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# Test and Acceptance Procedures For Minicomputer Systems

## Minicomputer Maintenance and Operations Center

## Minicomputer Maintenance Information Systems

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# 1. INTRODUCTION

## 1.1 Purpose

This practice provides guidelines for test and acceptance procedures of minicomputer systems. These procedures are intended to ensure that the Bell Operating Company (BOC) receives a system that performs the function it is intended to perform at an appropriate level of availability. Notes are also included to cover option additions and upgrades to existing minicomputers. This practice addresses ten key functions necessary to ensure that the minicomputer system performs according to design specifications; power and environment, physical equipment inspections, acceptance of vendor hardware, communication equipment-interface diagnostics, installation verification, documentation verification, system diagnostics, user load and run operations, and alarms. These specifications as well as expected standards of performance should be understood and agreed upon prior to purchase.

Sections of this practice cover Planning and Preparation items, although not directly involved in system test procedures are ABSOLUTELY ESSENTIAL to the successful acquisition, testing, and placing into service of any minicomputer system.

> THESE SECTIONS SHOULD BE REVIEWED BY PLANNING, ENGINEERING, CONTRACTING AND PURCHASING ORGANIZATIONS PRIOR TO PLAN APPROVAL AND IMPLEMENTATION.

Other sections cover more technically detailed steps for the actual testing processes and discuss responsibilities for various BOC organizations and vendors.

> THESE RESPONSIBILITY STATEMENTS SHOULD BE REVIEWED BY BOC PLANNING, ENGINEERING, CONTRACTING AND PURCHASING ORGANIZATIONS PRIOR TO PLAN APPROVAL AND IMPLEMENTATION.

This practice is a guideline to be used by BOC organizations involved in testing and acceptance of minicomputer-based systems. It does not apply to application software acceptance.

The use of specific General Trade Product (GTP) terms or procedures does not imply endorsement or exclusion of other products. For brevity and simplicity, only products which are presently a significant factor in operations system design and support are covered. Other products may be included at a later date.

## 1.2 Reason For Reissue

This practice is being rewritten to reflect changes in tests and acceptance procedures.

# 2. GENERAL

## 2.1 Organizational Structure and Responsibilities

This practice recognizes organizational structures and procedures unique to individual BOCs. The following paragraphs provide examples of BOC structure along with recommended functional responsibilities related to test and acceptance.

Each BOC should have an organization to provide both technical and administrative staff support to minicomputer users and to Minicomputer Maintenance and Operations Center (MMOC) personnel. This support organization should be the focal point for direction and guidance to ensure that proper test and

acceptance procedures are applied to minicomputer-based operations systems.

The MMOC Support Group (MSG) should establish and chair an operations system test and acceptance committee as a coordination subcommittee. The various engineering and operations organizations responsible for the areas listed in the following paragraphs should be represented.

### 2.2 Responsibility

If the minicomputer equipment is to be self-installed, then the diagnostic testing will be performed by the MMG. If the vendor is responsible for the installation, either with his own force or by the hardware manufacturer, then the appropriate BOC personnel should verify that all hardware diagnostics have been run.

The appropriate Minicomputer Operations Group is responsible for ensuring that the system meets all of its operational requirements. The MOG should not release the vendor or the in-house installation group from the job until all hardware operational tests have been satisfactorily completed.

Support for the MOG and MMG is provided by the MSG during the installation and acceptance process. The MSG should also be involved in the determination of any tests to be performed on operational systems at the time of negotiating the Purchase Agreement.

## 3. KEY FUNCTIONS

### 3.1 Power and Environmental

Responsibility for power should be assigned to appropriate building engineering organizations according to local practices. An evaluation should be conducted to determine if power in the building meets the computer manufacturer's design specifications. This evaluation should be conducted in stand-alone installations prior to the order being released so that site preparation activities can be completed before installation. This procedure will provide the opportunity to properly engineer the building power or to order isolation transformers if the need exists.

Where a computer system is added to an existing cluster, both grounding and power must be evaluated for adequacy as part of initial system implementation planning. Stand-alone installations must also be verified for power, environment, and grounding adequacy prior to power-up procedures following installation, whether or not an earlier evaluation was conducted.

In companies or areas not performing self-maintenance, support group personnel should participate in this evaluation as observers. Minicomputer Maintenance Group (MMG) personnel should participate where these groups have been established.

Power, environment, and grounding controls adequacy is of paramount importance for minicomputer systems. Systems should not be powered up or turned up for service if design specifications are not met.

Power acceptance and testing procedures are discussed in detail in section 4.

### 3.2 Physical Equipment Inspections

When the computer equipment is shipped to the installation location, the sales installation representative, the BOC engineer, and the manufacturing vendor should conduct a complete inventory of major system components. Individual modules (such as memory) must be verified to ensure that memory capacity ordered was provided. Individual piece parts (such as cables, etc.) must also be included in this verification. Personnel from the MMG should assist in this verification.

Physical equipment inspections are covered in detail in section 5.

### 3.3 Acceptance of Vendor Hardware by BOC Personnel

Where an operations system is ordered through a third party sales organization (e.g., AT&T), the responsibility for system acceptance from the vendor lies with that organization. Once the system is accepted the vendor warranty begins. While the sales organization bears no responsibility if the system does not perform properly, it is required to perform system tests and contact the vendor to correct problems covered under warranty.

A minicomputer system acceptance should be treated much the same as central office acceptance. This practice recognizes vendor responsibility for system acceptance and non-BOC involvement until turnover. However, BOC personnel should be involved in an observer capacity to ensure that appropriate tests are performed on the system prior to acceptance. Where the sales organization is not involved in system installation, the BOC is responsible for performing system acceptance.

Section 6 covers the acceptance of vendor hardware by a third party sales organization or BOC personnel in detail.

### 3.4 Communications Equipment

Special attention must be given to communications interface equipment on each system acceptance. The establishment and use of proper coordination procedures should have ensured that user station equipment is in place at the time of system installation and that dedicated circuits between remote users and the system have been established. Overall tests must be conducted from end user locations, to and through the system, as appropriate. Vector and set addresses for operations systems may be different than standard addresses found in the vendor peripherals handbook. Appropriate addresses can be found on the system drawings specifications, in the vendor installation specification, and the system schematic drawings. These addresses must be verified for correctness prior to overall user-system tests. The correct data set options are also found in the system schematic drawings.

Section 7 covers communications equipment test and acceptance functions.

> **NOTE:** It may not be cost effective to have all circuits and terminating equipment installed at the time of initial minicomputer installation. However, a representative cross section of the types of circuit and terminating equipment should be available for initial system testing.

### 3.5 Installation Verification

The vendors documentation must specify generic loading procedures and system tests that should be performed by the vendors installer prior to turnover to the BOC. The BOC engineer is primarily responsible for ensuring that appropriate tests are performed by the vendor. However, this responsibility may be delegated to the MSG, MMG, or Minicomputer Operations Group (MOG) operations personnel where appropriate expertise is available. Where systems are installed without the vendors involvement, the same organizational responsibilities exist to ensure internal compliance or to provide specific tests that must be performed by the hardware manufacturer.

Section 8 covers installation verification test and acceptance procedures.

### 3.6 Document Verification

Each system application has a unique level of documentation depending upon vendor, operations system, or nonoperations system application. The BOC engineer or designated BOC person must determine what information is available for the application and ensure document availability prior to acceptance.

Section 9 covers test and acceptance procedures for document verification.

### 3.7 Diagnostics—BOC

When minicomputer hardware has been turned over to the BOC, final system testing must be performed by the BOC. This may be performed by MMG personnel in a self-maintenance company or by operators with assistance from the BOC support organization in a nonself-maintenance BOC. Specific diagnostics should be run for each component where diagnostics are available. Special applications such as the UNIX* operating system Equipment Test Package (ETP) and/or resident software diagnostics should also be performed prior to turning the system over to the user.

Section 10 covers test and acceptance procedures for BOC diagnostics.

### 3.8 User Load and Run Operation

When appropriate system testing is complete in an BOC performing self-maintenance, MMG personnel should meet with the designated operations personnel who will ultimately be responsible for the system. Results of their acceptance involvement and testing should be reviewed with the operations personnel. At the same time, a mutually agreeable preventive maintenance schedule should be established (BR 007-505-330, Guidelines to Produce Service Agreements for Minicomputer-Based Systems).

The BOCs not performing self-maintenance must follow a slightly different approach. Overall system testing may not have been performed, and where the system was installed by the vendor or in-house installation group, operations personnel may not have been involved. In these instances, the operations personnel are directly responsible for determining start or boot procedures, loading the generic, and coordinating overall system tests. System resident diagnostics should be the responsibility of the operations group and applied during acceptance. Following acceptance, these diagnostics should be applied on a scheduled preventive maintenance basis by operations personnel.

Section 11 covers test and acceptance procedures for user load and run operations.

Section 12 covers test and acceptance procedures for alarms.

Examples of site management guides used for Digital Equipment Corporation (Figure 2) and Hewlett Packard (Figure 3) installations are provided in this section. A suggested Test and Acceptance Checklist is also provided (Figure 4).

## 4. POWER

### 4.1 General

Each potential site selected for a minicomputer system installation should be evaluated for proper environmental conditions, power, and adequate earth reference ground prior to system installation. Vendor reference documents should be used as the criteria. For example:

- HP1000 Computer Systems Configuration and Site Preparation Guide (Hewlett Packard)
- Digital Site Preparation Guide EK-CORP-SP-002 (Digital Equipment Corporation)

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* Trademark of Bell Laboratories.

### 4.2 Electrical System Checks

The electrical systems must be checked to determine if available power is adequate for system requirements and potential expansion and whether the site can be wired for maximum efficiency and economy of operation. The source must be independent of all other loads, i.e., it must not provide power for air conditioning equipment, convenience outlets, lighting, or office equipment. The following items should be evaluated when providing electrical service for the computer installation:

(a) Separate power transformer to provide isolation from electrically noisy loads.

(b) Remote trip circuit breaker that will remove all power from the computer system(s).

(c) Arrestors installed on the primary (high voltage side of the transformers to reduce power surges).

(d) Installation of line voltage regulators or motor generators if a stable, transient-free power source is not available.

(e) Auxiliary engine-alternator to ensure continued service during extended commercial power outages.

(f) Uninterruptible power supply (UPS) is required because of system criticality or called for in system specifications; for example, Automatic Message Accounting Recording Center (AMARC).

(g) Battery operated lighting system installed to provide emergency lighting in case of power failure or fire. Other references to ensure adequate provision of power for a computer installation are:

- Practice BR 007-550-303
- Practice BR 802-001-195
- National Electric Code (NFPA70)
- Protection of Electronic Computer/Data Processing Equipment (NFPA75)
- Installation of Air Conditioning and Ventilation Systems (NFPA90A)
- Lighting Protection Code (NFPA78)
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHARE) Handbook
- National Board of Fire Underwriters (NFBU) No. 70
- Electronic Industries Association (EIA) Standard RS-232C
- Underwriters Laboratories (UL) Handbook 478.

## 5. PHYSICAL EQUIPMENT INSPECTIONS

The primary purpose of the physical equipment inspection is to ensure that conditions are adequate to permit the minicomputer installation. This includes verifying the readiness of environmental equipment, power, and grounding. It also requires ensuring that the minicomputer equipment is undamaged and that there are no equipment shortages. In addition, verification is made to ensure the equipment is at the appropriate revision level, that it is properly configured, and that all cables and modules are properly seated.

### 5.1 System Grounding

Prior to the minicomputer installation, the system grounding should be checked to ensure that it is in compliance with vendor provided site drawings, vendor site preparation specifications guide, and practice BR 802-001-195.

In general, the ground system for the minicomputer equipment should consist of a single point ground with the ground window at the system earth reference ground bar located within, but isolated from, the system's distribution panel board which is to serve the minicomputer equipment.

It is also essential, in order to maintain signal and safety ground integrity, that there is no connection between the ac neutral and the system earth reference except at a separately derived power system (isolation transformer) or the service entrance. Any indiscriminate connection at other than these locations can create a potential for intermittent errors and degradation of system reliability. Once the equipment has been installed and powered up, ground-neutral connection should be checked as outlined in the appropriate site preparation specifications guide.

The ac receptacle used to supply the minicomputer power should be an isolated ground type receptacle so that the earth reference wire (green wire) connection in the receptacle is isolated from the receptacle yoke, the outlet box frame, and conduit feeding the box. This alleviates the requirements of insulating the conduit from metal work such as the building structure, air conditioning duct work, etc. In addition, this arrangement would tend to provide a ground reference that is less sensitive to transient noise pickup.

The chassis reference conductors are essential to equalize the potential of the logic reference between separated cabinets (or free-standing peripherals). These should be checked to ensure they are properly sized and connected as specified in the appropriate site preparation specifications guide.

### 5.2 Alternating Current (ac) Power Distribution

The 3-phase power configuration required for minicomputer systems is the 4-wire, 3-phase "wye" system which is ground referenced at the common connection of the 3-phase windings in the transformer secondary. Prior to equipment installation, verify that the transformer serving the minicomputer is properly configured. Likewise, verify that the voltage and phase rotation being supplied is appropriate for the equipment being installed (See BR 802-001-195). The equipment vendor will supply specific ac power requirements for the equipment, including what is needed for each device. Not everything is multi-phase or has an internal system distribution panel.

On the distribution side of the ac panel board serving the minicomputer, verify that the circuit breakers and ac supply branch conductors are appropriately sized and installed. Also, check the receptacles to ensure that the appropriate receptacle type has been installed for each equipment option.

Once the minicomputer has been installed and power has been applied, make a check to ensure that the phase currents are properly balanced within approximately 10 percent.

### 5.3 General Physical Inspection

Immediately upon delivery of the minicomputer equipment on the job site, the vendor installation representative should notify the appropriate BOC engineer, and they should jointly inspect the shipping containers and skids for visible signs of exterior damage. At the same time, they should check for any obvious shortages (prior to unpacking) against the packing slip or bill of loading. Any shortages or damage should be reported immediately to the hardware manufacturer by the appropriate vendor sales representative.

The BOC representative should be aware that unpacking, uncrating, or moving any minicomputer equipment from its initial place of delivery without prior approval from a vendor representative may void the equipment warranty.

All labor required for unpacking and placement of the equipment at the specified location and for permanently mounting the equipment will be provided by the vendor. Supervision of the work should be at no charge by a hardware manufacturer representative. A vendor representative should be present at the time the equipment is uncrated and placed to provide supervision and verify any evident damages for subsequent claims. This service is provided as a part of the vendor engineer, furnish, and install (EF&I) process. The BOC may also have an appropriate representative present to verify that no equipment is damaged.

Any damages to the minicomputer equipment discovered during the uncrating and placement operation should be brought to the attention of the hardware manufacturer representative for verification purposes. The hardware manufacturer representative should also be consulted regarding the extent and value of such damages and necessary replacement parts, repairs, or services. On EF&I orders, the vendor is responsible for filing damage claims and reordering damaged equipment.

If there is no evidence of damages or shortages, the vendor installation and hardware manufacturer representatives should jointly establish a manufacturer installation date acceptable to the BOC. The vendor installation representative should contact the hardware manufacturer field service organization no later than 30 days in advance of the desired installation date. **If the site is not ready for installation, the BOC may request that vendor invoke the storage provision of its general sales agreement with the hardware manufacturer to avoid loss of warranty.**

### 5.4 Inventory Verification

To ensure that no equipment shortages and to document the equipment associated with a given system, an inventory verification on the system must be performed. Initially, this verification should ensure all major components of the system are on site by comparing the received equipment against the office wiring list and drawing stock list, EF&I orders and the configuration control document. Any apparent discrepancy should be reported to the vendor installation representative who will contact the hardware manufacturing representative for verification and resolution. It is appropriate at this time to prepare the Minicomputer Inventory Form as per local procedures and forms.

In addition to verification of major components of the system, a verification should be made to ensure all modules, subassemblies, etc., are present **and at the appropriate revision levels.** The Configuration Work Sheet portion of the Site Management Guide should indicate the revision level of the equipment when it was shipped. Also, the Module Assembly portion of the hardware manufacturer's Maintenance Documentation Service form provides information regarding the current revision levels for each piece of equipment. One or both of these sources should be compared to the actual equipment modules, subassemblies, etc., to verify the appropriate revisions.

### 5.5 Internal Inspections

Make an internal verification to ensure equipment configuration is appropriate for the given system. Check the configuration to ensure the location is correct for each option and that the appropriate cables, jumpers, terminators, and grant continuity cards are installed at the proper location and properly seated. Verify that no cables were pinched during the process of opening and closing drawers.

In addition to the cable inspection, verify that modules are in the proper backplane slots and properly seated. Make sure all foreign material such as packing material or shipping restraints are removed. Inspect the logic backplane for bent pins, crushed or broken wires, or other abnormalities.

## 6. ACCEPTANCE OF HARDWARE MANUFACTURER HARDWARE BY VENDOR OR BOC PERSONNEL

This section contains many issues that must be agreed to by the BOC and the vendor prior issuing a Purchase Order. It must be carefully reviewed by BOC contracting or Purchasing organizations.

The correct timing for acceptance of operations systems minicomputer hardware depends largely on the conditions established and agreed to by the BOC and the vendor prior to the Purchase Order. Various arrangements for purchase, installation, and acceptance are used:

(a) The system is purchased from a Single Vendor who provides both the hardware, operating system, and the generic (application software)

(b) The system is purchased from a Prime Vendor who provides the application and is responsible for providing another hardware manufacturer's minicomputer and operating system

(c) The hardware and software are purchased from one vendor and application software from another

(d) In a, b, or c above, the installation and testing responsibility may be placed on the single vendor, the prime vendor, the original equipment manufacturer, or the BOC's own installation organization.

Test and acceptance procedures are necessary to ensure proper hardware installation, system operation, and to establish warranty periods. Warranty periods may vary from vendor to vendor, but the installation and acceptance of a system must be coordinated in the shortest possible time frame to avoid loss of warranty.

When a date has been established for the hardware manufacturer installation of a minicomputer system, the vendor representative and a representative from the BOC support group should be present to verify the installation and testing of the system. The vendor and BOC representatives should establish a checklist and criteria for observation of manufacturer diagnostics for individual system components. It is the responsibility of both the vendor and the BOC representatives to verify that testing and installation configuration is performed accurately. When the vendor is not involved in the manufacturer installation, the BOC representative should verify the testing and installation configuration of the system.

### 6.1 Single Vendor Hardware Acceptance

Acceptance of operations system minicomputer hardware purchased from a single vendor usually occurs after the generic software has been installed and completely tested. Under certain conditions, the BOC may elect to accept the hardware and operating system separately from the overall system.

Whether the BOC elects to accept hardware early or upon completion of User System Tests, MMG or MSG personnel should observe the vendor's hardware test procedures or, if self-installed, successfully perform all hardware acceptance tests. For option additions or upgrades, verification tests that the system was performing properly prior to installation must have been performed.

### 6.2 Hardware Acceptance, Prime Vendor Situation

When an operations system is ordered through a Prime Vendor, the responsibility for hardware acceptance from the hardware manufacturer lies with the Prime Vendor. Once the system is accepted by the Prime Vendor, the manufacturer's warranty begins. While the Prime Vendor bears no responsibility if the hardware does not perform properly, it is required to contact the manufacturer to correct problems covered under the warranty. In the case of self-installation, the Prime Vendor would be accepting the hardware from the BOC, and the BOC would be responsible for problems with the manufacturer.

When a date has been established for installation of the hardware, the Prime Vendor and a representative from the BOC support group should be present to verify the installation and testing of the hardware whether manufacturer installed or self-installed. The Prime Vendor and the BOC should establish a checklist and criteria for observation of manufacturer diagnostics for individual system components. It is the responsibility of both the BOC and the Prime Vendor representatives to verify accurate testing and installation configuration. Where Prime Vendor is not involved in the manufacturer installation, the BOC representative must verify the testing and installation configuration of the system.

### 6.3 Hardware Acceptance, Separate Vendors Situation

When the hardware and application software for a minicomputer system are purchased separately, the appropriate BOC representative has full responsibility for hardware acceptance. MMG or MSG personnel should observe the manufacturer's installation hardware test procedures or, if self-installed, successfully perform all hardware acceptance tests. For option additions or upgrades, verification tests that the system was performing properly prior to installation must have been performed.

### 6.4 Final System Acceptance Tests

When appropriate hardware tests have been completed and the generic (application software) loaded, final system tests involving the operations organization should begin. The vendor supplying the application software or the in-house development team if the system was developed in-house, is responsible for designing an acceptance test procedure that should be used under actual conditions or those that simulate live operation.

The tests required depend on the vendor equipment and the system configuration. Tests should be designed to test critical items of performance standards that have been agreed to prior to the purchase order. The tests should include no less than the following:

Power fail and restart tests

Input tests

Output tests

Internal diagnostic tests

CPU diagnostic tests

Communication diagnostic tests

Compatibility tests

Load tests

Remote user tests

Overall system tests

Live system performance evaluation tests

For standard systems, the vendor is responsible for performing all tests specified in the applicable handbook section(s). Consult the appropriate Bellcore practice and the vendor's handbook. Any functional tests required in addition to those specified must be jointly agreed to by the vendor and the BOC. Responsibility for the performance of the various tests must be clearly assigned and agreed to before the installation process begins.

For non-standard systems, responsibility for determining the appropriate documentation and procedures usually rests with the vendor, the in-house developer, the BOC project implementation coordinator, and the organization supporting the operations and maintenance groups.

Acceptance test procedures should be designed to allow test and measurement of the vendor's technical specifications and agreed to performance standards. For new systems, the means to measure the standards should be provided as part of the system design.

The acceptance test procedure should detail *exactly* how each test will be performed, including such details as lead designations, database file names, condition to be observed, how it should be observed, vendor's reference material to be used, any special equipment needed to perform the tests, etc. Responsibility for performing the tests must be negotiated with the vendor or in-house development team.

The organization responsible for performing tests must now work closely with the MMG (or MSG if not self-maintained), and the designated BOC operations people who will ultimately be responsible for the system. Results of acceptance efforts to this point and plans for final system tests should be reviewed with the operations personnel.

Throughout the following test procedures, the system operations and maintenance documentation should be checked for accuracy, clarity and ease of use by the operations or maintenance people. The documentation should be of sufficient detail as to allow the BOC to operate and maintain the system in accordance with specifications and agreed to standards of performance with only a reasonable amount of vendor support.

### 6.5 Vendor

Upon successful completion of hardware and software installation, the vendor installation supervisor will issue a memo to the regional customer service/field service representative, and to the BOC engineer. This memo is official notification of:

- Ship date
- Installation date
- Warranty expiration date.

### 6.6 Warranty

Warranty generally begins with installation of the system hardware. The hardware manufacturer will warranty a system on a predetermined number of hours. Warranty periods may vary depending upon coverage requested by the user. The system user determines the actual warranty coverage period based on system application and criticality. If warranty waiver options are applied by the BOC, the warranty may be reduced to 30 days at reduced cost.

## 7. CIRCUIT INTERFACE VERIFICATION AND COMPATIBILITY

Vector and set addresses assigned using the Digital Equipment Corporation handbook must be verified to match those assigned by the BOC user documentation. If inconsistent addresses and vectors are found, they must be corrected before the user program will function properly. This verification should

be done as early as possible by the BOC, working in conjunction with vendors and hardware manufacturing.

### 7.1 Compatibility

Minicomputer systems may be designed for processing of data received from directly connected sources, from telemetry channels, from other computers, etc. They must output the results of the processes to one or all of the same devices. Prior to accepting the system, the BOC must ensure that the system will perform its intended function once connected to existing related systems. Once stand alone diagnostics have been run successfully, the connections to existing equipment should be made where practicable. The *existing system* should then be tested to ensure no adverse effects from the connection. Testing on *existing systems* should also take place after the generic (application software) has been installed. In most cases, the design of test procedures for this effort should be provided by the vendor, with approval by the BOC.

For option additions or upgrades, the existing system must be thoroughly diagnosed prior to releasing it to the MMG or vendor installation organization. The tests must be documented and results available for verification prior to performing the work. Following the option addition or change, the diagnostics must be re-run. This may require that new diagnostic tests be designed or sequenced.

### 7.2 Directly Connected Equipment

Because of the potential for severe adverse reactions, directly connected systems must be very carefully tested at every stage of the minicomputer system installation:

Initial connections to existing equipment should be made with the minicomputer powered down.

The minicomputer system can then be powered up and initialized, and stand alone diagnostics run.

Final tests can occur after installation of the generic (application program).

At each stage of the testing process, the existing equipment must be very carefully tested to ensure no unexpected adverse reaction.

### 7.3 Compatibility with Telemetry Channels

In the case of the minicomputer systems that are connected to existing equipment via telemetry channels, tests must be devised to ensure that the minicomputer system will correctly receive, interpret and act on the received signals. The first step involves procedures for simulating most if not all the codes available from the distant end. This should include codes not presently used but available in the telemetry system. During these tests, the response signals from the minicomputer system to the distant end should be intercepted and analyzed. The second step involves procedures for simulating most if not all actions from the minicomputer to the equipment at the distant end to ensure no erroneous signals are transmitted and there are not adverse reactions from the existing equipment.

### 7.4 Compatibility with Other Computers

Compatibility with other computers will usually be tested after the generic (application software) has been installed. Data received from, or sent to other computers is usually transmitted via a data circuit, a data network, or the transportation of magnetic medium. In any case, a test of the other computer's ability to read and interpret the data being received should be designed and conducted. A test of the computer being installed should also be conducted to ensure that it will correctly read and interpret the data it is receiving from the existing systems. These tests should be conducted whether or not "test tapes" or "test signals" have been exchanged with the vendor prior to installation. If the data is being

transmitted via a data network, a separate series of tests may have to be designed to verify that the system being installed is compatible with the network, as well as the existing computer.

## 8. INSTALLATION VERIFICATION

### 8.1 Generic and Software Loading

Minicomputer systems are primarily purchased and installed by one of two procedures:

(a) **Procedure 1:** Use the EF&I service offered by a vendor. In this case, the minicomputer system is normally installed for the vendor by the appropriate minicomputer manufacturer. After installation, the manufacturer will exercise the system with diagnostic programs, correct any hardware faults, and turn the system over the vendor. Installation will be verified by the vendors installer. The installer should use appropriate handbooks, and drawings to verify the minicomputer system hardware installation and loading of the generic program. The EF&I procedure provides standard documentation, including a system configuration control document (CCD) and defined acquisition and installation procedures.

(b) **Procedure 2:** The BOC may purchase minicomputer systems directly from the hardware manufacturer. In this case, responsibility for providing documentation and decisions regarding installation alternatives and procedures must be negotiated by the BOC. This responsibility is often assigned to an implementation coordinator who is a member of the group that will operate the system after installation.

Once the minicomputer hardware has been shown to be acceptable, the generic (application software) must be loaded and the process of final system tests and acceptance can begin.

The vendor has responsibility for initial load of the generic. The vendor's installation organization should use vendor manuals or handbooks for the initial load. Tests which depend on the generic software (system diagnostics), must be run. This may involve either "live" or "test" BOC data.

BOC responsibility for software loading should be shared by the MMG and Minicomputer Operations Group. The BOC representative should verify that the vendor provided handbook or manual on system software loading is accurate and adequate for the operations force to use. Terminal input commands and outputs should be easily understood and instructions for loading or unloading media devices complete.

### 8.2 Vendor Handbook or Operational and Functional Check

If the system is provided via an EF&I job, the vendor is responsible for performing all tests specified in the applicable handbook section. Any functional tests required in addition to those specified in the handbook must be jointly agreed to by the vendor and the BOC. Responsibility for the performance of these tests must be assigned before the installation process starts. Resolution of all problems during the testing process is the responsibility of the vendor but should be monitored by the BOC. It is usually advisable to have the MMG (or equivalent) monitor the hardware installation and the MOG monitor the progress of the generic load.

Where the operations system is purchased and installed by the BOC or the system itself is nonstandard, responsibility for the performance of all tests rests with the BOC.

In the case of nonstandard systems, the documentation required to install and test the system may come from several sources. Some of the sources are:

- Hardware manufacturer

- In-house system development team
- Software vendor
- National Electric code
- Special MOG requirements
- Special MMG requirements
- Special support requirements.

The responsibility for determining the appropriate documentation and procedures usually rests with the BOC project implementation coordinator and the organization supporting the operations and maintenance groups.

### 8.3 System Test and Acceptance

Bellcore Practices (BRs) are available to assist in the acceptance of standard operations systems. Most of these are contained in the 007, 190, and 201 layers or in System Deliverable Information (BR 007-230-215) for the system being installed. Where available, they should be used to ensure that a newly-installed system operates as expected. If BRs for system acceptance testing are not available, the BOC MMG is responsible for defining the criteria to be used for acceptance testing. For nonstandard systems, the system expectations are normally defined in the planning study that precedes the initial order. This study should define both the hardware and software performance expectations.

### 8.4 Power Fail Recovery Procedures

Each system may have different priorities for restoration in the event of a commercial power failure or UPS failure. These priorities should be established prior to installation (See BR 007-505-330, Guidelines to Produce Service Agreements for Minicomputer-Based Systems). Acceptance testing should include a test of the restoration procedures. In many cases, this will only involve the verification of the location of important circuit breakers and the documentation required for an emergency situation. The documentation should contain the location of all important breakers, who should operate the breakers, and how they are to be operated. Procedures should be established and verified to allow the MOG to bring each system back on line after a power failure.

### 8.5 Turnover to BOC

The system hardware may be purchased separately from the applications software and installed by manufacturer, vendor, or in-house. The MMG personnel should participate when the final hardware tests are performed prior to turnover. Turnover to the BOC from hardware manufacturer, the vendor, or the in-house MMG normally occurs after the hardware installation and generic loading but prior to system tests.

The MOG is responsible for ensuring that the system meets all of its operational requirements. The MOG should not release the hardware manufacturer, the vendor, or the in-house installation group from the job until operational tests have been satisfactorily completed. Acceptance testing should be scheduled to immediately follow installation testing to ensure that the manufacturer or vendor personnel are available to correct any difficulties.

Support for the MOG and MMG is provided by the MSG during the installation and acceptance process. The MSG should also be involved in the determination of any special tests to be performed on a standard operations system or a system that is locally developed.

## 9. DOCUMENTATION VERIFICATION

This section furnishes information regarding the verification that complete documentation exists for the system being installed. All general trade minicomputer systems require the documentation described as vendor documentation. Self-maintenance organizations require both manufacturer documentation and the additional items listed which support maintenance operations.

Each system application has a unique level of documentation depending upon the vendor, manufacturer, operations systems, or nonoperations system application. The BOC's plans for maintenance will determine the level of maintenance information required, for example, "field replaceable units level" or "board repair level". The BOC engineer or designated BOC person must determine what information is available for the application and ensure document availability prior to acceptance. Some of the documents described below may have to be obtained as a result of negotiations with the vendor(s) at the time of the Purchase Order. For upgrades, revised documentation should be available prior to installation.

### 9.1 Site Management Guide

The manufacturer will supply a site management guide to users. Where self-maintenance is performed by the BOC, the MMG will develop and provide the operations group with a document similar to the hardware manufacturer site management guide.

The site management guide must be available to both users and maintenance personnel at all times. It should be stored in a cabinet or bookcase near each system. Practices generally included (in the order field) in a site management guide are as follows:

- Index
- General information
- User responsibilities
- User activity sheets
- Trouble report logs
- Preventive maintenance schedule and logs
- System configuration.

All sections of the site management guide must be completed upon installation of the computer system.

Examples of Digital Equipment Corporation and Hewlett Packard site management guide contents are illustrated in this section. (See Figures 2 and 3.)

### 9.2 User Hardware Operating Manuals

User manuals provide general information for customer preventive maintenance procedures and operating instructions. These documents are provided by the hardware manufacturer. Manuals should be retained at each system site.

### 9.3 Software Documentation

All systems should have on-site documentation for application and operating system software. Initial loading and booting procedures are provided by installation personnel. All documentation regarding software, generic updates, or operating procedures will be provided at acceptance by the vendor or hardware manufacturer representative and retained with the system. All documents which contain system application proposal information are also supplied and retained with the system.

### 9.4 Schematic Drawings and Circuit Drawings

Schematic drawings and circuit drawings for operations systems will be supplied by the vendor.

### 9.5 System Drawings

The system drawings will be supplied by the vendor when installing operations systems. These drawings describe in detail all options, connections, system hardware, and configurations required for a minicomputer system. These drawings must be retained on site by the user at all times.

### 9.6 System Options Drawing

Systems options drawings must be supplied by the vendor when they are installing the systems. These drawings describe in detail all options, connections, system hardware, and configurations required for the minicomputer system. The user must retain these drawings on site at all times.

### 9.7 Common Language Location Identifier (CLLI)

The common language coordinator should be contacted to assign a particular system's CLLI for reports and other system references.

### 9.8 Bellcore Practices (BRs)

The user must order Bellcore Practices regarding system software and hardware functions.

### 9.9 Self-Maintenance Document Verification — Hardware Manufacturer Maintenance Manuals

Maintenance manuals should be ordered with each installation for each option or peripheral associated with the system. All manuals become the property of the local MMG. The level of detail required in these manuals depends on the level of self-maintenance desired by the BOC, either initially or in the future. The BOC may wish to self-maintain either at a Field Replaceable Unit (FRU) level or at a Board Repair (BR) level. The desired level of detail must be agreed upon by the BOC and the vendor prior to the Purchase Order. The adequacy of these documents is a critical item of acceptance procedures.

### 9.10 Hardware Manufacturer Engineering Drawings

Each system will be supplied with a complete set of engineering drawings. These system prints include specific drawings for power supplies, peripherals, central processor unit (CPU), and all options unique to that system. Some vendors include the information normally included on schematic drawings, on drawings classified by them as "Engineering Drawings".

### 9.11 Diagnostic Listings

For self-maintenance organizations, the BOC MMG will be equipped with diagnostic listings. The maintenance group is responsible for keeping updates filed and stored in locations convenient for troubleshooting and preventive maintenance.

## 10. SYSTEM DIAGNOSTICS

This section provides the reader with the concepts underlying the effective use of diagnostic tests during the BOC acceptance of manufacturer supplied minicomputers.

First, it is important to note the different types of tests available to the maintenance person. They can be classified into the following broad categories:

- Specialized simple "toggle in" tests i.e., echo test for DL-11)

- Hardware manufacturer-provided tests designed to test a specific device or portion of a specific device (i.e., ZRJG—RP06 test)
- Hardware manufacturer-provided exercisers or modules of exercisers configured to test all or most components of a system concurrently (i.e., DEC* X-11 diagnostic system)
- Specialized tests provided by the vendors to test a given operations system or portion of an operations system (i.e., operations system test for Loop Maintenance Operations System [LMOS])
- A vendor-provided operating system based test designed to test a system or a portion of a system (i.e., UNIX operating system ETP)
- A vendor-provided built-in diagnostic designed to test a specific piece of equipment (i.e., the disk test on peripheral bus computer [PBC]).

Each of these tests is valuable if used at the proper time and in the proper sequence. It is important to understand the capabilities and limitations of each of these tests. Each test is described in greater detail in this practice.

Diagnostics must be run in a building block fashion. That is, a base must be established on which the results of the remaining diagnostics can be evaluated. For example, the basic reliability of the processor must be established before the disk drives and tape drives can be tested. Properly run diagnostics establish a solid hardware environment on which to load the system generic program and must be performed as effectively as possible.

### 10.1 Processor Testing

In determining the reliability of the processor, as with any device, the results of the diagnostics merely reflect the results of the stimuli applied. It is important to ensure that the environmental stimuli are as they should be before proceeding. Section 3 provides environmental and equipment specifications to be followed and monitored.

Once all the external factors have been verified, stand-alone processor diagnostics should be run. The specific diagnostics to be run will vary depending on the type of processor and will be listed in the appropriate processor installation manual or provided from the vendor if not listed in the installation manual. At this time, the processor options must be verified and tested. Options added to the basic processor vary from manufacturer to manufacturer, but all processor options must be tested.

Failure of the processor diagnostics at this point in the test sequence could be due to problems in the lower sections of memory and may be difficult to separate without running several passes of the diagnostic.

### 10.2 Memory Testing

Once the processor and the associated processor options are in good condition, the reliability of the memory should be determined. Again, the installation manual for the type of memory involved should be consulted for the appropriate tests to be run and the duration of the testing sequence.

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* Registered trademark of Digital Equipment Corporation.

### 10.3 Tape Drives and Disk Drives

Once the processor and memory are in good working condition, attention can be focused on the large mass storage devices. Consult the appropriate installation manual or hardware manufacturer-supplied diagnostics listed in the installation manual for the appropriate diagnostics to be run. The type of diagnostics, length of run time, error messages, and running sequence are all dependent on the manufacturer-supplied minicomputer and documentation. Each manufacturer may vary depending on type of equipment involved. It is important to verify the operation of the mass storage devices by ensuring that all diagnostics are run and that all electronic adjustments are tested and verified. The electronic adjustments are important to good system operation and compatibility between mass storage devices. Each manufacturer will have specific adjustments and tests to use for their particular devices.

### 10.4 Communication Devices

Communication devices are the simplest devices in the computer subsystem but probably the devices that create the most frustration due to "false", "all test pass" test results. This is usually due to a lack of understanding on how the test is actually run.

The communication devices must be tested using the conditions that they will experience during normal operations. Answers to the following questions must be known prior to running the diagnostics:

(a) Will the device be run synchronously or asynchronously?

(b) If synchronously, what are the sync characters?

(c) If asynchronously, what is the speed; how many bits per character; and how many stop bits are needed?

(d) Does the device need modem control?

(e) What are the address and vectors for the device and its associated modem control unit?

This information should be available from the hardware drawing, the vendor configuration sheet, or user documentation. Once this information is verified, the appropriate diagnostics listed in the corresponding installation manual or manufacturer-supplied diagnostic material should be run, beginning with the most basic and progressing to the more complex.

Hardware diagnostics must always be run on minicomputer equipment prior to acceptance of equipment from a vendor. This applies whether the equipment is a new product, a proven product, or an addition or upgrade to an existing product.

If possible, addressing interrupts, vectors, or any other device configuration should be verified against the hardware drawing. The standard manufacturer configurations are not always used and these must be checked before the system generic is loaded. If this is not verified, all diagnostics will run but the loaded generic will not. If hardware drawings are not available, close coordination between the user, manufacturer, and systems design personnel must be maintained.

### 10.5 Circuit Interface Verification

Special attention must be given to communications interface equipment on each system test and acceptance. The establishment and use of proper coordination procedures should have ensured that user station equipment is in place at the time of system installation and that dedicated circuits between remote users and the system have been established. The correct data set options must also be found in vendor provided system documentation.

**NOTE:** it may not be cost effective to have all circuits and terminating equipment installed at the time of initial minicomputer installation. However, a representative cross section of the types of circuit and terminating equipment should be available for initial system testing.

Overall tests must be conducted from end user location, to and through the system, as appropriate.

### 10.6 Peripheral Device Addresses and Vectors

Peripheral device address and vectors required for operations systems may be different than those found in the manufacturer's peripherals handbooks. Appropriate addresses can be found on system option specifications, or equivalents, in the vendor or manufacturer system installation specification, the system schematic diagrams or other vendor documents. BOC addresses should be made to match vendor/manufacturer specifications. If inconsistent addresses and vectors are found, diagnostics will run but the loaded generic (application software) may not. If appropriate vendor documents are not available, close coordination between the user, vendor, manufacturer, and systems design personnel must be maintained.

### 10.7 Diagnostic Loop Backs

Tests in the maintenance mode designed by computer manufacturers will not always test the output of associated multiplexers. Suggestions are:

(a) Connect loop-around plug at output of multiplexers or multiplexer cables and run through-put diagnostics.

(b) Install EIA NULL modem cable and connect loop-around plug on the end of cable. Run through-put diagnostics.

(c) If data set is involved, at computer end, operate appropriate looping key (if equipped), or otherwise cause data to loop back, and run through-put diagnostics.

(d) If data set is involved, at distant end, operate appropriate looping key (if equipped), and run through-put diagnostics.

(e) Perform diagnostics with cables open. Verify that the right lines are failing.

(f) Ensure that all EIA cables are correctly labeled with device destination.

### 10.8 System Testing

Systems such as LMOS, Automatic Trouble Analysis (ATA), Computer System for Main Frame Operations (COSMOS), and others are equipped with system level test packages. After all stand-alone diagnostics for the processor, memory, mass storage, and communications have been run, the system level diagnostics should be loaded. These diagnostics must be run if available. They are designed to test the computer configuration in a system's environment and not in a stand-alone mode. These diagnostics should reveal any problem that the system generic may encounter. If the system is not equipped with these test packages, the hardware manufacturer test package and system exerciser (if available) should be loaded and run. If there are no test packages available from the manufacturer or the system, the stand-alone diagnostics should be used to the fullest extent.

### 10.9 Power Fail and Restart Tests

These tests involve the ability for the operations system to recover from a loss of power. Systems equipped with automatic restart features are required to return completely to their original state within

the specified period of time without loss of data integrity. Systems without automatic restart features are required to maintain critical registers and provide a post crash report when the system is manually restored. This will enable the operations or maintenance personnel to fully restore the system and determine the cause of the failure. The data integrity of these systems must also remain intact during the power failure. Either automatic or manual restart systems should have a full system check performed after the crash to clear any incomplete files created at the time of the power failure. Systems designed for fault tolerant or duplex operation should be checked to ensure adequate isolation.

**10.10 Input Tests**

These test the reliability and options of the systems communications and interface equipment. The system's ability to collect data, monitor alarms, respond to data inquiries or communicate with other computers should be run on all input devices. The tests should be designed not only to detect total failures but also error conditions. The tests may be provided by the hardware manufacturer or incorporated in the system software. Testing input devices consists of generating remote conditions i.e. triggering an alarm or initiating a telemetry message, and ensuring the proper response is reported by the system. Input tests also include running terminal tests, or typing data to a file and verifying that all data is received (eg., RECEIVE message used in No. 2 Switching Control Center Systems). More detailed tests can be run if they are provided or if errors are incurred. Hardware manufacturer's diagnostics may be run by MMG personnel to test the communications links if the other tests fail.

**10.11 Output Tests**

These tests are similar to input tests and in many cases may be run in conjunction with them. They involve testing the system's ability to generate output signals, telemetry messages, output messages to remote devices, communicate with other computers etc. The output should be verified for errors, completeness and correspondence with the vendor's documentation. This test could be the data file that was input on an input test, or a test output program if provided with the system, or a loop-around test. These tests can be used to verify options such as baud rates and parity functions as well as protocol matching if required. Line printers may be tested using some output tests. Output of a maintenance file can be useful to maintenance personnel who are examining a data link.

**10.12 Internal Diagnostic Tests**

These tests are resident tests embedded in the system software. They should be run on the system's disk drives, tape drives, line printers, CPU, etc. However, they are not always found on the operations system. When available, they should be run as part of system acceptance. Examples include the Engineering and Administrative Data Acquisition System (EADAS) "Operations System" test or disk test in AMARC. If peripheral diagnostics are not available at the system level or fail to isolate trouble conditions, hardware manufacturer diagnostics should be run by maintenance personnel.

> **NOTE:** Many hardware manufacturers use components i.e. disk drives, CPU's etc. that are manufactured by other companies. When possible, the diagnostic used by the original device manufacturer should be made available to BOC maintenance personnel.

**10.13 CPU Diagnostic Tests**

Embedded CPU diagnostics are sometimes included in operations system software to isolate problems in up and down link processors, e.g. CAROT test processor diagnostics, or AMARC Data Set Interface Auxiliary Function (DSIAF) test. However, these tests are rare. The use of manufacturer provided CPU diagnostics is recommended to isolate processor-related troubles. These tests should exercise all

components of the CPU including line clocks, hardware math boards, and memory management options. Note the option specifications when running these diagnostics to ensure that all CPU options are being exercised. If these diagnostics fail to isolate the trouble, specific diagnostics should be performed on the options when available.

**10.14 Memory Diagnostic Tests**

These tests must be performed as part of acceptance testing or when "memory fail" output messages are received or frequent loss of data is incurred. Frequently, these tests are not included in operations system application software. This requires that error messages be retained and analyzed to determine what area of memory is failing. For self-maintenance organizations, the documentation for this analysis must be provided by the vendor. This will assist maintenance personnel in determining the area of memory on which to run vendor memory diagnostics. Memory problems can be elusive as portions of the system's main memory may be used infrequently or may be prone to temperature and voltage fluctuations. An example of these tests is the AMARC TEST-DET 6 (memory cyclic redundancy test).

**10.15 Communication Diagnostic Tests**

In many cases, these test are not diagnostics but tests performed on all interface devices, data sets, multiplexers, and terminals. On new systems, they indicate proper protocol, baud rates, and functions. These tests are used when errors are incurred during operation and testing to ensure reliability and compatibility. Communication tests are useful when testing data sets between locations where the compatibility of all segments of the link will be verified.

**10.16 Compatibility Tests**

Tests that are designed to verify the system's ability to perform all its intended functions when fully connected to all the devices, i.e. printers, multiplexers, communications networks, other computers, etc. For standard systems, bench-mark or factory tests should be performed prior to the purchase order. These bench-marks can then be used in designing test procedures for accepting the system once it is fully installed at the BOC site.

**10.17 Load Tests**

These tests include the installation of the application software and data files. During the initial loading of these programs, the user may have to verify the options and system parameters. Device assignments may need to be made at this time. These define the terminals, line printers, input channels, etc. File structures and space allocation must be determined on some systems though this may be automatic on others. In either case, these files should be verified for broken links or overlaps using the system file audits. After the initial parameters and options are set, any resident embedded diagnostics should be performed to ensure that the operating system is complete and safe for turnup. If the system appears in good condition, a backup tape or other system backup arrangement should be made to reflect any parameter or option changes. At this point the system should be ready for use.

**10.18 Remote User Tests**

These tests are performed to check all remote user functions including resetting of alarms, outputting reports, and performing remote system functions (e.g. removing a trunk from service). These may include initiating tests from a remote site. Security methods should be checked to ensure that remote user capabilities cannot be exercised by unauthorized personnel.

**10.19 Overall System Tests**

These tests include all functions that can be performed by an operations system. Each function in the system specification is tested individually and a record of the responses retained. If any emergency

backup equipment is included in the configuration, it should be turned up and tested for reliability. Automatic cutover devices are checked for failure or loss of data. Automatic restart features are tested and if equipped with emergency power systems, these are also tested. Battery backup tests are performed on the memory system at this time. All remote functions should be exercised and a record kept of all responses. All options should be tested where applicable. At the end of this series of tests, any error logging device and all system responses should be examined for possible failure. Each failure should have the appropriate diagnostic run to isolate the trouble. If these tests are unavailable or unsuccessful, the hardware manufacturer diagnostics should be run. All messages must be retained for the period of the warranty, and then, included in the site log. In an MMG environment, the site log is maintained by MMG.

### 10.20 Live System Performance Evaluation

These tests are performed after the system is operational and all other tests are complete. For new systems, soak sites, beta tests, etc., these tests can be for an extended period of time in order to allow for a thorough evaluation of the overall system reliability according to the vendor's specification and agreed to standards of performance. All devices, subsystems, file integrity, and functions should be examined for error, failure rates, and other indicators of reliability as agreed to with the vendor. All discrepancies observed during this period should be logged and evaluated. System through-put should be checked by the use of the performance and statistic monitors that should be included in the operating system. These monitors should include indicators for key areas such as CPU usage, disk usage, terminal usage, error rates, functional failures, etc. These indicators should be evaluated during normal and peak usage periods for overload conditions. During these peak periods, the highest incidence of failure will occur. File system audits should be performed to verify mass storage capabilities and software file management operations. All output and error messages must be retained and analyzed. During this period, any unusual activities on the system should be minimized as it will hinder the evaluation process. Significant failures during this period may trigger a restart of the acceptance process, especially if the vendor is required to make any sizable changes in the system to eliminate the cause of the failure.

## 11. USER LOAD AND RUN OPERATION

### 11.1 General

This section describes the software that should be loaded into the new installation and run under actual conditions or those that simulate actual operation. These programs vary with vendors. Refer to the Bellcore Practices for the specific vendor for detailed procedures on load and run programs for test and acceptance. The following may be considered general software classifications:

- Operating systems
- Application programs
- On-line diagnostics
- Hardware manufacturer diagnostics.

### 11.2 Test Classification

Procedures used during load and test operations depend on the manufacturer equipment and the system configuration. Consult the Bellcore Practices on the particular system for specific details. The on-line tests should consist of the following:

- Power fail and restart tests

- Input tests
- Output tests
- Internal diagnostics
- Central processing unit
- Communication diagnostics
- Load tests
- Remote user tests
- Overall system tests
- Live system tests.

**11.3 Definitions**

For the purpose of performing user load and run operations, the following will apply:

(a) **Load and Run:** This refers to performing certain functional operations on a new installation. This includes but is not limited to:

- Boot-up and restart tests
- Overall operational tests
- Internal diagnostics
- Input and output tests
- Live system performance tests.

(b) **Power Fail and Restart Tests:** This refers to testing the system's ability to recover from a power outage without the loss of data integrity. This includes testing of the automatic restart capability after a power failure if the system is equipped with this feature.

(c) **Overall Operational Tests:** These tests involve the actual performance of all system hardware and software in an integrated manner simulating actual operating conditions. Tests should include any communications and interface equipment.

(d) **Diagnostic Tests:** Embedded diagnostics are used for the purpose of this definition. However, if the system diagnostics fail to isolate a trouble, then manufacturer diagnostics should be run. These tests may be provided by the vendor or manufacturer and should be run to isolate any errors incurred during the operational tests. Embedded system diagnostics should be run on a routine basis to prevent untimely system failures.

(e) **Input and Output (I/O) Tests:** These test the reliability and options of the system's communication and interface equipment. They may be provided by the hardware manufacturer, as in Display Assistance Computerized (DASC), or incorporated in the system's software, e.g., Centralized Automatic Reporting on Trunks (CAROT) remote multiplexer test. These should be referred to whenever errors are incurred by I/O devices or if the user has difficulty performing tasks that require this equipment.

(f) **Remote User:** This refers to persons using the system from a remote location. These users generally require a data set and a remote terminal for communications with the system.

(g) **Live System:** This refers to a system that is on line and performing the function for which it was intended. These systems collect data or monitor the status of alarms and equipment.

**11.4 Test Descriptions**

The following subparagraphs describe tests referred to in paragraph 10.:

(a) **Power Fail and Restart Tests:** These involve the ability for the operations system to recover from a loss of power. Systems equipped with automatic restart features are required to return completely to their original state within the documented period of time without loss of data integrity. Systems without automatic restart features are required to maintain critical registers and provide a post-crash report when the system is manually restored. This will enable the operations or maintenance personnel to fully restore the system and determine the cause of the failure. The data integrity of these systems must also remain intact during the power failure. Either automatic or manual restart systems should have a file system check performed after the crash to clear any incomplete files created at the time of the power failure.

(b) **Input Tests:** These check the system's ability to collect data, monitor alarms, respond to data inquiries, etc. These tests are run on all input devices on a regular basis or when errors in data collection are suspected. Testing input devices consists of generating alarms from a surveillance site and ensuring the proper response is reported. In the case of remote terminals, run a terminal test or type data to a file and verify that all data are received (e.g., **RECEIVE** message used in No. 2 Switching Control Center Systems). More detailed tests can be run if they are provided or if errors are incurred. Manufacturer diagnostics may be run by maintenance personnel to test the communication links if the other tests fail.

(c) **Output Tests:** These are similar to input tests and in many cases may be run in conjunction with them. They involve operating any remote device when this function is appropriate or verifying the data output for errors and completeness. This could be the data file that was input on an input test or if provided with the system, a test output program or loop-around test. These can also be used to verify options such as baud rates and parity functions. Line printers may be tested using some output tests. Testing should be performed on a regular basis or when errors in output are suspected. Output of a data file can be useful to maintenance personnel who are examining a data link.

(d) **Internal Diagnostics:** These are resident tests run on the system's disk drives, tape drives, line printers, CPU, etc. However, they are not always found on the operations system. When available, they should be run on a regular basis or if error conditions exist that implicate these devices. Examples include the Engineering and Administrative Data Acquisition System (EADAS) "Operations System" test or disk test in AMARC. If peripheral diagnostics are not available to the system or fail to isolate trouble conditions, the manufacturer's diagnostics should be run by maintenance personnel.

(e) **CPU Diagnostics:** These are sometimes included in operations system software to isolate problems in up and down link processors, e.g., CAROT test processor diagnostics, or AMARC Data Set Interface Auxiliary Function (DSIAF) test. However, these tests are rare. The use of manufacturer-provided CPU diagnostics is recommended to isolate processor-related troubles. These tests should exercise all components of the CPU including line clocks, hardware math boards, and memory management options. Note the option specifications when running these diagnostics to ensure that all CPU options are being exercised. If these diagnostics fail to isolate the trouble, specific diagnostics should be performed on the options when available.

(f) **Memory Diagnostics:** These must be performed when "memory fail" output messages are received or frequent loss of data is incurred. Frequently, these tests are not included in operations system application software. This requires that error messages be retained and analyzed to determine what area of memory is failing. This will assist maintenance personnel in determining the area of memory on which to run vendor memory diagnostics. Memory problems can be elusive as portions of the system's main memory may be used infrequently or may be prone to temperature and voltage fluctuations. An example of these tests is the AMARC TEST-DET 6 (memory cyclic redundancy test).

(g) **Communication Tests:** These are performed on all interface devices, data sets, multiplexers, and terminals. On new systems, they indicate proper protocol, baud rates, and functions. They are used when errors are incurred during operation and ensure reliability and compatibility. Communication tests are useful when testing data sets between locations where the compatibility of all segments of the link will be verified.

(h) **Load Tests:** These include the installation of operating system application programs and data files. During the initial loading of these programs, the user may have to verify the options and system parameters. Device assignments may need to be made at this time. These define the terminals, line printers, input channels, etc. File structures and space allocation must be determined on some systems though this may be automatic on others. In either case, these files should be verified for broken links or overlaps using the system file audits. After the initial parameters and options are set, any resident diagnostics should be performed to ensure that the operating system is complete and safe for turnup. The user should configure the system to its multiuser mode at this time and observe for error messages. If the system appears in good condition, a backup tape should be made to reflect any parameter or option changes. At this point, the system should be ready for use.

(i) **Remote User Tests:** These are performed to check all remote user functions including resetting of alarms, outputting reports, and performing remote system functions (e.g., removing a trunk from service). They may include initiating tests from a remote user site. Security methods should be checked to ensure that remote user capabilities cannot be exercised by unauthorized personnel.

(j) **Overall System Tests:** These include all functions that can be performed by an operations system. Each function of the system is tested individually and a record of the responses retained. If any emergency backup equipment is included in the configuration, it should be turned up and tested for reliability. Automatic cutover devices are checked for failure or loss of data. Automatic restart features are tested and if equipped with emergency power systems, this is also tested. Battery backup tests are performed on the memory system at this time. All remote functions should be exercised and a record kept of all responses. All options should be tested where applicable. At the end of this series of tests, any error logging device and all system responses should be examined for possible failure. Each failure should have the appropriate system diagnostic run to isolate the trouble. If these tests are unavailable or unsuccessful, the manufacturer maintenance diagnostics should be run. All messages must be retained for the period of the warranty.

(k) **Live System Performance Evaluation:** This is performed after the operations system is operational. This evaluation is used to determine if full operational capability of the system is available. All devices, system subsystems, file integrity, and functions should be examined for error and reliability. All discrepancies observed during the operation of the system should be logged and evaluated. System through-put should be checked by use of the performance and

statistic monitors included in the operating system. These monitors include indicators for key areas such as CPU usage, disk usage, terminal usage, etc. These indicators should be evaluated during normal and peak usage periods for overload conditions. During peak periods, the highest incidence of error will occur. File system audits should be performed to verify mass storage capabilities and software file management operations. All output and error messages must be retained and analyzed.

## 12. ALARMS

### 12.1 General

Each Minicomputer Operations Center (MOC) or minicomputer cluster represents a large investment to the BOC and must be protected by adequate alarms to guard against environmental (temperature or humidity) failures.

### 12.2 Temperature and Humidity Recording Instruments

Each MOC or cluster must be equipped with temperature and humidity recording instruments. If the cluster is large, readings should be taken at several locations within the cluster to identify hot spots and to identify the need for one or more recording instruments (see BR 007-550-303).

### 12.3 Provision of Audible and Visual Environmental Alarms

Audible and visual alarms must be installed in each MOC or cluster to monitor the environmental controls. Alarm equipment must be adjusted or set to operate at approximately 5 percent before the upper and lower humidity limits and 5 degrees before the upper and lower temperature limits recommended by the vendor supplier. Physical tests should be conducted to verify the correctness of operation, prior to applying power to the equipment installation.

### 12.4 Alarm Extension

Provision must be made to extend the environmental alarms to a 24-hour remote location, whether or not the MOC cluster is occupied 24 hours a day, to ensure proper surveillance. Alarm extensions must be tested for proper operation. Arrangements for alarm installations, tests, and coverage must be made prior to applying power to the minicomputer equipment. If the installation and testing interval is long, the BOC may accept responsibility for surveillance of power and environmental alarms prior to system acceptance. This will require the vendor to provide explicit training or instructions concerning proper actions BOC personnel should take in the event an alarm condition occurs.

### 12.5 Emergency Power Down

If the MOC cluster is not occupied 24 hours each day, emergency procedures should be established to power down all computer systems in the MOC when temperature and or humidity levels approach critical levels. Without air conditioning, heat can build up rapidly within a computer system and if the system(s) is not shut down manually, limits will be exceeded causing the system to crash which will cause permanent component damage. Generally, when ambient room temperature is allowed to reach 80 degrees, a manufacturer maintenance contract is voided and the BOC must pay for time and materials to repair the system.

## 13. GLOSSARY

**AMARC**

Automatic Message Accounting Recording Center

**ASHARE**

American Society of Heating, Refrigeration, and Air Conditioning Engineers Handbook

**ATA**

Automatic Trouble Analysis

**BOC**

Bell Operating Company

**BR**

Bellcore Practices

**CAROT**

Centralized Automatic Reporting on Trunks

**CCD**

Configuration Control Documents

**CD**

Circuit Descriptions

**CLLI**

Common Language Location Identifier

**COSMOS**

Computerized System for MainFrame Operations

**CPU**

Central Processor Unit

**DASC**

Display Assistance Computerized

**DSIAF**

Data Set Interface Auxiliary Function

**EADAS**

Engineering and Administrative Data Acquisition System

**EF&I**

Engineer, Furnish, and Install

**EIA**

Electronic Industries Association

**Hardware Manufacturers**

The company responsible for the actual manufacturing of the minicomputer hardware

**LMOS**

Loop Maintenance Operations System

**MMOC**

Minicomputer Maintenance and Operation Center

**MMG**

Minicomputer Maintenance Group

**MOC**

Minicomputer Operations Center

**MOG**

Minicomputer Operations Group

**PBC**

Peripheral Bus Computer

**SD**

System Description

**UL**

Underwriters Laboratories

**UPS**

Uninterruptible Power Supply

**Vendor**

Most commonly, the company that sells the minicomputer system to the BOC. The "vendor" could also be the "hardware manufacture".

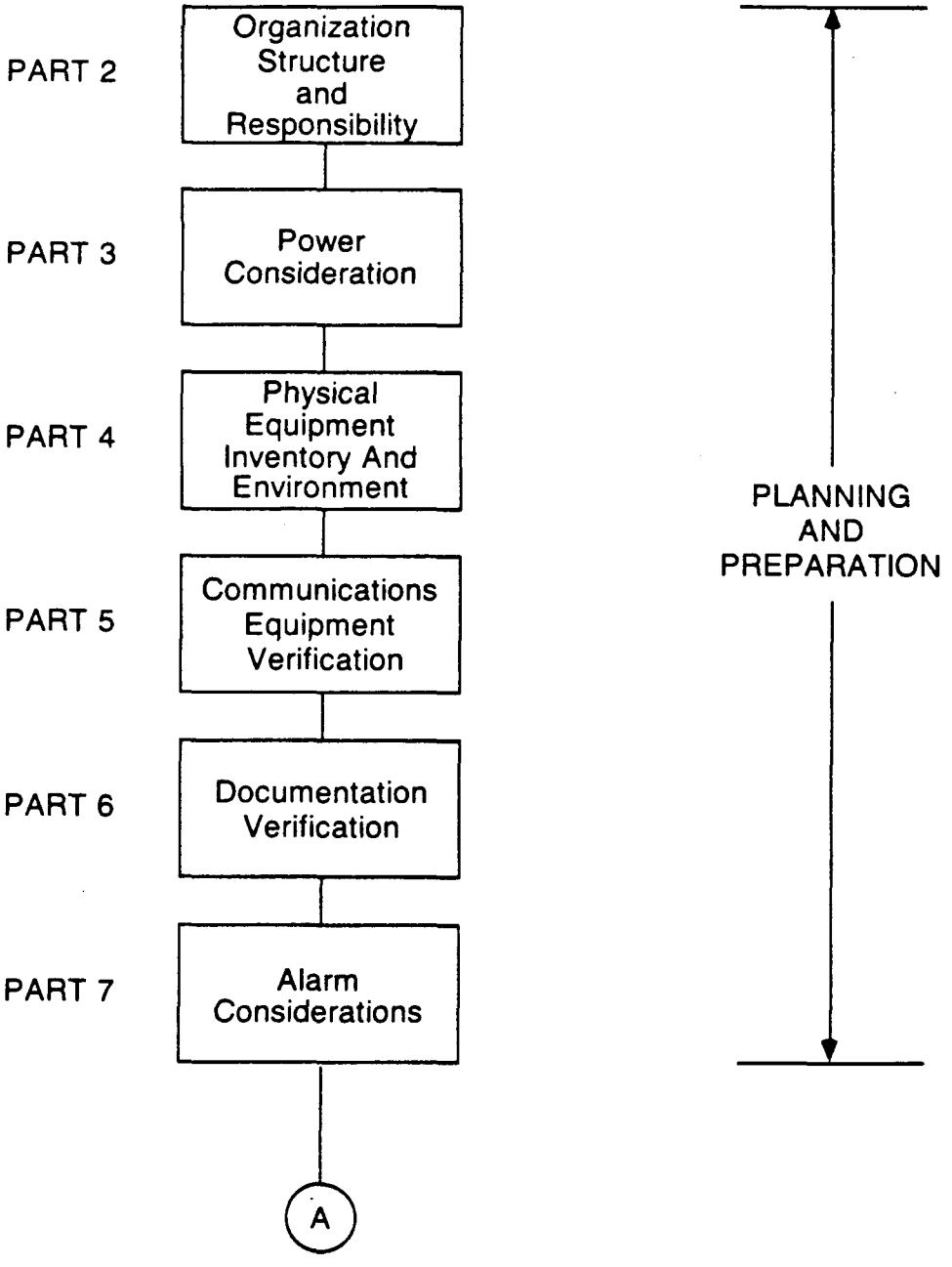


**Figure 1.** Typical Sequence of Operations (Sheet 1 of 3)

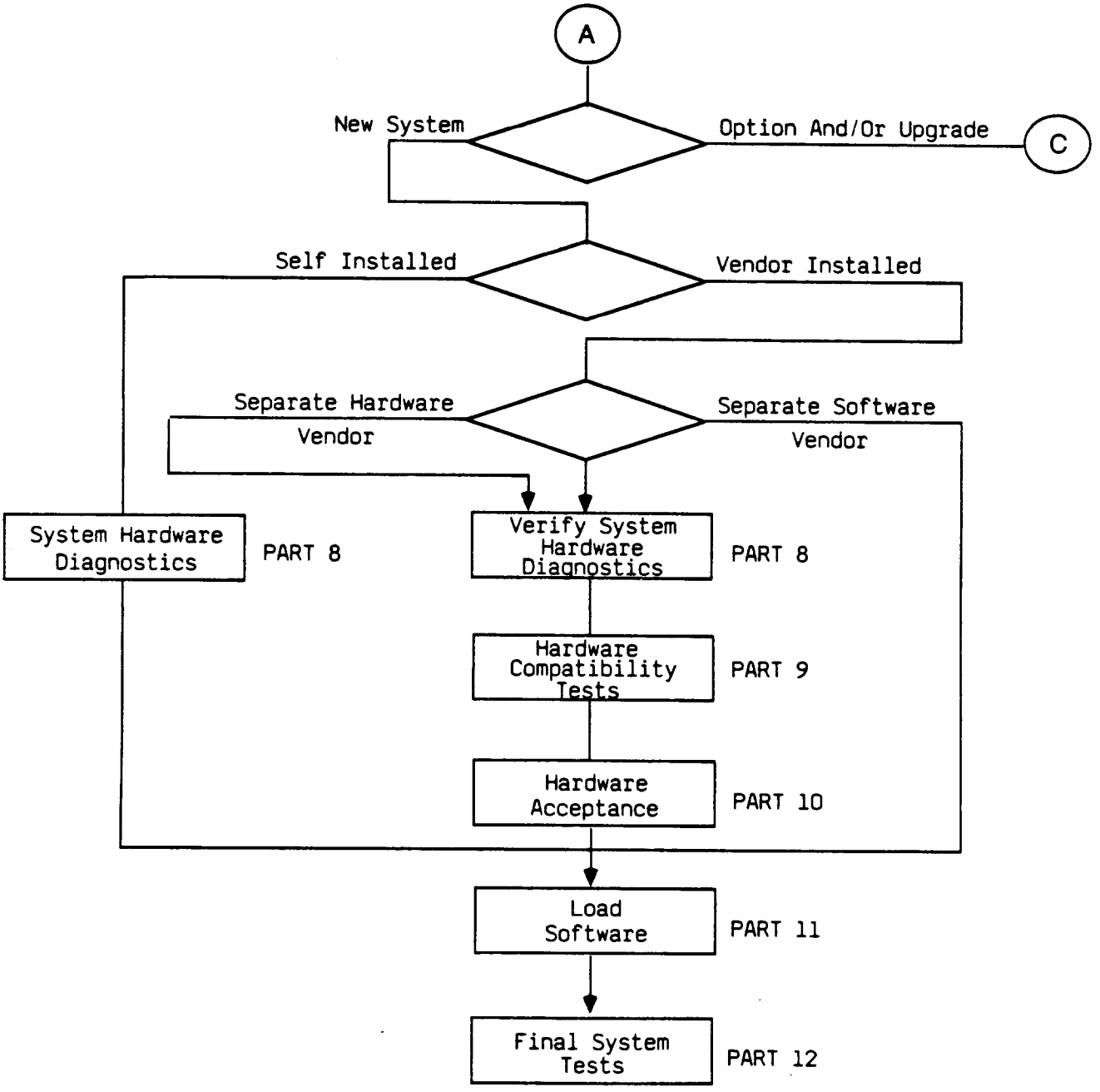


**Figure 1.** Typical Sequence of Operations (Sheet 2 of 3)

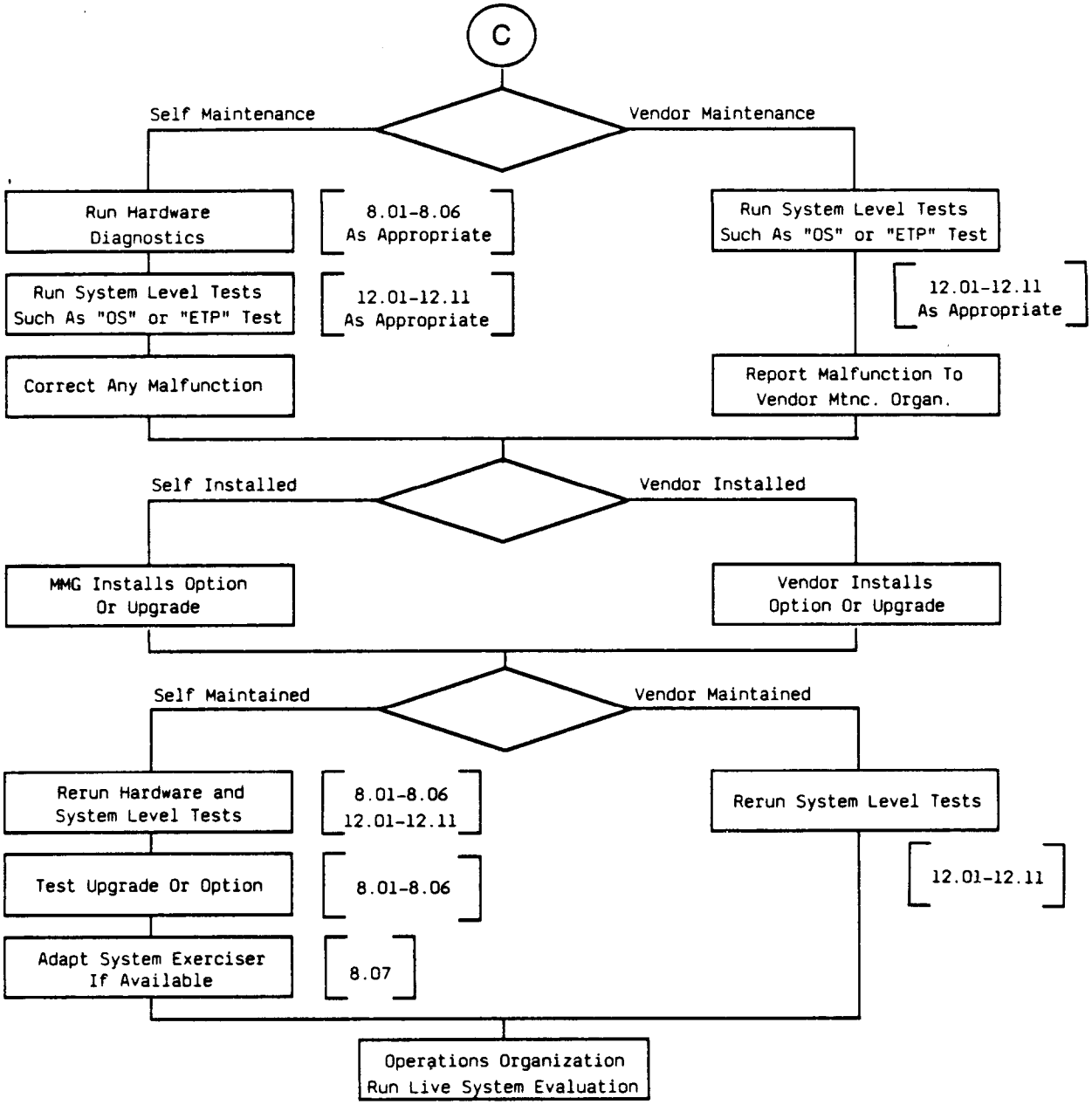


**Figure 1.** Typical Sequence of Operations (Sheet 3 of 3)

## SITE MANAGEMENT GUIDE (DIGITAL EQUIPMENT CORPORATION)

| CONTENTS | CONTENTS |
|---|---|
| Section 1: General Information<br>• Processor identity and serial number<br>• Telephone numbers for night and day service plus diagnostic index and options.<br>Section 2: Customer Equipment Care<br>• Option list and frequency of preventive maintenance<br>• Printer preventive maintenance, tape transport preventive maintenance, reader punch<br>• Disk drive.<br>Section 3: Customer Activity Log<br>Section 4: Problem Reporting and Trouble Log; Problem Report Form<br>Section 5: Configuration Work Sheet<br>• Cabinet layout<br>• Power supply chart<br>• Unibus sequence chart<br>• Processor layout chart.<br>Section 6: Option, Field Change Order (FCO)—Engineering Change Order (ECO)<br>• FCO revision sheet<br>• Field installed ECO/FCO activity log.<br>Section 7: Preventive Maintenance<br>• Recommended tools, test equipment, and supplies.<br>Section 8: Preventive Maintenance Schedule<br>• System Preventive maintenance planning chart<br>• Preventive maintenance schedule. | Section 9: System Power Supply<br>• Operation checklist<br>• Preventive maintenance for power supply.<br>Section 10: Processor Memories<br>• Preventive maintenance for processor.<br>Section 11: Disks<br>• Preventive maintenance for disk controllers, drives, etc.<br>Section 12: Tapes<br>• Preventive maintenance procedures for tapes.<br>Section 13: Terminals—Printers<br>• Preventive maintenance procedures for line printers.<br>Section 14: Communications<br>• Preventive maintenance procedures for multiplexers, line interfaces, etc.<br>Section 15: Options (General)<br>• Bus repeater, programmable clock.<br>Section 16: Performance Report<br>• Snap-out report forms.<br>Section 17: Related Documents<br>• Sample copy form of maintenance service agreement if vendor maintained or if under a self-maintenance service support contract.<br>Section 18: Miscellaneous |

**Figure 2.** Site Management Guide (Digital Equipment Corporation) Exhibit

SYSTEM SUPPORT LOG (HEWLETT PACKARD)

CONTENTS

Part 1: Description and Use

- How to assemble to log.

Part 2: Installation Record

- Constituent parts and configuration.

Part 3: Available Services

- Maintenance agreement
- Field support locally and nationwide.

Part 4: Preventive Maintenance

- Preventive maintenance schedule and completion record
- Standards and preventive maintenance intervals
- Procedures
- Specifications.

Part 5: Historical Records

- System performance
- Historical records.

Part 6: Repair Records

- Field repair order copy
- Maintenance history.

Part 7: Change Records

- Service notes
- Equipment or software revisions.

**Figure 3.** System Support Log (Hewlett Packard) Exhibit

MINICOMPUTER TEST AND ACCEPTANCE CHECKLIST

| ITEM NO. | WORK ITEM (SEE NOTE) | DEPARTMENT | ASSIGNED TO | PHONE NO. | DUE DATE | COMPLETE |
|---|---|---|---|---|---|---|
| 1. | Building Power (4.1) | | | | | |
| 2. | Electrical Checks (4.2) | | | | | |
| 3. | Physical Equipment Inspection (5.) | | | | | |
| 4. | System Grounding (5.1) | | | | | |
| 5. | ac Power Distribution (5.2) | | | | | |
| 6. | General Equipment Verification (5.3) | | | | | |
| 7. | Inventory Verification (5.4) | | | | | |
| 8. | Internal Inspection (5.4) | | | | | |
| 9. | Acceptance of Hardware (6.) | | | | | |
| 10. | Warranty (6.2) | | | | | |
| 11. | Communications Equipment (7.) | | | | | |
| 12. | Compatibility (7.1) | | | | | |
| 13. | Directly Connected Equipment (7.2) | | | | | |
| 14. | Compatibility - Telemetry C Manuels (7.3) | | | | | |
| 15. | Compatibility - Other Computers (7.4) | | | | | |
| 16. | Installation Verification (8.) | | | | | |
| 17. | Generic Loading (8.1) | | | | | |
| 18. | Handbook and Functional Checks (8.2) | | | | | |
| 19. | System Test and Acceptance (8.3) | | | | | |
| 20. | Power Fail Recovery (8.4) | | | | | |
| 21. | Turnover to BOC (8.5) | | | | | |
| 22. | Document Verification (9.) | | | | | |
| 23. | Site Management Guide (9.1) | | | | | |
| 24. | User Hardware Manuals (9.2) | | | | | |
| 25. | Software Documentation (9.3) | | | | | |
| 26. | Schematic Drawings and Circuit Drawings (9.4) | | | | | |
| 27. | System Drawing (9.5) | | | | | |
| 28. | System Options Drawing (9.6) | | | | | |
| 29. | CLLI (9.6) | | | | | |
| 30. | Bellcore Practices (9.7) | | | | | |
| 31. | Vendor Maintenance Manuals (9.8) | | | | | |
| 32. | Vendor Engineering Drawings (9.9) | | | | | |
| 33. | Diagnostic Listings (9.11) | | | | | |
| 34. | System Diagnostics (10.) | | | | | |
| 35. | Processor Testing (10.1) | | | | | |
| 36. | Memory Testing (10.2) | | | | | |

Note: The numbers in parentheses beside subjects in the Work Item column indicate the paragraph number in BR 007-560-310 wherein that particular work item is discussed.

Figure 4. Minicomputer Test and Acceptance Checklist Exhibit (Sheet 1 of 2)

MINICOMPUTER TEST AND ACCEPTANCE CHECKLIST (CONTD)

| ITEM NO. | WORK ITEM (SEE NOTE) | DEPARTMENT | ASSIGNED TO | PHONE NO. | DUE DATE | COMPLETE |
|---|---|---|---|---|---|---|
| 37. | Tape and Disk Drive Testing (10.3) | | | | | |
| 38. | Communication Devices (10.4) | | | | | |
| 39. | Circuit Inter Face Verification (10.5) | | | | | |
| 40. | Peripheral Device Addresses and U Erectors (10.6) | | | | | |
| 41. | Diagnostic Loop Back (10.7) | | | | | |
| 42. | System Testing (10.8) | | | | | |
| 43. | Power Fail and Restart (10.9) | | | | | |
| 44. | Input Tests (10.10) | | | | | |
| 45. | Output Tests (10.11) | | | | | |
| 46. | Internal Diagnostic Tests (10.12) | | | | | |
| 47. | CPU Diagnostic Tests (10.13) | | | | | |
| 48. | Memory Diagnostic Tests (10.14) | | | | | |
| 49. | Communication Diagnostic Tests (10.15) | | | | | |
| 50. | Compatibility Tests (10.16) | | | | | |
| 51. | Load Tests (10.17) | | | | | |
| 52. | Remote User Test (10.18) | | | | | |
| 53. | Over All Tests (10.19) | | | | | |
| 54. | Live System Performance Evaluation (10.20) | | | | | |
| 55. | User Load and Run Operation (11.) | | | | | |
| 56. | Alarms (12.) | | | | | |
| 57. | Recording Instruments (12.2) | | | | | |
| 58. | Audible-Visual Alarm Tests (12.3) | | | | | |
| 59. | Alarm Extension and Test (12.4) | | | | | |
| 60. | Emergency Power Down (12.5) | | | | | |

Note: The numbers in parentheses beside subjects in the Work Item column indicate the paragraph number in BR 007-560-310 wherein that particular work item is discussed.

Figure 4. Minicomputer Test and Acceptance Checklist Exhibit (Sheet 2 of 2)