Honeywell

4500 PROCESS COMPUTER GENERAL MAINTENANCE INFORMATION

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APPENDICES

4500 PROCESS COMPUTER
GENERAL MAINTENANCE INFORMATION

1. INTRODUCTION

The 4500 process computer maintenance manual provides both general maintenance information and specific maintenance information for Honeywell's 4500 process automation computer system and all standard hardware subsystems and functional products used on this system.

In addition to the General Information section, of which this publication is a part, the Computer Maintenance Manual contains several sections, each identified by a tab with the name of the product or subsystem covered. Maintenance manuals supplied as part of the documentation shipped with individual systems contain only the General Information section and the sections applicable to products contained in the system. The computer Maintenance Manuals supplied to Honeywell Process Control Division Field Engineers include all available sections, and in most cases, are composite manuals covering the 4500 and its predecessors, the HS4010 and HS4400. The composite manuals often have two or more publications in each section, each covering a different process computer system.

For the most efficient computer maintenance, we recommend that you become as familiar with the contents of this manual as possible. Time spent in study and review prior to need will be more than well spent.

Each maintenance publication in this manual, including this one, uses the same major headings to make it easier to locate specific types of information. Where one of the standard headings does not apply, it still appears, but the text indicates that it does not apply. The major headings are:

1. INTRODUCTION
2. PRECAUTIONS
3. OPTIONS
4. REFERENCES
5. COMPONENT LOCATIONS
6. TEST EQUIPMENT AND MATERIALS
7. PREVENTIVE MAINTENANCE
8. PERFORMANCE TESTS
9. ASSEMBLY AND DISASSEMBLY
10. ADJUSTMENTS
11. TROUBLESHOOTING
12. PARTS

The information under these same headings in this General Information publication describes the type of information that is provided under each of these 12 headings and gives you guidance in the use of this information.

You are encouraged to communicate with our Technical Publications people. Effective communication must be two-way communication and we are interested in hearing from you, whether your comments are favorable or not. You may direct your comments to the Manager of Technical Publications or to the Engineering Writers. They are identified on the Reader's Comments form, provided at the back of each publication.

It is important that these manuals be kept up to date. Therefore, each maintenance manual holder is responsible for the insertion of revisions, Document Change Notices, and Technical Bulletins, as they are issued. Updates for customer-held manuals are distributed by the Customer Documentation Unit at PCD/Phoenix. Those for Honeywell Field Engineers are distributed by Technical Publications.

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Our phone number is (602) 943-2341. Our HVN number is 8-364-1761 and our HMN code is PHE.

2. PRECAUTIONS

The information under this heading is provided to protect people from injury and to protect the equipment from damage. You should never venture into an unfamiliar product without reading the information under this heading first.

2.1 Some General Precautions

2.1.1 Remove Power from the Cabinet Chassis before Removing or Reinserting Boards or Subassemblies

This is always the safest practice because it is possible that power supply contacts may be removed in a sequence that kills an important bias for a circuit before its collector supply is removed. This can damage the electronics. See the Power Subsystem section of the Maintenance Manual if you don't know how to get the power off in a cabinet or chassis.

2.1.2 A Dirty Blower Filter is Worse than No Filter

This does not mean that it is OK to run a cabinet or device with no filter if it is designed to have one. It does mean that if you do not check and clean the filters periodically, a dirty filter may impede air flow so much that the high temperature limit is exceeded, which may result in faulty operation or may damage the equipment.

All filters should be checked about every two months and more often at dirty locations.

The filters are easy to find, clean, and/or replace. Generally any cabinet or device in which you hear one or more blowers running will have a filter at its air inlet. Typically, they can be removed and tapped gently on a hard surface to remove most of the accumulated dirt. Then reinstall them with the same side out, so that dirt isn't blown into the cabinet or device.

2.1.3 You Can Get a Nasty Shock even from a Computer that Uses only Low Voltage DC Power

The 4500 process computer system is designed to meet Honeywell hardware product safety standards. Warning labels are used to identify potential hazards. These decals must be heeded by operating and service personnel. Protective guards, covers, and interlocks have been installed where shock and energy hazards exist. Before accessing these areas, be sure that POWER IS OFF.

Become familiar with the location and function of power-off switches and system circuit breakers (see Power Supplies section of this manual). Reinstall all protective covers and restore interlocks before returning the system to service. Remember, panels and interlocks are there primarily to protect you.

When troubleshooting electrical equipment, always remove rings, wrist watch, or metal bands. Strange as it may seem, most electrical shocks happen to people who should know better.

If you are not already an expert in electrical safety, read "It's The Current That Kills" in Appendix A at the back of this publication.

3. OPTIONS

Under this heading you will find information that helps you identify which optional features in the product are implemented in the system you are working on. These options are usually operating options such as device addresses, priorities, other pin and switch selected options, and other functional options within the product.

You should be very careful before changing any switch or pin selected options. You may select an operating characteristic that requires a change in software in order to operate or you may select some characteristic that is inefficient or dangerous in the application for the specific computer system. There is usually a set of system-level documents that defines the specific options to be selected, and when any are changed for maintenance purposes, they should be returned to the original condition when you are finished.

Of course, there are several optional subsystems and products available for use on the 4500 computer and its Process Interface Units, and these are described in the 4500 General Description, PTH-019 and in the 7100 General Description, PTH-021. When TDC 2000 devices are connected to a 4500 process computer through the data hiway, service instructions for these products are provided in a TDC 2000 section of the Computer Maintenance Manual, and the TDC 2000 options implemented are defined in that section.

4. REFERENCES

Under this heading you will find a mention of all of the documents which, with the maintenance publication, comprise the support package for the product or subsystem. You may notice that for most 4500 computer products, logic drawings and printed wire assembly (PWA or PWB) drawings are not referenced. This is because logic and circuit analysis and field repair to the component level are not recommended for these products.

4.1 Documents Typically Included in the Product Support Package

4.1.1 4500 General Description

The 4500 General Description, PTH-019, contains a detailed functional description of all of the standard subsystems and products available on the 4500 process computer. It describes the parameters, speeds, tolerances,

and machine-level instructions related to the operation of each standard product. A copy of the General Description is included in this General Information section of the maintenance manual.

The General Description is the principal reference used in testing and troubleshooting the 4500 computer system. For example, should a test program error message indicate, "input channel status was 001 and should have been 000," a quick check in the appropriate section of the General Description might show you that this means status bit 0 was set, indicating that the input channel was not activated when it should have been, and this can be a significant clue in trouble isolation.

4.1.2 7100 General Description

Like the 4500 General Description, this manual, PTH-021, defines the parameters and performance for the 7100 Process Interface Units. It also contains a description of the PIUs' data base and the data hiway message protocol. For 4500 systems which include PIUs, PTH-021 is included in the PIU section of the Computer Maintenance manual.

The information in the PIU General Description is needed in isolating a trouble to a specific PIU and in isolating a trouble to a PWA or other assembly in a PIU.

Initially, a preliminary edition of PTH-021 is available, which covers only the High Level PIU. In 1978, the complete General Description covering all three PIUs, High Level, Low Level, and Low Energy, will be published.

4.1.3 Theory of Operation

Each standard 4500 product and subsystem is supported by a theory publication. Theory publications are contained in one or more theory binders in the customer documentation book set.

These publications provide a block diagram and PWA-related analysis of the operation of the products. The theory publications are useful in determining how the functions described in the General Description are accomplished and which PWA or subassembly contains the hardware that performs specific steps in the operation.

The theory publications also provide descriptions of the interfaces between the PWAs, subassemblies and devices in the subsystem covered. This information is used in inspecting and testing these interfaces to decide which side of an interface a trouble is on, thus making a large step toward isolation. The actual connection points (pin numbers, etc.) are defined in the maintenance publications.

4.1.4 System Drawings

One or more System Drawings binders is shipped with the system documentation. These binders contain drawings and other documents which pertain to the specific system, and Engineering drawings, which provide information on standard products.

The system-specific documents define the products implemented; addresses, priorities and other pin or switch selected options, and cabling between the cabinets and devices. This documentation also specifies the placement of PWAs.

The Engineering drawings define the PWAs and subassemblies which make up the standard products, the installation and power requirements for cabinets and devices, and the parts and wiring needed to construct or repair the standard cables.

4.1.5 Site Planning and Installation Manuals

The 4500 Site Planning Manual, PTH-020, and the 7100 Site Planning Manual, PTH-022, are normally provided by sales or product management people far in advance of the arrival of the computer equipment. These manuals define the site requirements, including power connections, power requirements, environmental requirements, process connections, and the principals of grounding practices and electrical noise control. The applicable installation outline drawings are aslo used in the site planning process.

The 4500 Installation Manual, PTH-023, provides instruction on the emplacement, power connections, cabling, and start-up of the system. For system start-up and check out, the installation manual refers to this Computer Maintenance manual (the power turn-on procedure is in the System Power section). This manual is included in the documentation shipped with the equipment.

4.1.6 Test Programs

Test programs instructions and listings are provided in binders labeled "Tests and Diagnostics" or "T&D." The load media are punched cards or tapes, which are shipped with the system documentation. It is anticipated that diskettes will be available in the future as a test program load medium to be read by a floppy disc drive.

4.1.6.1 How to Load, Run, and Use ATPG Programs

Most of the unit test programs are produced by an Automatic Test Program Generator program. These tests tend to be lengthy as does their documentation. Their use is facilitated by reference to publication ATPG-I, which is in the T&D section of this Computer Maintenance manual.

4.1.6.2 How to Load, Run, and Use System Exerciser

The System Exerciser Program does an interactive test of most of the standard subsystems on the 4500 process computer system. While these tests are not substitutes for the performance tests provided by the unit test programs, they do provide an excellent check of the ability of all of the system to operate together in real-time, much as it must when run by the on-line software.

The use of the System Exerciser is explained in publication SEX-I, which is in the T&D section of this maintenance manual.

4.1.7 Replacement Parts

Part 12 of each maintenance publication defines the part number for the PWAs and other replaceable parts. For cabinet-level parts not covered in the individual maintenance publications, refer to the parts catalog, 4500 PARTS, in the parts section of this maintenance manual.

4.1.8 Software Manuals

The manuals covering standard software are included in the documentation shipped with 4500 computer systems. These manuals are useful to the hardware service people as well as the process engineers and programmers. The RTMOS* Application Manual, especially the information provided on error processing and corrective action, is a rich source of symptomatic information.

4.1.9 Technical Data & Specifications

This series of short technical descriptions, with emphasis on features and benefits of the major products in the 4500 line, is useful as a quick reference. These sheets do not replace the General Description for troubleshooting, but they are useful as a quick reference. They are not included in the system documentation but may be requested from Technical Publications in Phoenix.

4.1.10 Technical Bulletins, Document Change Notices, and Replacement Pages

These update materials are mailed from time to time to customers whose equipment is under warranty or a maintenance contract and to Honeywell Field Engineers. Someone at each site should be sure that these bulletins and revisions are incorporated into the manuals. Past experience has shown that many customers do not realize how important this information is, especially early in the life of a new 4500 system, and these mailings are lost.

*Trademark

4.1.10.1 Technical Bulletins

Tech. Bulletins are issued to provide new ideas and techniques for the support of various products. They are also issued to define applicability of design changes or the effect of design changes. The Tech. Bulletin numbers are keyed to the tab under which they belong. For example, TB VID-12 is issued to the Video Displays section of the maintenance manual. Don't be concerned if you do not have a full set of consecutive numbers. Numbers may be missing because they are not applicable to your system or the bulletin may have been superceded or may have become obsolete.

4.1.10.2 Document Change Notices

DCNs are issued to specific theory or maintenance publications to modify the content because of errors, new information, or design changes. They are also issued to transmit changes to vendor manuals. As with Tech. Bulletins, consecutive numbers may not be present in a specific set of manuals.

4.1.10.3 Replacement Pages

These are issued to update software manuals and product system manuals such as PM/C, SEER*, SCADA, etc. They are transmitted by a letter from the Manager of Technical Publications which lists the affected pages and usually states the general nature of the changes.

4.1.11 Vendor Manuals

Several items on each 4500 computer system, such as peripherals and video display terminals, are purchased from outside vendors. The Honeywell theory and maintenance publications adapt the documentation supplied by the vendor to the Honeywell-supplied documentation. When a vendor makes a design change that affects his manuals, we issue a Document Change Notice to transmit that change. A DCN is issued, also, if we receive notice of an error correction or update to the vendor manuals not due to a design change.

Some vendors supply one copy of their manual for each individual unit, which reflects the revision status of that specific unit. Those manuals should be kept with the unit or with the documentation set kept at the computer site. Customers who purchase extra sets of vendor documentation will not necessarily receive manuals reflecting a specific unit's revision level, but the latest revision available at the time the customer documentation is assembled. These copies should be used only for reference and not for repair of the specific unit.

5. COMPONENT LOCATIONS

This part of each maintenance publication tells you how to identify the hardware in a product or subsystem and the components in the product that need service or are replaceable.

6. TEST EQUIPMENT AND MATERIALS

Here, the specific or special test equipment and materials needed for each product are defined. Mention of general purpose test equipment may be made also. The idea is to help you make sure you arrive at the site with everything you will need to test and troubleshoot the product.

6.1 General Test Equipment and Materials

6.1.1 Oscilloscope

A good general purpose oscilloscope is needed to observe interface signals on backpanels, connectors, etc. The 'scope may be used, also, to investigate the internal operation of vendor-supplied electro-mechanical devices such as disc drives. The 'scope should have at least two traces, a vertical band-width from DC to at least 30 MHz, and sufficient sensitivity to observe waveforms in the 20 mV amplitude range. Recommended 'scopes include: Tecktronix 465 or 475 with P6011 Probe (1:1).

6.1.2 Multimeter

Any good, general purpose multimeter is acceptable. A Simpson 260 or a Triplett 630 are good examples. Principal uses are DC voltage checks on interface signal lines and wiring continuity checks.

6.1.3 Hand Tools

Ordinary hand tools such as screw drivers, small wrenches, slip-joint pliers, diagonal cutting pliers, and needle nose pliers are useful. A small soldering iron may also be needed in a few instances. Normally, on-site repairs to printed wire assemblies (PWAs) will not be made except by authorized Honeywell personnel or when authorized by Product Service. Wiring, soldering, and part replacement repairs may be necessary in vendor-supplied devices. A wire-wrapping tool and bits may be needed. A Gardner-Denver 14R2/14H-1C wire-wrap gun with 30, 24, and 22 gauge bits are suitable. See Appendix B for wire-wrapping instructions.

7. PREVENTIVE MAINTENANCE

Recommended preventive maintenance tasks and schedules are defined under this heading. A general PM task is the regular inspection and cleaning of air filters at least every two months. See 2.2.2 under "PRECAUTIONS" in this publication.

The interval between PM visits and the time necessary to accomplish the tasks may be estimated by reference to each of the part 7 headings in the maintenance publications for a specific system configuration. The shortest interval recommended indicates how often the visits should be made. A table of intervals vs. tasks may be constructed to get an estimate of the time needed per visit. Where the intervals are specified as operating hours, estimate the probable hours of operation and convert to months or fractions of a month to determine the interval.

The intervals recommended are average for clean sites with relatively stable ambient temperatures. If experience indicates that the PM intervals are so short that very little corrective action is taken on each visit, the intervals may be increased. If the site is in a heavy industrial environment like a steel mill or cement plant, the intervals may need to be much shorter.

8. PERFORMANCE TESTS

8.1 Unit Tests

In part 8 of each of the maintenance publications, the tests required to verify proper performance of each product or subsystem are described. These tests may be considered as unit tests, as they verify the operation of each individual product and subsystem. The unit tests are required after replacement in, repairs to, or adjustments to a product.

Most unit tests are accomplished by running the unit test program specified in part 8 of the maintenance publications. These programs are usually test programs developed by the Automatic Test Program Generator. Information on the loading, running, and use of these programs in troubleshooting is provided in publication ATPG-I, which is under the T&D tab in this maintenance manual.

8.2 System Tests

A system level test is required during the system installation or after the installation of a major expansion to the system. The final verification of the proper operation of the complete system is accomplished by seeing that the intended functions of the entire system, including all of its hardware and software are working. This, of course, can be determined only in time, as the on-line operational system is used in its intended role.

Honeywell's completion of the correct installation of an operational system is verified by running the System

Exerciser program and all available product modules within that program for the specific system. The System Exerciser operates the system's functions interactively, in real-time, in a manner very similar to RTMOS, the standard real-time software operating system. Since the proper operation of all of the system's hardware is verified by Quality Control at the factory, successful operation of the System Exerciser during the installation provides a very high degree of confidence in the integrity of the hardware.

Information on the loading, running, and use of the System Exerciser program is provided in publication SEX-I, which is under the T&D tab in this maintenance manual.

8.2.1 System Test Procedure

1. When the equipment emplacement, cabling, and AC power connections are completed, as defined in the 4500 Installation Manual, PTH-023, go to 11.1 Power Up Procedure, in the Power Subsystem section of this manual (publication no. ACPU1PS-M). Return to step 2 when power is on and the power subsystem appears to be OK.

2. Go to part 8 of the Programming and Maintenance Console section. Also, make an initial check of the memory operation from the console by entering information in a few locations and reading that same information from them.

3. You should now be ready to load and run the System Exerciser. Refer to publication no. SEX-I in the T&D section of this maintenance manual for instructions. If you have trouble loading the program, go to 11. Troubleshooting, in this General Information publication. After the problem is corrected and the SEX executive and applicable modules are loaded, proceed with step 4, below.

4. The System Exerciser should run successfully for at least an hour. If there are no problems, the loading of RTMOS and the application software can begin. If they are to be loaded from a reader, refer to the RTMOS Loading Procedure in the 4500 Operator's Manual, PTH-039. If they are on disc or drum memory, refer to the RTMOS Initialization procedure, which follows the loading procedure in the same manual.

9. ASSEMBLY AND DISASSEMBLY

Instructions for taking things apart for repair or adjustment purposes are given here, as well as instructions for putting them back together. For most vendor devices, this is a reference to the appropriate parts of the vendor's manual.

Most computer assembly and disassembly procedures are self-evident, as conventional hardware and fastening devices are used. Some useful information and precautions on assembly and disassembly are:

- Always remove power from the cabinet or chassis before removing or replacing a PWA (board).

- To remove a PWA safely, use equal outward pressure on the removal/insertion tabs at each of the front corners of the board, so that the board is pulled straight out. If it doesn't come out easily, find out why before exerting additional pressure.

- To reinsert a board properly, check switch and pin options and then make sure it is aligned in the card slot and that the board plugs align with the backpanel jacks. Then push the board in with thumb contact on the insertion/removal tabs. If it does not go in easily, find out why before exerting additional pressure.

- Refer to part 2. Precautions in this publication before removing any of the protective covers in the equipment.

- Remove power before removing or reinstalling any subassembly, such as a power supply or chassis.

- Tag all cables and wires before removing a subassembly, so that proper connections are made when it or a replacement is reinstalled.

- When installing any new cables in a cabinet, make sure that support is provided for the cable, so that it does not depend on its connectors for support.

10. ADJUSTMENTS

Instructions for any adjustments for the covered product are provided here in each of the maintenance procedures. Many products have no adjustable components and this part simply says so.

As a general rule, you should not move any adjustment unless you have a good reason for doing so. Unnecessary movement of the adjustments can cause more trouble than cures. You should measure the parameter affected by the adjustment first, and move the adjustment only if the parameter is not within tolerance.

11. TROUBLESHOOTING

Part 11 in each of the maintenance publications contains information which should help you in isolating troubles to a replaceable PWA or subassembly. Sub-parts 11.1 through 11.4 in this General Information publication are intended to help you to go to the most probable product or subsystem in tracking down a trouble. If you do work on a single product or subsystem for some time without uncovering any new information and without getting any closer to a solution, return to this publication, especially to 11.4.1, as you may be on the wrong track.

Because the Central Processor and most other products on the 4500 process computer system use very modern technology, including microprocessor operated controllers, we do not recommend logic or circuit analysis in the field. That is, we do not recommend that you attempt to isolate troubles to an integrated circuit or other electrical component on a PWA or in a subassembly. Analysis of modern microprocessor based logic requires expensive, complicated test equipment, and requires extensive, time consuming effort, even by experts. Therefore, for most products on the 4500 system, we do not provide logic drawings and PWA assembly drawings, and we do not provide detailed analyses of the logic operation nor the firmware operation in our theory publications.

Our theory publications provide PWA-related block diagram analyses, analysis of the functional relationships to the rest of the system, and descriptions of the interfaces between PWAs, devices, and subassemblies. The troubleshooting information in the maintenance publications helps you interpret symptoms so that you can analyze them to decide which PWA or subassembly most likely contains the malfunction.

While the Central Processor has a fairly extensive self-testing function in its firmware, the hardware indications and the test program error messages almost always require interpretation and analysis to isolate troubles. This often means that symptomatic information about the behavior of the interfaces is necessary, so an oscilloscope may be needed to investigate the interfaces. The interface test points and pin numbers are defined in the maintenance publications.

Most peripheral and mass storage devices use conventional electro-mechanical devices and electronics and their troubl-shooting requires logic and circuit analysis. Exceptions are the display generators used in the HPV-1 and HPV-2 Video Display subsystems, which use microprocessors.

11.1 Getting Started

You may be called on to troubleshoot a 4500 system that has been on line and functioning properly, or the need for troubleshooting may have occurred during installation and start-up. The approach you take will be somewhat different in these two situations:

- During installation and start-up - The hardware and the standard software were tested at the factory and found to be operating properly, so you should be suspicious that something moved, broke, or became disconnected during shipment, and a careful inspection and re-check of the emplacement and cabling steps are in order. If after this re-check, the trouble still exists, use the flow chart on Fig. 1 as a troubleshooting check list.

- Trouble reported in a previously operating system - The typical conclusion here is that something broke, failed, an adjustment drifted, or someone got their hands on the equipment when they shouldn't have. One other idea to consider, however, is that the hardware or the software may have been used in a combination of circumstances that occurs infrequently, and that is why this trouble has not appeared before. Be particularly suspicious of special application software in this latter situation. You may find the flow chart on Fig. 1 a useful guide in looking for a place to go, in either situation.

11.2 Basic Operations Check

The following checks, all executed at the CSU's Programming and Maintenance Console, confirm the basic operations of the Processor, Memory, Memory Bus Controller, a major portion of the GENIE* Bus Controller, and the P&M Console itself. If you are familiar with the console controls and indicators and the console operations, you probably won't need to follow the procedures referenced here step by step. Just make sure the intent of each check is accomplished. If you are not sure that you won't miss any points, do follow the procedures step by step.

1. Skip this step if power is on and stable. Follow the power-up procedure, 11.1, in the System Power section. See 11.2 in System Power if you have trouble.

2. Do the display of register content check, 8.1, and the display of memory content check, 8.2, in the Programming and Maintenance Console section.

3. Do the CS register test 11.1.1 and the memory contact test, 11.1.2 in the Memory and MBC section.

*Trademark

( ): Sections in this General Information Publication.

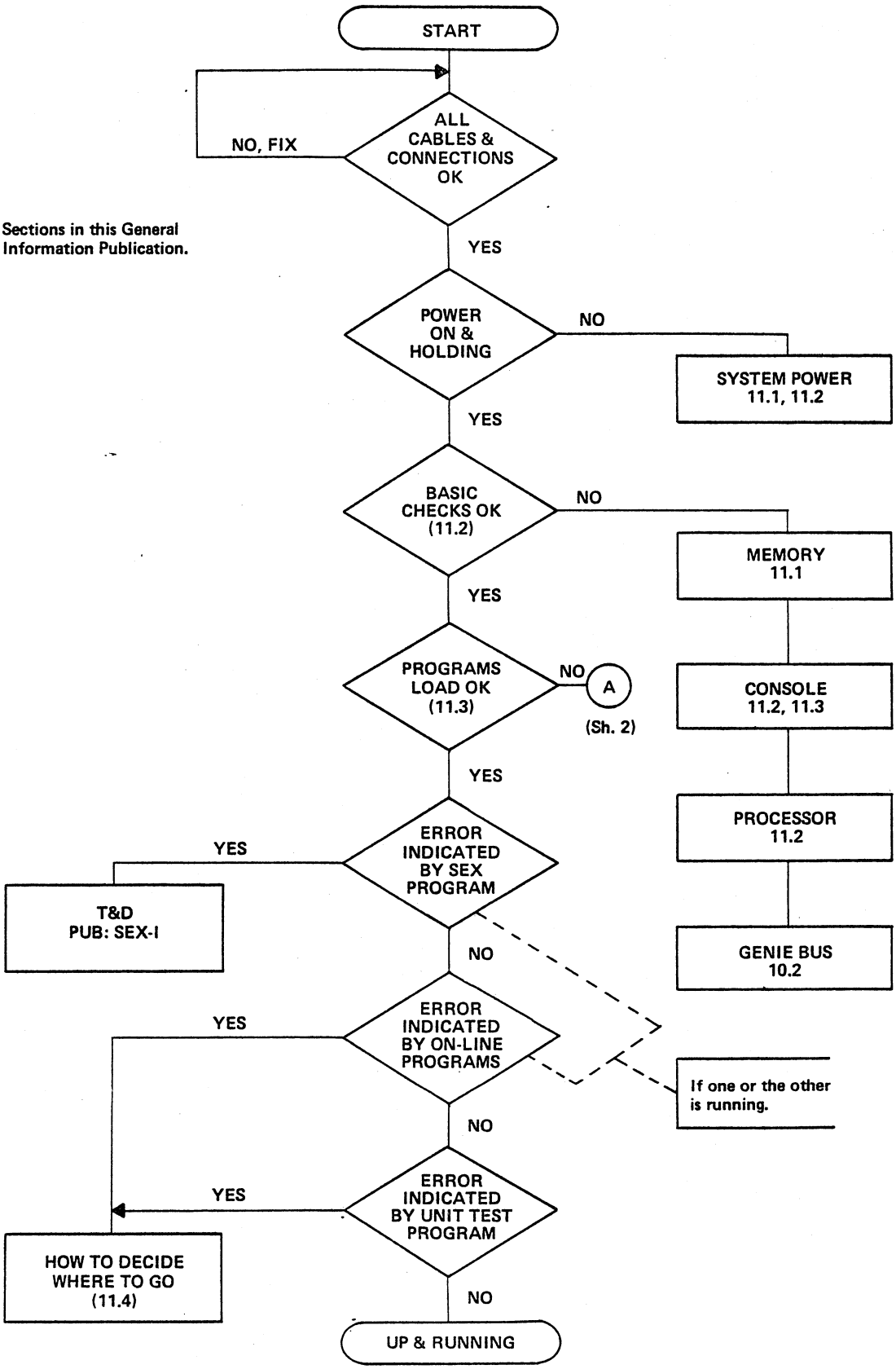


Fig. 1 Troubleshooting Flow Chart (Sheet 1 of 2)

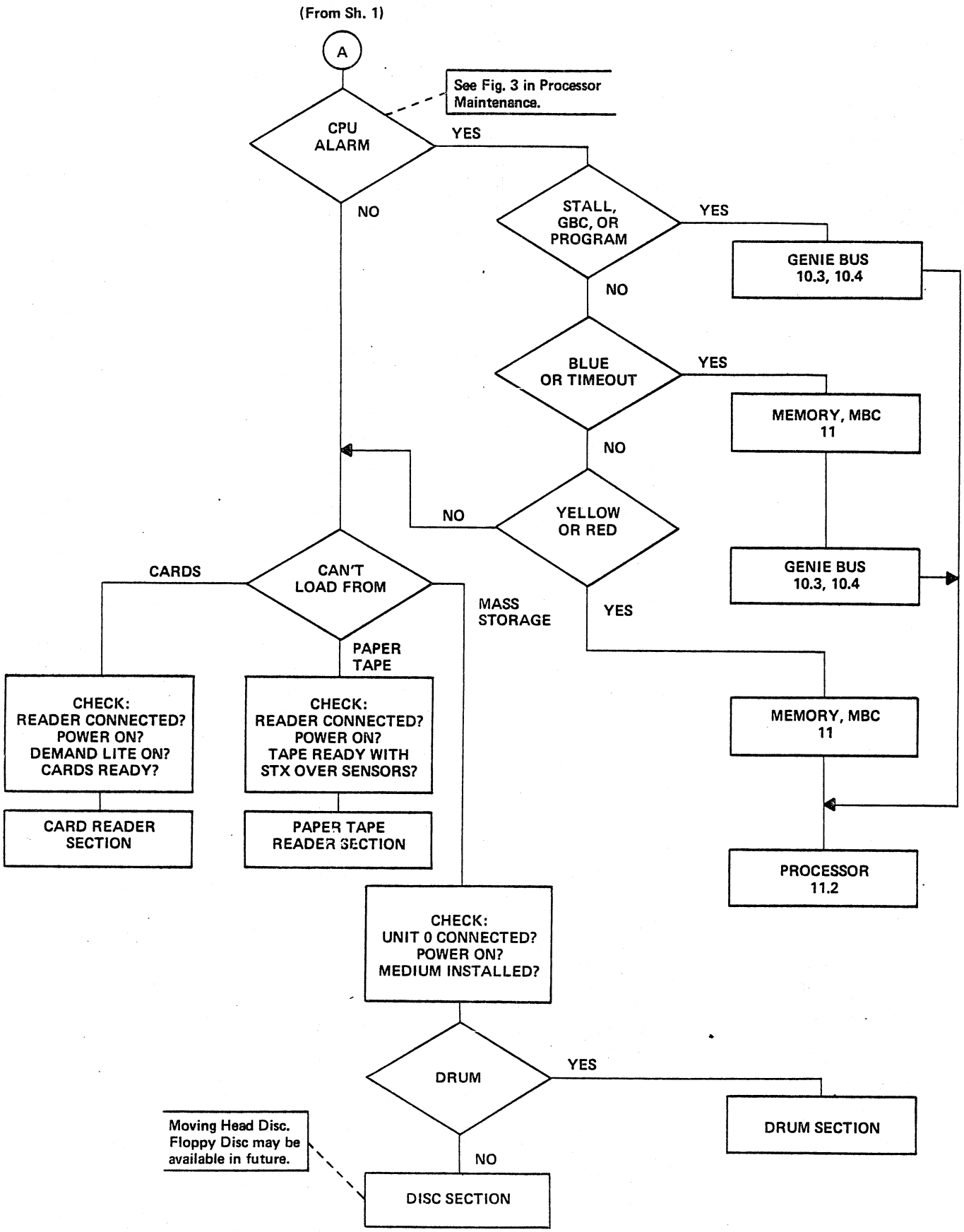


Fig. 1 Troubleshooting Flow Chart (Sheet 2 of 2)

11.3 Getting Test Programs Loaded*

At the Programming and Maintenance Console:

1. Enable the console (keyswitch clockwise), and go to HALT mode.

2. Lock out interrupts and stall alarm. Then initialize the system (press RESET and 0).

3. Clear the console switch (CS) register; select CS, push ENTER, push CE. If loading a 4500 from floppy disc, enter the desired program file number into CS register bits 22-18. All other bits must be reset.

4. Make the reader ready; put the cards in the hopper so that column 1 will enter the read station first and push RESET on the reader, or load the tape in the tape reader gate with the STX character over the sensors (see Fig. 2 in ATPG-1 in the T&D section).[1] If loading from floppy, disc, insert the diskette (use left drive on dual units).

5. Set up the internal bootstrap routine for the proper entry; push RESET and at the same time, push 1, if loading cards, 2, if loading paper tape, or 5 if loading from floppy disc. Release RESET before releasing 1 or 2.

6. Put the computer in the RUN mode.

7. If loading from cards or tape, push DMD. The cards or tape should start moving. If loading from floppy disc, the disc busy light should come on briefly.

If the reader stops before the entire deck or tape has been read, the bootstrap probably detected a checksum or data count error. If so, go back to step 4 (you have to reread the entire deck or tape).

If necessary, you can relocate the test program by entering a relocation constant in the CS register at step 3. This is not normally recommended because confusion results when the program locations do not match the listings. Some test programs cannot be relocated, so be careful.

After the program is loaded, go to the T&D section and refer to SEX-I, if it is the System Exerciser and its modules, or go to ATPG-I if it is a unit test program. Also follow the program's operating instructions in the test program drawing, which will be found in the T&D binders in the system documentation.

*This procedure is for free standing programs. Refer to publication SEX-I when loading exerciser-type programs.

[1] A minimum loader isn't needed on 4500 systems.

11.4 How to Decide Where to Go

Before jumping in with both feet, taking a system that is mostly operationsl off line, or disassembling something, take an inventory of all of the symptomatic data that is available. For example, a video display that does not work, is not always due to a display terminal or display monitor malfunction. The trouble can be in the monitor, the display generator, the cables, the computer's interface on the GENIE Bus, the GENIE Bus, the GENIE Bus Controller, the Processor, the Memory Bus Controller, or the Memory. If the trouble is in the Central Processor, it likely affects more than one device or subsystem, so a check for yet unreported symptoms might help avoid a wild goose chase.

11.4.1 Are There Alarm Indications?

Programming and Maintenance Console Alarm Indicator - This indicator comes on when a blue, red, or yellow Memory/MBC alarm occurs, when a GENIE Bus timeout occurs, or when a device controller on the GENIE Bus detects an alarm condition. See point (A) in Fig. 1.

Stall Alarm or Programmable Alarm - The stall alarm occurs because a program stall occurred. This is almost always a programming error and will almost never occur in a mature system. See 10.4.1.3 in the GENIE Bus Maintenance publication. The programmable alarm is deliberately set by the program when some software defined alarm condition occurs. This is typically an application-related alarm. See 10.4.1.4 in the GENIE Bus Maintenance publication.

11.4.2 Error Messages from the Software

When a Honeywell Field Service Rep. or a service engineer is called to a site, usually, the symptoms reported by the computer system users include one or more error messages from the Corrective Action Programs under RTMOS. Some of these print messages like, "VIDEO #3 OUT OF SERVICE," which are not too specific. Others, especially those provided by the Multi-bulk software subsystem, provide a wealth of symptomatic information. For help in using this information, refer to the RTMOS Application Manual, PTS-038, look up the program or software subsystem under RTMOS that is most likely involved in the product or subsystem with a trouble, and study the corrective action and error handling information. Often the meaning of the corrective action and error handling information is made more clear by reference to the hardware operation, as described in the 4500 General Description, PTH-019.

The standard software also prints error messages when a memory protect violation occurs. Refer to the Memory Protect section of the maintenance manual.

Should a software error message be related to the Data Hiway Interface driver in RTMOS, you may need to refer to the 7100 PIU General Description, PTH-021, and to the TDC 2000 Technical Data Sheets and Specifications, under the TDC 2000 tab in the maintenance manual.

11.4.3 It Just Won't Work

Troubles which involve CPU alarms, data errors on several devices, or any trouble which appears to affect more than one area are probably somewhere in the Central Processor; Memory, MBC, Processor, or GENIE Bus Controller. Change the board(s) you suspect the most, or refer to the appropriate section of the maintenance manual. Refer to part 9 of this publication for guidance on board handling that will help avoid troubles introduced by removing and reinserting boards.

Troubles which appear to be related to only one device or subsystem are probably in the device or devices connected to the computer's interface, or in that interface. If there is more than one device of the type involved on the system, exchange cables and see if the trouble follows the device or stays with the interface (controller) on the GENIE Bus.

In some cases, it is possible to use a unit test program in a "loop-back" mode, or with a test plug connected, to check out the controller on the GENIE Bus, and thus confirm that a trouble is either in the controller or in the device(s) connected to it. The Data Hiway Interface is one such controller. Refer to the individual maintenance publications for others.

11.4.4 How to Recognize that You Are On the Wrong Track

If you have been working on a trouble for more than a few minutes, at least consider the possibility that you are working in the wrong area. In mature systems which have been operating properly for some time, most troubles should be located in much less than an hour.

In recently installed systems or in systems with recent expansions, troubles that appear to be in hardware, may be in the software, and there is a real possibility of troubles in the application software, especially if a standard product system like SEER, SCADA, or PM/C is not in use. While a trouble in standard RTMOS is not impossible, it is not very likely. In any case, if you have been tracking a trouble for several hours, and you are sure that you are looking at the right subsystem, be suspicious of software. Get additional help, if you need it.

11.4.5 Keep the System On Line if You Can or You Must

Often the users of the computer system are reluctant to let you take it off line for troubleshooting if the system can be used even though there is a trouble somewhere. If the trouble symptoms do not suggest that the operation is unreliable or that the CPU's computation may be incorrect, you can leave the system on line and wait to troubleshoot, or troubleshoot while on line.

Troubleshooting of an on-line system requires considerable care to avoid upsets. You should not replace boards while power is on, but you can exchange device cables on devices not in use. You must be very careful if you are testing points on the backpanels with a 'scope or meter, because a mistake could cause a stall or error. You can be fairly free in working on an attached device that is not in use, but be aware that you could cause an inadvertent interrupt in the computer.

12. PARTS

Under this heading, each maintenance publication either tells you which parts are replaceable and the part numbers, or tells you how to find them. Replaceable parts that are not covered in the individual maintenance publications, such as blowers, filters, cabinet fuses, and circuit breakers, are identified in the Parts section of the maintenance manual in publications no. 4500 PARTS. This parts catalog also identifies the part numbers for the major cabinet assemblies, backpanels, etc.

APPENDIX A
IT'S THE CURRENT THAT KILLS

Offhand it would seem that a shock of 10,000 volts would be more deadly than 100 volts. But this is not so. Individuals have been electrocuted by appliances using ordinary house currents of 110 volts and by electrical apparatus in industry using as little as 42 volts direct current. The real measure of shock's intensity lies in the amount of current (amperes) forced through the body, and not the voltage. Any electrical device used on a house wiring circuit can, under certain conditions, transmit a fatal current.

While any amount of current over 10 milliamps (0.01 amp) is capable of producing painful to severe shock, currents between 100 and 200 ma (0.1 to 0.2 amp) are lethal.

Currents above 200 milliamps (0.2 amp), while producing severe burns and unconsciousness, do not usually cause death if the victim is given immediate attention. Resuscitation, consisting of artificial respiration will usually revive the victim.

From a practical viewpoint, after a person is knocked out by an electrical shock it is impossible to tell how much current passed through the vital organs of his body. Artificial respiration must be applied immediately if breathing has stopped.

THE PHYSIOLOGICAL EFFECTS OF ELECTRIC SHOCK

Chart A-1 shows the physiological effect of various current densities. Note that voltage is not a consideration. Although it takes a voltage to make the current flow, the amount of shock-current will vary, depending on the body resistance between the points of contact.

As shown in the chart, shock is relatively more severe as the current rises. At values as low as 20 milliamps, breathing becomes labored, finally ceasing completely even at values below 75 milliamps.

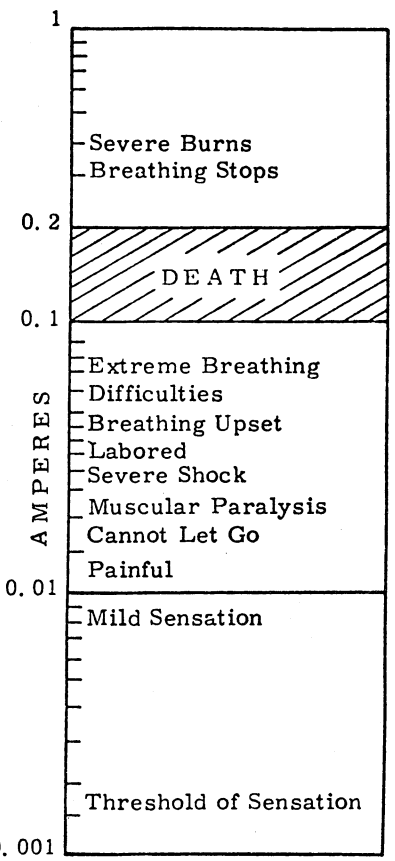
As the current approaches 100 milliamps, ventricular fibrillation of the heart occurs - an uncoordinated twitching of the walls of the heart's ventricles.

Above 200 milliamps the muscular contractions are so severe that the heart is forcibly clamped during the shock. This clamping protects the heart from going into ventricular fibrillation, and the victim's chances for survival are good.

DANGER - LOW VOLTAGE

It is common knowledge that victims of high-voltage shock usually respond to artificial respiration more readily than the victims of low-voltage shock. The reason may be the merciful clamping of the heart, owing to the high current densities associated with high voltages. However, lest these details be misinterpreted, the only reasonable conclusion that can be drawn is that 75 volts are just as lethal as 750 volts.

The actual resistance of the body varies depending upon the points of contact and the skin condition (moist or dry). Between the ears, for example, the internal resistance (less than skin resistance) is only 100 ohms, while from hand to foot it is closer to 500 ohms. The skin resistance may vary from 1000 ohms for wet skin to over 500,000 ohms for dry skin.



Physiological Effects of Electric Currents

Chart A-1

When working around electrical equipment, move slowly. Make sure your feet are firmly placed for good balance. Don't lunge after falling tools. Kill all power, and ground all high-voltage points before touching wiring. Make sure that power cannot be accidentally restored. Do not work on underground equipment.

Don't examine live equipment when mentally or physically fatigued. Keep one hand in pocket while investigating live electrical equipment.

Above all, do not touch electrical equipment while standing on metal floors, damp concrete, or other well grounded surfaces. Do not handle electrical equipment while wearing damp clothing (particularly wet shoes) or while skin surfaces are damp.

Do not work alone. Remember the more you know about electrical equipment, the more heedless you're apt to become. Don't take unnecessary risks.

WHAT TO DO FOR VICTIMS

Cut voltage and/or remove victim from contact as quickly as possible - but without endangering your own safety. Use a length of dry wood, rope, blanket, etc., to pry or pull the victim loose. Don't waste valuable time looking for the power switch. The resistance of the victim's contact decreases with time. The fatal 100 to 200-milliampere level may be reached if action is delayed.

If the victim is unconscious and has stopped breathing, start artificial respiration at once. Do not stop resuscitation until medical authority pronounces the victim beyond help. It may take as long as eight hours to revive the patient. There may be no pulse and a condition similar to rigor mortis may be present; however, these are the manifestations of shock and are not an indication the victim has succumbed.

APPENDIX B
WIRE WRAPPING

Wire wrapping may become necessary in 4500 process computer systems when repairs are made to interconnecting cables or in vendor supplied equipment. Wire wrapping may also be necessary in installing or repairing non-standard products. All field wire wrapping must meet the standards in this appendix.

> PRECAUTION
>
> Costly rework and call-backs can be caused by improper wire wrapping. Do not attempt wire wrapping unless you are familiar with the content of this appendix. These two points cause the most rework:
>
> 1. Use of the wrong wrapping bit and sleeve for the wire size.
> 2. Failure to include one full turn of insulation in the wrap.

APPROVED TOOLING

The following are the only approved wire wrapping bits/sleeves for use with hand wire wrapping tools.

Wire Size AWG	Terminal Size	Wrapping Bit/Sleeve
24	.045" sq. & .026" x .031"	504155/18840
22	.045" sq. & .062" x .031"	504939/18840
24	.025" Square	505415/502129
30	.025" Square	507063/507100
20	.045" Square	26495/26245

DEFINITIONS

- **Solderless Wrapped Connection**

  A solderless wrapped connection consists of a helix (spiral) of continuous solid uninsulated wire tightly wrapped around a sharp edge terminal. The contact force of the wire against the sharp corners of the terminal produces indentations in the wire, which, with the residual tension in the wire produces a gas tight joint which is electrically continuous and mechanically sound.

  Insulated wire turns are required at the start of the wrap to provide a strain relief for the first indentation point in the conductor and thereby protects this point from stress and vibration (see Fig. B-1).

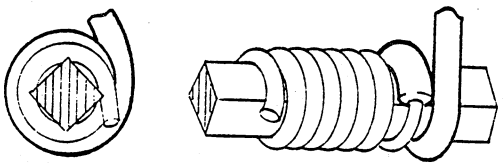


Fig. B-1

- **Turn of Wire**

  A turn of wire consists of one complete helical ring of wire wrapped 360° around a terminal and is to be considered as starting at a point on one coil and ending at a corresponding point on an adjacent coil.

- **Corner**

  A corner is defined as a contact point between the corner of a terminal and the wire and shall be considered to be equal to one quarter (1/4) of a turn. In other words, two contact points are equal to one half (1/2) turn, four contact points are equal to one turn, etc.

- **End Tail**

  An end tail (sometimes referred to as a "pig tail") is the final portion of the last turn of wire in a solderless wrapped connection which may extend in a tangential direction from the pin and/or vertically from the adjacent wrap instead of resting against the terminal and/or adjacent turn of wire.

- **Screw Wrap**

  A screw wrap is a wrapped connection in which the conductor has been distorted by the bit in such a manner as to alter the cross-sectional diameter of the conductor and give it the appearance of the threads on a screw. The surface that has been contacted by the bit in such a wrap will generally have a shiny appearance and may at times have exposed copper. (See Fig. B-2.)

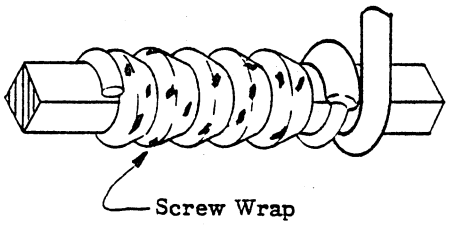


Fig. B-2

REQUIREMENTS

Visual examination of wrapped connections for adherence to these requirements will be made without aid of instruments except where noted.

- **Bare Wire Portion of Wrap**

(a) Bare Wire Turns

The number of bare wire turns shall be in accordance with the following table. Wraps with less than the minimum or more than the maximum designated are unacceptable and will be replaced.

Wire Size AWG	No. of Bare Wire Turns Minimum	Maximum
18	4	6
20	4	6
22	4	6
24	4 1/2	7
26	6	8
28	7	9
30	7	9

(b) Bare Wire Spacing

The maximum spacing between adjacent bare wire turns, except for the first (bottom) half turn shall not exceed one quarter (1/4) of the nominal bare wire diameter. The maximum spacing dimension for the various wire sizes is shown in the following table:

Wire Size AWG	Maximum Spacing Between Adjacent Turns
18	.010
20	.008
22	.006
24	.005
26	.004
28	.003
30	.003

(c) Open Helix

Wrapped connections with an open helix are not acceptable. The maximum space requirement does not apply below point "D". (See Fig. B-3a.)

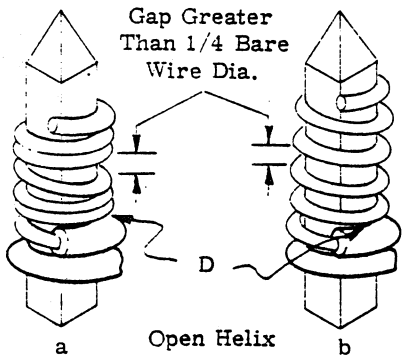


Fig. B-3

(d) Spread Wrap

Wrapped connections with a spread wrap are not acceptable. The maximum space requirement does not apply below point "D". (See Fig. B-3b.)

(e) Overwrap

Wrapped connections with an overwrap of bare conductor turns on top of each other are not acceptable.

(f) Bulged Wrap

Wrapped connections where the wrap is bulged away from the pin are not acceptable. (See Fig. B-4b.) This condition can be caused by a higher level wrap forced against a lower wrap until it bulges out or it may be the first stage of an overwrap.

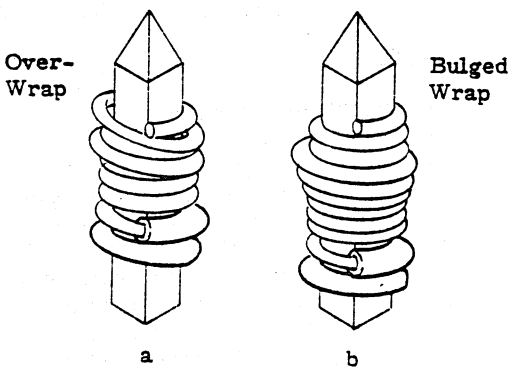


Fig. B-4

(g) Bit Damaged Conductor

Wrapped connections with the conductor damaged by the bit, as evidenced by exposed copper and/or distortion of the bare wire diameter, except for last (highest) wrap, are not acceptable.

> NOTE
> Missing plating on the wire (evidenced by randomly exposed copper) and plating discoloration (evidenced by a uniform discoloration of the conductor) should not be confused with bit damage. Both missing plating and plating discoloration when randomly found, are acceptable.

Wrapped connections with the conductor damaged by the insulation stripper are not acceptable.

(h) End Tail

The tail, or last quarter (1/4) turn, shall not protrude laterally or vertically from the previous turn of bare wire more than one bare wire diameter. (See Fig. B-5.) Wraps not meeting this criterion will be either replaced or reworked by wiping down the tail with approved end tail rework tool as listed. An end tail is not to be confused with an incompleted wrap.

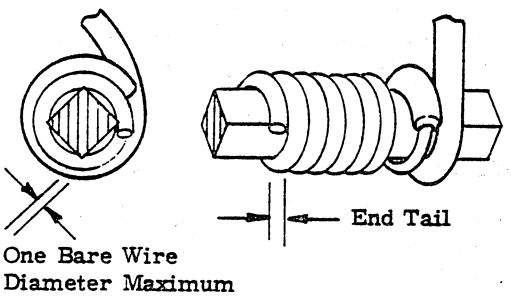


Fig. B-5

(i) Conductor Incompletely Wrapped

Wraps with the conductor incompletely wrapped are not acceptable and shall be replaced. An incomplete wrap is defined as a wrap having a tail of sufficient length to cover at least two sides of a pin (1/2 turn) if the wrap were completed. An incomplete wrap is not acceptable regardless of whether it has the minimum number of bare wire turns specified.

- **Insulated Portion of the Wrap**

(a) Insulated Wrap Turns

The connection shall have a minimum of one (1) complete turn with two (2) corner contact points of insulated wrap turns. (See Fig. B-6.) Wraps with more than the maximum insulation turns, as listed in the following table, are to be accepted unless the excess insulated turns cause additional defects.

Wire Size AWG	Maximum Insulated Turns
18	2
20	2
22	2
24	2
26	2 1/2
28	2 1/2
30	2 1/2

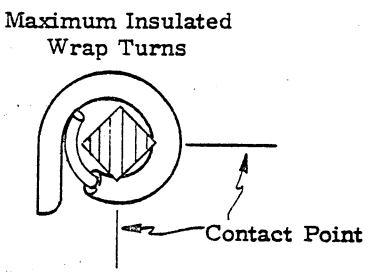


Fig. B-6

(b) Insulated Wire Spacing

There shall be no maximum spacing requirement between adjacent turns of insulated wire or between the first bare wire turn and its adjacent turn of insulated wire.

(c) Overlap Onto Lower Connection

The overlap of insulated turns of an upper level wrap over the conductor turns of a lower level wrap is acceptable providing that the equivalent of the minimum wrap turn requirements are met and that no other defects have been caused by the overlap.

(d) Insulation Damage

Wrapped connections in which the insulation is nicked at the start of the wrap (point "A" in Fig. B-7) or which have the conductor exposed on the insulation wraps are not acceptable.

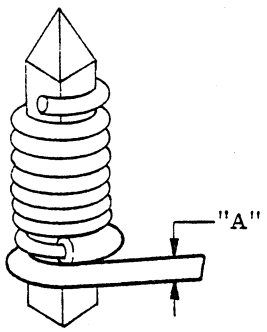


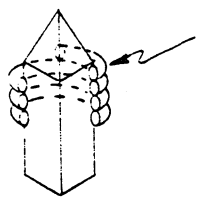
Fig. B-7

- **Vertical Placement of Wraps**

(a) Wraps will be installed on a pin at the lowest level possible, with the exception of soldered pins. Wraps which interfere with the placement of higher level wraps will be replaced when such interference is determined.

(b) Third Level Wraps

The last corner contact point of a third level wrap shall lie on the wrap surface of the pin. (See Fig. B-8.)



Third Level Wrap

Fig. B-8

- **Wiring Between Wrapped Connections**

(a) Wire Tension

(1) Tight wires with either one of the following conditions are <u>not</u> acceptable:

A wire pulled into a corner of a pin with sufficient pressure to displace the pin from its normally vertical position.

A wire pulled into a corner of a pin with sufficient pressure so that the wire cannot be pulled away from the pin when using an orange stick and applying a force of approximately two (2) pounds in a direction that will tend to move the wire away from the pin.

> NOTE
>
> The test that shows that a wire can be moved away from the pin shall be a sufficient test for tight wire. If the wire moves back to the pin after the orange stick has been removed it shall still be considered to have passed the tight wire test.

(2) Tight Wire Exceptions-"Kynar" insulation

Wire routed in a straight line between two pins that pulls the termination pins toward each other shall be considered acceptable providing that pins are not more than .050" from vertical.

Wire routed in a straight line between two pins that appears tight and runs parallel to the sides of the pins between the termination pins shall be considered acceptable.

(b) Wire Tension - PVC Insulated Wire

There shall be no residual tension in the wire after it has been laid such that there will be a continuous pressure of the wire against the corner of a pin which will cause the insulation to cold flow.

- **Insulation Damage Between Connections**

There shall be no insulation damage or exposed conductor due to cuts or nicks between wire termination points.

- **Routing**

(a) Wire Length

The wiring shall be essentially point to point with a sufficient slack left in the wire to permit the wire to be laid within the pins.

(b) Wire Routing

The wire shall be routed in such a manner so that the routing does not tend to unwrap the insulated turns of wire on the pin.

- **Connection Disturbance**

  Wire wrapped connections shall not be mechanically disturbed in any way after completion (with the exceptions of wiping down end tails). Mechanical disturbance is defined as:

  (a) Any axial movement which would disturb the gas tight connection, such as sliding a wrapped connection to a different position on the terminal, or

  (b) Any disturbance which would change the configuration or appearance of the connection, such as compressing a helixed connection, using pliers to close in an end tail or tightening of a connection.

- **Rewrapping**

  (a) Rewrapping Same Length of Wire

  It is not permissable to rewrap the portion of wire that has been previously wrapped on a terminal.

  (b) Rewrapping on Same Portion of Terminal

  A new wrap can be made on a portion of a terminal from which a previously made solderless wrapped connection has been unwrapped.

- **Wire Clippings**

  No wire clippings or other conductive materials are allowed as a residue of the wire wrapping process.

  (a) Bent Pins

  Pins shall not be bent more than .050" from their normally vertical position as measured from the tip.

  (b) Connections on Soldered Pins

  Wrapped connections shall not be made closer than the thickness of one insulated wire of the AWG being wired on any pin soldered to a ground panel or power bus.