

## MINICOMPUTER MAINTENANCE AND OPERATIONS CENTER TRAINING GUIDE—MINICOMPUTER MAINTENANCE GROUP

	CONTENTS	PAGE
1.	<b>GENERAL</b> . . . . .	1
2.	<b>AVAILABLE COURSES</b> . . . . .	1
3.	<b>GLOSSARY</b> . . . . .	17
 <b>Tables</b>		
A.	<b>Courses Available—MMG Personnel</b> . . . . .	14
B.	<b>Suggested Course Sequence for MMG Personnel</b> . . . . .	16

**1. GENERAL**

**1.01** This section contains a suggested curriculum and a description of available and proposed training courses for Minicomputer Maintenance Group (MMG) personnel.

**1.02** Whenever this section is reissued, the reason for reissue will be provided in this paragraph.

**1.03** The curriculum suggested in this section is designed to cover most operations systems currently in use by Bell operating company (BOC) personnel. Accordingly, the courses of instruction are for the maintenance and operation of hardware manufactured by the Digital Equipment Corporation and Hewlett-Packard Company.

**1.04** The courses suggested in this section are available at the Western Electric Bell System Training Center—Minicomputer Branch, Columbus, Ohio. Hands-on training for BOC employees is provided in laboratory areas where functional minicomputer systems are used to perform simulations of operations systems.

**2. AVAILABLE COURSES**

**2.01** A list of all the courses available for the MMG personnel is provided in Table A. The course

number, title, and potential user for each course listed are included.

**2.02** Details of each course listed in Table A are in paragraphs 2.03 though 2.84 of this section.

**A. Course No. 091**

**2.03** This is a self-paced course designed as an introduction to minicomputers for line engineers and engineering supervisors. It contains basic information common to all types of minicomputers used in operations systems. There are no prerequisite requirements or specified course length.

**B. Course No. 095A**

**2.04** This instructor-led course is designed for the Regional Technical Assistance Center (RTAC) engineer who will be supporting PDP\*11 systems embedded in operations systems. It covers basic machine architecture and instruction sets. Hands-on exercises are used to reinforce the classroom lecture. The course outline is as follows:

- (a) Unit A, Overview, which includes:
  - Lesson 1—Number Systems
  - Lesson 2—Overview of PDP 11 Systems
  - Lesson 3—Computer Operator Training
  - Lesson 4—Applications of Digital Equipment Corporation Minicomputer Systems.
- (b) Unit B, Digital Equipment Corporation Hardware, which includes:
  - Lesson 1—UNIBUS\* System Concepts
  - Lesson 2—Priority Control

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## SECTION 007-555-362

- Lesson 3—Processor Organization
- Lesson 4—Memory and Addressing
- Lesson 5—Use of the Console
- Lesson 6—Addressing Modes
- Lesson 7—Instruction Set
- Lesson 8—Input/Output (I/O) Programming
- Lesson 9—PDP 11 System Family.

### C. Course No. 095B

**2.05** This instructor-led course is designed for the operations systems RTAC engineer who will be supporting PDP 11 systems embedded in operations systems. It is designed to enable the engineer to read and interpret software program documentation for systems written in UNIX\* System Assembler, UNIX System C-Language, Digital Equipment Corporation Assembly Language, or Fortran. It also discusses operating systems in general and uses the Computer System for Main Frame Operations (COSMOS) and the Engineering and Administrative Data Acquisition System (EADAS) as examples. The prerequisite requirement is satisfactory completion of Course 095A or equivalent. The length of this course is 11 days. The course outline is as follows:

(a) Unit A, System Languages, which includes:

- Lesson 1—Digital Equipment Corporation Assembly
- Lesson 2—UNIX System Assembler
- Lesson 3—UNIX System C-Language
- Lesson 4—Fortran.

(b) Unit B, Operating Systems, which includes:

- Lesson 1—Selected System Programs, ie, Program Application (PA), Program Description (PD), and Program Request (PR)
- Lesson 2—System Software Peculiarities.

(c) Unit C, Systems Application, which includes:

- Lesson 1—I/O Manuals
- Lesson 2—COSMOS
- Lesson 3—EADAS
- Lesson 4—Other Systems.

### D. Course No. 095D

**2.06** This instructor-led course is designed for the operations systems RTAC engineer who will be supporting Hewlett-Packard minicomputer systems embedded in operations systems. It covers the machine architecture, instruction set, detailed hardware, and systems languages. Hands-on exercises are used to reinforce the classroom lecture. There are no prerequisite requirements for the course. The length of this course is 11 days. The course outline is as follows:

(a) Unit A, Overview of Hewlett-Packard Minicomputer Systems.

(b) Unit B, Hewlett-Packard Hardware, which includes:

- Lesson 1—Processor
- Lesson 2—I/O and Mass Storage Devices
- Lesson 3—Diagnostics.

(c) Unit C, Software, which includes:

- Lesson 1—Real Time Executive (RTE)
- Lesson 2—Centralized Automatic Reporting on Trunks (CAROT) Overview
- Lesson 3—Overwrites.

### E. Course No. 095E

**2.07** This instructor-led course is designed for the operations systems RTAC engineer who will be supporting PDP 11 systems embedded in operations systems. Methods and procedures for using the operations systems software and systems diagnostics to troubleshoot the operations systems are discussed.

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Additional hardware troubleshooting methods are explained and practiced in a "real-world" environment. The length of this course is 11 days. The course outline is as follows:

- (a) Unit A, EADAS Software, which includes:
  - Lesson 1—Operating System Organization
  - Lesson 2—Software Troubleshooting Tools.
- (b) Unit B, COSMOS Software, which includes:
  - Lesson 1—COSNIX Structure
  - Lesson 2—Debugging Aids.
- (c) Unit C, System Troubleshooting, which includes:
  - Lesson 1—COSMOS (PDP 11/70 system)
  - Lesson 2—EADAS (PDP 11/40 System)

#### F. Course No. 095F

**2.08** This instructor-led course is designed for the operations systems RTAC engineer who has completed Course No. 095C prior to June 1980. It covers the PDP 11/70 system processor, memory management, cache memory, and the UNIBUS system map subsystems. Fifty percent of the course is spent working hands-on exercises on the PDP 11/70 system machine. The prerequisite requirements for this course are satisfactory completion of Course No. 095A and Course No. 095G. The length of this course is 11 days. The course outline is as follows:

- (a) Unit A, Overview of Corrective Maintenance, which includes:
  - Lesson 1—Levels of Repair
  - Lesson 2—Procedural Approach
  - Lesson 3—PDP 11/70 System.
- (b) Unit B, Central Processor Unit (CPU), which includes:
  - Lesson 1—Introduction
  - Lesson 2—Modules
  - Lesson 3—Flow Diagrams.

- (c) Unit C, Memory Management Unit.
- (d) Unit D, Cache Memory Unit.
- (e) Unit E, Processor Subsystem, which includes:
  - Lesson 1—Review of Hardware Concepts
  - Lesson 2—Review of Corrective Maintenance Approach.

#### G. Course No. 095G

**2.09** This instructor-led course is designed for the operations systems RTAC engineer who will be supporting the PDP 11 systems embedded in operations systems. Skills and knowledge common to all PDP 11 systems are covered. Emphasis is placed on vendor diagnostics and operations systems diagnostics. The prerequisite requirements for this course are satisfactory completion of Course No. 095A, No. 095B, or equivalent. The length of this course is 11 days. The course outline is as follows:

- (a) Unit A, Peripheral Device Familiarization, which includes:
  - Lesson 1—Assignment of Device Addresses, Vectors, and Priority Levels
  - Lesson 2—Operating Peripheral Devices.
- (b) Unit B, Digital Equipment Corporation Engineering Drawings and Backplane Familiarization.
- (c) Unit C, Read-Only Memories (ROMs).
- (d) Unit D, Minicomputer Diagnostics, which includes:
  - Lesson 1—XXDP and XXDP (diagnostic programs)
  - Lesson 2—DEC\*X-11 System Exercisor Program (used to isolate location of PDP 11 system faults to a specific subsystem)
  - Lesson 3—Maintenance Program Generator (MPG)
  - Lesson 4—Operations Systems Test

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**SECTION 007-555-362**

- Lesson 5—Equipment Test Package (ETP)
- Lesson 6—Remote Access Testing System (RATS) Diagnostics.

**H. Course No. 512A**

**2.10** This instructor-led course is designed to give the trainee basic skills and knowledge associated with the identification and operation of the major components of Digital Equipment Corporation and Hewlett-Packard minicomputers. This includes processor and peripheral devices, addressing techniques, booting up the system, running diagnostic tests, identifying faulty equipment, and formatting disk packs.

**2.11** Forty percent of the training activity is spent with hands-on laboratory exercises, using actual working equipment. The laboratory exercises will be coupled with demonstrations, lectures, and reading assignments.

**2.12** The prerequisite requirements are that trainees be familiar with number systems, systems test equipment, and basic troubleshooting. Trainees should be those who will be (or are) currently installing and maintaining minicomputer systems prior to acceptance. The length of this course is 6 days. The course outline is as follows:

(a) On the first day, the course outline is as follows:

(1) Unit 1, Introduction and Minicomputer Systems Application, which includes:

- Automated Call Distributor ESS
- The CAROT
- The EADAS
- The COSMOS
- Automated Repair Service Bureau/Loop Maintenance Operation System (ARSB/LMOS)
- Reading Assignment.

(2) Unit 2, Review of Number Systems, which includes:

- Octal
- Binary
- Applications.

(3) Unit 3, Laboratory Tour and Demonstration, which includes:

- Processors
- Disk Drives
- Magnetic Tape Drives
- Paper Tape Punch/Reader and Line Printer
- Terminals.

(b) On the second day, the trainee will read assignments from Unit 3 and demonstrate ability to operate laboratory equipment.

(c) On the third day, the course outline is as follows

(1) Unit 4, Hardware Architecture, which includes:

- System Structure
- Addressing and Data Format
- Communication Links
- Laboratory Assignments.

(d) On the fourth day, the course outline is as follows:

(1) Unit 5, Bootstrap Loader Program and ROMs

- Absolute Loader
- Running Programs
- The ROMs.

(e) On the fifth day, the course outlines is as follows:

(1) Unit 6, Vendor Diagnostics, which include:

- The XXDP (Diagnostic Program)
- The DEC X-11 System Exercisor Program
- Formatting Disk Packs.

(f) On the sixth day, the course outline is as follows:

(1) Unit 7, System Documentation (self-paced)

(2) Unit 8, Acceptance (reading assignment and discussion) and Additional Diagnostic Testing.

#### I. Course No. 512T

**2.13** This instructor-led course is designed to give the trainee basic skills and knowledge associated with identification and operation of major components of Digital Equipment Corporation and Hewlett-Packard minicomputer processor and peripheral devices. This includes addressing techniques, booting up the system, running diagnostic tests, identifying faulty equipment, and formatting disk packs. Forty percent of the training activity is spent with hands-on laboratory exercises using actual working equipment. The prerequisite requirements for this course are that trainees be familiar with numbering systems, test equipment, and basic troubleshooting. Trainees should be those who will be (or are) installing and performing basic preventive maintenance on minicomputer systems. This length of this course is 6 days.

#### J. Course No. 567T

**2.14** This instructor-led course is designed to provide the MLT administrator and switching technician with the skills and knowledge required for maintenance of the MLT system. Two-thirds of the training time is devoted to hands-on exercises on an MLT system. This course is designed for a qualified switching technician with basic knowledge in electronics who has completed Course No. PTC-507 or equivalent. It is intended for craft personnel, support engineers, and system administrators who maintain

the ARSB/LMOS MLT system. The length of this course is 6 days. The class size is limited to ten trainees.

#### K. Course No. 578T

**2.15** This course is designed to provide the necessary skills and knowledge to test and/or maintain SMAS-5A/5B as well as the RTS-5A system. Approximately 50 percent of the trainee time is spent completing hands-on laboratory exercises including testing on the SMAS-5B and the RTS-5A system. The laboratory exercises are performed with lectures and demonstrations by an experienced instructor.

**2.16** The trainee should have a knowledge of schematic drawings before taking this course. The class size is limited to ten trainees. The length of the course is 9 days. Upon completion of this course, the trainee can identify the components and functions of the Switched Access Remote Testing System (SARTS) 1A subsystem, run tests to sectionalize system troubles, repair and maintain the RTS and SMAS equipment, and perform SARTS testing and troubleshooting. The course outline is as follows:

(a) On the first day, the course outline is as follows:

- Introduction
- Overview
- Overview Laboratory
- The SMAS-5B System.

(b) On the second day, the course outline is as follows:

- The SMAS-5B System
- The SMAS-5B Laboratory.

(c) On the third day, the course outline is as follows:

- The SMAS-5B Laboratory
- The SMAS-5A System.

(d) On the fourth day, the training time is spent in SMAS-5A laboratory exercises.

## SECTION 007-555-362

- (e) On the fifth day, the course outline is as follows:
- The RTS 5A-Controller
  - The RTS 5A-Controller Laboratory.
- (f) On the sixth day, the course outline is as follows:
- The RTS-5A Controller Laboratory
  - The RTS-5A Remote Test Ports.
- (g) On the seventh day, the RTS-5A Remote Test Ports will be given.
- (h) On the eighth day, the course outline is as follows:
- The RTS-5A Enhancements, Generic 2
  - The RTS-5A Enhancements Generic 2 Laboratory.
- (i) On the ninth day, the trainee will perform RTS-5A Enhancements, Generic 2 System Testing.

### L. Course No. NM-710A

**2.17** This self-paced course is designed to provide the trainee with basic performance capabilities in support of minicomputer hardware maintenance. The course will include hands-on assignments using the 1A training bays, modules A and B, to give the trainee experience in using test equipment. The course has been prepared for a population of craft personnel and first-level supervisors who have been selected for the minicomputer hardware maintenance job. This course should be presented in local company training centers. It is a prerequisite to other courses on minicomputer hardware maintenance. The overall objective of this course is to qualify a trainee in the basic concepts and organization of minicomputer hardware and software, the maintenance considerations of such devices, and the application of common tools in support of maintenance activities.

**2.18** This course is primarily intended for personnel from skilled craft jobs. Entrance to the

Minicomputer Maintenance Training Program requires successful completion of the following courses:

- (a) Applications of Solid State Devices—Course No. OJT-21
- (b) Using the 465 Oscilloscope—Course No. TTC-162A
- (c) Circuit Reading—Course No. TTC-366.

**2.19** The class size should be limited to eight trainees. This course is self-paced and should last approximately 8 days.

### M. Course No. NM-721A

**2.20** This instructor-led course is designed to provide the trainee with performance capabilities in support of PDP 11 system minicomputer maintenance. The acquired skills are unique to the PDP-11 system series, including the PDP 11/34 system, PDP-11/40 system, PDP 11/45 system, PDP 11/70 system, and the most common peripheral units. The overall objective of this course is to qualify a trainee in specific knowledge and skill requirements common to the maintenance of the PDP 11 system minicomputers.

**2.21** The lesson objectives focus on the following:

- Hardware Features
- Physical Organization of Components
- Processor Organization
- Memory Organization
- The UNIBUS System Concepts
- Peripheral Equipment Features
- Language Principles
- Diagnostic System Overview
- Reference Documentation.

**2.22** This course is primarily intended for personnel from skilled craft jobs who have successfully completed Course No. NM-710A. Potential trainees who claim equivalent experience to Course No. NM-710A must qualify on the tests of Course No. NM-710A. The class size should be limited to eight trainees. The length of the course is 11 days.

**N. Course No. NM-721B**

**2.23** This instructor-led course is designed to provide the trainee with performance capabilities in support of PDP 11 system maintenance. The acquired skills are unique to the PDP 11 system, including the PDP 11/34 system, PDP 11/40 system, PDP 11/45 system, PDP 11/70 system, and the most common peripheral units. This course will be presented at the Western Electric Bell System Training Center, Minicomputer Branch, Columbus, Ohio. Three-fourths of the training activity is devoted to hands-on practice. Sufficient equipment is provided to limit the practice groups to two trainees each. The overall objective is to qualify a trainee in the specific knowledge and skill requirements common to the maintenance of the PDP 11 systems.

**2.24** The lesson objectives focus on:

- Using front consoles to enter and extract data
- Operating disk and tape systems, card readers, paper tape reader/punches, and terminals
- Identifying and running Digital Equipment Corporation diagnostics.

**2.25** This course is primarily intended for personnel from skilled craft jobs who have successfully completed Course No. NM-721A. The class size should be limited to 12 trainees. The length of the course is 6 days.

**O. Course No. NM-721AB**

**2.26** This course is a repackaged version of Course Nos. NM-721A (length— 11 days) and NM-721B (length—6 days) into one hands-on course taught at the Western Electric Bell System Training Center, Minicomputer Branch, Columbus, Ohio. The skills and knowledge taught are identical to both Course Nos. NM-721A and NM-721B. The overall objective of this course is the same as for Course Nos.

NM-721A and NM-721B. This course is primarily intended for personnel from skilled craft jobs who have successfully completed Course No. NM-710A. It is not advisable to send trainees to this course who have taken Course No. NM-721A and/or NM-721B. The class size should be limited to 12 trainees. The length of this course is 14 days.

**P. Course No. NM-722A**

**2.27** This instructor-led course is designed to provide the trainee with performance capabilities in support of Hewlett-Packard HP-21 series minicomputer maintenance. The acquired skills are unique to the HP-21 series equipment, including HP-2100A, HP-2116A, HP-21MX, and the most common peripheral units. This course should be taught in local company training centers. The overall objective is to qualify a trainee in the specific knowledge and skill requirements common to the maintenance of Hewlett-Packard HP-21 series minicomputers.

**2.28** The lesson objectives focus on:

- Hardware features
- Physical organization of components
- Processor organization
- Memory organization
- Bus concepts
- Peripheral equipment features
- Language principles
- Diagnostic system overview
- Reference documentation.

**2.29** This course is primarily intended for personnel from skilled craft jobs who have successfully completed Course No. NM-710A. The class size should be limited to eight trainees. The length of this course is 6 days.

**Q. Course No. NM-722B**

**2.30** This self-paced course is designed to provide the trainee with performance capabilities in support of Hewlett-Packard tape drive maintenance. This course should be presented by the local company, either on the job or in a training center. The

## SECTION 007-555-362

course is offered to enable a maintenance person trained on Digital Equipment Corporation equipment to maintain Hewlett-Packard tape drives found in some Digital Equipment Corporation installations. The trainee should take this course just prior to attending Course No. NM-741A.

**2.31** The objective focuses on the following:

- Hardware features
- Hewlett-Packard documentation
- Functional organization.

**2.32** This course is primarily intended for personnel who have successfully completed the Digital Equipment Corporation hardware maintenance courses in the NM-731 series and who will be attending Course No. NM-741A. There are no prerequisite requirements for this course. The class size should be limited to eight trainees. The length of the course is 2 days.

### R. Course No. NM-731A

**2.33** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of the PDP 11/70 system and PDP 11/45 system minicomputers. The acquired skills are specific to the two types of computers and do not address peripheral equipment. This course should be presented at the Western Electric Bell System Training Center, Columbus, Ohio. At least 50 percent of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each. The objective of this course is restricted to what is commonly called board-level maintenance activity.

**2.34** The objective focuses on the following:

- The PDP 11/70 system, PDP 11/45 system power, and power supplies
- Cache, memory, and UNIBUS system map
- Board-level component identification
- Recognition of major logic functions performed by board circuit
- Recognition of logic interaction between boards

- Hardware trouble isolation by use of the front console, diagnostics, I/O signal analysis, bus and power verification
- Preventive maintenance procedures.

**2.35** The prerequisite requirements for this course are completion of Course Nos. NM-710A and NM-721B. This course is intended for craft personnel and first-level supervisors. The class size should be limited to 12 trainees. The length of the course is 17 days.

### S. Course No. NM-731B

**2.36** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of PDP 11/34 systems. The acquired skills are specific to the computer and do not address peripheral equipment. The overall objective is to qualify a trainee in the specific knowledge and skill requirements to maintain the hardware of the PDP 11/34 system. The objective is restricted to what is commonly called board-level maintenance activity.

**2.37** The objective focuses on the following:

- The PDP 11/34 system power and power supplies
- Board-level component identification
- Recognition of major logic functions performed by board circuit
- Hardware trouble isolation by use of the computer console, diagnostics, I/O signal analysis, bus and power verification
- Preventive maintenance procedures.

**2.38** The prerequisite requirements for this course are completion of Course No. NM-721B. The course is intended for craft personnel and first-level supervisors. The class size is limited to 12 trainees. The length of the course is 11 days.

### T. Course No. NM-731C

**2.39** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of PDP 11/40 systems. The acquired skills are specific to the computer and do not address peripheral equipment. It is intended that this course be presented at the Bell System Training Center, Minicomputer Branch, Columbus, Ohio. At

least 50 percent of the training activity is devoted to hands-on practice. Sufficient equipment is provided to limit practice groups to two trainees each. The overall objective is to qualify a trainee in the specific knowledge and skill requirements to maintain the hardware of the PDP 11/40 system. The objective is restricted to what is commonly called board-level maintenance activity.

**2.40** The objective focuses on the following:

- The PDP 11/40 system power and power supplies
- Board-level component identification
- Recognition of major logic functions performed by board circuit
- Hardware trouble isolation by use of the front console, diagnostics, I/O signal analysis, bus and power verification
- Preventive maintenance procedures.

**2.41** The prerequisite requirements for this course are completion of Course Nos. NM-731A or NM-731B. This course is intended for craft personnel and first-level supervisors. The length of the course is 11 days.

#### **U. Course No. NM-731D**

**2.42** This instructor-led course is designed to provide the trainee with performance capabilities in operating and maintaining different aspects of the VAX\*11/780 computer processor. It is intended that this course be presented at the Western Electric Bell System Training Center, Columbus, Ohio. A significant amount of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each. The overall objective is to qualify a trainee in the specific knowledge and skill requirements to maintain the Nexus hardware portion of the VAX 11/780 computer subsystem. The objective is restricted to what is commonly called board-level maintenance activity.

**2.43** The objective focuses on the following:

- Machine level unit identification
- The UNIBUS System and MASSBUS\* System Discrimination

\*Registered trademark of Digital Equipmental Corporation.

- Hardware trouble isolation to major system components such as memory, tape drives, disk drives, communication multiplexers, etc, using vendor "off-line" diagnostics
- Recognition of major logic functions performed by the CPU board circuits and major system components
- Recognition of logic interaction between boards or major subsystem components
- Preventive maintenance procedures
- Administrative procedures.

**2.44** The prerequisite requirements for this course are successful completion of Course No. NW-710A and Digital Equipment Corporation's Audio/Visual Course No. J2196A or Lecture/Laboratory Course No. J2154A. This course can be completed in 20 days. The course outline is as follows:

- The HEX Numbering System
- The VAX 11/780 Computer Hardware Architecture
- The VAX Computer Language and Communication Principles
- Internal Processor Operation
- Power and Memory Operation
- Diagnostics
- Preventive Maintenance Procedures
- Troubleshooting Techniques.

#### **V. Course No. NM-732A**

**2.45** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of HP-2100 and 21MX minicomputers manufactured by Hewlett-Packard. The acquired skills are specific to the two types of computers and do not address peripheral equipment. It is intended that this course be presented at the Western Electric Bell System Training Center, Columbus, Ohio. At least 50 percent of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each. The overall objective is to qualify a trainee in the specific knowledge and

## SECTION 007-555-362

skill requirements to maintain the hardware of the HP-2100 and 21MX computers. The objective is restricted to what is commonly called board-level maintenance activity.

**2.46** The objective focuses on the following:

- Recognition of the options, accessories, and special switch settings associated with a given Hewlett-Packard 2100A, 21MX-M, and E-Series computer configuration.
- Construction, load and verification of proper execution of simple machine language programs.
- Board-level component identification.
- Recognition of major logic functions performed by board circuits.
- Recognition of logic interaction between boards.
- Hardware trouble isolation by use of the front console, diagnostics, I/O signal analysis, bus and power verification.
- Preventive maintenance procedures.

**2.47** The prerequisite requirements for this course are successful completion of Course No. NM-722A. This course is intended for craft personnel and first-level supervisors. The class size is limited to 12 trainees. The length of the course is 11 days.

### **W. Course No. NM741A**

**2.48** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of peripheral equipment units associated with PDP 11 system minicomputers. Specifically, the course addresses magnetic tape systems (TWU/E16, Tape Unit [TU] 77, Tape Report [TR]79). The acquired skills are specific to the peripheral equipment and do not address computers. It is intended that this course be presented at the Western Electric Bell System Training Center, Columbus Ohio. At least 50 percent of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each. The overall objective is to qualify a trainee in specific knowledge and skill requirements to maintain the hardware of the mentioned peripheral equipment. The objective is restricted to what is commonly called board-level.

**2.49** The objective focuses on the following:

- Board-level component identification
- Recognition of major logic, electrical, and mechanical component functions
- Hardware trouble isolation by use of the computer console, diagnostics, I/O signal analysis, bus and power verification
- Preventive maintenance procedures.

**2.50** The prerequisite requirements for this course are completion of any NM-731 course. This course is intended for craft personnel and first-level supervisors. The class size is limited to 12 trainees. The length of the course is 11 days.

### **X. Course No. NM-741B**

**2.51** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of peripheral equipment units associated with PDP 11 system minicomputers. Specifically, the course addresses RJP05/06, RWP05/06, RK11/RK05, and RX11/RX01 disk systems. The acquired skills are specific to the peripheral equipment and do not address computers. This course will be presented at the Western Electric Bell System Training Center, Columbus, Ohio. At least 50 percent of the activity is devoted to hands-on practice training. Whenever possible, equipment is provided to limit practice groups to two trainees each. The overall objective is to qualify a trainee in specific knowledge and skill requirements to maintain the hardware of the mentioned peripheral equipment. The objective is restricted to what is commonly called board-level maintenance activity.

**2.52** The objective focuses on the following:

- Board-level component identification
- Recognition of major logic, electric, and mechanical component functions
- Hardware trouble isolation by use of the computer console, diagnostics, I/O signal analysis, bus and power verification
- Preventive maintenance procedures.

**2.53** The prerequisite requirement for this course is completion of any NM-731 course. This

course is intended for craft personnel and first-level supervisors. The class size is limited to 12 trainees. The length of the course is 11 days.

**Y. Course No. NM-741C**

**2.54** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of peripheral equipment units associated with PDP 11 system minicomputers. Specifically, the course addresses Communication Interface (DL11, DJ11, DR11, DN11, and DQ11), DECwriter (LA36) console terminal manufactured by Digital Equipment Corporation, Printer (LP11), Card Reader (CR11). The acquired skills are specific to the peripheral equipment and do not address computers. This course will be presented at the Western Electric Bell System Training Center, Columbus, Ohio. At least 50 percent of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each. The overall objective is to qualify a trainee in the specific knowledge and skill requirements to maintain the hardware of the mentioned peripheral equipment. The objective is restricted to what is common called board-level maintenance activity.

**2.55** The objective focuses on the following:

- Board-level component identification.
- Recognition of major logic component functions.
- Hardware trouble isolation by use of the computer console, diagnostics, I/O signal analysis, bus and power verification.
- Preventive maintenance procedures.

**2.56** The prerequisite requirement for this course is successful completion of any NM-731 course. This course is intended for craft personnel and first-level supervisors. The class size is limited to 12 trainees. The length of the course is 11 days.

**Z. Course No. NM-742A**

**2.57** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of peripheral equipment units associated with Hewlett-Packard HP-1000 series minicomputers.

**2.58** Classroom lectures are used to emphasize the functional operation and concepts associated with the Hewlett-Packard peripheral hardware to enhance fault resolution. Major emphasis will be placed on hands-on laboratory practices concerning the familiarization, alignments, and adjustments of the Hewlett-Packard peripheral hardware. Students will be provided with ample opportunities to isolate and resolve Hewlett-Packard peripheral hardware faults. The acquired skills are specific to the peripheral equipment and do not address computers.

**2.59** It is intended that this course be presented at the Western Electric Bell System Training Center, Columbus, Ohio. At least 50 percent of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each.

**2.60** The overall objective is to qualify a trainee with the skills and knowledge necessary to isolate Hewlett-Packard peripheral troubles to the board level. Paper tape reader, paper tape punch, display station line printer, magnetic tape unit, and disk drive unit peripheral devices are addressed.

**2.61** The objective focuses on:

- Board-level component identification
- Recognition of major logic, electrical and mechanical component functions
- Hardware trouble isolation by use of the computer console, diagnostics, I/O signal analysis, bus and power verification
- Preventive maintenance procedures.

**2.62** The prerequisite requirements are completion of Course Nos. NM-710A, NM-722A, and NM-732A. The course is intended for craft personnel and first-level supervisors. The class size is limited to 12 trainees. The length of the course is 11 days.

**AA. Course No. NM-743A**

**2.63** This instructor-led hands-on course is designed for minicomputer maintenance craft personnel and their first-level supervisors who will be maintaining KS peripheral disk and tape drives residing in such system as Voice Storage System (VSS), Mass Announcement System (MAS) and the 3B machine. The course provides a review of basic

## SECTION 007-555-362

peripheral concepts. For each device, students will learn operations theory, use special tools and test equipment, and diagnose malfunctions using off-line fault isolation techniques.

**2.64** This course is designed for minicomputer maintenance craft personnel who have a firm understanding of minicomputer peripheral operations. Trainees should have attended the network minicomputer peripheral courses (disks and tape transports) and gained some actual field experience in this area. There are no prerequisite requirements for this course. The course is intended for minicomputer maintenance craft personnel and first-level supervisors. The class size is eight trainees. The class length is 11 days. The course outline is as follows:

- (a) Lesson 1—Maintenance of KS-22072 L1, Control Data Corporation 300MB Stored Module Drive (SMD)
- (b) Lesson 2—Maintenance of KS-22072 L2, Century Data Systems 300MB Trident Disk Drive
- (c) Lesson 3—Maintenance of KS-21996 L2, Century Data Systems 80MB Trident Disk Drive
- (d) Lesson 4—Maintenance of KS-22091 L2, Kennedy Corporation Tape Transport and Formatter.

### **BB. Course No. NM-751A**

**2.65** This instructor-led course is designed to provide the trainee with performance capabilities in support of PDP 11 system hardware maintenance. Addressed are common maintenance techniques appropriate to complete computer systems consisting of minicomputer and peripheral equipment.

**2.66** This course will be presented at the Western Electric Bell System Training Center, Columbus, Ohio. At least 50 percent of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each.

**2.67** The overall objective is to qualify a trainee in the specific knowledge and skill requirements common to the maintenance of PDP 11 systems. The objective focuses on the following:

- Application of the computer front console
- The UNIBUS system discrimination

- Various methods of I/O signal analysis
- Application of DEC-X11 System Exerciser manufactured by Digital Equipment Corporation
- Representative trouble isolation procedures
- Administrative and preventive maintenance procedures.

**2.68** The prerequisite requirements for this course include successful completion of any computer hardware maintenance course in the NM-731 series, all peripheral hardware maintenance courses in the NM-741 series, and successful completion of Course No. NM-722B. Note that PDP 11/70 systems contain Hewlett-Packard tape drives.

**2.69** This course is intended for craft personnel and first-level supervisors. The class size is limited to six trainees. The length of the course is 11 days.

### **CC. Course No. NM-751B**

**2.70** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of the PDP 11/70 system and the PDP 11/45 system. Addressed are maintenance procedures particularly applicable to computer systems based on the mentioned processors.

**2.71** This course will be presented at the Western Electric Bell System Training Center, Columbus, Ohio. At least 50 percent of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each.

**2.72** The overall objective is to qualify a trainee in the specific knowledge and skill requirements to maintain hardware of the PDP 11/70 system and the PDP 11/45 processors and interconnected peripheral equipment.

**2.73** The objective focuses on the following:

- Diagnostic procedures
- Representative trouble isolation procedures
- Administrative and preventive maintenance procedures.

**2.74** The prerequisite requirement for this course is successful completion of Course No. NM-751A. This course is intended for craft personnel and first-level supervisors. The class size is limited to six trainees. The length of the course is 6 days.

**DD. Course No. NM-751C**

**2.75** This instructor-led course is designed to provide the trainee with performance capabilities in hardware maintenance of the PDP 11/34 system and the PDP 11/40 system. Maintenance procedures particularly applicable to the computer systems mentioned are addressed.

**2.76** This course will be presented at the Western Electric Bell System Training Center, Columbus, Ohio. At least 50 percent of the training activity is devoted to hands-on practice. Wherever possible, equipment is provided to limit practice groups to two trainees each.

**2.77** The overall objective is to qualify a trainee in the specific knowledge and skill requirements to maintain hardware of PDP 11/34 system and PDP 11/40 system processors to what is commonly called board-level maintenance activity.

**2.78** The objective focuses on the following:

- Diagnostic procedures
- Representative trouble isolation procedures
- Administrative and preventive maintenance procedures.

**2.79** The prerequisite requirements for this course are completion of Course Nos. NM-751A and NM-731B. This course is intended for craft personnel and first-level supervisors. The size of this class is limited to six trainees. The length of the course is 6 days.

**EE. Course No. NM-762A**

**2.80** This instructor-led course is designed to provide the trainee with performance capabilities in the maintenance of OSS applications that have embedded PDP 11 system minicomputers. The course will be structured around the Automatic Message Accounting Recording Center (AMARC),

COSMOS, EADAS, LMOS, SARTS, and No. 2 Switching Control Center System/Automatic Trouble Analysis (SCCS/ATA). Providing maintenance capabilities in these systems should provide transferable skills which can be used in other OSS applications.

**2.81** The prerequisite requirements for this course are successful completion of the NM-751A and NM-751B hardware maintenance courses. This course is intended for minicomputer maintenance craft personnel and first-level supervisors. The size of this class is limited to eight trainees. The length of the course is 10 days.

**2.82** The course outline is as follows:

- (a) Unit 1 — Introduction to OSS Applications
- (b) Unit 2 — System Configurations and Documentation (see note)
- (c) Unit 3 — Boot and Recovery Procedures (see note)
- (d) Unit 4 — Use of Application Software Commands and Diagnostics (see note)
- (e) Unit 5 — Hardware Trouble Isolation Using Interactive Commands (see note).

**Note:** Each of these units is covered on a per unit basis.

**FF. Course No. NM-762C**

**2.83** This instructor-led course is designed to provide the trainee with performance capabilities in the maintenance of OSS applications that have embedded Hewlett-Packard series minicomputers. The course is structured around CAROT-2 and Telecommunications Alarm Surveillance and Control (TASC). Providing maintenance capabilities in these systems should provide transferable skills which can be used in other Hewlett-Packard operations support systems applications.

**2.84** The prerequisite requirement for this course is successful completion of Course No. NM-742A. This course is intended for minicomputer maintenance craft personnel and first-level supervisors. The size of this class is limited to five trainees.

**SECTION 007-555-362**

The class length is 5 days. The course outline is as follows:

- (a) Unit 1—Introduction to OSS Applications
- (b) Unit 2—Hewlett-Packard Based Operations Systems Overview
- (c) Unit 3—The Hewlett-Packard RTE Operating System

(d) Unit 4—The **WHZAT** Command

(e) Unit 5—The TASC System

(f) Unit 6—The CAROT-2 Systems.

**2.85** The suggested course sequence for MMG personnel is provided in Table B.

**TABLE A  
COURSES AVAILABLE—MMG PERSONNEL**

COURSE NO.	TITLE	POTENTIAL USER
091	Introduction to Minicomputers	New MMG Supervision
095A	Digital Equipment Corporation PDP 11 Systems Hardware Minicomputers	New MMG Supervision
095B	Digital Equipment Corporation Systems Application Language	MMG Supervision
095D	Hewlett-Packard Hardware and Systems Language	MMG Supervision
095E	Digital Equipment Corporation Data Manipulation and Troubleshooting	MMG Supervision
095F	PDP 11/70 System Processor Subsystem Hardware	MMG Supervision
095G	Introduction to Minicomputer Diagnostics and Digital Equipment Corporation Hardware	MMG Supervision
512A	Introduction to Minicomputer Systems	MMG Implementation Personnel
512T	Introduction to Minicomputer Systems	MMG Personnel
567T	Mechanized Loop Testing (MLT) Maintenance	MMG Personnel
578T	Remote Test System (RTS) 5A and Switched Maintenance Access System (SMAS) 5A/5B Maintenance	MMG Personnel
NM-710A	Introduction to Maintenance of Minicomputer Systems	MMG Personnel

TABLE A (Contd)

## COURSES AVAILABLE – MMG PERSONNEL

COURSE NO.	TITLE	POTENTIAL USER
NM-721A	Basic Maintenance Skills for PDP 11 Systems	MMG Personnel
NM-721B	Hardware Maintenance of PDP 11 Systems	MMG Personnel
NM-721AB	Basic Hardware Maintenance Skills for PDP-11 Systems	MMG Personnel
NM-722A	Basic Maintenance Skills for Hewlett-Packard HP-21 Series Minicomputer Systems	MMG Personnel
NM-722B	Basic Maintenance Skills for Hewlett-Packard HP-21 Series Minicomputer Systems	MMG Personnel
NM-731A	Hardware Maintenance of PDP 11/70 Systems and PDP 11/45 Systems	MMG Personnel
NM-731B	PDP 11/34 Systems	MMG Personnel
NM-731C	Hardware Maintenance of PDP 11/40 Systems	MMG Personnel
NM-731D	Maintenance of VAX 11/780 Computer Control Processor Unit and Console Subsystems	MMG Personnel
NM-732A	Hardware Maintenance of Hewlett-Packard HP-210 and 21MX Minicomputers	MMG Personnel
NM-741A	Hardware Maintenance of Selected Magnetic Tape Systems	MMG Personnel
NM-741B	Hardware Maintenance of Selected Disk Systems	MMG Personnel
NM-741C	Hardware Maintenance of Selected Communications and I/O Devices	MMG Personnel
NM-742A	Hardware Maintenance of Hewlett-Packard HP-1000 Series Selected Peripherals	MMG Personnel
NM-743A	KS Peripherals Maintenance	MMG Personnel
NM-751A	Hardware Maintenance of PDP-11 Systems	MMG Personnel

TABLE A (Contd)

## COURSES AVAILABLE – MMG PERSONNEL

COURSE NO.	TITLE	POTENTIAL USER
NM-751B	Hardware Maintenance of PDP 11/70 Systems and PDP-11/45 Systems	MMG Personnel
NM-751C	Hardware Maintenance of PDP 11/70 Systems and PDP-11/40 Systems	MMG Personnel
NM-762A	Operations Support Systems (OSS) Applications (Digital Equipment Corporation Series)	MMG Personnel
NM-762C	OSS Applications (Hewlett-Packard Series)	MMG Personnel

TABLE B

## SUGGESTED COURSE SEQUENCE FOR MMG PERSONNEL

PERSON CAPABLE OF HARDWARE MAINTENANCE ON SYSTEMS USING	COURSE SEQUENCE				
PDP 11/70 System and PDP-11/45 System Processors and Peripherals	710A	721A	721B	731A	741A
	741B	741C	751A	722B	751B
PDP 11/34 System Processor and Peripherals	710A	721A	721A	731B	741A
	741B	741C	751A	751C	—
PDP 11/40 System Processor and Peripherals	710A	721A	721B	731C	741A
	741B	741C	751A	751C	—
PDP 11/70 System, PDP 11/45 System, and PDP 11/40 System Processors and Peripherals	710A	721A	721B	731A	731B
	741A, B, & C	751A	722B	751B	751C
PDP 11/34 System and PDP 11/40 System Processors and Peripherals	710A	721A	721B	731B	731C
	741A, B, & C	751A	722B	751A	751C
PDP 11/70 System, PDP 11/45 System, PDP 11/34 System, and PDP 11/40 Processors and Peripherals	710A	721A	721B	731A, B, & C	—
	741A, B, & C	751A	722B	751B, & C	—
Hewlett-Packard HP-2100 and HP-21MX Processor and Peripherals	710A	722A	732A	742A	—

**3. GLOSSARY**

3.01 Abbreviation/acronyms used in this section are defined as follows:

**AMARC**

Automatic Message Accounting Recording System.

**ARSB**

Automated Repair Service Bureau.

**ATA**

Automatic Trouble Analysis.

**BOC**

Bell Operating Company.

**CAROT**

Centralized Automatic Reporting on Trunks.

**COSMOS**

Computer System for Main Frame Operations.

**CPU**

Central Processor Unit.

**EADAS**

Engineering and Administrative Data Acquisition System.

**ETP**

Equipment Test Package.

**I/O**

Input/Output.

**LMOS**

Loop Maintenance Operations System.

**MAS**

Mass Announcement System.

**MLT**

Mechanized Loop Testing.

**MMG**

Minicomputer Maintenance Group.

**MPG**

Maintenance Program Generated.

**OSS**

Operations Support System.

**PA**

Program Application.

**PD**

Program Description.

**PR**

Program Request.

**RATS**

Remote Access Testing System.

**RTE**

Real Time Executive.

**RTAC**

Regional Technical Assistance Center.

**ROM**

Read-Only Memory.

**RTS**

Remote Test System.

**SARTS**

Switched Access Remote Testing System.

**SCC**

Switching Control Center.

**SECTION 007-555-362**

**SMAS**

Switched Maintenance Access System.

**SMD**

Stored Module Drive.

**VSS**

Voice Storage System.

**TASC**

Telecommunications Alarm Surveillance and Control.

**TR**

Tape Report

**TU**

Tape Unit.