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Environmental Sciences Division Computing and Geographic Information System Facility User Handbook

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R. A. McCord

ENVIRONMENTAL SCIENCES DIVISION
PUBLICATION NO. 3631

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ENVIRONMENTAL SCIENCES DIVISION

ENVIRONMENTAL SCIENCES DIVISION COMPUTING AND GEOGRAPHIC INFORMATION SYSTEM FACILITY USER HANDBOOK

R. A. McCord

Environmental Sciences Division
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ACRONYMS AND ABBREVIATIONS

ADP	automatic data processing
BLKS	blocks (512 bytes of disk space)
BPI	bytes per inch
C&TD	Computing and Telecommunications Division
CPI	characters per inch
CPU	central processing unit
CTSO	Computing and Telecommunications Security Organization
DMF	DISSPLA Metagraphics File
DPI	dots per inch
E00	ARC/INFO EXPORT data file format
EPA	Environmental Protection Agency
ESD	Environmental Sciences Division
ESRI	Environmental Systems Research Institute
GB	gigabyte (1 billion bytes)
GIS	Geographic Information System
HUC	Hydrologic Unit Code
ID	identification code
KB	kilobyte (1 thousand bytes)
LAVC	Local Area VAX Cluster
MB	megabyte (1 million bytes)
MMES	Martin Marietta Energy Systems

OA	office automation
ORNL	Oak Ridge National Laboratory
PC	personal computer
RBS	remote batch station
RTP	Research Triangle Park
STC	Scientific and Technical Computing
UID	user indentification
UPI	units per inch
USGS	U. S. Geological Survey

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ABSTRACT

MCCORD, R. A. 1990. Environmental Sciences Division Computing and Geographic Information System Facility User Handbook. ORNL/TM-11711 Oak Ridge National Laboratory, Oak Ridge, Tennessee. 138 pp.

The Environmental Sciences Division (ESD) at Oak Ridge National Laboratory (ORNL) operates a Computing and Geographic Information System Facility as a tool for its environmental research. This facility provides ESD staff and guests with three major computing functions: (1) a remote batch station (RBS) for processing print and plot output from other ORNL systems, (2) a geographic information system (GIS) for mapping and spatial analysis of environmental problems, and (3) an ethernet network for high-speed communications, file sharing, and printer sharing services.

This handbook provides an overview of the components of the facility. The overview includes the staff, computers, peripherals, and communications. Generic descriptions of the user commands to send print and plot output to the ESD RBS are also provided.

Information and guidelines are presented for the direct use of the ESD VAX and GIS. The unique operational aspects of this VAX installation (e.g. queue names, device names, local commands, and telecommunications pathways) are documented. The ESD GIS is an application of the direct VAX users. Because special GIS commands have been developed by ESD staff, these commands are documented in more detail in a series of appendixes. Computer security, authorization, disk management, backup, and facility access policies and procedures are described to clarify the users expectations and responsibilities while utilizing the ESD systems.

The network service functions of the ESD VAXes are described for the direct users and members of the ESD PC-VAX network. Explanations of commands for file transfer and remote system access are included. Remote disk sharing and remote printer sharing services for personal computers are also described.

1. HANDBOOK PURPOSE AND SCOPE

This will handbook provide assistance to Environmental Sciences Division (ESD) personnel in using the ESD Computing and Geographic Information System Facility. It complements other documentation currently available to ESD personnel, provides an integrated overview, and directs users to various other documentation. Specifically, this manual documents the aspects of the ESD Computing and Geographic Information System Facility that are unique to its operation. General information on using Martin Marietta Energy Systems, Inc. (Energy Systems) computer systems, VAX VMS, and ARC/INFO can be found in the following sources:

Energy Systems computer systems:

"A Guide to Computing at Energy Systems (in Oak Ridge)" Computing and Telecommunications User Services, Computing and Telecommunications Division, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., December 1987 (and subsequent revisions).

"C&TD Graphics Reference Manual" Computing and Telecommunications User Services, Computing and Telecommunications Division, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., March 1988.

VAX/VMS:

"VAX/VMS for New Users: A Conversion Guide" Computing and Telecommunications User Services, Computing and Telecommunications Division, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., September 1986.

"Guide to Using VMS, Version 5.0," AA-LA05A-TE, Digital Equipment Corporation, Maynard, Mass., 1988.

ARC/INFO:

"ARC/INFO, Volume 1 and 2," Environmental Systems Research Institute, Inc., Redlands, Calif., 1989.

"Understanding GIS -- The ARC/INFO Method," Environmental Systems Research Institute, Inc., Redlands, Calif., 1989.

For detailed information on these topics, users are referred to additional manuals and documentation available from Computer Manual Ordering Library (telephone, 4-0331

or use DO MANUAL on the PDP-10). Additional documentation ARC/INFO and other geographic information system (GIS) software can be found in the ESD GIS Laboratory (Room 175, Building 1505). The ESD staff listed in Sect. 2.3 of this handbook can also be contacted for additional information.

Many of the details reported in this handbook have changed several times in the past and will change in the future. The details included in this handbook are correct as of mid-November 1990.

2. FACILITY OVERVIEW

The Environmental Sciences Division (ESD) has maintained a computer facility since 1972. The original function of the ESD computer facility was to serve as a remote batch station (RBS) to the central computers at Oak Ridge National Laboratory (ORNL) that is, IBM mainframe, PDP-10, Scientific and Technical Computing (STC), and Office Automation (OA) VAXes. Currently, the RBS processes 800 to 1200 files of output per month from the central computers for output on two plotters and four printers. In addition to the RBS function, the ESD Computing Facility also provides a geographic information system (GIS), a network, and limited simulation computing with environmental models. This facility is intended to provide access to and complement, not replace, the capability of other ORNL computers. The facility operation is supported by an allocation of costs to ESD section overhead, which is based on usage.

2.1 PROCESSING EQUIPMENT AND DEVICES

The ESD computing facility consists of the following equipment:

VAX 11/750 - Hosts ESD Local Area VAX Cluster, communicates with RBS device, communicates data to printers and plotters, performs backup, and hosts a PC network. Devices include: 8-MB system memory, 1-GB on-line disk storage (three drives), three line printers, two laser printers, two electrostatic plotters, 8-mm tape drive, 9-track tape drive, and System Select connection.

MicroVAX 3500 - Primary user system for ARC/INFO GIS and modelling, satellite in ESD Local Area VAX Cluster. Devices include: 32-MB system memory, 2.3-GB on-line disk storage (seven drives), two pen plotters, 9-track tape drive, and cartridge tape drive.

VAXstation 3100 - Secondary ARC/INFO GIS workstation, satellite in ESD Local Area VAX Cluster. Devices include: 20-MB system memory, 0.7-GB on-line disk storage (three drives).

These systems are closely interconnected with network software to form a Local Area VAX Cluster.

The following systems and processors are also part of the ESD Computing and Geographic Information System Facility:

MicroVAX 2000 - ESD electronic bulletin board (under development).

SNA Gateway - Communicates and converts data from IBM mainframe to ESD VAXes.

SPANS PC - IBM PC/AT with 25-MHz 386 processor and dual monitor that hosts SPANS quadtree GIS software and Zennographics graphics software.

ERDAS PC - IBM PC/AT with ERDAS raster GIS and Image Processing software.

DECrouter 250 - Processes wide area DECnet routing information.

Sytek Broadband Modem - Multiport modem that connects terminals and PCs directly to broadband communications.

Bridge Ethernet Bridge - Connects ESD ethernet network to ORNL and Energy Systems broadband and ethernet networks.

DCA multiplexor - Individual connections for hundreds of ESD staff to Energy Systems System Select.

2.2 ESD VAX CLUSTER CONFIGURATION

The ESD Computing and Geographic Information System Facility is predominantly equipped with VAXes of various sizes. All of these VAXes use the VMS operating system (current version is 5.2), which is the same operating system used on a majority of the VAXes at ORNL. Three of the VAXes (VAX 11/750, MicroVAX 3500, and VAXstation 3100) are very closely connected with the network hardware and special software for Local Area VAX Cluster (LAVC). LAVC includes the following features for the implementation of VAXes:

Shared disks - Disks on any system in the cluster can be accessed from any system in the cluster. Therefore, the user has only one disk area that is used from any system in the cluster.

Shared operating system - System files are shared between systems. For example, all of the systems in the cluster use the same data set of user authorization information. Therefore, the user's relationship (i.e. home directory, login command file, and available devices and software) to a system is nearly identical for all systems in the cluster. All systems in a cluster use the same root copy of the operating and applications software. Systems can be added or removed from the cluster with significantly less effort than nonclustered systems.

Shared queues - Queues in the cluster can be accessed from any system in the cluster. This allows access to all printing and plotting devices from any

system in the cluster. Batch jobs may also be submitted to any system in the cluster from one system.

Simple commands - In contrast to regular network transfer of data, the user is not required to use extra syntax to accomplish these tasks within the cluster.

Independent components - Some part of the cluster remains available to the user when one or more of the systems is not working. Users are affected by system problems if they occur on the cluster host system or on the system to which their home disk is connected.

The host for the ESD cluster is the VAX 11/750. Its boot disk contains the root copy of the operating system for which subpieces can be defined for the systems in the cluster. The physical connection of disks, printers and plotters is described Sects. 10 and 11 of this handbook.

2.3 STAFF

The following staff members are responsible for the operation of the ESD Computing and Geographic Information System Facility. Users that are having problems with the ESD facility are encouraged to contact these individuals.

David Fowler -- Supervisor, Technical and Administrative Support Services
Address: Room 102-A, Building 1505
Phone: 4-7301
Mail Names: DXF, FOWLERDE
Typical working schedule: 8:00 a.m. to 4:30 p.m.
Duties: Supervises facility staff and budget.

Neil Griffith -- System Manager
Address: Room 118, Building 1505
Phone: 4-7817
Mail Names: NAG, GRIFFITHNA
Typical working schedule: 8:00 a.m. to 4:30 p.m.
Duties: System management, software installation and implementation, system software development, VAX user support, and serves as Laboratory Steward for ESD Computing Facility, and as DECnet Network Administrator.

Bert Harper -- Data Base Manager and System Configuration
Address: Room 122, Building 1505
Phone: 4-7301
Mail Names: HPR, HARPERJBJR
Typical working schedule: 8:00 a.m. to 4:30 p.m.
Duties: Design and implementation of ESD administrative data base system, and consultation on systems configuration.

Linda Littleton -- Office Automation Coordinator and PC Network Administrator

Address: Room 118, Building 1505

Phone: 6-2512

Mail Names: LZL, LITTLETONLW

Typical working schedule: 8:00 a.m. to 4:30 p.m.

Duties: Office automation coordination, PC network administration and implementation, and PC support, and servers as Alternate ESD computer security officer, and computer communications coordinator, and backup VAX System Manager.

3. REMOTE BATCH STATION (RBS) OPERATIONS

The Environmental Sciences Division (ESD) remote batch station (RBS) is operated by the ESD Computing Facility to process print and plot output from other computers at ORNL. Its operation is the result of coordinated communications between a series of computers and the final output device. All staff associated with ESD can route print and plot output to the ESD RBS from the ORNL Central Systems (e.g. IBM 3090, STC VAX, STC Ultrix, and PDP-10). When the ESD RBS is not operating, users may route print and plot output to devices in Building 4500N. If appropriate information is included in the name field, output generated at Building 4500N will be carried to Building 1505 by a regularly scheduled computer courier (see schedule posted in Room 119). Output generated after hours can be picked up in the Bin Room (near H-213) in Building 4500N (also near Laboratory Records).

3.1 RBS COMPONENTS

The components in the RBS operation include the following systems:

The computer system that originates the output data - These computers include the main user systems at ORNL (IBM 3090, PDP-10, STC VAX, OA VAXes, and STC Ultrix).

IBM 3090 - All of the central computer systems at ORNL route their output to printers through IBM "remotes." For example, the STC VAX sends a file for printing to the IBM 3090 which is subsequently relays it to the ESD RBS for output.

ESD SNA Gateway - The SNA Gateway is a communications server that translates data from SNA, which is the IBM communications language, to DECnet, which is the network protocol used by the ESD VAX 11/750. The SNA Gateway and its software emulates logical output devices to the IBM.

ESD VAX 11/750 - Software operating on the ESD VAX 11/750 handles the receipt of files from the SNA Gateway. The VAX then partitions the files for the RBS output into a separate subdirectory for each "IBM Remote Logical Device."

ESD output devices - In the final step of RBS processing, the VAX 11/750 executes command language programs that sends files to the appropriate printer or plotter. The RBS subdirectories are scanned for completed files to be sent to the printers or plotters every 5 min.

Successful communication of output files from the original central computer to the ESD output device depends on the correct operation of all of these devices.

Breakdowns in flow of output in the ESD RBS can occur when one or more of these systems fail. The most unreliable step in this process is the continued communications between the IBM and the SNA Gateway. The System Manager for ESD VAXes (Neil Griffith) has the responsibility for monitoring the correct operations for all of these devices. [If unusual delays appear to be occurring in the production of RBS output, please indicate problems to the System Manager (Neil Griffith).]

3.2 USER COMMANDS FOR SENDING OUTPUT TO ESD RBS PRINTERS FROM CENTRAL ORNL COMPUTERS

Print output from the ESD RBS can be generated by using a variety of commands. The ESD RBS printers are located in Rooms 119 and 121 of Building 1505. The following paper formats are available from the ESD RBS devices:

Size	Paper type	No. lines	No. of columns
14 x 8.5 in.	80% recycled, fanfold	60	132
14 x 8.5 in.	virgin, fanfold	60	132
8.5 x 11 in.	virgin, fanfold	60	80
8.5 x 11 in.	virgin, sheet	60	80

3.2.1 Printing from IBM 3090

The procedure for printing from the IBM 3090 depends on the type of job. Batch jobs are printed by adding a "ROUTE" statements to the JCL. The route cards look similar to the following:

```
//UIDname JOB ....... appropriate job card
/*ROUTE PRINT RMT44
```

The ROUTE statement may refer to remote 44 (RMT44) or remote 76 (RMT76). If a FORM option is not included on the "ROUTE" statement, then the default printer that has 14 x 8.5 in. paper is used with an upper case only format. Different printers can be selected from the forms option on the "JOBPARM" card. The correct syntax of this card is:

```
/*JOBPARM FORMS=####
```

Where #### is the form number.

The FORMS and REMOTE specifications operate in combination to determine which device is used for output. The available combinations include

Printer format and location	Remote No.	Form No.
14 x 8.5 in. recycled, line printer	44	none
(upper case only, fanfold)	76	4000
(Room 119, Building 1505)	44	4000
	76	4016
14 x 8.5 in. virgin, line printer	44	1016
(upper/lower case, fanfold)	76	1016
(Room 121, Building 1505)		
8.5 x 11 in. virgin, line printer	44	1003
(upper/lower case, fanfold)		
(Room 119, Building 1505)		
8.5 x 11" virgin, laser printer	44	L6BL
(upper/lower case, cut sheet)	76	L6BL
(Room 119, Building 1505)		

Interactive TSO printing can be executed with the TSOPRINT command. The syntax of this command is as follows:

TSOPRINT UID.FILE.NAME ACCOUNT(#####) ROUTE(RMT44) FORMS(1003)

The PRINTOFF utility can also be used in TSO. Its syntax is similar TSOPRINT, but it does not allow for specification of FORMS.

PRINTOFF UID.FILE.NAME DEST(RMT44)

3.2.2 Printing from STC or OA VAXes

Printing files from the STC and OA VAXes can be accomplished with the PRINT command after the user profile has been set. The profile is set with the PROFILE command on these VAXes. The PROFILE command prompts the user for definition or changes in the default charge number, name string for labelling print output, and the IBM remote for printing. To direct output to ESD RBS, users should specify RMT44 for output. Options for printing on different printer forms are not available from these VAXes.

3.2.3 Printing from STC Ultrix

Printing files from the STC Ultrix (STC06) system can be accomplished by way of the IBM remote and forms designations or by way of the TCP/IP network. Both of these commands should be reviewed by the STC Ultrix user because they use different communication pathways.

The LPRINT command allows for the specification of the IBM remote as a destination. For example, remote 44 of the IBM 3090 at ORNL is nx10a.rmt44. The LPRINT command also allows for the specification of an IBM FORM number, as described in Sect. 3.2.1. The syntax of an LPRINT command to print a file called "text" on the ESD LaserJet 2000 is as follows:

```
lprint -a"user name" -dnx10a.rmt44 -c##### -fl6bl text
```

where "user name" is a label string for the output header, nx10a.rmt44 specifies remote 44 of the ORNL IBM 3090, ##### is a valid C&TD charge number, and l6bl is the form for the LaserJet 2000 printer. (Note: UNIX commands are case sensitive.) The -a, -d, and -c information can be stored in a .prtcr file in the home directory in the following format:

```
addr:  user name
dest:  nx10a.rmt44
char:  #####
```

More information on LPRINT can be found with the "man lprint" command.

Sending print output to the ESD printer queues by way of the TCP/IP network can be accomplished with the ESDPRINT command. In this command, the following queues may be defined in the user's PRINTER global symbol:

PRINTER symbol	ESD queue	Paper type
lpco or uc	LPC0	recycled, 14 x 8.5 in., line printer
lcb0 or lc	LCB0	virgin, 8.5 x 11 in., line printer
lj0 or lj	LASERJET	virgin, 8.5 x 11 in., laser printer

The ESDPRINT uses the lpr command in a script file. Other lpr options may be specified on the ESDPRINT command and will override the script defaults.

3.2.4 Printing from PDP-10

To print files from the PDP-10, use the PRINT command with the remote option. Options for specifying printer FORMS to control which printer is used are not

available from the PDP-10. This command follows this syntax

PRINT FILE.DAT /FORM:RMT44

3.2.5 Printing from EPA IBM Systems at Research Triangle Park

The ESD RBS is also defined as an IBM remote from the IBM mainframe system operated by Environmental Protection Agency (EPA) at Research Triangle Park (RTP), North Carolina. The EPA RTP system is occasionally accessed by ESD personnel to retrieve data from STORET. ESD has a "dial up" connection that can be enabled to transfer output to the ESD output devices. On the EPA IBM systems at RTP users should specify REMOTE 106. The commands for using this remote are similar to those used on the ORNL system. After output has been generated on the EPA system for REMOTE 106, users should contact the System Manager (Neil Griffith) and request that the output be downloaded. If files are desired instead of printed output, this should also be communicated to the System Manager. Additional information on how to access the EPA IBM computers at RTP can be obtained from Carolyn Hunsaker, ESD.

3.3 USER COMMANDS FOR SENDING OUTPUT TO ESD RBS PLOTTERS FROM CENTRAL ORNL COMPUTERS

Plot output from IBM and VAX software (e.g. SAS/GRAPH, DISSPLA, TELLAGRAF, CUECHART, and MAPPER) can be sent to the ESD RBS plotters by using the PLOT command. The PLOT commands use a DISSPLA metagraphics file (DMF) as an intermediate file generated by the original software. The DMF file is a very useful intermediate file because the PLOT command contains options to send the same DMF file to ESD plotters, Computing and Telecommunications Division (C&TD) plotters, FR-80 Film Recorder (for slides), and to the user's terminal under numerous Tektronix and Hewlett Packard specifications. Versions of the PLOT command are found on the IBM, STC VAX, and PDP-10.

The black and white plotters accessible from the ESD RBS are:

Small (11 in.) Versatec electrostatic plotter with 200 dots per inch (DPI) resolution and minimal operating condition for draft plots only.

Large (36 in.) Versatec electrostatic plotter with 400 DPI resolution and very good condition for final plots.

Both of these plotters are located in Room 119, Building 1505.

3.3.1 Plotting from IBM 3090

Plotting from the central IBM 3090 at ORNL is accomplished with the PLOT command. Its syntax is generally as follows:

```
PLOT ESD T.UID#####.FILE.DMF ACCOUNT(#####)
CARDS(50000)
```

where UID is C&TD user identification code (ID) and ##### is the C&TD charge number. The value for the CARDS option may need to be increased or decreased depending on the intensity of the graphics and the size of the plot file. This command will send the plot to the small Versatec plotter at ESD. If the DMF file is be plotted on the large Versatec, then the PAPER option needs to be added to the PLOT command as follows:

```
PLOT ESD T.UID#####.FILE.DMF ACCOUNT(#####)
CARDS(50000) PAPER(500)
```

Other options and devices available for the PLOT command can be found with the HELP PLOT command on the IBM 3090.

3.3.2 Plotting from STC and OA VAXes

Plotting from the STC and OA VAXes at ORNL is accomplished with the PLOT command. Its syntax is generally as follows:

```
PLOT/NEW/DEVICE_TYPE=ESD File.name
```

This command sends the DMF file to the small Versatec plotter. Output can also be sent to the large Versatec by including the PAPER option as follows:

```
PLOT/NEW/DEVICE_TYPE=ESD File.name/PAPER=500
```

Because the plot data are sent to ESD by way of the IBM 3090 computer, a CARDS option may be needed for large plot files. This option can be added to the end of the above commands as a /CARDS=number. The default number for CARDS is 20000.

Other options and devices available for the PLOT command can be found with HELP PLOT command. The PLOT command on the VAXes has recently been improved to process CGM and HPGL input. Postscript output is also now available.

3.3.3 Plotting from STC Ultrix

A limited set of graphics software is available on the STC Ultrix system. Users should seek assistance from the C&TD computer graphics group of C&TD User Services for additional information on the graphics libraries and plot transfer options available on STC Ultrix.

3.3.4 Plotting from PDP-10

Graphic output from the PDP-10 is transferred with the PLOT command. The command syntax is generally as follows:

```
PLOT ESD:=FILE.DMF/CARDS:50000
```

The value for the cards option depends on the intensity of the plot and can be adjusted higher or lower. Currently, plots cannot be sent from the PDP-10 to the large Versatec by using the PDP-10's PLOT command. Because the PDP-10 is being phased out, this feature is unlikely to be implemented. Other information on the PLOT command can be found with HELP PLOT command on the PDP-10.

3.4 REPRINTING AND REPLOTTING OUTPUT ON ESD RBS

Because print and plot outputs are occasionally lost, the ESD RBS retains the files that generated the output until 4:00 p.m. of the next working day. Once a file for printing or plotting has been received by the ESD RBS, it can be readily reused for printing or plotting additional copies. These copies can be reprinted without repeating the initial cost of the job. Requests for reprinting and replotting should be made by contacting the System Manager (Neil Griffith). Users requesting printing or plotting reprocessing should provide as much of the following information as possible:

User ID,
JOB name (if known),
approximate time and date of the original printing or plotting, and
number of copies to be produced.

3.5 USE OF RECYCLED PAPER IN ESD PRINTERS

In November 1989, the ESD RBS started a Performance Improvement Process (PIP) project for using recycled paper in its line printers. Because recycled paper is expected to have a shorter shelf life than "virgin" paper, a FORMS has been made available for printing on other paper. Because most of the forms are not accessible from the other computers at ORNL, it may be necessary for users to "reprint" their output after it has printed on the default paper. These reprints are generated from the same files previously described above in this handbook. The user may request

a reprint by forwarding a mail message to the System Manager [Neil Griffith (NAG)] or by leaving a message in the labelled box in the printer room (Room 119) in Building 1505. If possible, the user should indicate the JOB number of the print job to be reprinted. The JOB number can be found on the first and last page of each listing. If the first page looks like this:

```
NAME  * JOB 4817 UIDNAME  AA 1  001 001 NX10A START 10.00 14 FEB 90
NAME  * JOB 4817 UIDNAME  AA 1  001 001 NX10A START 10.00 14 FEB 90
NAME  * JOB 4817 UIDNAME  AA 1  001 001 NX10A START 10.00 14 FEB 90
NAME  * JOB 4817 UIDNAME  AA 1  001 001 NX10A START 10.00 14 FEB 90
```

In this example, the JOB number is 4817.

4. USER AUTHORIZATION ON ESD SYSTEMS

The Environmental Sciences Division (ESD) Computing and Geographic Information System facility provides access to and complements the computing resources available from the central facilities at ORNL. Therefore, the authorization of users is restricted to those having one or more of the following special needs:

1. access to printers and plotters in ESD from other computer systems in ESD,

2. access to ESD network,

3. access to ESD geographic information system (GIS), or

4. limited processing of CPU intensive, production ready, environmental models.

4.1 AUTHORIZATION ON ESD VAX CLUSTER

Users can acquire authorization to the ESD systems by:

- Discussing their computing needs with and getting approval from the System Manager (Neil Griffith). This verifies that the user has computing needs that fit the above categories.

- Having or obtaining a valid User ID from C&TD. When users have an existing user ID from C&TD, it assures ESD that the individual already has been approval to have access to computers at ORNL and Energy Systems.

- Submitting a request through their management to the C&TD Office of Computer Charges (4-5315). The request submitted to this office is the same as the one for requesting access to any other ORNL computer, except it specifies access to the ESD VAX. This is an "information" requirement for C&TD, not an approval requirement. Because the ESD computers are accessible from the central System Select network, keeping C&TD informed about our authorized users is a security requirement.

- Providing ESD Computing Facility operations staff information about yourself. This includes, your name, user ID, address, phone number, and section/program assignment within ESD.

- Setting a password After an account is built for the user, they must log in under the System Manager's (Neil Griffith) supervision to change a temporary password to their current C&TD password. Use of the C&TD passwords is a required security procedure on ESD VAXes. (Note: Sharing of passwords with other users is a violation of Energy Systems Computer Security Policy).

These steps do not take more than about 1 day if the user already has a valid C&TD user ID. Obtaining a valid C&TD user ID can take 3 to 7 days.

4.2 AUTHORIZATION ON ESD WORKSTATIONS

The user authorization for access to ESD workstations is the responsibility of the owners of the workstation. The use of valid C&TD user IDs and passwords are required for workstation accounts.

5. OPERATION OF ESD COMPUTING AND GIS FACILITY

This section paraphrases the Standard Operating Procedure for the Environmental Sciences Division (ESD) central computing facility. More details on this information can be found in the ESD procedure files. This discussion is to provide the user with a general understanding and appreciation of the operations and their limitations. Normal operations and staffing, abnormal events, and computer room access limitations are discussed.

5.1 NORMAL OPERATIONS

The normal operation of the ESD computing and GIS facility continues on a 24-h, 7-day per week basis. The equipment in this facility is capable of normal operation without direct supervision by staff. Normal operations will be interrupted if the computer room environmental conditions (e.g., temperature, humidity, and power supply) are inappropriate. Staff to control and intervene in the operation of the facility are on hand from 8:00 a.m. to 4:30 p.m., Monday through Friday. Other times during the week (nights and weekends) are considered "after hours." Operations staffing for after hours is evaluated on an as-needed and case-by-case basis.

5.2 ABNORMAL EVENTS AND OPERATION INTERRUPTIONS

The ESD computer room is sensitive to a few operational restrictions that will result in alarms and abnormal event notification. The following items describe the abnormal event and the appropriate response.

Power supply - The main circuit breakers for the computer room will trip if the electricity supply is inadequate or interrupted. Electricity should not be automatically reenabled after outage. Computing facility staff should always be contacted before electricity is reenabled. If an unscheduled power outage occurs, power in the computer room should not be started without contacting one of the emergency contacts. The main power circuits in the computer room are locked to prevent the unauthorized restoration of power.

High temperature - A sensor sends an alarm to the ORNL Laboratory Emergency Response Center when the temperature exceeds 82° F and shuts down the power when the temperature reaches 88° F. Computing Facility and Plant and Equipment Division (P&E) staff should investigate all temperature problems before continuing computer operations. If a failure in the cooling supply occurs after normal working hours, one of the emergency contacts listed at the end of this section should also be called. If the cooling supply fails during normal working hours, the operation of the equipment may

continue for a limited time (1 to 2 h), but requires fairly constant surveillance by one of the emergency contacts listed at the end of this section.

High or low humidity - A sensor sends an alarm to the ORNL Laboratory Emergency Response Center when the relative humidity is below 20% or above 80%. Computing facility and P&E staff must investigate all humidity (and potential temperature) problems before normal operations can continue.

Water under floor - A "water bug" sends an alarm to the ORNL Laboratory Emergency Response Center and shuts down the electrical power when water is detected on subfloor. Computing facility and P&E staff must investigate all water present before normal operations can continue.

Heat and smoke detector - This detector sends an alarm to the ORNL Laboratory Emergency Response Center, activates building evacuation alarm, and shuts off electrical power and air-conditioning. Normal operations will not continue until the alarm is investigated by the ORNL Fire Department and facility staff.

The Laboratory Emergency Response Center and ORNL Shift Supervisor's office have an "emergency notification" procedure indicating who to contact after an alarm event occurs. In an emergency or any other event that affects the power or cooling supply in the computer room, one of the following people should be contacted:

	Name	Work phone	Home phone
1st contact:	Neil Griffith	574-7817	690-1876
2nd contact:	David Fowler	574-7301	966-7047
3rd contact:	Ken Pate	574-5665	922-6193

5.3 COMPUTER ROOM AND GIS FACILITY ACCESS

The ESD Computer Room (Room 121, Building 1505) is designated as an area of "restricted access." This designation is to protect the automated data processing (ADP) equipment and its operation. Access restriction is not based on the need to protect "sensitive" information. All computing in the ESD computing facility is "unclassified and nonsensitive." The central computer room, along with Room 119, Building 1505 (Printer Room) have also been designated an "ESD Laboratory" with a designated Laboratory Steward (Neil Griffith) and Group Leader (David Fowler). ESD policies confer complete responsibility and authority over the activity and access to these areas on the Laboratory Steward and Group Leader. The printer room is open to all personnel at all times.

The following persons have unrestricted, authorized access to the ESD Computer Room. They have keys or have access to keys to Room 121 and are capable of assisting with shutdown and startup procedures.

David Fowler	Supervisor and Group Leader
Kris Dearstone	GIS Operations Coordinator
David Fowler	Supervisor and Group Leader
Mike Friend	C&TD Systems Support
Neil Griffith	System Manager
Linda Littleton	Network Manager and Systems Support
Raymond McCord	ESD Computer Security
Ken Pate	I&C Repair Supervisor
Danny Sluss	I&C Repair Technician

Access to the ESD Computer Room by other persons is limited to normal working hours and must include registration in the Martin Marietta Energy Systems, Inc. Visitor Record Logbook For Controlled-Access ADP Facilities (UNC-16956).

The GIS Laboratory (Rooms 173 and 175 of Building 1505) has not been designated an "ESD Laboratory." Its access is unrestricted during normal working hours. The GIS Laboratory is usually locked after hours. The locking of the GIS Laboratory after hours is solely to protect the fragile equipment. Staff members needing after-hours access to this area should make arrangements with Kris Dearstone. Other ESD staff members with keys to the GIS Laboratory include Carolyn Hunsaker, Raymond McCord, Dick Olson, and Mary Alice Faulkner. The GIS Laboratory is also accessible from the computer room. The last person leaving the GIS Laboratory after 4:30 p.m. is responsible for locking Room 175 and turning off all PCs and terminals.

6. TELECOMMUNICATIONS WITH ESD COMPUTERS

The Environmental Sciences Division Computing and Geographic Information System Facilities are accessible via several methods of telecommunications. Telecommunications with the ESD computers are used for "terminal" interactions and for uploading and downloading files to and from the user PCs.

Although many telecommunications alternatives exist, the best, most responsive, and reliable one will have the fewest number of intermediate devices. Users are encouraged to select the most direct communications route possible (i.e., a direct terminal line is most responsive and reliable). However, the network options have the potential for the greatest quantity and variety of communications with other computers. Some of these options are only available to a limited segment of the user community because of their increased cost.

To assist users in understanding and troubleshooting the alternatives, the following discussion describes the commands and hardware components for each alternative. Successful communication with each alternative requires the simultaneous operation of each the components and the final host ESD VAX.

The following information summarizes the number of components and systems involved in each communications option:

Option	No. of intermediate components	Other accessibility
System Select	4	100 other Energy Systems computers
Broadband	5	System Select and DECnet
DECnet	6	other VAXes
TCP/IP	5	other VAXes and workstations
Direct Line	2	None

6.1 SYSTEM SELECT NETWORK

The ESD VAX 11/750 is directly connected to the System Select Network communications equipment. This is the system to which most of the wall ports are connected at ORNL. When answering the "Which System" prompt, the user can access the ESD system by entering 46.

After selecting System 46, the user will be prompted to log in to the ESD VAX 11/750. After logging into the VAX 11/750, users are requested to immediately connect to one of the other ESD VAXes. The VAX 11/750 is not intended to

support direct user computing; its primary purposes are the hosting of the ESD VAX cluster, processing print and plot information, handling intermediate communications, and making backup tapes. Connection to other ESD systems is accomplished with the "SET HOST" command discussed in the DECnet section (Sect. 6.5).

In addition, by using the System Select to access ESD computers from wall ports at ORNL, users can access the System Select Network remotely by dialing a series of modems. The 300/1200/2400 baud modems are accessible from the following phone numbers: 574-7474, 576-5750, 576-6922, and 576-4822. All users accessing the Energy Systems System Select Network from the modems must enter a valid C&TD user ID and password, before they can select a system. Users should verify that their ID and password are valid for the security device before they travel to a remote location and try to attempt dial-up access to System Select.

Equipment pathway for System Select communications

- The user's terminal or PC with terminal emulator (e.g., SmarTerm and Kermit).
- A "phone" circuit from the user's wall port to the System Select concentrator or multiplexor in ESD.
- A "phone" line from Building 1505 to 4500S to another multiplexor.
- A "phone" line back to Building 1505 to the VAX 11/750 communications controller.

6.2 ENERGY SYSTEMS BROADBAND NETWORK

Many computer users in ESD have terminal communications provided by the Energy Systems broadband network. The ESD computers are also accessible from the broadband network. If a user is connected to the broadband network, they will have a special terminal cable to plug into the wall port, and they will see a "#" for their initial prompt.

From the broadband network, the user can connect to the System Select described in Sect. 6.1 and select system 46. System Select is accessed from broadband by using a "CALL DD00" or "CALL DCF0" command. The broadband user can also connect to ESD systems by way of a DECnet terminal server (accessed by "CALL 450"). After the terminal server is connected, the user will see a "Local>" prompt. Any ESD VAX (or other Energy Systems VAX) can be connected from the terminal server by the CONNECT command with the DECnet node name. For example: C ESDV03 is command needed to connect directly to the ESD MicroVAX 3500 from the terminal server. ESD VAX systems have the following DECnet node names:

System	Node name	Node No.
VAX 11/750	ESDV01	55.7
MicroVAX 3500	ESDV03	55.20
VAXstation 3100	ESDMJS	55.29

Because the broadband users are on a true communications network, ESD systems can also be accessed by making direct connections to other systems (e.g., STC VAXes "CALL 700") and by using DECnet to "SET HOST" to ESD systems.

Equipment pathway for broadband communications

- The user's terminal or PC with terminal emulator (e.g., SmarTerm and Kermit).
- A "phone" circuit from the user's wall port to the Broadband modem in ESD.
- The broadband line from Building 1505 to Building 4500S to a Broadband "router".
- One of the following:

1. System Select multiplexor in 4500S.

   A "phone" line back to Building 1505 to the VAX 11/750 communications controller.

or

2. The DECnet terminal server and router in Building 4500

   Broadband cable back to a DECnet Bridge in Building 1505

   DECnet network and router in Building 1505.

6.3 DECNET

All of the ESD VAXes are accessible from the Energy Systems network by way of DECnet. DECnet communications protocol and ethernet hardware is a network system connecting VAXes across ORNL and Energy Systems. With DECnet a user can connect to another VAX system on the network with the "SET HOST" command.

The SET HOST command with the Node Names described in Sect. 4.3 can be used on any VAX at ORNL to connect directly to an ESD VAX.

Many of the PCs in ESD have their own DECnet software and network cable. These PCs on the ESD network are also able to use a "SETHOST" command for a direct connection to one of the ESD VAXes. The node names and numbers for the ESD VAXes must be defined on each networked PC before it can communicate directly with ESD VAXes. This PC command is functionally similar to the VAX "SET HOST" command. (Note: SETHOST on the PC is a DOS command that is all one word.)

Equipment pathway for DECnet communications with ESD VAXes

1. The user's terminal or PC with terminal emulator (e.g., SmarTerm and Kermit).

   A "phone" circuit to System Select

   System Select components necessary to connect to first host system with DECnet (e.g., STC VAXes).

   The first DECnet host and router.

   Broadband cable back to Ethernet network bridge in Building 1505.

   DECnet network and router in Building 1505.

or

2. Network software, board, and cable for the user's PC.

   ESD network and router.

6.4 TCP/IP

TCP/IP is another network protocol using most of the same hardware as DECnet does. However, unlike DECnet, it is not predominantly restricted to VAXes. The part of TCP/IP that handles terminal communication is called TELNET. Users may access the ESD VAXes by entering the node name to the TELNET prompt. For example, to reach the ESD MicroVAX 3500 from the STC VAX, the user would enter ESDV03 to TELNET prompt.

TELNET is also a way of accessing ESD system from remote locations around the world. Users at remote locations will need to specify the full TELNET node names or numbers. The names given to the ESD systems are as follows:

System	TCP/IP node name	TCP/IP No.
MicroVAX 2000	ESDV02.ESD.ORNL.GOV	128.219.24.12
MicroVAX 3500	ESDV03.ESD.ORNL.GOV	128.219.24.13

Other systems in ESD may be using TCP/IP, but they may or may not be available with TELNET. TELNET may also be accessed from System Select 99. At the DCA TELNET prompt, the users should specify the OPEN Command and the TCP/IP number. Dial-up access to System Select 99 requires registration and prior approval with Telecommunications Security. A public domain version of TCP/IP software is also available for PCs on the ESD network.

Equipment pathway for "TCP/IP" communications

The user's terminal or PC with terminal emulator and one of the following:

1. A "phone" circuit to System Select.

   System Select components necessary to connect to first host system with TCP/IP (e.g., STC VAXes).

   The first TCP/IP host.

   Broadband cable back to Ethernet network bridge in Building 1505.

or

2. The network software, board, and cable for the user's PC.

   The ESD network.

6.5 DIRECT TERMINAL LINE

Several users in Building 1505 access the ESD VAXes by way of direct terminal line. All of the operations and GIS terminals use direct terminal lines. Direct terminal lines are the most responsive type connection to the ESD VAXes. However, they do have the disadvantage that the user must always log in on an ESD VAX before they can use the direct terminal lines for communications with other computers.

Equipment pathway for direct terminal line communications

The user's terminal or PC with terminal emulator.

A "phone" circuit and components necessary to connect from the user's wall port to terminal port controller on the ESD VAX.

7. COMPUTER SECURITY PRACTICES FOR ESD VAXES

Because ESD VAXes and workstations are multiuser computers that are remotely accessible, good computer security practices are essential to avoid interruptions and delays in computing projects. The following is a brief reminder of computer security basics.

7.1 IMPORTANT PHONE NUMBERS

Name	Phone	Official capacity
Neil Griffith	4-7817	ESD VAX Cluster Computer Security Officer
Raymond McCord	4-7827	ESD Computer Security Officer
Linda Littleton	6-2512	Alternate ESD Computer Security Officer and ESD Network Security Officer
Bill Rich	4-7024	ORNL Computer Security Officer
CTSO Hotline	4-5445	Computing and Telecommunications Security Organization Hotline

7.2 ESD COMPUTERS FOR OFFICIAL USE ONLY

All ESD personnel should be constantly aware that all computing equipment at ORNL and ESD is government property. Therefore, the use of this equipment is restricted by Energy Systems policies and DOE orders. Unauthorized and inappropriate use of government computers can result in civil and criminal penalties. ESD personnel should be aware that Energy Systems policies allow for the review by supervisory personnel and the Computer Security Organization of your system use and data files at anytime without warning. The following guidelines for computer security are designed to help you to avoid violating these restrictions.

You are authorized to use ESD computers for the exclusive purpose of performing your work assignment. Games, hobby or club activities, personal correspondence, and personal or outside consulting or business activities constitute "misuse of Government property." Appropriate supervisory personnel and authorities will be notified if violations of this principle is suspected.

7.3 COMPUTER SECURITY INCIDENT REPORTING

You are required to report computer security incidents (e.g., suspected unauthorized system access and tampering with your programs and data) to one of the staff members or organizations listed in Sect. 7.1. An appropriate ESD staff member should be contacted first, if at all possible. Prompt reporting of incidents greatly assists the accurate analysis and evaluation of the incident.

7.4 PASSWORDS

7.4.1 C&TD Password

Users are required to use their C&TD passwords on ESD VAXes. These passwords are randomly generated, and are changed approximately every 12 months by C&TD. They are your first and best defense against unknown access and modification of your data. One of the most-routine practices of "hacker" programs is to scan systems for easy passwords (especially passwords that are the same as the user ID).

7.4.2 Password Sensitivity

Computer security procedures at ORNL and Energy Systems specifically prohibit activities that have the potential to breach password security. These include:

- Visibly posting your password near your PC or terminal,
- Including your password in programs and "script" files,
- Storing your password in "smart keys" in a terminal emulation, or
- Sharing your password.

If you need help in sharing data or programs with other users on the ESD VAXes without violating password security, please contact the System Manager (Neil Griffith).

7.5 UNATTENDED INTERACTIVE SESSIONS

It is a violation of Energy Systems computer security procedures to leave interactive sessions unattended. If you are going to leave your terminal or PC for more than a few minutes you should log off, lock your PC, or lock your office. The ESD VAXes routinely run a program called Sphinx that issues warnings and kills inactive (e.g., unattended) interactive jobs. Sphinx generates the first warning message after 10 minutes of terminal inactivity, a second warning after an additional minute, and terminates the job after a 12th minute of inactivity. Users who encounter routine problems with Sphinx (e.g., GIS processes that may have long periods of no apparent terminal response) should contact the System Manager (Neil Griffith).

7.6 PROTECT DATA FROM UNAUTHORIZED ACCESS

Security features are available on each system to protect the access of your data files by others. Information in your custody is a valuable company asset that should be protected according to its highest level of sensitivity. Many ESD personnel may have information (i.e., preliminary research data and environmental monitoring and

assessment data) that is subject to public disclosure limitations. Because all of the multiuser ESD systems are accessible from remote (public) networks, users must be careful not to violate disclosure limitations by leaving data unprotected or accessible to the public.

Some ESD personnel will use some data whose access will be restricted to a limited group of other Energy Systems personnel. Limitations on the internal access to data should also be followed at all times.

7.7 ESD VAX FILE PROTECTION

File protection under the VMS operating system used on the ESD VAXes can be specified for different groups of users to allow different levels of access to files and directories. Before a file can be accessed by another user its protection and the protection of its directory and any directories above it must all be set up to allow access to the other user.

7.7.1 User Group File Protection

The user groups defined for file protection include:

The system - The system account of the VAX. It is not actually possible for a user to completely prevent system access to a file. System privileges can make the file accessible and unprotected from the system.

The owner - Files are not usually protected from the owner, unless the owner is interested in preventing accidental deletion.

The group - User IDs are assigned to groups that collectively can provide secondary access and privileges to specified files and programs. The group-level designation provides a means of allowing for file access to a "known" group of users without allowing access to the "world" discussed in the following. ESD VAXes currently have four groups of users that are defined by the System Manager (Neil Griffith):

Operations staff
GIS users
Other users
PC network users

The world - The world group of users includes all users on the local system and all users on any system networked to the ESD VAXes. The world group includes users connected by way of the Energy Systems network, which includes connections to over 100 other VAXes in Oak Ridge and numerous (thousands of) other systems from other remote networks around the world.

7.7.2 Protected File Activities

For each file or directory you can specify controlled access by the groups described in Sect. 7.7.1 for the following activities:

> Read - The reading of a file can be specifically allowed. If a file can be read by another user, it can also be copied.
>
> Write - The ability to write, edit, or enter information into a file can be specifically granted to other users.
>
> Execute - If the file is a program, its execution can be specifically controlled.
>
> Delete - A file may be deleted by any user that has this level of access.

Any form of access to a file also requires access to the directories above it.

The default file protection on ESD VAXes is:

System - Read, Write, Execute, Delete
Owner - Read, Write, Execute, Delete
Group - Read, Execute
World - Read, Execute

7.7.3 Changing File Protection

The protection of a file may be changed with the following type of command:

```
SET PROTECTION=(O:R,W) file.name
```

This command would change the protection so that the owner could only read the file and the world would have no access to the file. Note that when complete access is to be denied, none of the access options are included for the group. Group levels that are not included in a SET PROTECTION remain unchanged. If the protection of several files is to be changed, then wildcard file specifications can be used with the SET PROTECTION command.

The extremes of protection include files so protected that the only action the user can do is change their protection (unprotect them) and files that are so unprotected that any user can delete them.

The protection of a file may be shown with the /PRO option on the DIRECTORY command. The default protection is shown by the directory command in the following syntax:

(RWED,RWED,RE,RE)

The order of the group in this syntax is system, owner, group, and world.

8. USER SOFTWARE

The ESD VAXes are equipped with the standard, proprietary VMS operating system software available from DEC. The version of the operating system is usually the same as the one used on the C&TD VAXes. In addition to the basic file commands of COPY, RENAME, DELETE, DIR, etc., several other commands are highlighted below. Help is available for all of these utilities with the HELP command.

8.1 ELECTRONIC MAIL

The electronic mail available on ESD VAXes is standard VMS Mail. The mail command is executed by MAIL. Help is available within the mail program. ESD VAX users can send mail to each other by specifying the appropriate user identification (UID). Mail can be sent to users of other Energy Systems computers by sending the mail message to the nearest mail router. For example, a "send" name string of STC::DXF will send mail to David Fowler on his default mail host system. The mail can be sent directly to a network location by including the node name (e.g., STC10::) in the mail address.

8.2 PHONE AND TALK

PHONE is a user communication command that allows users to dialogue by generating a split screen for typing. The command is useful for communicating with users who cannot be reached by telephone. TALK is a TCP/IP utility that is equivalent to PHONE. TALK can be used to communicate with users on UNIX systems.

8.3 EDITORS

Text files can be edited via two editors (EDT and EVE). EDT is the default text editor that is used when the command EDIT (filename) is specified. EDT has both line and full screen editing modes. Full-screen editing requires the use or emulation of a standard DEC terminal (e.g., VT100, VT240, or VT340). All of the common terminal emulators for IBM PCs (Kermit, SmarTerm, PibTerm, PC Talk, and TGRAF) can emulate one of these types of terminal. In addition to the updating of full screen edits, the emulation also provides for the definition of advanced functions (e.g., Find, and Next Screen). A significant amount of editing can be accomplished without these advanced functions.

The EVE editor is also available on the ESD VAX. It uses a full-screen editing style with a limited number of commands. EVE is a more powerful editor than EDT and has advanced functions such as split-screen editing. Because it is more powerful, it is sometimes slower than EDT. The challenge to sophisticated usage of either of

these editors is figuring out the location of the advanced function keys for your favorite terminal emulator.

8.4 FORTRAN COMPILER

The FORTRAN compiler is available on all systems on the ESD VAX cluster. This compiler is from DEC and is identical to the one available on the STC VAXes. The FORTRAN command is used to compile FORTRAN source code. The LINK and RUN commands are also used to link and run the final executable program.

8.5 C COMPILER

DEC's C compiler is available on the ESD VAXes. This compiler can be accessed with the CC command.

8.6 GRAPHICS DEVICE LIBRARIES

Several Graphics Device Libraries are available on the ESD VAXes. These include libraries for the Calcomp plotter, Versatec plotters, Tektronix terminals, and Imagen laser printers. These libraries contain standard graphics subroutines such as DRAW, NEWPEN, SYMBOL, PLOT, etc. The following files can be used for linking to user written programs:

Library name	Output device
SYS$LIBRARY:V9COL2.OLB	-- small Versatec
SYS$LIBRARY:COL2V0.OLB	-- large Versatec
G$ESDISK:[ARC50.ARC.PLOTTERS]CAL907.OBJ	-- Calcomp pen plotter
G$ESDISK:[ARC50.ARC.LIB]IGLLIB.OLB	-- Tektronix terminals
SYS$LIBRARY:IMPLOT.OLB	-- Imagen laser printer (IMPLOT closely emulates Versatec library).

These libraries can be linked to your FORTRAN object file by a command similar to the following:

```
$ LINK myprog,sys$library:implot.olb/lib
```

Users interested in developing graphics access to these devices are encouraged to contact the System Manager (Neil Griffith) for additional details and examples on how to send the graphics files to the appropriate devices.

9. ESD GIS SYSTEMS

The Environmental Sciences Division (ESD) Computing Facility has installations of four commercial geographic information systems (GISs). These systems were acquired so that ESD research staff and technicians could have "hands on" interaction with spatial processing and map generation. These GISs include:

ARC/INFO - Vector- and polygon-based GIS software by Environmental Systems Research Institute (ESRI), Inc., operating on the MicroVAX 3500 and VAXstation 3100.

GRID - Raster based GIS software by ESRI, Inc., operating on the MicroVAX 3500.

SPANS - Quadtree based GIS software by TYDAC, Inc., operating on a PC 386 Clone in the GIS Laboratory (Room 173, Building 1505).

ERDAS - Raster GIS and image processing software by ERDAS, Inc., operating on an IBM PC/AT in the GIS Laboratory (Room 173, Building 1505).

Each of these GISs have both similar and unique spatial analysis capabilities. All also have data exchange formats with one or more of the other GIS systems. These systems also have hardware connections to many of the peripherals.

9.1 ARC/INFO

ARC/INFO is a vector- and polygon-based GIS developed by ESRI, Inc., in Redlands, California. ESD installed ARC/INFO in late 1986. Currently, ARC/INFO is fully licensed to operate for multiple users on the MicroVAX 3500. A single-user license for basic ARC/INFO is installed on VAXstation 3100 workstation.

9.1.1 ARC/INFO Software Overview

The ARC/INFO software includes the following GIS modules:

Basic ARC/INFO - the part of ARC/INFO which is used for basic GIS data manipulation such as DESCRIBE, COPY, KILL, CLEAN, and INTERSECT.

ARCSHELL - an optional menu-based command interface.

INFO - a data management subsystem by Henco Software, Inc., for editing, reporting, and manipulating attribute data.

ARCPLOT - a graphic display subsystem for generating maps and graphics.

ARCEDIT - an editing subsystem for entering and modifying geographic and attribute data.

TIN - a subsystem for three dimensional (3-D) data processing and surface estimation. This system is based on the triangulation of an irregular network of x,y,z data or a regular lattice. It can generate contours and 3-D views. (TIN is not licensed on the VAXstation 3100.)

NETWORK - a network analysis subsystem for defining and analyzing linear networks. This subsystem is suitable for transportation resource allocation and routing design. (NETWORK is not available on the VAXstation 3100.)

LIBRARIAN - A GIS data management subsystem for storing, accessing and maintaining reference GIS data.

SYMBOL - an editing subsystem for user-defined point, line, and text symbols.

Two copies of manuals (eight volumes covering hundreds of commands) for the ARC/INFO modules are kept in the GIS Laboratory. Several of the core GIS users also have copies of the manuals. Additional sets of the documentation can be ordered for approximately $1000.

9.1.2 ARC/INFO Hardware Overview

The ARC/INFO GIS configuration in ESD also includes the following hardware items:

Tektronix 4111 color graphics terminal (GIS Laboratory, Room 175, Building 1505)
Tektronix 4107 color graphics terminal (GIS Laboratory, Room 173, Building 1505)
Calcomp 9100 Digitizer (GIS Laboratory, Room 173, Building 1505)
Calcomp 1044 color pen plotters (Computer Room, Room 121, Building 1505, and Room 225, Building 1000)
Versatec 36 in. 400 DPI black and white plotter (Printer Room, Room 119, Building 1505)
Imagen 2308 graphics laser printer (GIS Laboratory, Room 175, Building 1505)
Tektronix 4692 color inkjet printer (GIS Laboratory, room 175, Building 1505)
QMS Colorscript 100 color postscript printer (Graphics Laboratory, Room 165, Building 1505)

9.1.3 ARC/INFO GIS Reference Data

The ARC/INFO GIS has several reference coverages of political boundaries, land use, and hydrology that can be useful to several ESD projects. These data are stored in a library disk area (LIB:[LIB], LIB:[ECPA]) and described below:

Political Boundaries

Contents:	**U.S. Counties and States, 48 States**		
Work space:	[ECPA.COUNTY48]	Name:	COUNTY48
Resolution:	1:2,000,000	Source:	USGS
ESD contact:	Kris Dearstone		

Contents:	**U.S. 48 States**		
Work space:	[ECPA.STATES]	Name:	STATES
Resolution:	1:2,000,000	Source:	USGS
ESD contact:	Kris Dearstone		

Contents:	**Medium Resolution, U.S. Counties and States, 48 States**		
Work space:	[LIB.USA.USGS]	Name:	US_7HM
Resolution:	1:7,500,000	Source:	USGS
ESD contact:	Dick Olson		

Contents:	**Low Resolution, U.S. Counties and States, 48 States**		
Work space:	[LIB.USA.USGS]	Name:	US_17M
Resolution:	1:17,000,000	Source:	USGS
ESD contact:	Dick Olson		

Contents:	**Very Low Resolution, U.S. Counties and States, 48 States**		
Work space:	[LIB.USA.USGS]	Name:	US34M
Resolution:	1:34,000,000	Source:	USGS
ESD contact:	Dick Olson		

Federal Administrative

Contents:	**U.S. Federal Administrative Units (National Parks, Forests, etc.) 48 States**		
Work space:	[ECPA.ADMIN]	Name:	ADMIN
Resolution:	1:2,000,000	Source:	ESRI
ESD contact:	Dick Olson		

Land Use - Ecoregions

Contents:	**Major Land Resource Areas, 48 States**		
Work space:	[LIB.USA]	Name:	MLRA
Resolution:	1:7,500,000	Source:	SCS
ESD contact:	Sidey Timmins		

Contents:	**Ecoregions, 48 States**		
Work space:	[ECPA.ECOREGN]	Name:	ECO_STATES
Resolution:	1:2,000,000	Source:	EPA
ESD contact:	Dick Olson		

Runoff

Contents:	**Estimate Annual Runoff, 48 States**		
Work space:	[ECPA.RUNOFF]	Name:	RUNOFF
Resolution:	1:2,000,000	Source:	USGS
ESD contact:	Kris Dearstone		

Hydrology

Contents:	**USGS Hydrologic Units (HUCS), by HUC Region (1-18)**		
Work space:	[ECPA.HUC]	Names:	HUC01...HUC20
Resolution:	1:2,000,000	Source:	USGS
ESD contact:	Kris Dearstone		

Contents:	**EPA River Reaches, by HUC Region (1-18)**		
Work space:	[ECPA.REACH]	Names:	REACH1...REACH 6,17,18
Resolution:	1:500,000	Source:	USGS
ESD contact:	Kris Dearstone		

DOE Oak Ridge Reservation (S-16A)

Contents:	**DOE Oak Ridge Reservation S-16A Map Data in 47 Thematic Layers**		
Work space:	[LIB.S16A]	Name:	L01...L59
Resolution:	1:24,000	Source:	TVA/DOE
ESD contact:	Raymond McCord		

All of the US data is projected in a "standard" Albers projection of meters with the following parameters:

Standard parallel latitudes	29.5° and 45.5° N
Central meridian longitude	96° W
Latitude of projection origin	23° N
False easting	0
False northing	0

The S-16A map data have been transformed to the Administrative Coordinate System, which is projected in the Tennessee State Plane Projection (NAD-27).

9.1.4 Getting Started with ARC/INFO

Access to ARC/INFO requires the addition of the following line to your LOGIN.COM file:

$ @S1:[ARC50]ARC50IN.COM for version 5.0.1 of ARC/INFO

ARC/INFO is then started with the ARC command.

If ARC/INFO is going to display graphics on the terminal, then the user should be connected to a graphics terminal (in the GIS Laboratory) or its equivalent (e.g., a PC with the TGRAF terminal emulation program). Many ARC/INFO commands can be executed without a graphics terminal. ARC/INFO commands can also be executed in batch jobs on the systems.

9.1.5 Locally Developed ARC/INFO Commands

Several command have been developed locally at ESD to provide access to special data formats and output devices. The following discussions briefly describe those commands.

ARCDUR - This command generates GIS data suitable for exchange with the data format used by the GIS developed by Richard Durfee's group in the Computing and Telecommunications Division (C&TD). The procedure exports coverages with line or polygon topology into XY chain format with left and right condition codes. Specially named variables must be included in the attributes to pass line or polygon code values to this Durfee data format. Point coverages are exchanged by way of the "Generate" or X, Y, ID format. Additional documentation for this data interface is found in Appendix A.

DURARC - DURARC command is used for importing XY chain files from Durfee's GIS system into line or polygon coverages into ARC/INFO. The result of this procedure is equivalent to completed digitizing. Therefore, additional processing (i.e., CLEAN or BUILD) is required to fully import the data. Code values for lines and polygons are stored in ancillary INFO files.

Point data is exchanged in a "Generate" or X, Y, ID format. Additional documentation for this data interface is found in Appendix B.

LASER - The LASER command translates ARC/INFO plot files for plotting on the Imagen Laser printer in the GIS Laboratory. This command uses IMPLOT, which is a graphics library that emulates the control library for the Versatec plotters. The IMPRINT command is then used to send the Impress instructions generated by IMPLOT to the laser printer. IMPRINT is a commercial product that has many of the optional features (e.g, multiple copies, delayed submission) available in the VMS PRINT command. Valid options for IMPRINT can be added to the end of the LASER command. Detailed information on IMPRINT can be found in the system HELP files.

The color change commands in an ARC/INFO plot file are interpreted by the LASER program to modify the hardware line thickness. This allows plots to be generated by the laser printer without modifying them to remove color changes. It also is an efficient means of generating bold lines and characters without communicating a large number of parallel vector instructions. Plots on the Imagen printer are scaled to fill the page (X=7.5 in. Y=10.0 in.) with the graphic origin at the lower left of the printer. Plots that have an actual size less than the laser page size will be produced at a 1:1 scale.

LASERS - The LASERS command is identical to the LASER command except that it has the capability to interpret hardware-filled polygons and to generate hardware shade patterns. Seventy-five different shade patterns are available with the LASERS command. Additional documentation on the LASERS command and hardware shade patterns is found in Appendix C.

PLOT36 - Sending plot files from ARC/INFO to the large Versatec is accomplished by the PLOT36 command. This command converts the ARC/INFO plot file to different graphic command file and submits a second command to VAX 11/750 for final communication of the intermediate file to the plotter. Once the processing has started on the VAX 11/750, the plot is usually generated within a few minutes on the plotter.

PLOT36S - The PLOT36S command is identical to the PLOT36 command except that it has the capability to interpret hardware-filled polygons and to generate hardware shade patterns. These are the same shade patterns available from the LASERS command. The patterns are smaller in size because of the higher resolution of the large Versatec. Additional documentation on the patterns used in the PLOT36S command is found in Appendix C.

REPLOT36 - The intermediate graphic command files from the ARC/INFO plot files are saved with the other RBS data for 2 working days. The

REPLOT36 command file can be used in ARC/INFO to submit additional copies of the plots to the plotter. The intermediate files have a name of UIDGISPLOT.DAT##. The user can distinguish their plot files by looking at the time and date of the file. After displaying the directory information of the files, the user is then prompted to enter the intermediate filename and number of copies. An optional format of the command allows the user to specify the filename and the number of copies on the initial command line.

SASGARC - SASGARC is a procedure for importing graphics generated by PC SAS/GRAPH (Versions 6.03 and 6.04) and VAX SAS/GRAPH (Version 6.06) into the ARC/INFO plot file format. Conversion of these graphics from SAS/GRAPH to ARC/INFO allows for the placement of one or more graphs on a map. The SASGARC procedure can generate one or more plot files from a SAS/GRAPH metafile. The PLOT command in ARCPLOT is used for the placement of the SAS/GRAPHs on maps. Additional documentation for this procedure is found in Appendix D. The PC device driver is available from Raymond McCord, ESD.

9.1.6 Data Exchange Between ARC/INFO and SAS

ESD ARC/INFO users frequently need to exchange data between ARC/INFO and SAS for additional data management and statistical operations. Two SAS macros have been developed by Barbara Jackson (ORNL/C&TD) to convert INFO data files in ARC EXPORT format into and out of SAS data sets on the IBM Mainframe and PC. These commands convert data files from one system to the other in a nearly automated fashion. The convert data files will not be totally identical because of differences in the length of variable names and valid characters allowed in variable names.

ARCTOSAS - The ARCTOSAS SAS macro converts an export file into SAS (See Appendix E.) INFO data files should be exported with the following ARC command before the data is transferred to system with SAS:

```
ARC: EXPORT INFO DATA.FILE DATA NONE
```

where DATA.FILE is an INFO data file in that work space. The output of the EXPORT command will be written in a file called DATA.E00 (an E00 export file). The NONE option on the EXPORT command prevents data compression which results in incorrect translation of data onto another system. Additional information on the EXPORT command is available from HELP in ARC/INFO. (Note: INFO also has an EXPORT command which generates files with a totally different format. Do not confuse the EXPORT commands.) The E00 file is a relatively simple ASCII file that can then be transferred to the IBM system that hosts SAS.

QUICKARC - SAS data sets can be formatted in ARC/INFO export format by the QUICKARC SAS macro (see Appendix F.) After the files have been generated by QUICKARC, they can be transferred to the ESD VAX and imported into ARC/INFO with the IMPORT Command in ARC. The syntax for this command is as follows:

ARC: IMPORT INFO DATA.E00 DATA.FILE

where the data to be imported is in the current work space in a file called DATA.E00 and with output into an INFO data file called DATA.FILE.

9.1.7 Guidelines for ARC/INFO Processing

Processing GIS data with ARC/INFO requires several extra considerations when compared with other types of computer applications. These considerations include the complexity of GIS data, size limitations of GIS data, and optimal use of interactive vs batch processing. Although ARC/INFO is a fairly comprehensive and robust software system, these issues will frequently force the user to do additional planning to ensure successful GIS processing.

9.1.7.1 Spatial Data Complexity

Processing GIS data is one of the most difficult data management application tasks in the realm of computing. All of the quality assurance issues associated with regular tabular data are associated with GIS data (e.g., Are the values stored correctly by data management system? Are the values the correct magnitude? Are all the values entered and transferred correctly?) as are the following additional concerns:

Aesthetic aspects of graphics data - Do the points and lines of the GIS data visually represent the geographic information in an appropriate way?

Topological correctness of the spatial data - Are the numbers of points, lines, and polygons correct? Is the digital resolution of the geographic data appropriate for the required analysis and mapping. Are all of the lines connected and intersected correctly? Are all of the polygons closed? Are sliver polygons present near line intersections? Has a code or class value been identified for each line or polygon?

Correctness of the linkage between the geographic features and the attribute data - Are the attributes records linked to the correct geographic features? Do all features have attributes?

9.1.7.2 ARC/INFO Data Limitations

Because of the complexity of maintaining all of the relationships, the ARC/INFO system has several limitations. These include:

number of vertices per arc (line) (500)
number of arcs per polygon (10,000)
number of arcs per node (100)
number of bytes per attribute record (4096)

There are several other indefinite limitations in which ARC/INFO's performance becomes minimal when the coverages are very large (10,000's of lines or 100,000's of points). If the coverages are very large, then every processing step is very time consuming, and disk space can be limiting. Additional information on data limitations in ARC/INFO can be found in Volume 1 of its documentation.

9.1.7.3 Interactive vs Batch Processing

When several GIS users are working at the same time on the system, it is not uncommon for the capacity of the system to become saturated and the performance of the system to be marginal. Interactive use of the system should be considered a premium resource to be used carefully. Although all of the commands for GIS processing can be executed interactively, intensive use of interactive execution will cause the system to be sluggish for all users and will waste time for those users executing tasks that require the interactive mode (e.g., graphic editing and map composition). Therefore, GIS users are asked to consider the following guidelines so that more efficient GIS processing will be achieved by all users.

- Interactive processing should be minimal and be reserved for those tasks that cannot be executed in batch mode.

- Batch job runs that require more than 2 h of central processing unit (CPU) time should be started in the late afternoon. (On a busy day, getting more than 2 h CPU from a batch queue may take all day otherwise.)

- Do not use more than one batch queue at a time unless the system is lightly used. This guideline is especially true if the batch jobs use the same work space. Simultaneous access of ARC/INFO data in the same work space by multiple batch jobs or batch and interactive jobs will cause one or more of the jobs to access the INFO data in a read-only mode. A read-only limitation on INFO will cause procedures that write new data to fail.

A detailed description for the appropriate batch queues is discussed in Sect. 10.1.

9.2 GRID

GRID is a raster-based library of GIS software developed by ESRI prior to the development of ARC/INFO. The development of the GRID software ended in the late 1970s, and as a result, its user interface and output capabilities are fairly primitive. However, the analysis capabilities of GRID are very powerful. GRID data structures support single-variable files and multivariable files. Up to 50 variables per grid cell can be stored in the multivariable files.

A raster-based GIS system has several advantages over a vector-based system such as ARC/INFO. These include the rapid processing of multithematic polygon overlays and "modelling," the direct input of spatial data from a simulation model, and more potential for data compression. The disadvantages of a raster system are in the digitizing of new GIS data, detailed editing of existing data, difficulty of processing of data of mixed resolution, efficiency of representing point and sparse linear features, and the selection and quality of output devices. The most common output device for GRID when it was commonly used was the line printer with character overstriking for a "shaded effect."

Access to the GRID system is obtained by adding the following line to LOGIN.COM file:

```
$ @S1:[ESRI]GRIDIN
```

Most of the GRID system can then be accessed with the EXEC command. This command system will then prompt the user for the names of programs and control files used in the execution of the GRID system. The GRID programs are all written in FORTRAN and ESD has most of the source code for the programs. The control files contain fixed-format records on which choices for procedure options are specified in certain columns of the record.

Programs for converting data to and from the GRID data format are included in ARC/INFO (POLYGRID, GRIDPOLY). Aside from grid input from simulation models, conversion from the ARC/INFO data structure is the easiest means of loading GRID data.

Documentation on the GRID system can be found in the manuals located in the GIS Laboratory (Room 173).

9.3 SPANS

SPANS (Version 4.300) is a quadtree-based GIS system developed by TYDAC, Inc. It is installed on a IBM AT (with a 386-clone board) located in Room 173 of the GIS Laboratory. A quadtree GIS has characteristics from both the vector-based and raster-based GIS systems. A quadtree system can efficiently store, display, and

process polygon overlays. The repeated processing of polygon overlays is accomplished more quickly in a quadtree system than a vector or raster system. Because it is functioning like a variable resolution raster system, it has better display characteristics. The quadtree data structure also has the major feature of efficiently storing spatial data. However, like a raster system, it is very inefficient at representing sparse point and line features. It is also unable to exactly represent the coordinates of a boundary.

Access to the SPANS system is obtained only by direct usage of the PC in the GIS Laboratory. The software is copy protected with a hardware key and is installed on drive D:. It is accessible anywhere on the system by the SPANS command. The SPANS system starts in a comprehensive menu interface. The menus are displayed on the monochrome monitor and graphics on the color monitor.

Even though the spatial data of SPANS is fairly efficiently stored, it can still use relatively large amounts of disk space. Therefore, SPANS users are advised to obtain one or more 20-MB Bernoulli cartridges. This prevents other users from accidentally altering your data and keeps the system disk drives from being overloaded and cluttered.

Input of digital data into the SPANS system is best accomplished by using ARC/INFO to enter (digitize) and finalize the polygon topology of the data. An import procedure for loading uncompressed ARC/INFO export files (E00) is available in the SPANS system. The input of attribute data is accomplished by way a simple "flat file" format that can be readily generated by any data base system.

A major limitation of the SPANS system is its ability to generate hard-copy output. The system is excellent for developing "slide show" type presentations with the color monitor. However, hard-copy output has limited choices and output. All hard-copy output is accomplished essentially as a "screen dump" which frequently results in poor-quality text. The ESD spans system has a Tektronix 4696 color-ink jet printer.

Documentation for SPANS is contained in a three volume series of manuals located in the GIS Laboratory. Dick Olson, Raymond McCord, and Aaron Rosen have limited experience with SPANS.

9.4 ERDAS

Another PC-based GIS system available within the ESD GIS is the ERDAS GIS and Image processing software (version 7.2). This software (and its required hardware) is installed on an IBM PC AT located in Room 173 of the GIS Laboratory. This PC contains a 30-MB primary drive and a removable 15-MB hard disk cartridge system. (The cartridge system is in a questionable state of operation.) The special ERDAS hardware includes a joy stick for cursor control and a secondary monitor for image display.

ERDAS is a raster-based GIS system that is used frequently with aerial and satellite image data. In addition to performing GIS-type overlays of grid/image data, the ERDAS system can also do a minimal amount of Image Processing that results in a color display of the reclassified image. Statistical tabulations of image classifications can also be generated with ERDAS.

The software is started by entering ERDAS at the DOS prompt. The remainder of the ERDAS can be entered from a menu command system. Additional documentation on ERDAS can be found in the "ERDAS User's Guide" located in the GIS Laboratory.

10. ESD LAVC QUEUES

Queues are used on the Environmental Sciences Division (ESD) LAVC to organize and control the noninteractive processing of user and system computations and print and plot output. The queues control the CPU, priority, schedule, and peripheral device used to accomplish a noninteractive task. All queues on all systems in the LAVC are directly accessible from all systems in the cluster. However, each queue uses a specific system that must be operating for that queue to process output. This section describes the names, devices, and purposes of the queues accessible from the ESD LAVC.

10.1 USER BATCH QUEUES

User batch queues are available on each system in the ESD LAVC for the batch processing of user programs. These programs may be command instructions (e.g., delete, copy, rename, and directory), execution programs (e.g., run user.exe), or applications instructions (e.g., ARC/INFO commands). All of the queues are limited so that they operate at a lower priority than the priority of interactive use. This prevents batch processing from interfering with the interactive responsiveness of the system. Users are encouraged to submit tasks that do not require interactive processing (e.g., graphic editing) to batch queues.

Batch processing by users on the VAX 11/750 is limited to Geographic Information System (GIS) plots only. All other batch processing should be submitted to the MicroVAX 3500 or VAXstation 3100. (Extensive use of the VAXstation 3100 queues should be coordinated with Mary Alice Faulkner or Yetta Jager.) The MicroVAX 3500 is between 4 and 7 times faster than the VAX 11/750. The VAXstation 3100 is located in Room 396, Building 1505, and runs at approximately the same speed as the MicroVAX 3500. The only batch queue listed for the VAX 11/750 is one that is used for processing PLOT files. The VAX 11/750 should not be used for other general processing because it is primarily used for running printers and plotters and the processing needed to generate output for these devices.

For tasks that are not urgent and may require a long time to complete, users are encouraged to submit jobs to the SLOW or STANDBY queues. The SLOW queue will not interfere with interactive processing or other batch queues, but it will execute the tasks with the leftover capacity of the system. The STANDBY queue is active only during "off" hours (4:00 p.m. to 8:00 a.m.) and should be used for jobs that will not require monitoring by the user.

The following sections describe the available user batch queues.

10.1.1 MicroVAX 3500 User Batch Queues

Queue name: **GIS** Priority:[1] 3 Job limit:[2] 1
Purpose: Processing GIS programs

Queue name: **SLOW** Priority: 2 Job limit: 1
Purpose: Processing GIS and modelling programs

Queue name: **STANDBY** Priority: 2 Job limit: 1
Purpose: Processing GIS and modelling programs, stopped between 8:00 a.m. and 4:30 p.m.

Queue name: **UTM3** Priority: 3 Job limit: 1
Purpose: Modelling programs.

10.1.2 VAXstation 3100 User Batch Queues

Queue name: **MJSGIS** Priority: 3 Job limit: 1
Purpose: GIS processing

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[1] The priority of a queue controls the order in which jobs get CPU time. The highest priority jobs get CPU time first. If more than one job is competing for CPU time (e.g., the demands on the system exceed its capacity), then jobs of equal priority get an equal share of the CPU. If the higher priority jobs are limited by other factors than CPU (e.g., disk and terminal I/O, and page faulting), then CPU time will be available for lower-priority jobs. When higher-priority jobs are absent or inactive on the system, then lower-priority jobs will execute with a portion of the CPU time that is very similar to normal-priority jobs. The priority of 3 is used because it keeps the CPU-intensive processes from slowing down the interactive response needed for editing, etc. However, when interactive usage (which has a higher priority of 4) is idle, then the batch jobs in a queue of priority of 3 will run essentially as fast as the machine will go.

[2] The job limit of a queue limits the number of jobs that will actively execute in a queue at one time. Most of the queues for users are limited to one job at a time. This allows the system to more effectively process the active work. When the jobs are run one at a time, then they are run in the order of their submission. This orderly execution is advantageous for GIS processing.

Queue name: **MJS$BATCH** Priority: **3** Job limit: **1**
Purpose: General batch processing.

10.1.3 VAX 11/750 User Batch Queues

Queue name: **FAST** Priority: **3** Job limit: **1**
Purpose: Processing plots for large and small Versatec.

10.2. SYSTEM BATCH QUEUES

The information about the system batch queues is included in the following to provide users with a general overview of other activity on the systems that interact with their processes. Users should not submit batch jobs to these queues.

10.2.1 Time Periods for Routine System Maintenance Programs

There are two major time periods when the system queue processes automatically submitted system maintenance jobs that will affect the performance of the system. The first begins 3:00 p.m. At this time, disk-defragmentation software starts executing on the VAX 11/750. The impact of this process is small unless you are using the VAX 11/750 directly or for short periods when major disk read/write activities occur.

The second time period of system maintenance programs begins at midnight and continues until about 3:00 a.m. During this time period, daily backup, disk accounting, and disk cleanup occur. These processes may take between 2 and 3 h to complete. During the time, system performance on the entire ESD LAVC is noticeably decreased.

10.2.2 MicroVAX 3500 System Queues

Queue name: **JOB** Priority: **3** Job limit: **1**
Purpose: Executes a periodic process that provides queue information to the JOBS command.

Queue name: **V03$BATCH** Priority: **3** Job limit: **5**
Purpose: Executes maintenance programs such as clean scratch, E00 archive, disk quota accounting, and mail compression.

10.2.3 VAXstation 3100 System Queues

Queue name: **MJSJOB** Priority: 3 Job limit: 1
Purpose: Executes a periodic program that generates data on U5 disk usage.

10.2.4 VAX 11/750 System Queues

Queue name: **BACKUP** Priority: 4 Job limit: 1
Purpose: Executes a daily backup program.

Queue name: **PRTPLT** Priority: 3 Job limit: 3
Purpose: Executes a periodic program that submits remote batch system (RBS) files to printers and disk-defragmentation programs.

Queue name: **V01$BATCH** Priority: 3 Job limit: 5
Purpose: Executes maintenance programs such as delete day-old print, and printing supervision.

10.3 PRINTER QUEUES

This section discusses the ESD LAVC queues used to control output to printers. Printers that also have graphics capability are discussed under the section on plotter queues (Sect. 10.4). LPC0 is the default printer queue for all systems on the ESD LAVC.

10.3.1. MicroVAX 3500 Printer Queues

None of the printers are attached to the MicroVAX 3500. Print jobs without a queue specification go to the SYS$PRINT queue, which relays output to the 14 x 8.5 in. recycled paper. Printer queues on the VAX 11/750 are directly accessible to users of the MicroVAX 3500.

10.3.2 VAXstation 3100 Printer Queues

None of the printers are attached to the VAXstation 3100. Print jobs without a queue specification go to the SYS$PRINT queue, which relays output to the 14 x 8.5 in. recycled paper. Printer queues on the VAX 11/750 are directly accessible to the users of the VAXstation 3100.

10.3.3 VAX 11/750 Printer Queues

Queue name: **LASERJET** Device: **HP LaserJet 2000**
Speed: 20 pages per min. Location: Room 119, Building 1505
Paper type: 8.5 x 11 in., other paper size available with the appropriate forms

Queue name: **LCB0** Device: **Upper/lower case line printer**
Speed: 1200 lines per min. Location: Room 119, Building 1505
Paper type: 8.5 x 11 in. virgin, fanfold paper.

Queue name: **LPB0** Device: **Upper/lower case line printer**
Speed: 900 lines per min. Location: Room 121, Building 1505
Paper type: 14 x 8.5 in. virgin, fanfold paper.

Queue name: **LPC0** Device: **Upper case only line printer**
Speed: 1200 lines per min. Location: Room 119, Building 1505
Paper type: 14 x 8.5 in. recycled, fanfold paper

Queue name: **PCFS$LASERJET** Device: **HP LaserJet 2000**
Speed: 20 pages per min. Location: Room 119, Building 1505
A generic network printer queue for PCSA and VMS Services.

Queue name: **QT1200** Device: **Printserver**
Speed: NA Location: Room 223A, Building 1000
Paper type: NA, a printer is not currently attached to the Printserver.

Queue name: **SYS$PRINT** Device: **Upper case only line printer**
Speed: 1200 lines per min. Location: Room 119, Building 1505
Paper type: 14 x 8.5 in. recycled, fanfold paper

10.3.4 LaserJet 2000 Printer Forms

The LaserJet 2000 printer can be set up for various printing effects by grouping the printer control commands into defined forms for the VMS PRINT command. The forms option can be used when printing to the LaserJet 2000 with VMS PRINT. The following is an example of using the forms option with the PRINT command:

```
print/queue=laserjet/form=##### filename
```

where ##### is either the form name or number.

The following forms have been defined for use with the LaserJet 2000:

Form name:	LG_PORT12	Form number:	10
Orientation:	Portrait	Paper size:	8.5 x 11 in.
Type style:	Letter Gothic 12 CPI	Left margin:	15
Form name:	CONDENSED	Form number:	20
Orientation:	Portrait	Paper size:	8.5 x 11 in.
Type style:	Courier 16.66 CPI	Left margin:	0
Form name:	DP_MODE	Form number:	22
Orientation:	Landscape	Paper size:	8.5 x 11 in.
Type style:	Courier 16.66 CPI	Left margin:	0
Form name:	LM16_CONDENSED	Form number:	23
Orientation:	Portrait	Paper size:	8.5 x 11 in.
Type style:	Courier 16.66 CPI	Left margin:	16
Form name:	LARGE	Form number:	24
Orientation:	Portrait	Paper size:	11 x 17 in.
Type style:	Courier 12 CPI	Left margin:	0

Standard 8.5 x 11 in. paper is usually loaded in the LaserJet 2000. The following sizes are also available and can be loaded upon request.

Executive	7.25 x 10.5 in.
Letter (default)	8.5 x 11 in.
Legal	8.5 x 14 in.
Ledger	11 x 17 in.
A4	210 x 297 mm
A3	297 x 420 mm

If a type style (font) is not requested, the default is Courier 12 CPI. A listing of available type styles can be found in Room 119, Building 1505.

10.4 PLOTTER QUEUES

This section discusses the ESD LAVC queues that are used to control output to plotters. The Imagen and QMS printers also have text printing capability but should be used for graphics. All plotter queues are accessible from all systems in the ESD LAVC.

10.4.1. MicroVAX 3500 Plotter Queues

Queue name:	**SYS$PLOT**	Device:	**Calcomp 8-pen plotter**
Location:	Room 121, Building 1505		
Paper type:	Cut sheets up to E size, and 15 in. and 36 in. rolls of paper and mylar.		
Operational notes:	This plotter is accessible with the PLOT Command of ARC/INFO. It is located in the ESD Computer Room. Its wiring is such that it can be temporarily located in the GIS Laboratory during "off hours." This plotter is typically not in a operationally ready state. It is the users responsibility to set it up and load the appropriate pens and paper. The pens and paper for this plotter are stored in the GIS Laboratory. Contact the System Manager (Neil Griffith) for assistance.		

Queue name:	**SYS$PLOT_1000**	Device:	**Calcomp 8-pen plotter**
Location:	Room 225A, Building 1000		
Paper type:	C.ut sheets up to E size, and 36 in. rolls of paper and mylar.		
Operational notes:	This plotter is accessible with the PLOT Command of ARC/INFO. It is located in the Tammy White's office. This plotter is typically not in a operationally ready state. It is the users responsibility to set it up and load the appropriate pens and paper. Contact Tammy White for assistance.		

10.4.2 VAXstation 3100 Plotter Queues

None of the plotters are attached to the VAXstation 3100. Plotter queues on the VAX 11/750 are directly accessible to the users of the VAXstation 3100.

10.4.3 VAX 11/750 Plotter Queues

Queue name:	**LWA0**	Device:	**Versatec, 200 DPI electrostatic**
Location:	Room 119, Building 1505		
Paper type:	11 in. rolls of paper, black and white only.		
Operational notes:	This plotter is not accessible from the ESD GIS software. Users wishing to use this plotter directly from the ESD LAVC should use their own graphics program and link it to the SYS$LIBRARY:V9COL2.OLB control library. Documentation on this library is available from the System Manager. This plotter is over 10 years old and is useful only for draft plots.		

Queue name: **LWB0** Device: **Versatec, 400 DPI electrostatic**
Location: Room 119, Building 1505
Paper type: 36 in. rolls of paper, black and white only.
Operational notes: This plotter is accessible from the ESD ARC/INFO software with the PLOT36 and PLOT36S commands. Users wishing to use this plotter directly from the ESD LAVC can use their own graphics program and link it to the SYS$LIBRARY: COL2V0.OLB control library. Documentation on this library is available from the System Manager. This plotter has it own rasterizer and is typically in very good operating condition.

Queue name: **TXC2** Device: **Imagen, 300 DPI laser**
Location: Room 175, Building 1505 (GIS Laboratory)
Paper type: 8.5 x 11 in. paper and transparency film.
Operational notes: This graphics laser printer is accessible from the ESD ARC/INFO software with the LASER and LASERS commands. It is operated with the IMPRINT printer control software. Users wishing to use this printer directly should see the information available under HELP IMPRINT. User-written graphics programs can also be linked to SYS$LIBRARY: IMPLOT.OLB. IMPLOT emulated the VERSAPLOT graphics library and generates and IMPRESS file, which may be printed with IMPRINT.

IMPRINT includes a special communications protocol that improves the serial 19,200 baud communications to the printer. A VT100 type terminal can be attached to the rasterizer for the IMAGEN printer. This terminal can show local information about the printer setup, status and communications statistics.

Queue name: **TXC6** Device: **QMS, 300 DPI color Postscript**
Location: Room 165, Building 1505 (ESD Graphics)
Paper type: 8.5 x 11 in., 11 x 17 in. paper and transparency film.
Operational notes: This printer/plotter <u>only</u> accepts Postscript files. Postscript files can be generated by ARC/INFO with the POSTSCRIPT command. Files are then sent to the printer with a normal print command. This printer is shared with the Apple Talk network used in ESD graphics. Therefore, it is not routinely left on-line to the ESD LAVC. Switch boxes allow it to be switched from Apple Talk to the VAX. The printer/plotter also must be rebooted (powered off) after the communication switches have been changed. Users should verify the status (e.g., its availability and the type and size of media) of the printer/plotter before sending files to it. Users should also verify that the printer/plotter is idle before switching its

operational setup. Postscript files are frequently large and can take several minutes to process. Therefore, the printer/plotter may be "busy" even though it is not actively printing. The ESD Graphics staff can provide assistance in using the plotter.

10.5 OTHER ESD GRAPHICS DEVICES

10.5.1 Tektronix 4692 Inkjet Plotter

The ESD GIS Laboratory has a secondary plotter that is accessible from ESD Systems and others. The Tektronix 4111 terminal in the GIS Laboratory has a Tektronix 4510 Rasterizer and Tektronix 4692 color ink jet plotter attached to it. This terminal can be used to display graphics from the ESD GIS or other systems (e.g., IBM mainframe and STC VAX). Local set up commands on the terminal enable it to capture and relay the plotting instructions to the 4692 plotter. This plotter has approximately 150 DPI resolution and can be setup to use paper or transparencies. Instructions on how to capture the commands are attached to the terminal. The rasterizer and plotter are also accessible from the Tektronix 4107 in Room 173.

10.5.2 Matrix PCR Film Recorder

A film recorder is a computer graphics device used for the high-resolution exposure of film. The Matrix PCR film recorder has 2K and 4K scan lines of exposure resolution across the 35-mm negative and can process many hues of color with combinations of color filters and exposure intensity. The camera attached to the recorder can use any type of 35 mm film.

The film recorder is located in the GIS Laboratory (Room 173). This film recorder is currently accessible by way of a special controller installed in an IBM PC/XT clone located in Room 173. This controller requires the input of special control codes in SCODL. SAS/GRAPH (PC), Freelance, and Harvard Graphics all have device drivers that can generate SCODL files. SCODL file can also be indirectly generated by ARC/INFO. Tektronix 4105 instructions that are captured by TGRAF-07 can be converted to Zennographics Image files by TZLINK software. Zennographics can then be used to generate SCODL files. TGRAF-07, TZLINK, and Zennographics are installed on the "SPANS" PC located in Room 173 of the GIS Laboratory.

After SCODL files have been created, they must be transferred by floppy disk to the IBM PC/XT clone. This system has control software for the film recorder processor called MVP. This software is located in the C:\MVP subdirectory of the PC. It is invoked by the MVP command. From the MVP command menu, batch files can be loaded to process a set of plots. An example of batch files can be found by looking at C:\MVP\PROCESS*.BAT. These batch files load a few setup parameters and the users SCODL files. Users are encouraged to adapt an existing batch file for

processing their files. Processing SCODL files requires between 1.5 and 4 min. per slide. A roll of 36 exposures can take an hour and batch files enable the film recorder to operate "unattended."

Additional information on using the film recorder can be obtained from the appropriate graphics software manuals and the film recorder manuals (located in the GIS Laboratory, Room 175). Several personnel in ESD have experience using the film recorder.

11. ON-LINE DISK HARDWARE AND MANAGEMENT

The Environmental Sciences Division (ESD) LAVC has 4.27 GB of on-line disk space on 13 drives. Ten of the disk drives provide the users 2.35 GB of data storage space. System and application software are located on portions of four disks and occupy 0.76 GB of disk space. This section discusses the disk hardware and operational policies including quota and backup.

11.1 DISK HARDWARE OVERVIEW

11.1.1 MicroVAX 3500 Disks

Device name:	**ESDV03$DUA0**	Logical name:	**LIB**
Hardware vendor:	DEC	Model number:	RA70, fixed media
Device capacity:	290 MB	User capacity:	190 MB (380,000 BLKS)
Accessibility:	System owned, mounted cluster-wide.		
Backup:	User requested only.		
Purpose:	System page and swap files and GIS data library.		

Device name:	**ESDV03$DJA1**	Logical name:	variable
Hardware vendor:	DEC	Model number:	RA60, rem. media
Device capacity:	200 MB	User capacity:	180 MB (360,000 BLKS)
Accessibility:	User owned, mounted cluster-wide.		
Backup:	User requested only.		
Purpose:	"Private," removable disk packs that can be dedicated to single users having a short-term need for large storage capacity.		

Device name:	**ESDV03$DJA2**	Logical name:	**SCRATCH**
Hardware vendor:	DEC	Model number:	RA60, rem. media
Device capacity:	200 MB	User capacity:	180 MB (360,000 BLKS)
Accessibility:	System owned, mounted cluster-wide for all users.		
Backup:	None.		
Purpose:	Storage of temporary data sets. Files with a modification date greater than 13 days old are deleted.		

Device name:	**ESDV03$DUB0**	Logical name:	**U6**
Hardware vendor:	Fujitsu	Model number:	M2333, fixed media
Device capacity:	337 MB	User capacity:	214 MB (442,000 BLKS)
Accessibility:	System owned, mounted cluster-wide for all users.		
Backup:	Daily, weekly, and monthly.		
Purpose:	General-purpose disk for non-GIS users.		

Device name:	**ESDV03$DUB1**	Logical name:	U1
Hardware vendor:	Fujitsu	Model number:	M2344, fixed media
Device capacity:	690 MB	User capacity:	427 MB (854,000 BLKS)
Accessibility:	System owned, mounted cluster-wide for all users.		
Backup:	Daily, weekly, and monthly.		
Purpose:	General-purpose disk for GIS users.		

Device name:	**ESDV03$DUB2**	Logical name:	U2
Hardware vendor:	Fujitsu	Model number:	M2333, fixed media
Device capacity:	337 MB	User capacity:	214 MB (442,000 BLKS)
Accessibility:	System owned, mounted cluster-wide for all users.		
Backup:	Daily, weekly, and monthly.		
Purpose:	General-purpose disk for GIS users.		

Device name:	**ESDV03$DUB3**	Logical name:	U3
Hardware vendor:	Fujitsu	Model number:	M2333, fixed media
Device capacity:	337 MB	User capacity:	214 MB (442,000 BLKS)
Accessibility:	System owned, mounted cluster-wide for all users.		
Backup:	Daily, weekly, and monthly.		
Purpose:	General-purpose disk for GIS users.		

11.1.2 VAXstation 3100 Disks

Device name:	**ESDMJS$DKA700**	Logical name:	None
Hardware vendor:	DEC	Model number:	RZ23, fixed media
Device capacity:	104 MB	User capacity:	None
Accessibility:	System owned, local CPU use only.		
Backup:	None.		
Purpose:	System page and swap files only.		

Device name:	**ESDMJS$DKB0**	Logical name:	U5
Hardware vendor:	Trimarchi	Model number:	Datakeg, fixed media
Device capacity:	325 MB	User capacity:	260 MB (520,000 BLKS)
Accessibility:	System owned, mounted cluster-wide for limited group of users.		
Backup:	Daily, weekly, and monthly.		
Purpose:	Disk for direct users of the workstation.		

Device name:	**ESDMJS$DKB100**	Logical name:	variable
Hardware vendor:	Trimarchi	Model number:	Laserase, rem. media
Device capacity:	325 MB	User capacity:	260 MB (520,000 BLKS)
Accessibility:	User owned, user mounted, local CPU use only.		
Backup:	User requested.		

Purpose:	Erasable optical disk with a 325-MB capacity on each side. This disk is mounted by individual users and is used to archive and predominantly "read only" data. The optical media is erasable, but it has a finite number of rewrite cycles.

11.1.3 VAX 11/750 Disks

Device name:	**ESDV01$DUA0**	Logical name:	None
Hardware vendor:	DEC	Model number:	RA81, fixed media
Device capacity:	450 MB	User capacity:	None
Accessibility:	System owned, mounted cluster-wide for all systems.		
Backup:	Intermittently by System Manager.		
Purpose:	Stores VMS operating software for all of the cluster.		

Device name:	**ESDV01$DUB0**	Logical name:	**S1**
Hardware vendor:	Fujitsu	Model number:	M2333, fixed media
Device capacity:	337 MB	User capacity:	None
Accessibility:	System owned, mounted cluster-wide for system tasks.		
Backup:	As requested by System Manager.		
Purpose:	Stores ARC/INFO programs, and print/plot files from RBS.		

Device name:	**ESDV01$DUB1**	Logical name:	**U4**
Hardware vendor:	Fujitsu	Model number:	M2344, fixed media
Device capacity:	337 MB	User capacity:	214 MB (442,000 BLKS)
Accessibility:	System owned, mounted cluster-wide for all users.		
Backup:	Daily, weekly, and monthly.		
Purpose:	General-purpose disk for PCSA network users.		

11.2 DISK SPACE MANAGEMENT

11.2.1 Disk Quota

A majority of the disks in the ESD LAVC is managed by a VMS disk quota utility. Disk quota limits the amount of on-line disk storage that a user can access on a disk. Disk quota is used to prevent the data files from being damaged when the disks are too full. This utility also allows the System Manager a means of encouraging personnel to use disk space wisely and avoid an endless accumulation of files. Disk quota cannot be bypassed by the user, and when it is exceeded the interactive task (e.g., copy) will abort. Batch jobs will terminate when disk quota is exceeded. A small "overrun" is allowed so that small, temporary overages will not cause problems. Users can determine their current disk quota and disk usage with the SHOW QUOTA command. (NOTE: some ARC/INFO tasks use 2-3 times the amount of disk space used by a coverage for temporary files during processing.) Increases in

disk quota must be explained and justified to the System Manager (Neil Griffith). Users are encouraged to minimize disk space demands by keeping old files cleaned up, archiving data, requesting special backups, and using the scratch disk. The following sections will provide additional details on these options.

11.2.2 Old File Clean Up

In VMS, each time a file is updated a new version is generated. This feature enables programmers to go back to old versions of logic. However, if you repeatedly edit a file, it is easy to end up with ten versions of it. Users are encouraged to PURGE old versions of files. The PURGE command will delete all but the most recent version of files. (See HELP PURGE.) Unique or permanent variations of data should never be stored by different versions of the same filename. It is too easy to get the versions confused and overwrite one. The system also sets a maximum concurrent version limit of five for each filename. The number of concurrent versions is reduced to three after each weekly BACKUP.

Several types of old files should be regularly reviewed for disposal. These include the following:

*.LOG files - Batch jobs frequently generate LOG files. These files are useful to determine if the job failed or succeeded but frequently have little long-term value. Some LOG files may be large.

*.COM files - ARC/INFO batch jobs that fail may not delete small temporary COM files. Generally these should be deleted.

TX*.* - ARC/INFO uses a variety of TX*.* named temporary files. S$*.DAT is another ARC/INFO temporary file. These files are left on the system when ARC/INFO procedures fail, and routine system maintenance programs are designed to delete them. Users are also encouraged to check their areas for old temporary files.

*.PLT files - ARC/INFO PLT files are frequently large. The long-term usefulness of the PLT files should be reviewed. Generally, users are encouraged to keep the data and the program that generates the PLT files. Then the PLT files can be regenerated and do not require long-term storage. PLT files can also be archived.

*.PST files - ARC/INFO Postscript files are also frequently large. The storage of these files should be reviewed in a manner similar to that for PLT files.

FOR*.DAT - Aborted ARC/INFO and FORTRAN programs may leave files named FOR*.DAT, where * is a number such as 001. Unless you are doing

your own programming in FORTRAN, these are probably lost temporary files from ARC/INFO that do not need to be retained.

Data files over 2 years old should also be considered for "clean up." In the last few years, system and application software have advanced so rapidly that files over two years old may no longer be compatible with the current software version. Users are encouraged to review old data to dispose of it or keep it current and accessible.

11.2.3 Filemaster Software

The MicroVAX 3500 system is licensed for a file management software called Filemaster by Hancock Software Company. This software presents the user with a multisection terminal display that shows the directory tree, number of files, and amount of space used by subdirectories and files. It is not uncommon for active VMS and ARC/INFO users to accumulate hundreds or thousands of files. Filemaster is highly recommended as a means of reviewing disk usage and cleaning up old files. It is a menu-operated system that requires a VT terminal or emulator (e.g., Kermit, SmarTerm, TGRAF, or PibTerm). The commands allow the user to select, individually or by wildcards, groups of files for file management (e.g., deletion, copying, or renaming).
Filemaster is accessed with the FLM command. During the first initiation, Filemaster loads a large amount of directory data into a process. This may require a few minutes for a large disk area. If Filemaster is exited with the menu option, this information is retained for rapid retrieval in an idle subprocess. Subsequent initiations of FLM will start in seconds. Filemaster can also be limited to operate on a specific portion of a directory. This limitation is specified by the /ROOT=DEV:[UID.XXX] option of the FLM command. In this example, Filemaster would only process the files and directories contained in the XXX subdirectory. Using subdirectories also improves Filemaster performance.

The default deletion of Filemaster is a "soft" deletion. This means that the file is actually transferred to a temporary directory (dev:[FLM_DELETED.UID], where dev is the user's home disk and UID is the user ID). Files in the temporary "soft" delete directory still have the same ownership and still count against the owner's disk quota. Files can be permanently deleted by accessing the temporary directory with the UNDELETE window and using the KILL option.

11.2.4 Scratch Disk Space

The ESD LAVC operation includes one removable disk drive as "scratch" disk space. Scratch disk space is intended to provide the user space to temporary, short term data processing. This disk is operated without Disk Quota controls and is protected such that any user can create directories and files on it. Users are also encouraged to use the scratch disk for intensive data processing. This disk has a removable media and can be more extensively repaired (by I&C) without interrupting normal

system operations. All other user disks are more expensive, less convenient and require system interruption to repair.

Users of the Scratch disk need to have a very clear understanding of it's operational design and intent. Using the disk contrary to its designed purpose is a risky data processing policy. The following operating procedures should be considered for plans to use the scratch disk:

The Scratch Disk does not have routine backup. This means that it is always available to the user. It also means that the user should not perform critical work on the only copy of data on Scratch; Digitizing is an example of a very risky utilization of the scratch disk because if something happens to the disk during digitizing, the only copy of that effort will be lost. If known problems are occurring with the disk, the System Manager will attempt to backup and restore the current data for recovery after maintenance and repair.

Each night, a routine system maintenance program deletes files that have not been modified in the past 13 days. This program will clean up the disk to make space for new files. However, if users have been making extensive use of scratch with large files, they may want to delete the files sooner. Users may request a special backup tape of when useful, "final" files are generated on the scratch disk. Users should contact the System Manager (Neil Griffith) for special backup tapes.

The disk is not controlled by disk quota. The absence of disk quota has positive and negative consequences on the disk operation. Without disk quota, users can make files as large as needed (up to the capacity of the device) without system intervention. However, a negative aspect of this feature is that it is possible for a careless user to "overfill" the device with files, which will result in damage to their data, others data, and the disk device. Users should have a reasonable estimate of the disk storage requirements for a task. The SHOW DEV D command can be used to list the FREE BLOCKS. If the number of FREE BLOCKS is less than 50,000, users should contact the System Manager before adding a significant amount of new files to the disk.

The disk is a shared but limited resource. Users should understand that the availability of scratch disk space is a function of how reasonably it is used. If inadequate space is available, it is because someone is using the disk for "long-term storage" or is using an excessive amount of space. The System Manager routinely reviews the usage of the Scratch disk. If it has limited free space, the System Manager has the option of requesting users to free space or to reduce the time that the files can stay on the disk. Manually negotiating space on the scratch disk is a hassle. Users are encouraged to "police" their own usage.

11.2.5 Private Disks

The ESD LAVC operation also includes the availability of a "private" disk. One of the drives with removable media can be set up to provide the user with a large amount of disk space (180 MB, 360,000 blocks) on an interim basis. "Private" disks are intended to provide space for the processing of a large amount of input data. A "private" disk is accessible from the entire cluster, but its access is restricted to one user. Procedures for backups of the disk are arranged by the user with the System Manager.

The availability of a private disk is determined by the demand for that resource. Users generally can have their disk media mounted until another user needs a private disk. The availability of private disks is also limited by the cost of the media (approximately $350 per disk pack). Private disks can be changed only by the System Manager (Neil Griffith) during normal working hours.

11.2.6 Optical Disk Cartridges

The VAXstation 3100 of the ESD LAVC has an erasable optical disk drive. This drive uses 5.25 in. cartridges that can hold 325 MB of data on each side. These cartridges can have a function similar to the private disks discussed above. However, there are several differences between the cartridges and the removable disk packs. The major disadvantage is that although the cartridges are erasable (a higher-intensity laser beam melts and refinishes the data storage code), the cartridges do have a lower number of times it can be rewritten than do magnetic media. The other major disadvantage is that the data retrieval rate is 3 times slower compared with magnetic media. The advantages of the optical disks are that they hold more data, are lower in cost and much smaller (about the same size as 5.25 in. Bernoulli cartridge), and do not have strict environmental considerations for storage such as temperature, magnetic fields, dirt, and aging. Arrangements to use an optical disk cartridge should be coordinated with the System Manager and ESD personnel in charge of the VAXstation 3100 (Mary Alice Faulkner and Yetta Jager).

11.3 DATA ARCHIVE PROCEDURE

A special form of backup and restore (archival) data processing has been implemented to meet the needs of the ESD VAX, especially GIS users. Because the GIS data sets are frequently very large, require a large amount of labor to finalize, and have a complicated data structure, a backup system was devised to "automatically" backup and restore GIS data. In ARC/INFO, if the coverage (a thematic data unit) is processed with the EXPORT command (exported), then it is portable (directory, device, or system independent) and self-contained in one VAX file. These EXPORT files or other data files can then be copied and relocated by the system backup utilities. Other data files can also be processed by the Archive procedure if they meet the filename convention listed below. An ARC/INFO PLOT

file is an excellent example of a file that should be archived. Plot files are frequently large, are sometimes time consuming to regenerate, and have an uncertainty for subsequent reuse.

11.3.1 Archive Procedure Description

An archival procedure was designed to facilitate the removal of "old" or preliminary GIS data from the on-line disk space. It scans all user disks and the SCRATCH disk once each week (at 3:30 a.m. on Thursdays) and backs up all export files. This procedure also automatically generates mail messages and listings to the file owners that describe the directory and filenames of the data recorded by backup. This mail message or listing of the backup information provides users the complete specifications necessary to make a clear, unambiguous requests for data to be restored to the disk. Any users not receiving mail or a listing when they expect *.E00 files to be backed up should contact the System Manager (Neil Griffith) so any problems that arise can be immediately investigated. Requests for restored data should be sent to the System Manager (Neil Griffith).

In an effort to further enhance the movement of data off-line, the archive procedure also sends messages to users after 1 week to delete files that have been previously recorded by backup. Export files whose backup date is over 14 days old are automatically deleted by the procedure.

Several copies of the archive and export data are made by the procedure. The backup data are recorded on disk drives that do not otherwise contain user data. The backup data are recorded separately by the daily and weekly backup procedures. When the disk area holding archive data is full, special archive data tapes are written. Logs of files recorded are also stored in paper and electronic format by the system operation. The multiple copies of the data and recording documentation offer the user a reasonable assurance that the data can be retrieved. Archive data will be retained for 4 years, unless the user makes other arrangements.

11.3.2 Archive Data File Specification

The procedure can archive any file that is selected by the following wildcard specification:

.E0 Where * can be any valid filename character or characters.

<u>The RENAME command should not be used to change filenames to be included in the archive request because RENAME does not reset the date of the file.</u> If a file over 14 days old is renamed, it may be deleted by the archive procedure instead of being recorded. The COPY command should be used to change the filename so that it will be incorporated correctly by the procedure.

Although this procedure described above was devised for GIS users, it can be used for other types of files. Other files can be archived by this process if they are copied to a filename to fit the selection criterion.

12. TAPE HARDWARE AND SOFTWARE

12.1 TAPE HARDWARE OVERVIEW

This section presents an overview of the tape hardware available within the ESD LAVC. In contrast to disks, tape drives are not directly accessible to CPUs across the cluster. Therefore, the VAXstation 3100, which has no tape drives, has no access for direct processing of tapes. Users may also process data on tapes with the STC VAX and transfer data to the ESD VAXes with the network or a more familiar tape format.

Device name:	**ESDV01$MSA0**	Host system:	**VAX 11/750**
Media type:	9-track reel	Hardware model:	Cipher M-900
Recording density:	1600-6250 BPI	Storage capacity:	45-175 MB
Media cost:	$12.00 per reel		
Accessibility:	Accessible from VAX 11/750 by way of Tapeshare switch, available to users except during weekly and monthly backup.		

Device name:	**ESDV01$MUA0**	Host system:	**VAX 11/750**
Device type:	8-mm cassette	Hardware model:	Exabyte
Recording density:	~30,000 BPI	Storage capacity:	256-2300 MB
Media cost:	$30.00 per cassette		
Accessibility:	Accessible from VAX 11/750, typically unavailable to users, tape continuously loaded for daily backup.		

Device name:	**ESDV03$MUA0**	Host system:	**MicroVAX 3500**
Device type:	1/2 in. cartridge	Hardware model:	DEC TK-70
Recording density:	10,000 BPI	Storage capacity:	296 MB
Media cost:	$50.00 per cassette		
Accessibility:	Accessible from MicroVAX 3500, used as a secondary tape device for daily and weekly backup, available to users with tapes of this proprietary format.		

Device name:	**ESDV03$MUB0**	Host system:	**MicroVAX 3500**
Media type:	9-track reel	Hardware model:	Cipher M-900
Recording density:	1600-6250 BPI	Storage capacity:	45-175 MB
Media cost:	$12.00 per reel		
Accessibility:	Accessible from MicroVAX 3500 by way of Tapeshare switch, available to users except during weekly and monthly backup.		

The ESDV01$MSA0 and ESDV03$MUB0 devices are actually the same tape drive. This tape drive is connected to a tape switch, which connects to a similar controller in both the VAX 11/750 and MicroVAX 3500.

12.2 TAPE POLICIES

All of the tape drives connected to the ESD LAVC are located in the Computer Room (Room 121). This is necessitated by the relatively short cable that supports high data rates to the tape drive. Because the Computer Room is a locked, limited-access area, the tape drives are accessible only during normal business hours. Use of the tape drives after hours requires coordination with the System Manager (Neil Griffith.) (See also commands in Sect. 12.3.1.)

Users are allowed to use the tape drives on an "as needed" basis. The routine backups described in Sect. 13 take priority over user access to the tape drives.

Users are responsible for verifying that the tape processing is conducted correctly. The System Manager (Neil Griffith) will assist users in understanding tape processing. Users are also responsible for obtaining tape documentation when data are to be loaded from tape. Tape documentation includes format information (e.g., record length, block size, and density) and source information (e.g., generating system and software version, filenames, data description, and contact personnel). When ESD users wish to write tapes for distribution, they are responsible for determining and recording this information.

Users need to store their own tapes. The ESD computing facility can provide for a limited amount of tape storage. Users are also responsible for knowing the storage location of their tapes.

12.3 TAPE PROCEDURES

12.3.1 INIT, MOUNT and DISMOUNT Commands

The MOUNT command is essential for all tape processing. This command makes the tape accessible to a users process. There are several variations of this command:

> ALLOCATE tapeunit: logicalname - This assigns the tape drive to the user's process, so it can be initialized. "Logicalname" is any temporary character string. Note: Cassette (8 mm) and cartridge (TK-50) tapes do not require initialization.
>
> INIT logicalname: label - Prepares a new tape for writing. This command is only required for 9 track tapes. Cassette and cartridge tapes do not require this command.
>
> MOUNT tapeunit: - A simple MOUNT command can be used for tapes with a VMS label. This command will also prompt for and check the label name.

MOUNT/FOR tapeunit: - The FOREIGN option is used on the MOUNT command to mount a tape without a label or without checking the label.

MOUNT/NOUNLOAD tapeunit: - The NOUNLOAD option is on the MOUNT command to keep the media loaded and on-line after the process terminates. This option is particularly useful if you are using a tape after hours. If a tape is loaded during normal working hours, it can be used several times with this option. If this option is not used, the tape will dismount and unload when the interactive or batch job terminates. (Note: errors in a batch job will cause it to stop, and the tape will normally unload unless this option is used.) A MOUNT/UNLOAD command must be used to eventually unload the tape.

DISMOUNT tapeunit: - A simple DISMOUNT command will rewind the tape and unload it (unless MOUNT/NOUNLOAD was specified).

DISMOUNT/NOUNLOAD tapeunit: - The NOUNLOAD option on the DISMOUNT command is an effective way to rewind the tape without unloading it. Because tapes are sequential devices, they must be rewound before portions past on the tape can be reprocessed.

These commands have numerous other options. Additional information on the command is available in HELP on the system.

12.3.2 COPY Command

The COPY command that is normally used to transfer disk files can also be used to read and write data with VMS labelled tapes. When the COPY command is used, the tape maintains a modified form of the directory information about the data files. The COPY command is the simplest way to process a tape to be used on another VAX. However, COPY has some limitations:

- COPY does not make a valid directory structure of information for subdirectories. Therefore, all files must be in the same directory for both read and write processes (ARC/INFO data should not be processed with the COPY command.)

- The entire tape is treated as one volume or set of files.

- Tapes generated with COPY are not fully "self documenting." (See Backup discussion below.)

The BACKUP command discussed in Sect. 12.3.3 overcomes these limitations.

12.3.3 BACKUP Command

The BACKUP command is a major VMS system utility. It has numerous options and modes of operation. This discussion only presents the functions of BACKUP. Users wishing further information about BACKUP should use HELP, contact the System Staff, or consult the VMS manuals.

The BACKUP command is the best, but most difficult, manner of writing tapes for other VAXES. It is better than COPY in that it records the complete directory information. It can also process and duplicate the subdirectory structure. It is "self documenting" by recording a "backup date" on disk files and encoding the commands and system used to generate the tape in the front of the tape data. This documentation enables other systems to review the details of the tape generation process should problems occur. The BACKUP command can generate the appropriate subdirectories on either disk or tape. BACKUP can be used to transfer ARC/INFO data if they are processed at the "work-space" level. The BACKUP command should only be used with tape processed with BACKUP on another VAX/VMS system.

Because BACKUP is a moderately complicated and powerful command, users should always work with the System Staff when using it.

12.3.4 TAPECOPY Program

ESD has a program to read a few types of non-VAX tapes including ASCII, BCD, and EBCDIC tapes. It can handle a variety of block sizes and record lengths. The TAPECOPY program is located in ESDV01$DUA0:[EBCDIC] directory. It is a FORTRAN program that is executed with the RUN command. Instructions for allocating and mounting the tape are contained in the program. The System Manager (Neil Griffith) can also assist users with this program.

12.3.5 ARC/INFO TAPEREAD and TAPEWRITE

ARC/INFO contains TAPEREAD and TAPEWRITE commands that have some non-VAX tape processing capabilities. These procedures use a highly specified form of the VMS COPY command to read and write generically formatted ASCII tapes. Users are referred to the ARC/INFO manual for additional documentation on these commands. These commands are designed to minimize compatibility problems during the transporting of ARC/INFO data between different hardware types.

12.4 TAPE PROBLEMS

Problems with processing tapes are not uncommon (e.g., the quote "I have never met a tape I like except those I wrote, and I don't even like all of those"). The tape processing software and expertise in ESD is not extensive enough to handle more

than a few tape problems. Processing tapes from other systems can be very tedious, time consuming, and frustrating. Users are strongly encouraged to use C&TD Programmer Aides [Susan Thomas or Kathy Dunlap (4-5400), Building 4500N] to solve tape problems. These aides work full time with tapes and have access to numerous tools and systems to process data. Once data have been unloaded, it can be transferred to the ESD systems with the network or less troublesome tapes that have known attributes.

13. ESD BACKUP PROCEDURES

The operations of the Environmental Sciences Division (ESD) LAVC includes several layers of backup support for user data. The objective of the ESD backup procedure is to be able to reestablish a user's data to the previous working day should a disk drive fail. A secondary goal of the backup scheme is to be able to recover previous versions of data after it has been accidentally damaged by user procedures (e.g., accidentally deleted or corrupted by an inappropriate procedure option). The final purpose of the ESD backup procedure is to provide long-term storage of user data. At this time, 2 years of full monthly backup data is stored "off-site" in Building 1503. The compatibility of backup and the shelf life of magnetic tapes allow data to be retrieved over this time period.

13.1 ESD BACKUP OVERVIEW

Frequency:	**Daily**	Schedule:	**Midnight - 2:30 a.m. every night**
Backup host:	VAX 11/750	Tape drive:	8-mm 500-2300 MB cassette
Backup data structure:	Separate data set for each user disk each night.		
Files included:	All user files modified or created since the last weekly backup. Recent archive data (E00 export).		
Tape retention:	Until the same "week number" of the next month.		

Frequency:	**Weekly**	Schedule:	**6:45am - ~9:00 a.m. every Friday**
Backup host:	MicroVAX 3500	Tape drive:	9-track, 6250 bpi
Backup data structure:	Separate data set for each user disk.		
Files included:	All user files modified or created since the last monthly backup. Recent archive data.		
Tape retention:	until the same "week number" of the next month in Building 1503.		

Frequency:	**Monthly**	Schedule:	**See Sect. 13.3**
Backup host:	MicroVAX 3500	Tape drive:	9-track, 6250 bpi
Backup data structure:	Separate data set and sequence of tapes for each user disk.		
Files included:	All users files available at the time of backup.		
Tape retention:	2 years in Building 1503.		

13.2 ESD DAILY AND WEEKLY BACKUP FILE COVERAGE

The diagrams below describe the files included and available in each daily and weekly backup. The diagrams indicate that the backup periods are cumulative and overlapping. This means that files created or modified early in the period are recorded multiple times. Each line in the diagram below represents a separate

backup data set. A rotation of tapes are used throughout the month so that the backup data sets are accessible until the equivalent week of the next month.

Daily backup is performed in an unattended mode on an 8-mm tape drive. Because of the low number of users at midnight, users are not prevented from computing during this backup. However, the amount of file processing during daily backup makes the ESD LAVC relatively sluggish. Daily backup ends sometime around 2:30 a.m.

Users are prevented from using the system during the weekly backup to avoid the possibility of changing files during the backup processing. Weekly backup is attended by the System Manager (Neil Griffith), and its duration varies according to the amount of data being processed. Generally, weekly backup is finished by 9:00 a.m. on Friday.

13.2.1 Daily Backup Diagram

```
Time of backup                 File "creation" time period
                               Fri   Sat   Sun   Mon   Tue   Wed   Thu

00:10 a.m. Saturday            -----|
00:10 a.m. Sunday              -----|--------|
00:10 a.m. Monday              -----|--------|--------|
00:10 a.m. Tuesday             -----|--------|--------|-------|
00:10 a.m. Wednesday           -----|--------|--------|-------|-------|
00:10 a.m. Thursday                 -----|--------|--------|-------|-------|-------|
00:10 a.m. Friday              -----|--------|--------|-------|-------|-------|-------|
```

13.2.2 Weekly Backup Diagram

```
Time of backup                 File "creation" time period
                               MB*   wk1   wk2   wk3   wk4

Friday a.m. week 1             ------------|
Friday a.m. week 2             ------------|--------|
Friday a.m. week 3             ------------|--------|--------|
Friday a.m. week 4             ------------|--------|--------|-------|
```

* Weekly backup starts with the Friday of the previous Monthly Backup.

Not all months have the same number of weeks of backup, depending on the day of the week on which the month ends. The first weekly backup occurs on the first Friday after the monthly backup that was performed on the previous Friday. Each subsequent weekly backup covers files created or modified back to the Friday of the previous monthly backup.

13.3 MONTHLY BACKUP SCHEDULE

The monthly backup is a full copy of all files on the user disk at the time of the backup. This backup takes much longer than the partial daily and weekly backups. Therefore, only one or two user disks are recorded during the monthly backup schedule. Monthly backup starts at approximately 7:30 a.m. on the scheduled day. Its operation is attended by the System Manager (Neil Griffith) and is generally completed between 9:00 and 10:00 a.m. The users authorized for the disks are not allowed access to the system during the monthly backup period of their home disk. This access limitation means that each user will be blocked only once each month.

User disk(s)	Backup Day
U1	Last Tuesday of the calendar month
U2 and U6	Last Wednesday of the calendar month
U3	Last Thursday of the calendar month
U4 and U5	Last Friday of the calendar month

The disks are not scheduled for backup in the same order each month because some times the last Friday of the month may occur before or after the last Tuesday. Therefore, there are some weeks in which monthly backup is being completed early in the week and the weekly backup cycle is started on Friday.

13.4 SPECIAL USER BACKUPS

Users may request special backups of their data at times that don't conflict with the regularly scheduled backups. These requests are coordinated with the System Manager (Neil Griffith). User requested backups are intended to enable users to "capture" a particular stage of their data processing for their own project records or as a prelude to a major cleanup of a user's disk space. Users may also request special backups for the purpose of obtaining tapes to be distributed to other sites. Regular request for special user backups are generally discouraged. Users should understand and depend on the regular daily, weekly, and monthly backups. A user-requested backup may include all or part of the users disk area or from the scratch disk or private disk.

It is the users responsibility to:

- appropriately define the files to be included in the backup,
- review the log of the backup to determine is adequacy and correctness, and
- store special backup tape and its documentation.

The System Manager (Neil Griffith) will assist in the review of the backup log. He will also provide a listing to the user of the log with the special backup tape user after the backup is completed.

During a special backup, users are advised not to access the system. This avoids confusion in the version stored by the backup.

14. ESD NETWORK FUNCTIONS

14.1 ESD NETWORK DESCRIPTION

Network applications in Environmental Sciences Division (ESD) include remote system access, data transfer, and remote device access. The ESD Computing and Geographic Information System Facility is a part of the ESD network. This network is a "local area network (LAN)" and it part of "wide area network (WAN)" that spans all of Martin Marietta Energy Systems, Inc. (Energy Systems). The Energy Systems network has connections to worldwide networks (e.g., bitnet, ARPAnet, and Internet). The ESD network is based on Ethernet hardware. Systems connected to the network in ESD use DECnet and TCP/IP communications protocols on this network.

The communications backbone of the network spans all of the hallways of Building 1505 except for the loading dock, machine room, and a portion of the hall near the change rooms. A network backbone segment in Building 1000 (from Rooms 200 - 223) is connected to the Building 1505 segment by fiber communications. These ESD segments are connected to the Oak Ridge National Laboratory (ORNL) and Energy Systems network with a bridge connection to the inter-plant broadband in Building 1505.

The network is connected to all multiuser systems in ESD (4 VAXes) and all workstations in ESD (approximately 15 systems). Approximately 40 PCs are also connected to the ESD network. (See Sect. 14.3.)

14.2 NETWORK COMMUNICATIONS

14.2.1 Network System Access

Accessing other systems for interactive computing is one application of the network communications in ESD. Remote system access can be accomplished with DECnet and TCP/IP. Both types of network connections allow for multiple hops to additional remote systems. ESD Systems Staff can provide users assistance in using these commands and identifying the network names or other systems.

In VMS and DECnet, the SET HOST command is used with the following syntax:

SET HOST nodename

where the nodename is the DECnet name of the remote system. The SET HOST command can be used to access only those systems running DECnet. All ESD VAXes, most VMS VAXes, and a few UNIX systems are accessible with DECnet. After the SET HOST command is executed, the user will be immediately prompted to log in into the remote system. When the remote system is logged out, the

interactive process is returned to the first system. Users should be aware that connect time charge will continue to accrue for all systems involved in SET HOST communications.

The TELNET part of TCP/IP can also be used for remote system access. The TELNET command starts a prompting mode for connecting to other systems. Other ORNL systems can be accessed by using the first part of the TCP/IP name (e.g., ESDV03 for the MicroVAX 3500). Access to systems away from ORNL require the full TCP/IP name or number (e.g., ESDV03.ESD.ORNL.GOV or 128.219.24.13). The MicroVAX 3500 is the only system in the ESD LAVC that operates the Multinet TCP/IP software. Several PCs and workstations in ESD operate the TCP/IP software.

14.2.2 Network Data Transfer

Another application of the ESD network is the transfer of data files with other systems. File transfer can be accomplished with either DECnet or TCP/IP. Data transfer rates over the network are much higher than other communications (several hundred KB per minute). ESD Systems staff can provide more detailed information on remote systems and on the file transfer commands described in the following.

File transfer with DECnet and VMS is executed with the COPY command. An example of a copy command to send a file called "local.file" to a file called "remote.file" on the STC VAX is:

```
COPY local.file STC10"uid password"::U1:[uid]remote.file
```

where uid is the C&TD user ID, password is the C&TD password, U1: is the users default disk device, and [uid] is user's directory (or existing subdirectory).

File transfer with TCP/IP uses the FTP utility. The following example of FTP shows the transfer of "local.file" on the ESD MicroVAX 3500 to "remote.file" on the STC VAX (STC10). This is an abbreviated version of the FTP dialogue. The underlined portions are commands entered by the user.

From ESD to STC10 with ESDV03

FTP STC10	(VMS command to start FTP with STC10)
FTP prompt> log	(FTP command to set up remote process on STC10)
username: C&TD uid	(User ID and password dialogue)
password: password	
FTP prompt> put	(FTP command to send file to STC10)
local file: local.file	(filename on local host)
remote file: remote.file	(filename on remote host, STC10)
FTP prompt> quit	(stop FTP and disconnect from STC10)

The following example retrieves a file from the STC VAX to the ESD MicroVAX 3500.

From STC10 to ESD with ESDV03

FTP STC10	(VMS command to start FTP connection with STC10)
FTP prompt> log	(FTP command to set up remote process on STC10)
username: C&TD uid	(User ID and password dialogue)
password: password	
FTP prompt> get	(FTP command to retrieve file from STC10)
remote file: remote.file	(filename on remote host, STC10)
local file: local.file	(filename on local host)
FTP prompt> quit	(stop FTP and disconnect from STC10)

Additional information on FTP is available from VMS HELP and FTP HELP.

14.3 PC-VAX NETWORK SERVICES

Another network application of the ESD network is to use the ESD LAVC as a "server" for approximately 40 PCs connected to the network. The "server" relationship between the VAXes and PCs uses a DEC software product called DECnet PCSA Client for DOS or VMS Services for PCs. VMS Services are an extension of DECnet for PCs and use DECnet protocols and ethernet hardware.

The server functions of the network provide the PCs with remote disk and printer connections. This enables ESD staff to access "shareable" data and printers from their PCs. PCSA also allows for a direct VT240 terminal type communication between the PC and VAX. PCSA also provides some utilities to send mail and emulate DECwindows terminals.

The connection of a PC to the network requires a special ethernet controller board in the PC and the installation of PCSA software on the PC. Network functions on a PC operate as resident tasks. The memory required for these resident tasks depends on the hardware configuration of the PC. Without expanded or extended memory, the PCSA software may reduce the available memory below the requirements for some PC software. Additional information about the PC-VAX network facilities is available from Linda Littleton. Linda coordinates the installation, implementation, and maintenance of the ESD PC-VAX network.

14.3.1 File Services

The file services provided by the network functions on a PC as extra disk drives. These network (remote) disk drives are directly accessible to DOS and other PC

software. The performance of the network disks is comparable to a slow hard disk (but faster than a floppy drive). The number of network disks defined for a PC depends on the needs of the user. Network disks offer a feature beyond the "normal" PC disk because they can be designated "read only" and simultaneously accessed by multiple users. Data translation and virtual file services are available with network.

Data translation is the slower type of file service provided by the network. Its major benefit is that it provides both VAX and the PC users access to the same data from one version of the file. This is accomplished by the VAX server translating the data from a VAX format to a PC format. In this type of data access the "network disk" definition is linked to a specific VAX subdirectory. All files and subdirectories that meet PC filename limits (eight-character file name and three-character extension) are directly accessible by the PC. Both VAX users and PC users can alter the structure and content of this type of "network disk."

A faster type of network disk is structured as a virtual disk file. In this type of data access, each network disk defined from the PC is a single large file on the VAX. This file on the VAX has an internal structure similar to a DOS disk. This data format results in faster data transfer than when data translation is required. However, information in a virtual disk file is not accessible by VAX users.

14.3.2 Printer Services

Access to VAX hosted printers from PCs is another function of the PCSA network. It is possible to define VAX printer queues as auxiliary DOS printers (LPT1 or LPT2) on the PC. Because this definition is set up at the DOS level, it is possible to send print output to VMS devices by modifying the printer definition in the PC software. For example, a PC connected to the network with the Laserjet queue defined as printer LPT2 can print on the high-speed HP Laserjet 2000 printer from WordPerfect by changing printer setup to use a LaserJet attached to LPT2. After a VAX printer and its queue have been defined by PCSA as a DOS printer device, additional setup specification (e.g., remote node name) is not required in the applications software. The VAX printers remain "shareable" to other VAX users and network PC users after PC-VAX printer relationship has been defined.

14.3.3 Data Transfer Services

An 80386 PC operating the network DECnet PCSA client software is available to all ESD staff and guests for the purpose of data transfer. This PC is located in Room 118, Building 1505. File transfer with PC DECnet DOS uses the NFT utility. NFT allows file transfer between the local PC node and remote nodes (VAXes) connected to the Energy Systems DECnet network. The PC is equipped with 5.25 in. (1.2 MB) and 3.5 in. (1.44 MB) floppy disk drives as well as 8.5 in. and 5.25 in. external Bernoulli drives (20 MB).

Appendix A

ARCDUR COMMAND FOR EXPORTING ARC/INFO GIS DATA IN DURFEE'S GIS DATA FORMAT

A.1 COMMAND FORMAT

ARCDUR <cover> <Durfee> {GEO | STATE}

A.2 COMMAND PURPOSE

ARCDUR converts a polygon or line coverage into Durfee chain format.

A.3 COMMAND ARGUMENTS

<cover> - The existing coverage to be converted. This must be a line and/or polygon coverage.

<Durfee> - The name of a new Durfee chain file.

{GEO | STATE} - The output format of the Durfee chain file from <cover>.

GEO - Coordinates will be written in the latitude/longitude system, expressed in decimal degrees. Longitude is multiplied by -1 to change east/west reversal. F10.6 format is used to write coordinates.

STATE - Coordinates will be written into a rectangular coordinate system (e.g., State Plane Feet, Albers Meters), F10.1 format is used to write coordinates.

A.4 USAGE NOTES

- The Durfee chain file produced by ARCDUR is a card image format using 80 characters per record.

- ARCDUR searches the AAT or PAT (or both) of <cover> standard Durfee item names. The type of items written to the <Durfee> output depend on which ones are found and the types topology in the <cover>. If the items are not found, then blanks are written in that field. The source and placement of standard Durfee items are described in Sect. A.4.1.

A.4.1 Standard Durfee Items and Attributes

Standard Durfee items or attributes have special names and may have a character, integer, binary, or floating type of item format. All numeric values stored in this field are truncated to integers on the output records. Character values are written to the output record without change and are left justified within their fields.

DURCOD - A polygon attribute or item found in the PAT. Values of DURCOD are written in the output file when the cover has both polygon and line topology.

DURNAM - An arc attribute or item found in the AAT. DURNAM is similar to a chain identifier.

DURRHT - An arc attribute or item found in the AAT. DURRHT is the arc attribute that represents the condition that occurs on the right side of the arc. DURCOD from the PAT will supersede values from DURRHT in the AAT.

DURLFT - An arc attribute or item found in the AAT. DURLFT is the arc attribute that represents the condition that occurs on the left side of the arc. DURCOD from the PAT will supersede values from DURLFT in the AAT.

A.4.2 Topology and Data Cases for Code Output

The following table shows the translation of arc and polygon attributes into the topology of the Durfee data format.

	Input status				Output status		
Top[1]	PAT	AAT					
	DUR-COD	DUR-NAM	DUR-RHT	DUR-LFT	DUR-NAM	DUR-RHT	DUR-LFT
none	m[2]	m	m	m	m	m	m
po	p[3]	m	m	m	m	m	m
li	m[4]	p	p	p	p	p	p
po,li	p	m	m	m	m	p	p
po,li	p	p	m	m	p	p[5]	p[5]
po,li	p	p	p	p	p	p[5]	p[5]

[1] "Top" represents the type of topology present in <cover>: po = polygon topology, li = line topology.

[2] m = missing.

[3] p = present.

[4] When polygon topology is missing, any of the arc attributes present in the data will be written in the output. Note: Line topology must be present for any of the codes to be written in the output. However, attributes will be generated without any of the special items in the AAT.

[5] The right and left values from the PAT item DURCOD will supersede the AAT values from DURRHT and DURLFT.

A.5 COMMAND DISCUSSION

The Durfee chain file is a Geographic Information System (GIS) data interchange format between ARC/INFO and the ORNL Computer Geographics Group GIS software. The chain file consists of two types of data records: header records and chain records. One chain is written for each arc in a coverage. Each chain consists of one header record and one or more chain records. The format and contents of each record type is listed in the following.

A.5.1 Header Record Format

The following table lists the format of the header records in the Durfee GIS chain file format.

Item name	Format	Starting column	Ending column
DURNAM	A10	1	10
DURCOD (right)	A10	11	20
DURCOD (left)	A10	21	30
y minimum	{F10.6 | F10.1}	31	40
y maximum	{F10.6 | F10.1}	41	50
x minimum	{F10.6 | F10.1}	51	60
x maximum	{F10.6 | F10.1}	61	70
number of pts	I10	71	80

DURNAM and DURCOD are values derived from items the of AAT and/or PAT of <cover>. The x and y minimums and maximums are calculated by ARCDUR.

A.5.2 Chain Record Format

The following table lists the format of the chain records in the Durfee GIS chain file format.

Item name	Format	Starting column	Ending column
X(1)	{F10.6 | F10.1}	4	13
Y(1)	{F10.6 | F10.1}	14	23
X(2)	{F10.6 | F10.1}	27	36
Y(2)	{F10.6 | F10.1}	37	46
X(3)	{F10.6 | F10.1}	50	59
Y(3)	{F10.6 | F10.1}	60	69

A.6 RELATED ARC/INFO COMMANDS

DURARC, GENERATE, UNGENERATE

Appendix B

DURARC COMMAND FOR IMPORTING GIS DATA IN DURFEE'S GIS DATA FORMAT INTO AN ARC/INFO COVERAGE

B.1 COMMAND FORMAT

DURARC <Durfee> <cover> {GEO | STATE}

B.2 COMMAND PURPOSE

DURARC converts a Durfee chain file into a raw ARC/INFO coverage.

B.3 COMMAND ARGUMENTS

<Durfee> - The name of an existing Durfee chain file.

<cover> - The output coverage to be generated.

{GEO | STATE} - The Durfee chain file format that <cover> will be converted into.

GEO - Coordinates will be read from the latitude/longitude system, expressed in decimal degrees. Longitude is multiplied by -1 to change east/west reversal. F10.6 format is used to read the coordinates.

STATE - Coordinates will be read from a rectangular coordinate system (e.g., State Plane Feet, and Albers Meters). F10.1 format is used to read the coordinates.

B.4 USAGE NOTES

- The Durfee chain file read by DURARC is a card image format using 80 characters per record.

- The coverage produced by DURARC should be processed further to build line and/or polygon topology. Attributes from the headers for the Durfee chain file should be joined to the PAT or AAT immediately after topology is built. If feature editing (addition or removal of features) occurs before the joining of attributes, the attributes will not be joined correctly. If the data from the chain file are not topologically correct (i.e., unresolved intersections, or unclosed polygons) the attribute codes from the chain file will not join correctly with the geographic features. (See the Sect. B.6, "Examples of Topologically Correct Processing" under Command Discussion.)

- DURARC generates a label point on each side of every arc. When polygon topology has been established, a label error condition will result because the polygons have more than one label per polygon. CREATELABELS with an option of 0 should be used to remove all of the generated label locations and

to set up one new centralized label per polygon. The topologic relationships within the coverage then needs to be updated with IDEDIT POLY option to associate the correct attributes with the new label locations.

B.5 COMMAND DISCUSSION

B.5.1 Topology and Format of Durfee Chain File

The Durfee chain file is a GIS data interchange format between ARC/INFO and the ORNL Computer Geographics Group GIS software. The chain file consists of two types of data records: header records and chain records. Each chain with less than 499 points is represented as one arc in the coverage. Chains that have between 500 and 999 points are split into two arcs. Chains over 999 points cannot be processed by DURARC.

Each chain consists of one header record and one or more chain records. The chain record format repeats for as many records necessary to complete the XY chain. The format and contents of each record type are listed below.

B.5.2 Header Record Format

The following table lists the format of the header records in the Durfee GIS chain file format.

Item name	Format	Starting column	Ending column
DURNAM	I10	1	10
DURCOD (right)	I10	11	20
DURCOD (left)	I10	21	30
y minimum	{F10.6 | F10.1}	31	40
y maximum	{F10.6 | F10.1}	41	50
x minimum	{F10.6 | F10.1}	51	60
x maximum	{F10.6 | F10.1}	61	70
number of pts	I10	71	80

B.5.3 Chain Record Format

Item name	Format	Starting column	Ending column
X(1)	{F10.6 | F10.1}	4	13
Y(1)	{F10.6 | F10.1}	14	23
X(2)	{F10.6 | F10.1}	27	36
Y(2)	{F10.6 | F10.1}	37	46
X(3)	{F10.6 | F10.1}	50	59
Y(3)	{F10.6 | F10.1}	60	69

The chain record format is repeated for as many "card images" as is necessary to complete the chain.

Codes for the attributes of the chain are written to two INFO data files (cover.PCODE for polygon attributes and cover.ACODE for arc attributes). The following list explains items in each INFO data file.

B.5.4 Definitions of Durfee Code Fields

DURNAM - A chain identifier. The value in DURNAM can be any ten-character value and may or may not be equal to the User-ID in the coverage. It is usually a sequence-type chain identifier and not used for representing attributes.

DURRHT - The code value for the right side of the chain. DURRHT can be any 10 character value. The right and left side of a chain is designated to represent that area to the right and left the chain when it is viewed from its starting point and facing toward its endpoint.

DURLFT - The code value for the left side of the chain. DURLFT can be any ten-character value.

DURCOD - The code value to correspond to the labels generated to the right and left for each arc.

User-ID - It is written to permit relating these ancillary files to the feature attribute table (PAT and AAT).

DURNAM, DURRHT, DURLFT and User-ID are written into cover.ACODE and can subsequently be joined with the AAT after BUILD has established line topology. DURARC write one ACODE record for each arc. (Note: The information in cover.ACODE can provide information about attributes in areas to the left and right side of the arc even though polygon topology is not developed for the coverage.)

DURCOD and User-ID are written into cover.PCODE and can be joined with the PAT after BUILD has established polygon topology. Two PCODE records will be generated for each ARC processed. The number of PCODE records correspond with the number of labels generated by DURARC (two label points for each arc, one on the right and one on the left). Even though numerous labels may be generated per polygon, when the coverage topology is processed before editing, the polygon attributes will be associated correctly and the "extra" label information will be dropped.

B.5.5 Ancillary INFO Attribute Files

The definition of items of the ancillary INFO attribute files are described in the following.

ACODE file - The ACODE file contains the following information for each Durfee chain:

Column	Item name	Width	Output	Type	N.dec
1	User-ID	4	5	B	-
5	DURNAM	10	10	C	-
15	DURRHT	10	10	C	-
25	DURLFT	10	10	C	-

PCODE file - The PCODE file contains the following information for each Durfee chain:

Column	Item name	Width	Output	Type	N.dec
1	User-ID	4	5	B	-
5	DURCOD	10	10	C	-

B.6 EXAMPLES OF TOPOLOGICALLY CORRECT PROCESSING

B.6.1 Line Topology

DURARC REG1.DUR REG1 {GEO | STATE}
BUILD REG1 LINE
JOINITEM REG1.AAT REG1.ACODE REG1.AAT REG1-ID REG1-ID
Edit or delete labels, continue with other GIS processing.

Note: If the attribute codes from the header data records of the <Durfee> file are important for linking other thematic data to the geographic features, then it is very important that the steps through the JOINITEM be completed before any other editing or GIS processing

occurs. The JOINITEM step depends on the original sequencing of the User-ID for successful linkage of the ancillary attributes. Editing frequently results in the renumbering of the User-ID and subsequently can result in "lost" attributes.

B.6.2 Polygon Topology

DURARC REG2.DUR REG2 {GEO | STATE}
BUILD REG2 POLY
JOINITEM REG2.PAT REG2.PCODE REG2.PAT REG2-ID REG2-ID
CREATELABELS REG2 0
IDEDIT REG2 POLY
Edit geographic features, continue with other GIS processing.

Note: If the attribute codes from the header data records of the <Durfee> file are important for linking other thematic data to the geographic features, then it is very important that the steps through the IDEDIT be completed before any other editing or GIS processing occurs. The JOINITEM and IDEDIT steps depend on the original sequencing of the User-ID for correctly relating the attributes to the geographic features. If these steps are not completed successfully, then the ability to correctly link the attribute codes will be lost.

Incomplete polygon topology in the Durfee chain file can also interfere with the successful linkage of attributes because of changes in the number and sequence of the User-IDs. When incomplete polygon topology results, the most efficient approach to correcting the problem is to edit correct coordinates into the chain file. Correcting "errors" in the geographic features with ARC/INFO will most likely result in the reordering of the User-ID and the loss of the ability to link the attributes correctly.

B.7 RELATED ARC/INFO COMMANDS

ARCDUR, GENERATE, UNGENERATE

Appendix C

LASERS COMMAND FOR PLOTTING HARDWARE SHADES ON THE IMAGEN 2308 LASER PRINTER

C.1 COMMAND FORMAT

LASERS <plot file name> {any valid IMPRINT Options}

C.2 COMMAND PURPOSE

LASERS command sends ARC/INFO PLOT files with graphic polygons to be shaded with hardware shade patterns to the IMAGEN 2308 graphics laser printer located in Room 175, Building 1505 (ESD GIS Laboratory).

C.3 COMMAND ARGUMENTS

<plot file name> -	The name of a plot file containing hardware shade polygon logic generated by ARC/INFO. Hardware shade logic is enabled by the DISPLAY 1039 2. (Note: the "2" option on this command causes polygon logic to be used.)
{any valid IMPRINT OPTIONS} -	Any string of valid IMPRINT options can be optionally entered on the LASERS command. This command must be proceeded by a single space and should not contain any imbedded blanks. IMPRINT is an analog of the VMS PRINT command for the IMAGEN laser printer. More information on IMPRINT can be found on the system with HELP IMPRINT.

C.4 USAGE NOTES

- The hardware shade patterns are positioned and scaled by the resolution of the graphics device. Therefore, the pattern will not change as the map scale or polygon size changes. The position of the pattern origin is also independent of map scale and size. Therefore, the left edge of the shade pattern may not start at the left edge of the polygon. However, the entire polygon will be filled with the shade pattern. [The PLOT36S command for the Versatec plotter also used hardware shade patterns. The patterns are generally darker on the Versatec because it has higher resolution (400 DPI) and a larger minimum dot size.]

- The total number of vertices that define a shade polygon is limited by the plotter software. This limit is approximately 4500 vertices. This limit included not only the number of points along the outside edge, but also the number of

points defining any inside holes in the polygon. When the shade polygon vertices limit is exceeded, the plotting software will either fail to shade the polygon or will join the last point it can use with the first point. This joining process results in some odd triangles of shading.

- Not more than 64 different shade patterns can be specified in each plot.

- Intermittent problems in correctly shading the plot may occur if the number of polygons or patterns is very large. This tends to overrun the memory of the plotter processor.

- For plots with a predominance of heavily shaded polygons, using the hardware shade pattern option can reduce the size of the PLOT file by 80%. Smaller plot files mean less computing effort is required to generate the PLOT file and communicate it to the plotter.

- PLOT file commands that would ordinarily indicate color changes are interpreted by the LASERS command (and LASER, PLOT36, PLOT36S commands) as changes in "hardware line thickness." Therefore, specification of higher color number (e.g., 2 = red, 3 = green, 4 = blue, . . .) results in darker, thicker and bolder lines and patterns.

C.5 COMMAND DISCUSSION

C.5.1 Hardware Shading Setup in ARCPLOT

Several ARCPLOT commands must be used to appropriately generate the hardware polygon shades from ARCPLOT. These include the following:

DISPLAY 1039 2 - The "2" option must be used on the DISPLAY statement. Otherwise, vector-based shade patterns will be specified.

SHADESET PST.SHD - ESD has a special shade set initially developed for postscript printer that specified a hardware-generated shade pattern using colors 1 to 100. Because the LASERS program keys on "color number" to select its hardware pattern, this shade set should be specified.

C.5.2 Hardware Shade Patterns

The patterns shown in Figs. C-1 and C-2 represent the shade patterns available with the ESD LASERS commands. Patterns from the PLOT36S command are similar, except they are finer and darker. Shade pattern numbers less than 1 are

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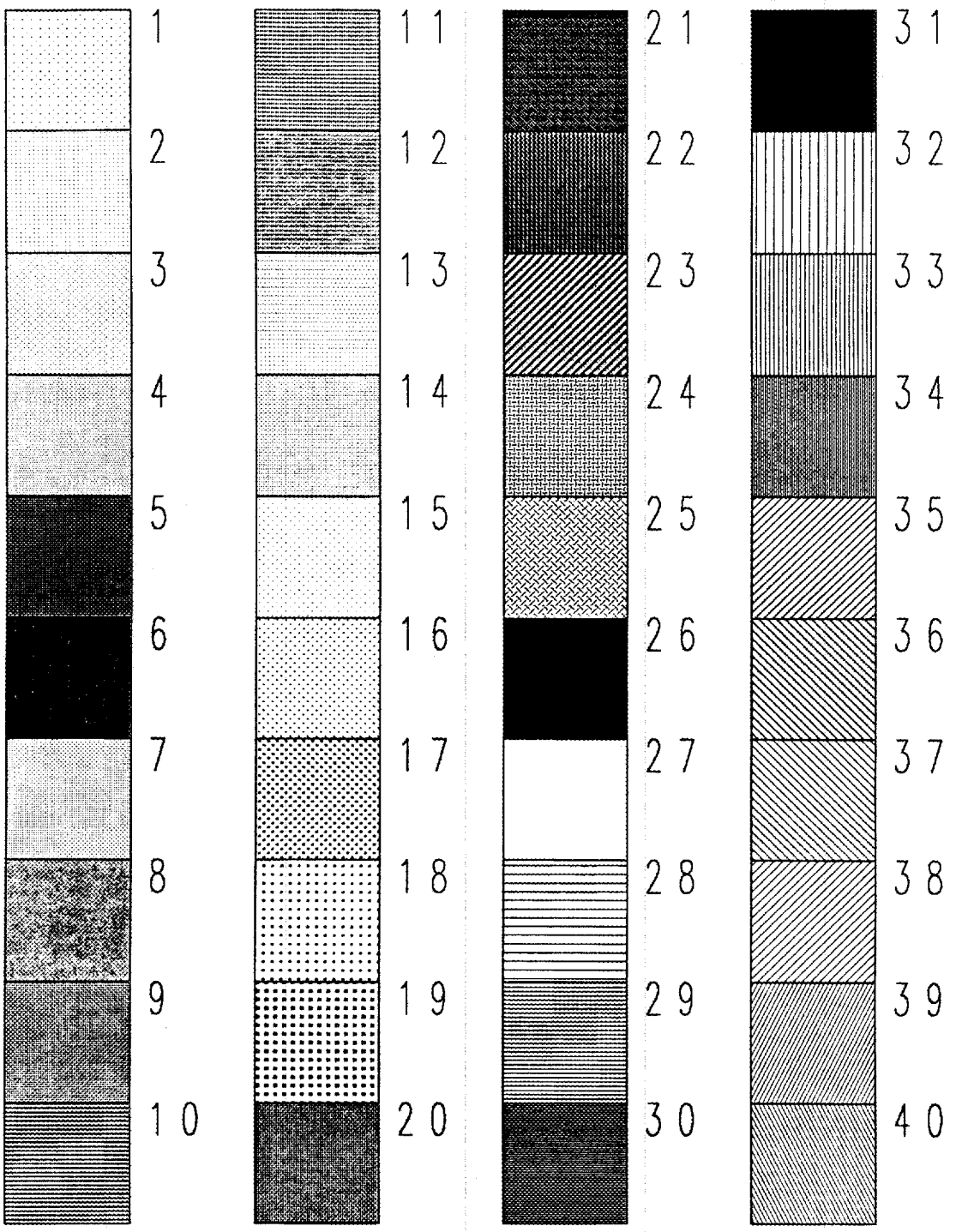

Fig. C-1. Hardware shade patterns (Nos. 1-40) generated with the LASERS command.

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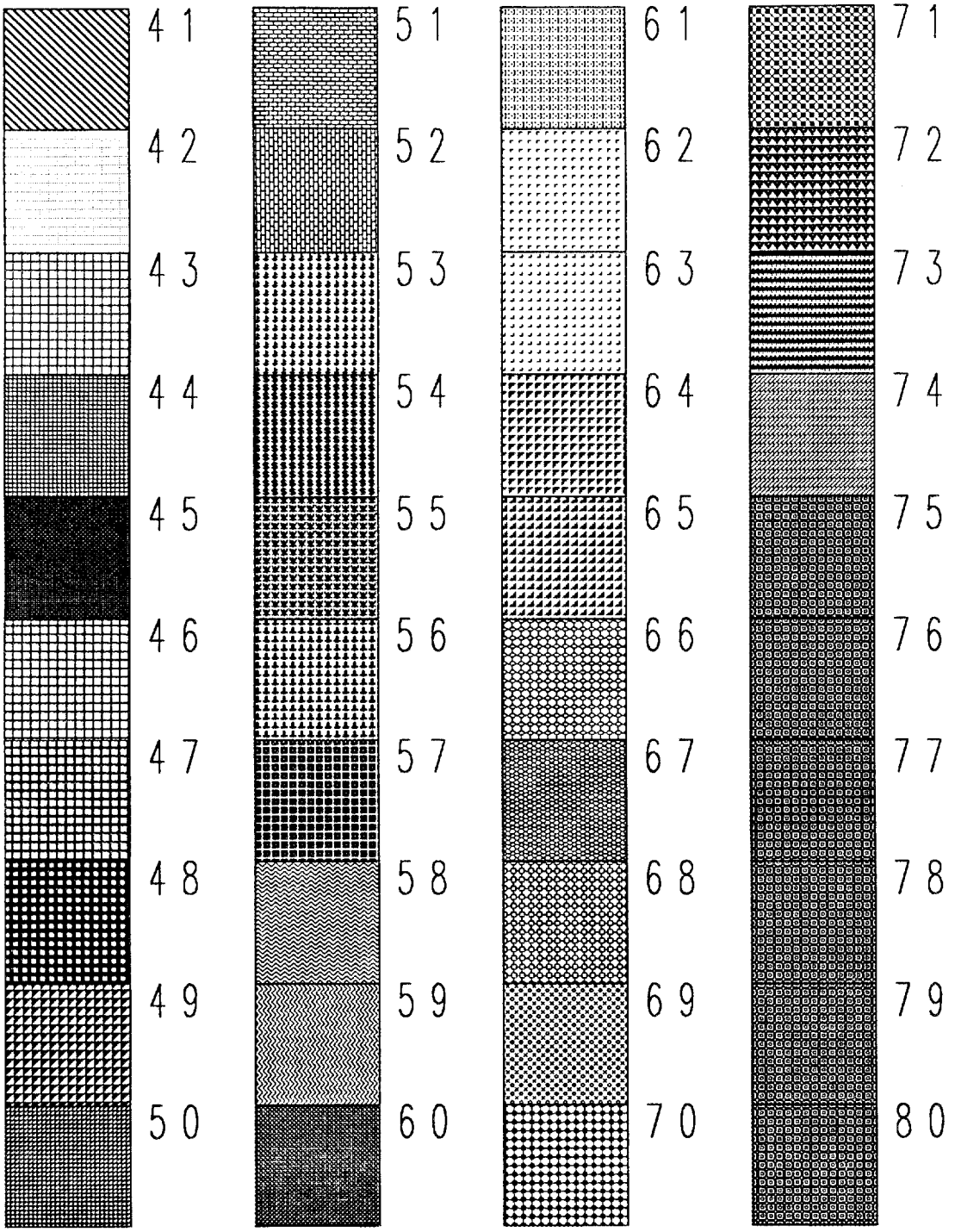

Fig. C-2. Hardware shade patterns (Nos. 41-75) generated with the LASERS command.

ignored. Shade pattern numbers greater than 75 are set equal to 75.

C.6 RELATED ARC/INFO COMMANDS

ARCPLOT, POSTSCRIPT, DISPLAY, SHADESET

Appendix D

SASGARC COMMAND FOR IMPORTING GRAPHICS GENERATED BY SAS/GRAPH INTO ARC/INFO PLOT FILES

D.1 COMMAND FORMAT

SASGARC <SAS/GRAPH.file> <plot filename root> {resolution (UPI)}

D.2 COMMAND PURPOSE

SASGARC converts PC SAS/GRAPH Version 6.03 (and 6.04) metafile output into one or more ARC/INFO PLOT files.

D.3 COMMAND ARGUMENTS

<SAS/GRAPH.file> - The name of the SAS/GRAPH metafile that was transferred from the PC to the ARC/INFO host. This file may contain one or more graphs.

<plot filename root> - The root of the names for the output PLOT files. A sequence string of '####.PLT' that starts with '0001.PLT' is appended to the root to make a sequence of plot filenames.

{resolution (UPI)} - The resolution specified for the metagraphics device driver in PC SAS/GRAPH. The resolution is specified in units per inch (UPI) and defaults to 300. If values that are larger or smaller than the value in PC SAS/GRAPH device driver are used, the resolution factor can become like a scale factor.

D.4 USAGE NOTES

- The metafile from SAS/GRAPH may contain one or more graphs. Each graph will be made into a separate PLOT file.

- The root for the plot filename should not contain an extension for the filename. If an extension or "." is contained in the filename, the procedure will build an invalid PLOT filename (e.g., test.plt.plt) and the conversion procedure will fail.

- The resolution of the device driver may be optionally specified in the command string. This option allows for two features in the interface. First, it allows for the interface to read metafiles and produce PLOT files to a scale whose resolution is different from the default 300 UPI. Second, different values of resolution will cause the resulting PLOT file to have a different scale from the SAS/GRAPH original. For example, if a resolution of 150 is specified when the metafile has a resolution of 300, the PLOT file will be enlarged by a factor of 2. If a resolution of 600 is specified when the metafile

has a resolution of 300, the PLOT file will be reduced by one-half.

- The command echoes to the monitor or log file the full filenames and min-max of the resulting PLOT files.

D.5 COMMAND DISCUSSION

The SASGARC command interface supports the importing of graphics from PC SAS/GRAPH versions 6.03 and 6.04 into ARC/INFO versions 4.01, 5.0, and 5.0.1. (The device driver has also been implemented on the STC VAX with SAS version 6.06). The importing of graphs may used for the illustration of a few, general, summary statistics with a few graphs. It may also be used for the examination of detailed patterns of multivariate factors by importing numerous graphs. Potential applications of this interface are discussed in McCord and Olson (1989).

The importing of graphics is accomplished by way of a graphics metafile that is generated on the PC and transferred to the ARC/INFO host. The metafile is an ASCII file with record length of 80 and contains strings of numeric codes that detail the "pen" movement instructions to compose the graph. There are numerous methods of transferring files from PCs to the host. A method with an error-checking protocol (e.g, Kermit) is recommended.

The device driver supports a resolution of 300 UPI, 16 colors and page size of 8 x 10 in. These parameters of the device driver could be altered by a knowledgeable SAS/GRAPH user with PROC GDEVICE. If these are the only parameters modified in the device driver, then the SASGARC programs should continue to work without modification.

A few graphs may be placed on a map generated in ARC/INFO with the PLOT command in ARCPLOT. The PLOT commands allows for several options for positioning and scaling the graph on the map. These include the specification of the lower left corner or x-y min-max box in either page units. (Note: The ARC/INFO documentation on the PLOT command indicates that MAP units may also be used. However, this positioning option is not currently enabled.)

If numerous (tens to hundreds of) graphs are to be placed on a map, it is suggested that an Arc Marco Language program be used to read the PLOT filenames and positioning coordinates from a data file (INFO) and to generate the necessary PLOT commands in ARCPLOT.

The graphs that are converted to PLOT files can also be manipulated as map elements if the map composition features of ARCPLOT are used.

D.6 INSTRUCTIONS FOR USING SAS/GRAPH METAGRAPHICS DEVICE DRIVER

After the modified device driver has been installed into a subdirectory on the PC, the following SAS commands will enable the driver. (NOTE: the following example below assumes that the device driver is installed in C:\ARCINFO. The driver can be installed in any subdirectory.)

LIBNAME GDEVICE0 'C:\ARCINFO';

Using a libname of gdevice0 puts the catalog for the device driver into an automatic search path for SAS/GRAPH.

FILENAME ARCINFO 'path:\filename';

'path:\filename' is a string that defines the path and filename for the metagraphics output. SAS will put the metagraphic instructions into this file as long as the FILENAME statement is in effect. As a result, the metagraphics file may contain more than one graph. These are the products of more than one SAS/GRAPH procedure or a SAS/GRAPH procedure with a BY statement.

GOPTIONS DEVICE=ARCINFO;

The GOPTIONS statement activates the modified metagraphics driver.

After these three statements have been executed in SAS, any number of SAS or SAS/GRAPH statements may be executed.

NOTE: All of these three SAS statements remain in effect until they are replaced by an equivalent statement or the SAS session ends. For example, the SAS/GRAPH device can be changed to EGA monitor by the later execution of a "GOPTIONS DEVICE=EGAL;" statement.

D.7 CHARACTERISTICS OF THE MODIFIED SAS/GRAPH METAGRAPHICS DEVICE DRIVER

Colors:

SAS color	PLOT file logical pen number	Tektronix color
black (background)	0	black
white	1	white
red	2	red
green	3	green
blue	4	blue
cyan	5	cyan
magenta	6	magenta
yellow	7	yellow
orange	8	orange
brown	9	light green
gray	10	pale green
lime	11	pale blue
violet	12	dark blue
rose	13	pale red
tan	14	dark gray
gold	15	light gray

Resolution: 300 addressable units per inch.

Page size: 10 in. X, 8 in. Y

Hardware options disabled for device portability:

characters, symbols, dash, fill, polyfill, piefill, dash, and circlearc

D.8 SASGARC DEVELOPMENT ENVIRONMENT

PC: IBM PC AT
DOS 3.2
PC SAS, SAS/GRAPH 6.03

ARC/INFO HOST: MicroVAX 3500
VAX/VMS 4.7A and 5.2
ARC/INFO 4.01 and 5.0
VAX FORTRAN 5.0

The VAX part of the interface was developed and executed under both versions of VMS and ARC/INFO. The current version of the executables were compiled and linked with the most recent versions of the software.

Although this interface has been developed for version 6.03 of SAS for the PC, the metagraphics driver and documentation are also available for SAS versions 5 and 6 on the VAX, IBM, Prime, etc.

D.9 EXAMPLES OF SAS/GRAPH PRODUCTS GENERATED ON THE GIS LASER PRINTER

Figures D-1, D-2, and D-3 in this section represent examples of SAS/GRAPH products plotted with the ESD GIS laser printer. These figures also represent plots of the test data provided with the installation of the SASGARC procedure.

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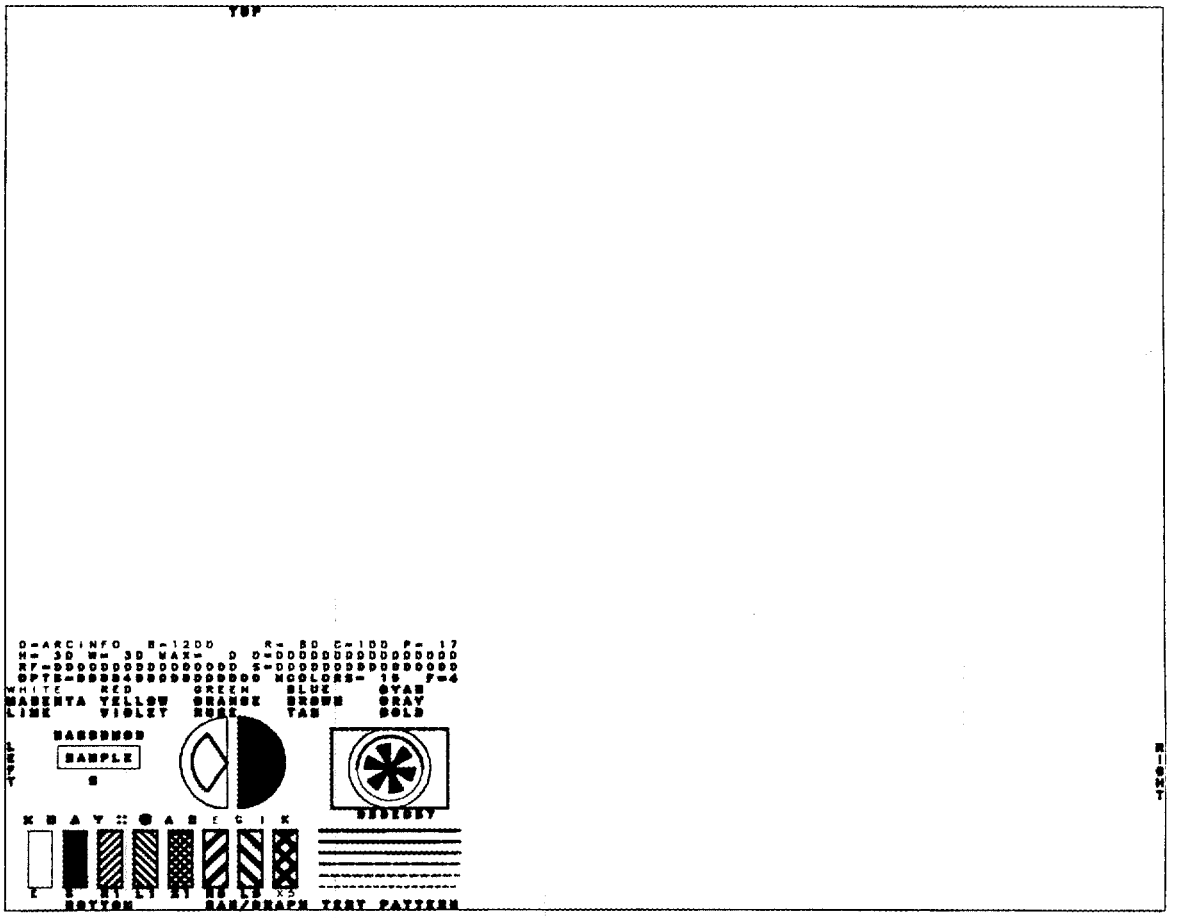

Fig. D-1. Picture 1 from PROC GTESTIT of SAS/GRAPH (Plot of SAST10001.PLT). Note: color/pen selection commands in the plot file have been converted to increased line thickness commands on the laser printer.

ORNL-DWG 90-16799

Top line of the first plot in white

Bottom line in red

Fig. D-2. Word slide showing the text of test strings in SAS/GRAPH fonts (Plot of SAST20001.PLT). Note: color/pen selection commands in the plot file have been converted to increased line thickness commands on the laser printer.

ORNL-DWG 90-16800

Top line of last plot in green

Bottom line in blue

Fig. D-3. Word slide showing the text of test strings in SAS/GRAPH fonts (Plot of SAST20002.PLT). Note: color/pen selection commands in the plot file have been converted to increased line thickness commands on the laser printer.

D.10 INSTALLATION INSTRUCTIONS FOR SASGARC

1. Install modified metagraphics device driver into SAS catalog.

Copy the modified metagraphics device driver from the floppy disk to a subdirectory on a hard disk. The SAS statements in the following example will copy the device driver from a SAS catalog on a floppy disk in drive A:\ to a subdirectory of C:\ARCINFO.

```
libname gdeva 'a:\';
libname gdevc 'c:\arcinfo';
proc catalog c=gdeva.devices;
        copy out=gdevc.devices;
        select arcinfo.dev;
run;
```

2. Restore command file and programs to ARC$UTOOL with VMS COPY on VAX.

The following files are stored on a tape labeled SASGAR:

SASGARC.COM - VMS DCL command file that provides user interface for input/output filenames and resolution. (5 blocks)

SASG5A.FOR - FORTRAN source code for first program that reads SAS/GRAPH metagraphics file and writes temporary binary intermediate file. (2 blocks)

METAFL.CMN - FORTRAN source code from ARC/INFO source code library that defines variables for the plot metafile format. (5 blocks)

SASG5B.FOR - FORTRAN source code for second program that reads temporary binary intermediate file and writes ARC/INFO PLOT files. (8 blocks)

SASG5A.EXE - Executable for SASG5A.FOR. (6 blocks)

SASG5B.EXE - Executable for SASG5B.FOR. This file is linked with [ARC50.ARC.LIB]ARCLIB.OLB from the ARC/INFO source library. (190 blocks)

SASG5B.LOA - LINK command file for SASG5B.FOR. (1 block)

SASTEST1.DAT - SAS/GRAPH metafile that will generate test picture number 1 from PROC GTESTIT of SAS/GRAPH. (135 blocks)

SASTEST2.DAT - SAS/GRAPH metafile that will generate 2 "word slides" in separate plot files. (67 blocks)

SASTEST2.SAS - SAS program that generated SASTEST2.DAT. (1 block)

SAST10001.PLT - PLOT file from SASTEST1.DAT. (105 blocks)

SAST20001.PLT - First PLOT file from SASTEST2.DAT. (17 blocks)

SAST20002.PLT - Second PLOT file from SASTEST2.DAT. (36 blocks)

The files can be restored to ARC$UTOOL with the following VMS commands:

Log in to VAX with an account that has privileges to write files in the ARC/INFO area and has the ARC/INFO logicals defined.

```
$ MOUNT <tape>: SASGARC
$ COPY/LOG <tape>:*.* ARC$UTOOL:*.*
$ DISMOUNT <tape>:
```

These commands will copy the nine files described above into the ARC$UTOOL directory. After the files have been copied to ARC$UTOOL, the command SASGARC is available to all ARC/INFO users from the ARC: prompt.

D.11 REFERENCES

ESRI. 1987. ARCPLOT Users Guide, Map Display and Query. Environmental Systems Research Institute, Redlands, Calif.

McCord, R. A., and R. J. Olson. 1989. New Dimensions from Statistical Graphics for GIS Analysis and Interpretation. ESRI User Conference Proceedings for 1989. May 22-26, 1989, Palm Springs, Calif.

SAS. 1987. SAS/GRAPH Guide for Personal Computers, Version 6 Edition. SAS Institute, Inc., Cary, N.C. 534 pp.

SAS. 1988. SAS/GRAPH Hardware Interfaces for Personal Computers , Version 6 Edition. SAS Institute, Inc., Cary, N.C. 353 pp.

Appendix E

ARCTOSAS MACRO FOR IMPORTING AN ARC/INFO EXPORT INFO FILE INTO A SAS DATA SET

E.1 MACRO FORMAT

```
%ARCTOSAS(INFILE=e00,    OUTSAS=mysas.member,
WORKFILE=work1, DUMMY=dummy);
```

E.2 MACRO PURPOSE

The ARCTOSAS macro creates a SAS (version 5.18) data set from an ARC/INFO export (.E00) file of an INFO data file. [There is also an ARCTOSAS program for SAS version 6. that runs on the PC or VAX or IBM mainframe. Contact Barbara Jackson (4-8680), the author of this macro, for additional information and assistance on other systems.]

E.3 MACRO ARGUMENTS

<INFILE=e00> -	e00 is the filename that the export data file which is allocated to on the IBM.
<OUTSAS=mysas.member> -	OUTSAS specifies the output SAS data set name.
<WORKFILE=work1> -	WORKFILE is a temporary SAS data set.
<DUMMY=dummy> -	DUMMY is a five-character or less SAS variable name that is not the name of an INFO variable in the .E00 data set.

E.4 USAGE NOTES

- The SAS data set that is created will have as many variables as there are INFO items in the .E00 file. The names of the SAS variables will be identical or close to the INFO item names. If a set of unique SAS variable names cannot be created from the set of INFO item names, the SAS variable names will be VAR1-VARn, where n is the number of items.

- The LABEL for the SAS data set will be the name of the .E00 file and the name of the originating ARC file.

- The LABELs for the SAS variables will exactly correspond to INFO item names.

- The length and type of the SAS variables are shown in the following:

INFO item	SAS variable
binary (4,8)	numeric (8)
char (1-4096)	char ($1-$200)
date (8)	date (8)
floating (4,8)	numeric (8)
integer (4,8)	numeric (8)

- The SAS data set will have the same number of observations as the .E00 file.

- The ARCTOSAS macro will print a PROC CONTENTS and ten observations from PROC PRINT of the SAS data set.

E.5 INTERACTIVE PROCESSING INSTRUCTIONS

This section presents the instructions for interactively processing the data in ARC/INFO and SAS to complete the conversion. These procedures can also be executed with modification in batch mode.

E.5.1 Create the ARC/INFO EXPORT File

The ARCTOSAS reads as input an ARC/INFO export file. This file will normally have a name extension of .E00. The export file must be created in ARC on the ESD VAX with the EXPORT command. The following steps illustrate this process.

1. Log on to the ESD VAX.

2. Invoke ARC/INFO:

   $ ARC

3. Execute the EXPORT command:

   arc: EXPORT INFO ARCFILE.EXT OUTNAME NONE

   where ARCFILE.EXT is the ARC file, OUTNAME is the name of the export file (OUTNAME.E00), NONE specifies no compression.

4. Exit from ARC:

   $ arc: quit

E.5.2 Copy the Export File to the IBM 3090

The .E00 file has record length of 80 but is stored as variable-length records of undefined length on the VAX. The IBM requires that the length of the records be defined as 80 bytes, fixed length. Therefore, you can use the CONVERT command on the VAX to copy the file to the IBM and, at the same time, convert it to fixed length. Alternatively, you can use the COPY command and use switches to specify the length of the file.

```
$convert/truncate/fdl=fix80.fdl arcfile.e00 nx10b::"[uid]ibmfile.e00"
```

or

```
$copy arcfile.e00 nx10b::"[uid]ibmfile.e00/fixed:80/pad:20"
```

Note: You must have a proxy between IBM and ESD VAX or else specify your password in the nx10b parameter. (Contact Neil Griffith for help with a proxy.)

The fix80.fdl file can be created from an existing 80-byte, fixed-length record file using the ANALYZE/RMS_FILE/FDL command.

E.5.3 TSO Interactive Execution of ARCTOSAS

The ARCTOSAS macro can be "included" into the edit screen of your TSO SAS session by supplying the appropriate allocate statements for the .E00 export file, the SAS data set, and the file containing the ARCTOSAS macro. Your SAS session or program should then include the call statement for ARCTOSAS with the appropriate arguments; and then, "submit" as illustrated in the following:

1. Log on to TSO.

2. Invoke SAS.

3. Submit the following to allocate the .E00 input file:

```
tso alloc fi(e00) da(arcfile.e00) old;
```

4. Submit the following to allocate the ARCTOSAS macro:

```
tso alloc fi(arcprog) da('bjh.arc.prog') shr;
```

5. Submit the following to allocate your (existing) SAS data set:

```
tso alloc fi(mysas) da(mysas.sas) old;
```

6. Enter the following command on the command line of the edit screen:

   include arcprog(arctosas)

   (The entire ARCTOSAS macro listing will appear in the edit screen.)

7. Hit the SUBMIT PF key <PF3>, or enter the SUBMIT command on the command line. This will compile the ARCTOSAS macro so that it can be used anytime during the rest of your SAS session.

8) Invoke the macro with a call statement and submit:

   %ARCTOSAS(INFILE=e00, OUTSAS=mysas.member, WORKFILE=work1, DUMMY=dummy);

   where INFILE is the filename of the ARC/INFO export data set, OUTSAS is the one-level (temporary) or two-level (permanent) SAS output data set, WORKFILE is a SAS work data set (temporary), and DUMMY is a five-character or less SAS variable name that is not the name of an INFO variable in the .E00 data set. The default values for these arguments are shown below:

   %ARCTOSAS (INFILE=e00, OUTSAS=outsas, WORKFILE=work1, DUMMY=dummy);

   if a parameter is omitted from the argument list, the default value will be used.

The SAS log screen will display the progress of the macro. The output screen will display work data sets. Hit the END PF key <PF3> to clear the output screen so the macro can continue.

The macro will print a PROC CONTENTS and ten observations with PROC PRINT to the output screen. You may continue the SAS session as desired after the macro has been completed.

Appendix F

QUICKARC MACRO FOR EXPORTING A SAS DATA SET IN AN ARC/INFO EXPORT INFO FILE FORMAT

F.1 MACRO FORMAT

%QUICKARC(SASDATA=mysas.abc, FILE=e00, WORKFILE=work2, DUMMY=arra);

F.2 MACRO PURPOSE

The QUICKARC macro creates a flat, .E00-type file that can be imported by ARC/INFO from a member of a SAS version 5.18 data set. [There is also a SAS version 6. QUICKARC program that will run on the PC, VAX/VMS, or IBM mainframe. Contact Barbara Jackson (4-8680), the author of this macro, for additional information and assistance on other systems.]

F.3 MACRO ARGUMENTS

<SASDATA=mysas.abc> -	SASDATA is assigned the name of the input SAS data set.
<FILE=e00> -	FILE is the ddname of the output E00 flat file.
<WORKFILE=work2> -	WORKFILE is a temporary SAS data set.
<DUMMY=arra> -	DUMMY is a four-character or less SAS variable name that does not appear in the SASDATA data set.

F.4 USAGE NOTES

- The filename of the .E00 file appears in the first record of the .E00 file. The name of the SAS data set appears in the third record of the .E00 file. This feature will help to keep track of the origin of data sets.

- All of the variables in the SAS member are included as INFO items in the output file. All SAS variables will have their same name in the INFO data set.

- All numeric variables in the SAS data set will be floating (8-byte) INFO items, regardless of their SAS length. The INFO display format will be (10.4).

- All character variables in the SAS data set will be character items in the INFO data set, with the same length.

- SAS numeric variables with a date format will be floating (8-byte) in the INFO data set. Because the SAS date value is not useful in INFO, variables for year, month, and day should be created in SAS as needed.

- Missing values in the SAS data set will be written as blank in the .E00 file. (OPTIONS MISSING=' '; appears in the macro.) ARC/INFO will read in the blank values as zeros. If this is not acceptable, modify the missing values in the SAS data set before invoking the QUICKARC macro.

- To summarize, the SAS data set should have exactly the variables and observations of interest with the desired name, type, and length before invoking the QUICKARC macro. It is very tedious to alter the .E00 file after it is created. Instead, modify the SAS data set and invoke the QUICKARC macro again.

F.5 INTERACTIVE PROCESSING INSTRUCTIONS

This section presents the instructions for interactively processing the data in SAS and ARC/INFO to complete the conversion. These procedures can also be executed with modification in batch mode.

F.5.1 SAS Creation of ARC/INFO EXPORT Format

The QUICKARC macro can be "included" into the edit screen of your TSO SAS session by supplying the appropriate allocate statements for the output .E00 file, the SAS data set if necessary, and the file for the QUICKARC macro. Your SAS session or program should then include the call statement for QUICKARC with the appropriate arguments, and then "submit" as illustrated in the following.

1. Log on to TSO.

2. Invoke SAS.

3. Submit the following to allocate the QUICKARC macro:

```
tso alloc fi(arcprog) da('bjh.arc.prog') shr;
```

4. Submit the following to allocate the E00 output file:

```
tso alloc fi(e00) da(myfile.e00) new like(anyfile.e00);
```

(anyfile.e00 is an existing fixed block file with record length of 80.)

or

```
tso attrib dcb1 recfm(f b) lrecl(80) blksize(3120);
tso alloc fi(e00) da(myfile.e00) new unit(disk) space(5 5)
tracks using(dcb1);
```

or

switch to TSO by entering X on the command line, enter %ISPF, use option 3.2 to allocate myfile.E00, exit from ISPF, and switch back to SAS with EXIT command at READY prompt.

5. Submit the following to allocate your (existing) SAS data set:

```
tso alloc fi(mysas) da(mysas.sas) old;
```

6. Create the SAS data set member(s) with exactly the variables (length and type) and observations desired.

7. Enter the following command on the command line for the edit screen:

```
include arcprog(quickarc)
```

(The entire QUICKARC macro listing will appear in the edit screen.)

8. Hit the SUBMIT PF key <PF3>, or enter the submit command on the command line. This will compile the QUICKARC macro so that it can be used anytime during the rest of your SAS session.

9. Invoke the macro with a call statement and submit:

```
%QUICKARC(SASDATA=mysas.abc, FILE=e00,
WORKFILE=work2, DUMMY=arra);
```

where SASDATA is assigned the name of the input SAS data set member, FILE is the ddname of the output E00 flat file, WORKFILE is a (one-level) SAS work data set, and DUMMY is a 4-letter (or less) SAS variable name that does not appear in the SASDATA data set. The default argument values are shown below:

```
%QUICKARC(SASDATA=sasin, FILE=e00,
WORKFILE=work2, DUMMY=arra);
```

If a parameter is omitted, the default value will be used. The SAS log screen will display the progress of the macro. The output screen will display work data sets. Hit the END key <PF3> to clear the output screen so the macro can continue.

10. It is possible to view the .E00 file without terminating the SAS session. This option is illustrated below:

    X (entered on the command line and the TSO screen will appear)

    list myfile.e00

    return (to return to SAS)

F.5.2 Copy the Export File to the ESD VAX

After logging on to the ESD VAX, copy the E00 file to the ESD VAX as illustrated with the following command:

```
$convert/truncate/fdl=[bjh]anye00.fdl nx10b::"[uid]myfile.e00" vaxfile.e00
```

Note: You must have a proxy between IBM and ESD VAX or else specify your password in the nx10b parameter. (Contact Neil Griffith for help with a proxy.)

The anye00.fdl file can be created from an .e00 file using the ANALYZE/RMS_FILE/FDL command on the VAX.

F.5.3 Import the Export File

The EXPORT file generated by QUICKARC can be imported into ARC/INFO with the commanded illustrated in the following:

```
$ARC

arc: IMPORT INFO VAXFILE.E00 ARCFILE.EXT
```

where VAXFILE.E00 is the data generated by QUICKARC and ARCFILE.EXT is the resulting INFO data file.

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