85	0.000	10
11	0.000	0	0.000	85	0.000	10
12	0.000	0	0.000	85	0.000	10
13	0.000	0	0.000	85	0.000	10
14	0.000	0	0.000	86	0.000	11
15	0.000	0	0.000	84	0.000	9
16	0.000	0	0.000	83	0.000	8
17	0.000	0	0.000	82	0.000	7
CALIBRATION		0		75		

COMMENTS EXPOSED TO 10 HALON DUMPS.

APPENDIX B

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APPENDIX B

PROCEDURE FOR ANALYSIS OF PRINTED CIRCUIT BOARDS

1. GENERAL

There are three major cabinets in the GE 115/2 configuration housing computer boards and circuitry. The remainder of the installation consists of equipment that is supportive in nature, i.e., power supplies, printers, card readers, etc. The three cabinets that contain the printed circuit boards were selected as primary areas of study for these investigations and experiments. These cabinets are designated as follows for further reference:

Wing H - Controller cabinet for the LP-300B card reader-punch
Wing C - Central Processing Unit
Wing A - Controller cabinet for the MZ 4 printer

2. CATEGORIES

There are four categories of investigations within this subsystem of the total series of tests. A preliminary base of resistance, voltage and signal levels was established of a representative sample of the three cabinets or "wings" before the first test exposure. These readings were used for comparison of subsequent measurements.

Each PCB is the same size, of similar construction and has a standard 17-pin plug-in connector (Figure B-1).

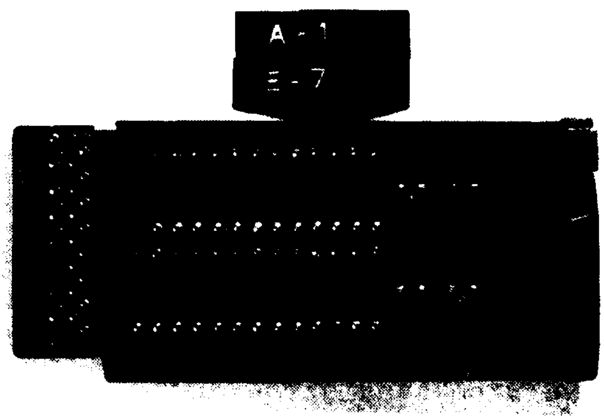

Figure B-1. Printed Circuit Board (PCB).

The exact circuitry of each PCB is dependent upon its function. The voltage measurements and signal levels were made on each pin of each board connector from the equipment side of the connector. These measurements were made with the GE 115/2 up-and-running with a test diagnostic routine programmed in the computer. The resistance measurements were made with computer power turned off. Due to the test leads containing some resistance (approximately 90 milliohms) they were checked before each reading, and the resistance measured was adjusted by this amount. The resistance readings were taken in the following procedure.

One lead was connected securely to the printed circuit board and the other lead was connected to the equipment side of the connector in such a manner that the contact resistance between the PC pins and its receptacle was measured in each instance.

a. Category 1

This category included three PCBs from each of the three selected wings (A, C and H). Resistance, voltage, and signal level measurements were made before each test exposure on three PCBs in wings A and C. Contact resistance measurements were made on the PCBs from wing H. After exposure to a test the same measurements were repeated on the same PCBs. These PCBs were then removed from their respective cabinets and ultrasonically cleaned in a cleaning solution and replaced in the cabinets. This measurement procedure was followed on the same PCBs for each test; they were subjected to only one test exposure before cleaning. A sequence of clean, measure, exposure, measure, clean was used throughout the series of tests.

b. Category 2

This category included nine PCBs from wing H. Wing H was connected to the system and power applied for each test; however, its function to furnish logic and controlling signals to the LP-300 card reader-punch was not used. Wing H PCBs were removed from the cabinet, ultrasonically cleaned in a clearning solution and sealed in a plastic container. These PCBs were removed from their protective container 5 minutes before each test and placed in specified exposed portions in the computer room. Immediately after a test, these PCBs were sealed in a plastic container and placed with other test data for later measurements and analysis. These PCBs were exposed to only one test. Nine different PCBs were used for each test, using this same procedure.

c. Category 3

This category included three PCBs in wing H. Resistance measurements were made on these boards after test A-7. These PCBs had been exposed to all previous tests and had not been disturbed (not removed or moved). Three different PCBs were selected from wing H after test A-8, A-9, etc. Each set of three PCBs, measured after each test, had been exposed to that test and all previous tests.

d. Category 4

This category includes three PCBs from a third generation type of computer equipment (ICs). These three PCBs were placed on a parts cabinet in the computer room and had been exposed to all tests. Upon completion of the test program, these boards were sealed in plastic containers for post-test examination of contact resistance, operational function, and an analysis of the effects of accumulated residue.

3. SIGNAL COMPARISONS

Measurements were made of selected computer signals during each pretest preparation phase and during each post-test phase. The selected signals were present on the base of the PCBs selected for resistance and voltage measurements. Measurements were made on 17 pins each of 9 PCBs for 11 pretests and 11 post-tests, a total of 3366 signal measurements. All measurements made were within the manufacturer's standards for this equipment.

The SE01, photodisc signal voltage on pin no. 1 of PCBs location AG-26 may be within the limits of +5 to +8 volts. The actual measurements made varied from +6.3 volts on pretest, test A-1, to +5.8 volts on post-test, test B-1.

The MIPA1, write drive voltage on pin no. 16 of PCBs location CT-20 has a nominal value of -32 v $\pm$10 percent. The actual measurements were stable -135v on all pretests and post-tests.

The F001, photodisc signal amplitude on pin no. 4 of PCBs location AG-26, may not be less than .3 volts. The actual measurements made were .6 volts on A-1 pretest and this level had dropped to .45 volts on B-1 post-test. Even though the level had dropped 25 percent, it has remained within operating parameters.

Other signal measurements made were transitional logic states, pulse commands, and pulse trains. These observations were specifically concerned with pulse timing, shape and consistency. No degradation of pulse timing or shape could be detected.

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