SYSTEM DEVELOPMENT CORPORATION
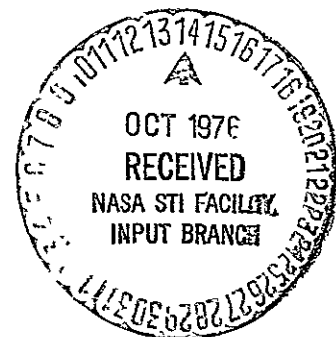
IMAGE DATA PROCESSING SYSTEM

(IDAPS)

USER MANUAL

31 MARCH 1975

TM-HU-037/000/00

00071

System Development Corporation

IMAGE DATA PROCESSING SYSTEM (IDAPS)

USER MANUAL

S-056 EXPERIMENT

SYSTEM DESCRIPTION
VOLUME I

BATCH IDAPS
VOLUME II

INTERACTIVE IDAPS
VOLUME III

CONTRACT NO. NAS8-30740

31 MARCH 1975

TM-HU-037/000/00

FOREWORD

The IDAPS facility is maintained by the Marshall Space Flight Center as a service to S-056 researchers for processing S-056 image data. The IDAPS facility became operational in November 1974. Since that time the facility has been in joint use by the S-056 researchers for data processing and by the system development contractor for continued facility development. As additional facility capabilities are incorporated, the IDAPS User Manual will be updated by the insertion of change pages.

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Figure 1-1.   IDAPS Terminal Room

1.0 INTRODUCTION

IDAPS (Image Data Processing System) was developed by the Marshall Space
Flight Center (MSFC) to satisfy the image processing requirements of the
Skylab S-056 experiment. The S-056 experiment was designed to obtain high-
resolution photographs of the sun in the far ultraviolet, or soft X-ray
portion, of the electromagnetic spectrum. Thirty-five thousand photographs
were obtained by the three flights of the program; and, faced with such a
massive volume of imagery, the designers of the experiment decided to develop
a computer-based system which would reduce the image processing workload by

- Eliminating the processing of image frames which contain little or
  no information of scientific value.

- Treating only those regions within a frame which are of scientific
  value.

- Allowing the individual researcher to tailor the nature and sequence
  of image processing operations to satisfy his own needs.

The purpose of the IDAPS User Manual is to give the IDAPS user the necessary
information and instructions to effectively utilize the system. The Manual
is divided into three volumes:

    Volume I - System Description
    Volume II - Batch IDAPS
    Volume III - Interactive IDAPS

Volume I presents a suggested training plan, an introduction to the IDAPS
hardware configuration, and a description of overall system capabilities.
A brief discussion of digital image processing fundamentals is provided in
Appendix A. The IDAPS Terminal Room is shown in Figure 1-1 on the facing
page.

2.0 TRAINING PLAN

A training plan, outlined below, is suggested for the beginning user of
IDAPS.

IDAPS Orientation

Step 1 - Read Volume I

Step 2 - Attend an IDAPS orientation demonstration (approximately 30 minutes)

Interactive IDAPS Use	Batch IDAPS Use
Step 3 - Read Volume III	Step 3 - Read Volume II
Step 4 - Attend an Interactive IDAPS Training Session (approximately two hours)	Step 4 - Attend a Batch IDAPS Training Session (approximately one hour)

An IDAPS Orientation Demonstration, an Interactive IDAPS Training Session,
or a Batch IDAPS Training Session can be scheduled through the MSFC Data
Systems Laboratory, EF32, phone (205) 453-3706.

3.0 HARDWARE DESCRIPTION

This section provides the IDAPS user with a description of the IDAPS hardware configuration and the general capabilities of the individual hardware components. Detailed instructions in the use of the various components are presented in Volume III.

The IDAPS hardware configuration is presented in Figure 3-1. The components are discussed in the following paragraphs in five functional groupings:

- Terminal Minicomputer
- Film Scanner
- Interactive Display and Control
- Hardcopy Devices
- Host Computer

3.1 TERMINAL MINICOMPUTER

An Interdata Model 70 serves as the control and communication device for the IDAPS terminal. It interfaces directly to the host computer through a selector-channel to selector-channel interface. The terminal minicomputer consists of the following items:

- Computer Mainframe, I/O and Memory
- Magnetic Tape Units
- Disk Drive
- Card Reader
- Printer
- Teletype

3.1.1 Computer Mainframe, I/O and Memory

The Interdata 70 mainframe, I/O and memory incorporates the following design features:
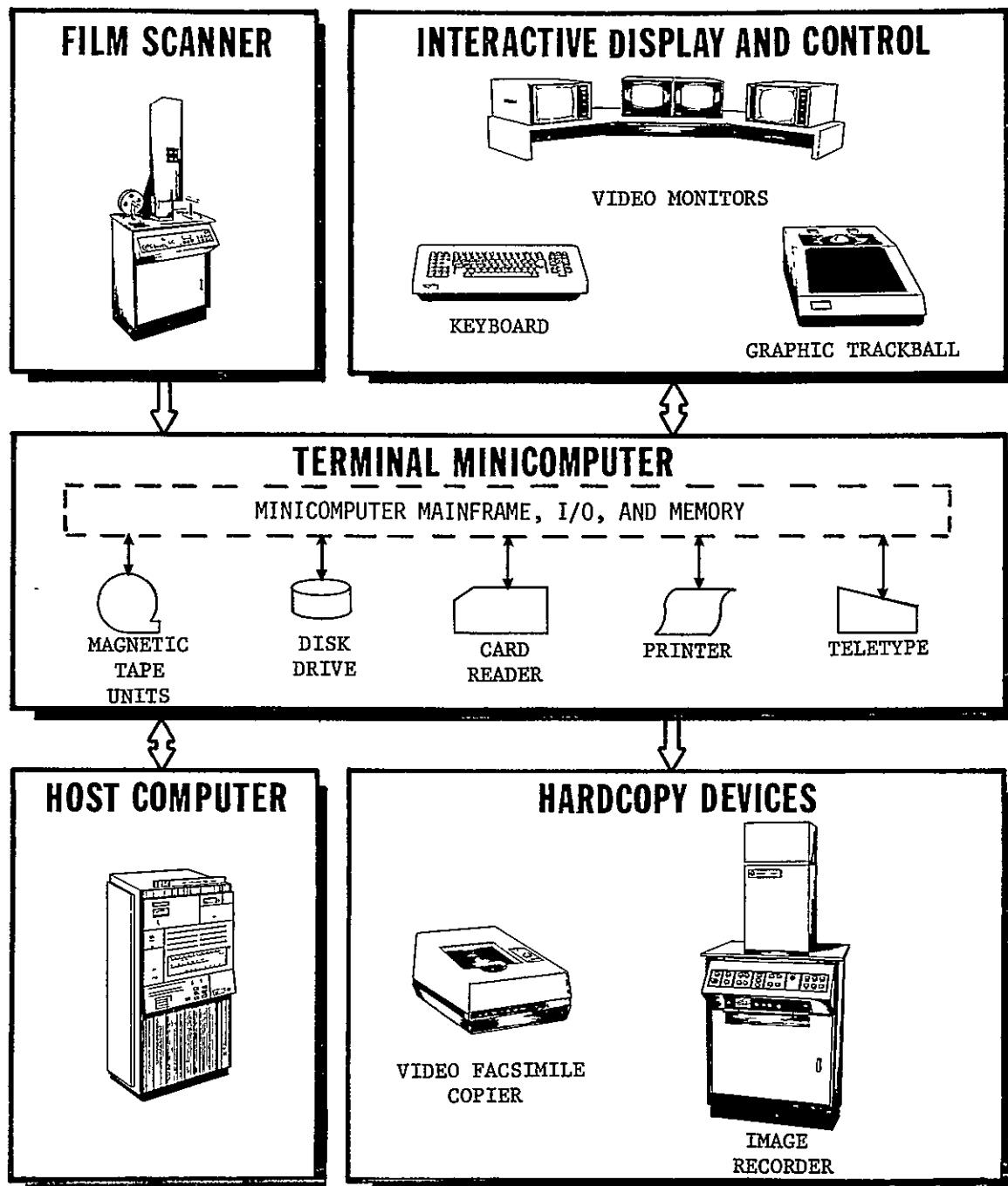
Figure 3-1.   IDAPS Hardware Configuration

- Core of 65,536 bytes
- Cycle time of 1.0 µs
- Multiplexor channel for up to 255 devices
- Four selector channels

3.1.2 Magnetic Tape Units

Two magnetic tapes, used primarily for image input/output, are included in the system. These tape units have the following characteristics:

- IBM compatibility
- Nine track
- Density of 800 bits/inch

3.1.3 Disk Drive

A disk drive, used for program storage, temporary image storage and data storage, is a part of the system and has the following design features:

- Capacity of 9,830,000 bytes
- Selector channel interface at 250,000 bytes per second
- Average rotational latency of 12.5 ms
- Average access time of 38 ms

3.1.4 Card Reader

A card reader, used primarily for data or table input, is provided. It reads at a rate of 400 cards/minute.

3.1.5 Printer

A line printer, used primarily for data output, history data, etc., is provided. It has a standard 64-character set and prints 132 characters per line at a rate of 200 lines/minute.

3.1.6 Teletype

A Model 33 ASR teletype is included as an aid to programming and maintenance and as a backup to other peripherals.

3.2 FILM SCANNER

The image-dissector scanner used in the S-056 system is the Dicomed Model 57 image scanner. With 35-mm optics, the Dicomed scanner will scan an entire 35-mm frame or, under program control, it can scan any smaller area of any aspect ratio, including a single point. Thus, it provides both raster scans and random point scanning. The scanner incorporates variable signal limiting and expansion, which allow preliminary image analysis and preprocessing within the scanner itself. The scanner has the following pertinent specifications:

- Film Size: 35 mm in individual, mounted frames or up to 10-inch reels

- Film Density Range: 2.45 D

- Maximum Area Scanned: 35 X 35 mm

- Scan Axis Orthogonality: Horizontal and vertical axes are at 90° ± 0.05°

- Scan Line Curvature: Less than 0.2 percent

- Scan Nonlinearity: Less than 1.5 percent

- Scan Matrix Resolution: 2048 X 2048 maximum

- Effective Scan Aperture: 35 microns

● Scan Times: (See Figure 3-2)

● Signal Conditioning: The transmittance or density signal produced
  by an image when scanned at a fixed illuminator level is divided
  into eight segments, each containing approximately 12.5 percent of
  the total signal. Any continuous set of these segments may be
  selected for digitization and are represented by the full range of
  output codes. The lowest amplitude segment is provided with a
  vernier adjustment to allow suppression of background "noise" when
  desired.

● Logarithmic Amplifier: A switch-selectable logarithmic amplifier
  is included in the amplifier chain of the output of the image
  dissector tube. A rotary switch on the front panel allows selection
  of linear output of transmittance codes or a log output of density
  codes. The log output corresponds to an inverse linear output of
  density. A log output can be selected to cover two decades (i.e.,
  100:1 ratio of density).

● Output Code Formats: Eight bits (256 gray levels), linearly
  proportional to film transmittance (with the log amplifier, the
  output codes are approximately proportional to film density).

● Scan Position Drift: Less than two scan points out of 2048 after
  one hour (after thermal equilibrium is reached).

● Digitizing Drift: The mean output code representing a specific
  point is within $\pm$ two, six-bit output codes over a one-hour period
  (after thermal equilibrium is reached).

The Dicomed scanner interfaces with the terminal minicomputer through a
selector channel. The scanner is completely controllable through the

SCAN SPEED SWITCH SETTING	NO. 1	NO. 2	NO. 3	NO. 4
Point integration time in microseconds	1280	320	80	20
Point-to-point positioning in microseconds (1)	1295	335	95	35
Corresponding S/N in db	41	35	29	23
When m=n=256 (2)	85 seconds	22 seconds	6.3 seconds	2.3 seconds
When m=n=512	5.7 minutes	88 seconds	25 seconds	9.2 seconds
When m=n=1024	23 minutes	5.9 minutes	1.7 minutes	37 seconds
When m=n=2048	91 minutes	24 minutes	6.7 minutes	2.5 minutes

(1) Sum of point integration time plus 15 microseconds point-to-point travel time. Maximum scan line flyback is 125 microseconds.

(2) m = number of scan lines in the image
     n = number of points in a scan line

Figure 3-2.   Film Scanner Scan Times

(3) Timing data above reflects scanner characteristics only and does not include external computational or data handling requirements.

minicomputer so that adjustments such as scan position, scan resolution, and
film density can be made without manual intervention by the user. A roll
film transport is included in the configuration for convenience in handling
up to 200-foot rolls of 35-mm film.

3.3 INTERACTIVE DISPLAY AND CONTROL

The interactive display and control equipment design is based on the use of
a disk refreshed digital television system. This system accepts image data
in a digital matrix format and stores the digital data on a high-speed disk.
The digital data is then converted to a high-quality television signal for
display on commercial grade television monitors. Major components of this
system are:

- Digital Television Display Generator
- D/A Video Driver/Distributor
- Video Monitors
- User Console Keyboard
- Graphic Trackball

3.3.1 Digital Television Display Generator

A digital television display generator, with its associated interface to the
Interdata 70 computer and display refresh disk, provides a capability to
produce 16 single-bit digital images. The digital television consists of a
display generator, a 128-character ASCII character generator, a refresh
memory, and 16 digital video output channels plus proper timing channels to
produce composite video signals. The digital television output is fed to
the D/A video driver/distributor, where the signals are grouped to provide
analog television outputs of various configurations.

3.3.2 D/A Video Driver/Distributor

A D/A video driver/distributor accepts inputs from the digital television
refresh memory and provides the following outputs:

- Two six-bit, 64-level, gray-scale signals obtained by combining digital video channels 0, 1, 2, 3, 8, and 9 for the first, and 4, 5, 6, 7, 10, and 11 for the second. The two resulting 64-levels-of-gray, analog television channels are displayed on two black-and-white monitors (Monitors 1 and 2).

- Three four-bit, 16-level, gray-scale signals from video amplifiers, connected to contiguous digital video channels 0 to 11. These three analog signals are displayed as the red, green and blue components of the Color Monitor.

- Three single-bit, 2-level, video signals representing digital video channels 12, 13, and 14. These three analog signals are displayed as the red, green and blue components of the Master Monitor.

3.3.3 Video Monitors

Four video monitors are provided, two black-and-white (Monitors 1 and 2) and two color (Color Monitor and Master Monitor). Each monitor is a standard, 14-inch diagonal, commercial grade television with appropriate amplification, control, and deflection circuitry to display the video data from the digital television display system. The Master Monitor serves the user in controlling and monitoring his image processing operations. While system control information is being displayed on the Master Monitor, the user may view before-and-after results of his image processing runs on the two black-and-white monitors. When working with color data, the user may monitor the color image on the Color Monitor.

3.3.4 User Console Keyboard

The interactive display and control station of the user terminal includes a keyboard for alphanumeric input of parameters and instructions to the system. This keyboard interfaces with the Interdata 70 and serves as the primary

man-to-machine terminal interface. In addition to 95 standard ASCII characters,
special function keys are included on the keyboard. These keys are used to
initiate frequently repeated options or special functions.

3.3.5 Graphic Trackball

A graphic trackball, used primarily as a pointing device, is interfaced with
the digital television display and with the Interdata 70 so that a position
cursor appears on all of the video monitors and can be controlled to an
accuracy of one picture element in a 480 X 640 array. The Interdata 70
reads the cursor X-Y position from the trackball electronics. An "enter"
button is normally used to signal the terminal minicomputer that position
data should be read.

3.4 HARDCOPY DEVICES

IDAPS possesses a capability for producing permanent copies of printed,
graphic, and image data. Two different hardcopy devices are provided at the
user console:

- Video Facsimile Copier
- Image Recorder (Color or black and white)

3.4.1 Video Facsimile Copier

A video facsimile copier, the Tektronix 4632, provides quick-look gray tone
(approximately 12 gray levels) hardcopy from the user console. This unit
makes permanent facsimile copy from static television signals at a rate of
10 seconds per image. The copy command is initiated by pressing a front
panel control. Contrast and density are adjusted by the operator with
simple-to-use front panel controls.

3.4.2 Image Recorder (Color or Black and White)

A capability for recording on color film, for making permanent black-and-
white photographs, and for obtaining quick snapshots of image data on Polaroid

film is provided by the image recorder. This device can record a 2048 X
2048 resolution image in color in 10.5 minutes and in black-and-white in 3.5
minutes. The film recorder exposes photographic film to any of 256 different
exposure levels and features a 4 X 5 inch Grafloc back so that a number of
standard film formats may be accommodated. Film carriers are provided for
making Polaroid prints as well as 4 X 5 inch cut film and 120 roll film
photographs. Except for film loading, film advance and exposure adjustment,
the D47 is completely controllable through the terminal minicomputer.

3.5 HOST COMPUTER

The host computer of the S-056 configuration of IDAPS is an IBM 360/65.
This computer, used primarily for performing the image processing techniques
specified by the user, has the following features:

- 1 million bytes of core memory
- 1.2 billion bytes of disk
- Both seven-and nine-track tape drives
- Standard I/O peripherals, such as printers and card reader
- OS/MVT/HASP operating system

4.0 SYSTEM FUNCTIONAL DESCRIPTION

This section provides the IDAPS user with a functional description of the system by specifying what the system does without describing how to operate it. Instructions for operating the system are presented in Volumes II and III.

IDAPS performs in two modes: interactive and batch. Each mode has its particular place in the processing of S-056 images. In general, Interactive IDAPS is used for image familiarization, sequence and parameter optimization, selective feature extraction and analysis, i.e., those operations which require real-time visual analysis or trial-and-error processing. Batch IDAPS is best used where the desired parameters and sequence of operations are known and when long images-processing times are required.

The emphasis of this section is on the capabilities of Interactive IDAPS. Once Interactive IDAPS is understood, the understanding and operation of Batch IDAPS reduces to a straight-foreword lesson in control-card formatting. The following functional areas are discussed:

- Picture Input
- Picture Storage
- Interactive User Control
- Picture Display
- Picture Recording
- Special Functions
- Application Programs

4.1 PICTURE INPUT

The picture input function of Interactive IDAPS refers to those functions necessary to enter picture data into the system. Picture input may be accomplished through the on-line scanner or through one of the magnetic tape units.

4.1.1 On-Line Scanning

Interactive IDAPS gives the user the capability to digitize an image and transfer the results to one of several devices as follows:

- SCANNER TO DISPLAY: This operation is used in viewing the data stored on film and for making quick on-line analysis of images.

- SCANNER TO TAPE: This operation allows the user to scan a picture and store it on magnetic tape for later processing or display.

- SCANNER TO FILM: This operation provides for direct transmittance of an image from the scanner to the film recorder, making such changes in the film data as can be accomplished by the scanning and film recording equipment itself. No computer image processing is performed.

- SCANNER TO SYSTEM: This operation allows the user to scan a film and transmit an image to the host computer system for subsequent use in image processing operations. The host computer logs the image into the system and assigns it a unique file name.

- SCANNER TO PRINTER: This operation allows the user to scan a small portion of a film and to print the gray values of the selected portion on the terminal line printer.

4.1.2 Tape Input

A capability exists to input picture data from magnetic tape. Such tapes may have been produced by a scanner-to-tape operation or by an off-line scanner. Off-line scanning may be desired to obtain resolutions and accuracies beyond the capabilities of the on-line scanner or to avoid tying up the terminal when scanning large volumes of data. Capabilities exist to transmit picture data from one of the terminal magnetic tape transports to a number of system devices:

- TAPE TO DISPLAY: A capability for transmitting picture data from magnetic tape to one of the console displays for previewing information on the tape is provided. The ability to automatically fit the picture to the display format is a feature of this operation.

- TAPE TO TAPE: A capability for transmitting picture data from one magnetic tape to another is provided in order to strip off single files from multiple file tapes or to extract a small portion of a large array from a master tape.

- TAPE TO FILM: The ability to transmit picture data to the film recorder is provided. This operation features the ability to extract a small window or subarray from the scanned tape for the film recording process.

- TAPE TO SYSTEM: The ability to enter picture data from magnetic tape into the host computer is provided.

- TAPE TO PRINTER: The ability to print the gray-scale values of a selected small area of a picture array stored on magnetic tape is provided.

4.2 PICTURE STORAGE

To provide timely input of picture data to various image processing operations of the system, it is necessary to store image data arrays on a high speed, highly accessible, mass storage device. Ease of use, speed, and accessibility also require an efficient file management and data retrieval capability. These features are included in IDAPS.

4.2.1 Storage Media

The primary storage device for picture data in the system is the host computer disk. All images input to the system during a run and all subsequent images

that are created as a result of an image processing operation reside on the host computer disk. A limited amount of additional image storage exists on the minicomputer disk.

4.2.1.1 System Files

The host computer provides adequate high-speed disk storage capacity for storing a number of image arrays. The host computer disk features rapid access and high-speed transfer of data. All input images, as well as all subsequently processed images, are available to the user at any time during his sequence of operations, and can be referenced by unique file names assigned to them by the system.

4.2.1.2 Terminal Files

Storage of image arrays on the minicomputer disk is limited to those image arrays which are actively being displayed on one of the console television monitors. Picture display on console monitors is limited to a square array of 480 X 480 elements. Thus, picture storage on the minicomputer disk consists of up to five files of 480 X 480 eight-bit bytes, that is, one file for each of the two black-and-white picture monitors and one file for each of the red, green, and blue color guns of the color monitor. Such active storage in the user console minicomputer disk allows immediate query by the minicomputer of the actual gray-scale value of any picture element being displayed on one of the display monitors. Terminal files are referenced by the monitor on which they are displayed.

4.2.2 Storage Format

Picture data is generally stored in integer format such that each picture element is represented by an eight-bit byte. This allows up to 256 levels of gray for each picture element. Picture files are so arranged that a single scan line of picture information is represented as a single computer record and one record exists in the picture file for each scan line of picture data within the frame. In addition to the integer format, certain

mathematical operations, such as H-D CORRECTION, generate picture data in floating point format.

4.3 INTERACTIVE USER CONTROL

To provide an effective interactive control of the image processing capabilities of the system, the following features are provided:

- Operator Specification
- Parameter Specification
- Input Image Specification
- Data Specification
- "HELP" Feature
- Error Trapping and Recovery
- Repeatability

4.3.1 Operator Specification

A multiple choice menu selection process is used to control the sequence of image processing operations. Each of these operations, such as scanning an image and transferring it to the host computer, is referred to as an "operator". Because of the number of operators which the system employs, two levels of menu selection are used. The first, referred to as the Master Menu and presented in Figure 4-1, identifies the various categories of image processing that may be performed by the system. Upon selection of a particular category, a second level or submenu is presented for the selected image processing category. The entries on the submenu identify specific image processing operators. If, for example, the user selects the Image Input/Output category from the Master Menu, a submenu is displayed as shown in Figure 4-2. The user can then select and request a specific operator from the submenu.

4.3.2 Parameter Specification

To provide flexibility in controlling the image processing operations, the user is given the opportunity to specify operator variables. These variables

```
360 STATUS: DOWN       INTERACTIVE  IDAPS        TIME: 11:07:10
                                                 ELAPSED:03H,01MIN

MASTER MENU

IMAGE PROCESSING CATEGORY

   A - IMAGE INPUT/OUTPUT

   B - FUNCTION GENERATION

   C - GRAY SCALE ADJUSTMENT

   D - MANUAL IMAGE MODIFICATION

   E - FILTER OPERATIONS

   F - GEOMETRIC OPERATIONS

   G - CLASSIFICATION/PATTERN RECOGNITION

   H - MATH/LOGIC FUNCTIONS

   I - IMAGE ANALYSIS

   J - PSEUDOCOLOR

   K - IMAGE DATA PRESENTATION

   L - LOGOUT

OPTION =
```

Figure 4-1.   Interactive IDAPS Master Menu

```
                    INTERACTIVE  IDAPS        TIME: 16:33:15
                                              ELAPSED:06H,36MIN

IMAGE INPUT/OUTPUT

                                    OUTPUT TO:
```

	DISPLAY	TAPE	FILM	PRINTER	SYSTEM
SCANNER	A (S-D)	B (S-T)	C (S-F)	D (S-P)	E (SCA)
TAPE	F (T-D)	G (T-T)	H (T-F)	I (T-P)	J (INP)
SYSTEM	K (DIS)	L (OUT)	M (FIL)	N (PRI)	

INPUT FROM:

```
OPTION =
```

Figure 4-2.   Image Input/Output Submenu

may be in forms such as multiple choice options, numeric values, or positional

data. Once a specific operator is selected from a submenu, a parameter

specification display is presented. Figure 4-3 presents the parameter

Figure 4-3.   Typical Operator Parameter Specification Display

specification display for the SCANNER TO SYSTEM operator. It can be seen

from this display that entries are already provided for each of the required

parameters. Such entries are designated "system defaults" and are the best

estimate of the most desired option or value available. If the user desires

to change any or all of these parameters, he may do so by entering the

desired values through the keyboard or trackball. Upon specifying the

operator parameters, the user may request execution of the operator. Upon

initiation of operator execution, the system will return to the Master Menu

and the user may proceed with his sequence of operations.

4.3.3 Input Image Specification

With the exception of the operators which perform an input image function, most operators require the specification of one or more images to be processed by that particular operator. The images to be processed are referred to as "input images"; that is, they are input as far as that particular operator is concerned.

As previously mentioned, each image input into the system is given a unique name by the system. In order for the user to perform an operation on a particular image, he must specify the image by name. Since the user typically processes an image in a serial manner (that is, he performs one operation on image "A" to create image "B" and then perform some other operation on image "B"), the system provides a default capability for those operators which require only one input file. If the default capability is used, the input file name is the last generated file. For those operators which require more than one input image, or where there is ambiguity, the user must specify all input images by name. For those operators which require an input image, such specification is done in the parameter specification process. Figure 4-4 shows the specification of an input file name (first line under Parameter Description).

4.3.4 Data Specification

Control of an operator may require input data other than the simple parameter specification. Such input data is typically in the form of a one-dimensional table of values. Here again, system default tables are provided to assist the user. Depending on the particular operator, data tables may be entered by the user through the keyboard, card reader, trackball, or scanner. Figure 4-4 illustrates how a data source is specified (second line under Parameter Description).

```
  36O STATUS: READY        INTERACTIVE  IDAPS        TIME: O4:14:1O
  FILE NAME:  8AUT                                   ELAPSED:14H.39MIN

  IMAGE ANALYSIS - ISOGRAM (ISO)

  OPTION │   PARAMETER DESCRIPTION
  ───────┼──────────────────────────────────────────
   8AUT  │  INPUT FILE NAME
         │
     A   │  TABLE SOURCE
         │     A - SYSTEM DEFAULT (ISO )
         │     B - CARDS
         │
         │
    435  │  NUMBER OF LINES
         │
    464  │  NUMBER OF COLUMNS
         │
     1   │  STARTING LINE
         │
     1   │  STARTING COLUMN
         │
     A   │  INPUT
         │     A - SMOOTH DATA
         │     B - DO NOT SMOOTH DATA



  INPUT: ISOGRAMS OF NOISY INPUT FILES WILL BE CLUTTERED BY EXTRANEOUS CONTOURS.
         AN OPTION OF APPLYING A MODERATE LOW PASS FILTER TO THE INPUT FILE BEFORE
         CONTOURING IS OFFERED TO REDUCE THE NOISE CONTENT.
```

Figure 4-4.   Operator Specification Showing Input File Name, Table Source,
               and "HELP" Message

Data tables, like images, are uniquely named. They may be modified through
use of the Table Modification operator by specifying the table name and
editing selected values. Figure 4-5 presents a typical Table Modification
process.

4.3.5 "HELP" Feature

If the user needs assistance during the parameter specification process, he
can obtain help from the system by pressing the special function key on the
keyboard which is labeled "HELP". The system will display an explanatory
message at the bottom of the screen to assist him. "HELP" messages either
explain what a particular parameter is or more clearly define the various
options available to the user. Figure 4-4 shows a typical "HELP" message
(bottom of screen) which was requested to help clarify the term Input (last
major entry under Parameter Description).

```
360 STATUS: READY    INTERACTIVE   IDAPS        TIME: 08:10:25
FILE NAME:  2AUT                                 ELAPSED:00H,06MIN
FUNCTION GENERATION - TABLE MODIFICATION
                                                  TABLE NAME : PRED

              0        0   0   0   0   0   0   0   0   0   0
             10        0   0   0   0   0   0   0   0   0   0
             20        0   0   0   0   0   0   0   0   0   0
             30        0   0   0   0   0   0   0   0   0   0
             40        0   0   0   0   0   0   0   0   0   0
             50        0   0   0   0   0   0   0   0   0   0
             60        0   0   0   0   0   0   0   0   0   0
             70        0   0   0   0   0   0   0   0   0   0
             80        0   0   0   0   0   0   0   0   0   0
             90        0   0   0   0   0   0   0   0   0   0
            100        0   0   0   0   0   0   0   0   0   5
            110        9  14  19  23  28  34  38  43  48  53
            120       58  63  73  79  84  89  95 100 106 111
            130      117 122 127 133 139 144 150 156 162 168
            140      174 180 185 191 192 193 193 194 195 195
            150      196 196 197 198 198 198 200 200 200 201
            160      201 202 203 203 204 205 205 206 207 207
            170      208 208 209 210 210 211 211 212 212 213
            180      214 214 215 215 216 217 217 218 218 219
            190      220 220 221 221 222 223 223 224 224 225
            200      225 226 226 227 228 228 229 229 230 231
            210      231 232 232 233 233 234 234 235 235 236
            220      236 237 237 238 238 239 239 240 240 241
            230      242 242 243 243 244 244 245 245 245 246
            240      247 247 248 248 249 249 250 250 251 251
            250      252 253 253 254 254 255 **
```

Figure 4-5.   Table Modification

4.3.6   Error Trapping and Recovery

To the extent possible, IDAPS assists the user in the parameter specifi-
cation process by identifying and trapping erroneous input or operating
conditions. Operation is suspended at the point of erroneous input and the
user is given the chance to correct the input or condition. After correction,
normal operation is continued. Error messages and the recovery procedure
are displayed at the bottom of the screen.

4.3.7   Repeatability

To utilize the full power of the image processing system, the user must be
able to repeat a sequence of operations without having to specify every
single operator and parameter in the sequence that he has previously performed.
IDAPS makes provision for such repeatability through use of the following
features:

- User Default Parameters
- User Default Tables

4.3.7.1 User Default Parameters

System default parameters, discussed in Section 4.3.2, provide the user with standard values for each parameter. These system defaults are active only until changed by the user, at which time the values entered by the user become the default values. For the next use of that operator in the same processing session, the user supplied parameter values will be displayed as the default parameters. Thus, when using an operator repetitively, the user can establish his own set of parameters the first time and not have to modify them on subsequent calls to that operator. When the user terminates his processing session, the system defaults are automatically restored.

4.3.7.2 User Default Tables

Tables, like parameters, may be modified by the user with the user entered table values replacing the system defaults during a specific processing session.   ——

4.4 PICTURE DISPLAY

Pictures are displayed on one of the black-and-white monitors designated Monitor 1 or Monitor 2, or on the second color monitor, designated Color Monitor. Pictures can be displayed from a number of sources: scanner, tape drive, or host computer.

Pictures displayed on one of the black-and-white monitors will exhibit 64 levels of gray; that is, the black-and-white monitors are refreshed with the six most significant bits of the normal eight-bit picture element. Pictures displayed on the Color Monitor will be displayed at 16 levels for each color gun; that is, the red gun, as well as the green and blue gun, will be modulated by the four most significant bits of the normal eight-bit picture element. Sixteen levels of intensity for each of the three color guns provide a capability for displaying 4096 different colors.

Spatial resolution of all monitors is standardized to 480 X 480 picture
elements. On a 14-inch diagonal monitor, such an image will appear as
approximately 8 X 8 inches.

4.5 PICTURE RECORDING

Three types of image recording are provided by IDAPS:

- Magnetic tape recording
- Film recording
- Facsimile hardcopy recording

4.5.1 Magnetic Tape Recording

If images are to be stored in digital form, they may be recorded by transfer-
ring them to tape. This operation is performed by the SYSTEM TO TAPE operator.

4.5.2 Film Recording

Permanent, high resolution recording of images on film is accomplished by
use of the image recorder. This device is capable of exposing several types
of film (cut film, film packs, roll film and Polaroid film packets) at a
resolution that will produce a 2048 X 2048 array of picture elements in a 57
X 57 mm area.

The image recorder is controlled by the user through the interactive keyboard.
The capability is provided for specifying such parameters as the source of
the image data to be recorded, the filter to be used, the size of the image
to be produced, and its resolution.

Depending upon the size of the picture, the resolution desired, and whether
or not the picture is color or black and white, film recording time will
vary from 5.5 minutes to as little as 0.5 minute. This does not include, of
course, film processing time.

4.5.3 Facsimile Hardcopy Recording

If high resolution film hardcopy is not required, the user may obtain quick image hardcopy through use of the facsimile copier. This device uses a dry silver paper process and produces an 8 1/2 X 11 copy of the image presented on the black-and-white monitor to which it is connected. This device is controlled manually and requires about 10 seconds to produce one copy.

4.6 SPECIAL FUNCTIONS

There are several functions performed by IDAPS which are outside the menu-selection/parameter-specification concept of operation. They are functions that are often repeated, have few or no parameters, or for some other reason require minimal transfer of information from the user to the system. These functions are designated "Special Functions" and are generally activated by a single special function key on the keyboard. Examples of special functions are:

- Histogram
- Quick-look Scan
- Coordinates
- Erase

4.7 APPLICATION PROGRAMS

The majority of IDAPS functions discussed thus far are executed entirely by the terminal minicomputer. The real power of IDAPS, however, lies in its ability to execute image processing algorithms on large images in a very short time. This is accomplished by using an on-line host computer for the "number crunching" jobs which require large amounts of core, disk, and central processing unit time.

A basic set of image processing algorithms or operators are currently operational on the IBM 360/65, the S-056 IDAPS host computer. As the development of IDAPS continues, more operators will be added. Examples of currently operational operators are:

- ROTATE
- REGISTER
- AUTOMATIC SCALE
- FRAME

See Volumes II and III for a complete description of the available operators.

APPENDIX A - IMAGE PROCESSING FUNDAMENTALS

1.0 IMAGE PROCESSING

Digital image processing involves the manipulation of imagery by digital
computers to restore, enhance, or analyze the imagery. Images are two-
dimensional fields of intensity recorded in a medium, frequently photographic
film, by a sensor. The goal of image processing is to render the information
in the processed image more useful to the analyst than the same information
in the unprocessed form.

Increasing the utility of the image information begins with the removal of
degrading effects introduced by the sensor, environment, or the systems
through which the image passes in being translated to a form amenable to
digital computation.

Subsequent processing operations enhance the availability of the information
to the user. Operations can be conducted to increase the contrast or to
move the average intensity to a level more visible to the eye. Levels of
brightness can be converted to shades of color, either to emphasize features
or to provide better intensity discrimination. If the discernment of fine
structure is required, high-frequency emphasis filters may be invoked.

Finally, image processing provides direct analysis aids; and, in many cases,
actually performs analyses. Features, for example, can be isolated, and
computations can be performed on the elements of entire areas or centroids.

Digital image processing normally involves three steps. The image is first
converted to a form which can be manipulated by a digital computer, processed
by appropriate algorithms to accomplish the desired effects, and then recon-
verted to a form convenient for the analyst to interpret. Since the recon-
version and recording of the image at the end of the process is usually the

inverse of the initial conversion, or digitization, these two steps are
discussed below under a single heading. The processing technique is discussed
as three types of data transformations: intensity transformations, geometric
transformations, and transformations to nonimage domains.

2.0 DIGITIZATION AND RECORDING

Since an image is a continous intensity field, it must be sampled and converted
to an array of numbers before processing by a digital computer. The process,
called digitization or scanning, involves running a small, sampling spot
along sequential horizontal lines. As the spot moves along each line, a
sensor regularly samples the amount of light transmitted through the trans-
parency and encodes the transmitted intensity as an eight-bit integer number.
When the spot is positioned over a dense, dark area of the transparency, the
encoded intensity is near zero. Conversely, a bright area is encoded as the
maximum integer value. The intensity field in the image is thus converted
to a two dimensional array of numbers.

The process of conversion from digital form to film proceeds in an analogous
manner. A small, illuminated spot is scanned over unexposed film. As the
spot moves along each line, either its intensity or sample-position dwell
time is modulated proportional to the corresponding numeric value in the
digital array.

3.0 PROCESSING TECHNIQUES

The basic tools of digital image processing consist of hundreds of processing
algorithms largely developed over the last ten years. Some are general
purpose, others are "application specific". The application-specific algo-
rithms, however, are usually variations of more general purpose procedures.
The following section undertakes to review some of the basic operations from
which the more sophisticated procedures are developed.

3.1 INTENSITY TRANSFORMATION

The transformation of each level of intensity to a new value provides a
widely used tool to increase the visibility of information in imagery. If,
for example, a feature of primary interest in an image contains intensities
which fall in a narrow range, the visibility of structure within the feature
can be enhanced by performing an intensity transformation which converts the
lowest intensity in the feature to a lower level, the upper intensity to a
higher level, and all intensities between to proportional values. The
feature in the transformed image would then contain intensities falling in a
broader range, thereby exhibiting greater contrast and improved visibility
of interval structure.

3.2 GEOMETRIC TRANSFORMATIONS

Geometric transformations modify the spatial relationships among image
points. These operations serve both to remove distortions, such as "pincushion"
distortion produced in the optical system of a sensor, and to reorient the
image, as in image registration where the features of one image are moved to
achieve coincidence with corresponding points in a second image. A geometric
transformation is the application of either a mathematical function of
position defined over the entire image or a displacement map (occasionally
referred to as a "rubber sheet" transformation) which is either directly
specified at each point of the image or is interpolated based on specified
points scattered throughout the image.

Geometric transformations of the mathematical function type may be defined
by specifying parameters such as angle of rotation, magnification factor,
and horizontal or vertical translation, or by identification of the locations
of a set of points in the input and a set in the output to which the input
points are to be transformed. In the latter approach, the functional para-
meters are computed either to yield the specific transformation of points or
a "best-fit" transformation which optimizes pre-established error criteria.

3.3 TRANSFORMATIONS TO NONIMAGE DOMAINS

In both intensity and geometric transformations, the product of the transformation is an image generally resembling the input. There also exists a class of quite useful mathematical transformations which produce sampled arrays which may be treated as images but which exhibit no similarity to the input image. Fourier, Hadamard, Walsh, and "Z" transformations are of this class. Their primary utility occurs in filtering, data compression, and pattern recognition. The Fourier is the most commonly used of these transformations, and its most frequent application is that of filtering to remove noise or sharpen edges.

The Fourier transform converts the gray values of the image into an array of complex numbers which represent the image in terms of sinusoidal components of amplitude, phase, and frequency. The Fourier transformation results in an array which has the same number of lines and columns as the image, but in which there is no simple relationship between samples in the input and Fourier arrays. The complex value of each sample point in the Fourier array is the amplitude and phase of a sinusoidal component. The frequency of the component is given by the location of the sample point in the transform. The center location of the transform represents a zero frequency (which corresponds to the average of all gray values in the image). The maximum frequencies, which occur at the edge of the transform, correspond to a wavelength of two input-image samples. An important property of the Fourier transformation is that an inverse transformation can be performed whereby the image is recovered from the transformation.

An image which contains a high proportion of small scale information will generate a Fourier transform with higher values toward the edges than will an image of nearly uniform intensity with few sharp features. The crispness of an image, therefore, can be enhanced by increasing the magnitudes of the samples of its Fourier transformation which fall in the vicinity of the

edges of the transform. Similarly, noise exhibiting a speckled appearance
can be removed by reducing samples near the transform edges. These processes,
referred to as filtering, consist of:

1. Computation of the Fourier transformation of the image.

2. Point-by-point multiplication of the transform by an overlaid
    filter function.

3. Computation of the inverse Fourier transformation of the filtered
    transform to yield the enhanced image.

Due to certain properties of the Fourier transformation, a different filtering
procedure exists which accomplishes a result identical to that produced by
Fourier domain filtering. This process, known as convolutional filtering,
consists of:

1. Computation of the inverse Fourier transformation of the filter
    function.

2. Convolution of the inverse transformed filter function with the
    image to obtain the enhanced image.

Convolution is accomplished by overlaying the input image with the inverse
transformed filter function so that the center of the overlay coincides with
a specific sample of the input image. The sum of the products of all coin-
cident points in the input image and the overlay is then computed. The
process is repeated at each sample in the input image, yielding a correspond-
ing sample in the output equal to the sum of products computed with the
overlay positioned at the sample.

In general, convolutional filtering requires greater computation than does
Fourier domain filtering. However, when the inverse Fourier transformation
of the filter function contains significant areas of zero magnitude, convolu-
tional filtering becomes more efficient. Useful filter functions exist for
which the inverse transforms are of sufficiently limited extent to render
convolutional filtering more economical, but the performance of these
filters tends to be less than optimal. Algorithms are available which
construct filter functions exhibiting inverse transforms of limited extent
and which approximate within constraints optimal filter functions. Using
these substitute filters, admittedly poorer enhancements may be obtained,
but in many cases great computational economy can be achieved.

System Development Corporation

IMAGE DATA PROCESSING SYSTEM (IDAPS)

USER MANUAL

S-056 EXPERIMENT

BATCH IDAPS VOLUME II

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VOLUME II

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1.0 INTRODUCTION

The S-056 Image Data Processing System (IDAPS) is a flexible, high-volume
image processing system. Flexibility and responsiveness to the user are
provided by an interactive mode, and high-volume capacity by a batch mode.
This document, Volume II of the IDAPS User Manual, is the Batch IDAPS Manual.
It is a companion document to Volume III, the Interactive IDAPS Manual.
Volume I describes the general features and capabilities of the IDAPS concept,
hardware, and software.

Batch IDAPS operations utilize an extensive library of image processing
operators (software modules) and an image processing control system. Each
image processing operator is an independent software module capable of
performing a specific image processing task or technique. An operator may
be executed by itself or in series with other operators. The Batch IDAPS
system provides a capability for applying sequences of operators to sizable
image data arrays with minimal user interaction.

The user exercises complete and straight-forward control over the capabilities
of the Batch IDAPS system by writing instructions in simple computer-card
formats. Jobs are submitted by computer card deck, and image data arrays
are input from magnetic tape. The Batch IDAPS system assigns appropriate
file names, keeps track of and adjusts data formats as needed, opens and
closes files, maintains a file directory, generates printed information
required by the user or system, and outputs data files on magnetic tape for
user reference. On the basis of a deck of control card instructions, the
system will apply selected IDAPS operators for restoration, enhancement, and
analysis of the input data.

This manual provides concise instructions for the use of Batch IDAPS, assuming
the user has some minimal experience with computer card preparation and a
general understanding of image processing techniques. The manual has three
major sections:

- A Glossary section to acquaint the user with Batch IDAPS nomenclature.

- A System Use section to describe the mechanics of preparing a Batch IDAPS run. This section defines card formats, system features, capabilities and limitations encountered in controlling the Batch IDAPS run.

- A Batch IDAPS Operators section to define the purpose, individual card formatting, parameters, Data card format, input/output data types, and restrictions for each operator.

The user of this manual, after acquiring a general understanding of the IDAPS system by following the Training Plan outlined in Volume I, should be able to select the operators required to process his data, prepare his Batch IDAPS Run Deck, submit his job, and retrieve his processed image data. If the user is uncertain of the operators to be used to accomplish a desired objective, or of the sequence of operators, or of the parameters to be specified, he should explore these variables with Interactive IDAPS, described in Volume III.

Appendix A, Batch IDAPS Operator Index, provides an alphabetical list of the operators currently in the system. A brief statement of purpose is included for each operator.

Appendix B, Batch IDAPS Operator CPU Time Requirements, provides the number of minutes of CPU time that each operator is estimated to require.

2.0 GLOSSARY

Account Number — The accounting number against which the job will be charged. (Same as charge number)

Array — A rectangular array of picture elements; an image file.

Asterisk (*) — When used in a data table on a Data card, the asterisk indicates that the preceding number in the table is the number of times the following data value is to be repeated (see paragraph 3.10).

Batch IDAPS — The high-capacity data processing mode of IDAPS requiring minimum user interaction.

Batch IDAPS Initiator Card — Indicates to the IDAPS system that the job is a Batch IDAPS job as opposed to an Interactive IDAPS job.

Batch IDAPS Run Deck — The set of cards which define the sequence of image processing operations to be performed by Batch IDAPS.

Bin Number — The bin in which the output of the job will be deposited.

Charge Number — The accounting number against which the job will be charged. (Same as account number)

Clipping   —   Defines the upper and lower limits of
                                 gray values on which a process is to be
                                 performed. All signals outside the
                                 clipping limits are set equal to either
                                 the maximum or minimum gray value (0 or
                                 255).

Column   —   A one-dimensional vertical array of
                                 picture elements. The first column of
                                 a picture is designated as column 1.

CPU Time Requirement   —   Minutes of Central Processor Unit time
                                 that the job is allowed to run. An
                                 estimate may be obtained by reference to
                                 Appendix B.

Data Card   —   Provides data for the operator in addition
                                 to the parameters on the operator card.

Data Definition (DD) Card   —   Identifies the required image input and
                                 output tapes.

DD Card   —   Data Definition card.

Delimiter /* Card   —   Signifies the end of the IDAPS Control
                                 cards. The last card in the Batch IDAPS
                                 run deck.

EOF Code   —   End of File code is an electronic mark
                                 on magnetic tape which is used to signal
                                 the end of a data file.

EXEC Card   —   Invokes the Batch IDAPS system.

File Identification   —   A parameter which tells the computer
                                     operations personnel which tape to
                                     mount. (Same as Tape Identification)

File Name   —   A unique temporary identification name
                                     automatically assigned to each image
                                     file which is stored on the host com-
                                     puter disk during an IDAPS run.

File Number   —   The Tape File Number; it identifies a
                                     specific image file on a given tape.

Flags   —   Alphabetic characters used to signify
                                     options in an IDAPS operator.

Floating Point   —   Numeric values containing a decimal
                                     point.

Frame   —   An image or data file.

Gray Scale   —   A value (0-255) assigned to a picture
                                     element to indicate its degree of gray-
                                     ness. 0 = black; 255 = transparent.

IDAPS   —   Image Data Processing System.

IDAPS Control Card   —   Cards which control the operators and
                                     the associated data input.

Image — Same as image data array.

Image Data Array — A rectangular array of picture elements; an image file.

Image File — A two-dimensional array of numbers filed on disk or tape representing the gray levels of pixels in a digitized picture.

Image Number — The sequential index within a run deck of the image files to be input by the INP Operator or output by the OUT Operator.

Input Tape — The image data tape which is the source of data for the Batch IDAPS run.

Interactive IDAPS — The operating mode of IDAPS which provides interactive user control of image processing.

JCL Card — Job Control Language card.

JOB Submittal Card — The card under which the Batch IDAPS job is submitted to the IBM 360 control desk.

JOB Cards — The first two cards in the Batch IDAPS run deck. The first JOB card is used by computer operations personnel for job control; the second for job accounting.

Line   —   A one-dimensional horizontal array of
                                    picture elements. The first line of a
                                    picture is designated as line 1.

Line and Column Coordinates   —   A pair of integer numbers used to describe
                                    the location of a single picture element
                                    within a frame of data; the row and
                                    column numbers of a picture element.

Operator   —   A single image processing technique or
                                    control process. It may be a subroutine
                                    or a collection of subroutines, called
                                    by an identifying name, which carries
                                    out a specific task.

Operator Card   —   Designates that a specific operator is
                                    to be run.

Operator Code   —   The unique three letter code for each
                                    IDAPS operator.

OS-MVT   —   Operating System – Multiprocessing with
                                    a Variable Number of Tasks. The IBM
                                    operating system under which Batch IDAPS
                                    runs.

Output Tape   —   The tape on which the image output of
                                    the Batch IDAPS run is written for
                                    permanent record.

Parameter   —   Variables entered on the Operator card
                                    to define and control a process.

Picture Element   —   The smallest unit of a digitized picture
                             representing the average gray level (0-
                             255) of a single area sample of an
                             image. (One data point)

Pixel   —   Picture element.

RET Code   —   Retention code, used on output tape
                             labels.

Row   —   A line.

Run Deck   —   The set of JCL and IDAPS Control cards
                             which controls a Batch IDAPS run.

Scanner   —   Refers to the on-line Dicomed Film
                             Digitizer or similar off-line film
                             digitizing device.

Size   —   The vertical and horizontal dimensions
                             of an array expressed in terms of picture
                             elements. A 320 X 480 image has 320
                             pixels in the vertical line and 480
                             pixels in the horizontal line. Size
                             should not be confused with the physical
                             dimensions of an image on film.

SYSIN Card   —   Defines the set of IDAPS Operator cards
                             that belong to the job being run.

Table   —   A one-dimensional array of real or
                             integer data used as input to the IDAPS

system for use by an operator. Tables
are input to the computer by data cards.

Tape Identification   —   A parameter which tells the computer
                                  operator which tape to mount. (Same as
                                  File Identification)

3.0 SYSTEM USE

This section provides the user of Batch IDAPS with the information and procedural instruction required to set up an image processing run and to enter it into the computer for execution. Also provided is a brief explanation of Batch IDAPS image data input/output techniques so that the user will better understand overall system performance and capability. The instructions in this section are directed toward the user who has a general knowledge of image processing techniques.

3.1 CAPABILITY, LIMITS, AND APPLICATIONS

Proper application of Batch IDAPS is important to the efficient utilization of NASA resources and to the timely turn-around of image processing jobs. The IDAPS concept centers on the use of both batch and interactive processing. The two mutually supporting approaches provide a means for setting up and testing a job run by interactive operation and for performing the more time-consuming processing of whole and multiple frames in a batch mode.

In preparing to use Batch IDAPS, three steps are usually required:

- Prepare IDAPS format image data tapes using an available film scanner.

- Interactively process a representative subset of the input data using Interactive IDAPS to establish operator sequences, parameters, and data tables.

- Set up the Batch IDAPS run deck in accordance with the instructions in this manual.

As the user becomes more familiar with IDAPS, he will find that less time is required with the interactive mode and that man-machine time can be greatly reduced by increased use of the batch mode.

Since Batch and Interactive IDAPS are designed to complement each other, special capabilities exist in the interactive system which are not available to the batch user and vice versa. Because all image I/O is through magnetic tape in the batch mode, operators are provided for reading and writing image format tapes. Because some interactive tasks require peripheral hardware which is not directly available to the host computer, such operators as Pseudocolor-SYSTEM TO DISPLAY and Image I/O-SCANNER TO FILM are only available to the interactive user. Section 4.0 of this manual presents descriptions of the operators available to the Batch IDAPS user.

3.2 HOST COMPUTER

The Batch IDAPS runs described in this manual are processed by the NASA Marshall Space Flight Center's IBM 360/65 computer. A full compliment of standard computer peripherals is available, including high-speed line printers, card reader/punch, and magnetic tape drives. Batch IDAPS runs utilize the IBM OS-MVT software system. By operating under OS-MVT, it is possible to take advantage of the many utility features of the IBM software and to run multiple tasks concurrently. Batch IDAPS is set up as a procedure under OS-MVT and is invoked by a small card deck as explained in the following paragraphs. The user then instructs the Batch IDAPS system which input data to use, which operations to perform, and how to record the results. These instructions are conveyed to the Batch IDAPS system by the Batch IDAPS Run Deck.

3.3 BATCH IDAPS RUN DECK SET-UP

Two types of run-deck card inputs are required: JCL cards and IDAPS Control cards. The JCL cards and IDAPS Control cards are as follows:

JCL Cards	IDAPS Control Cards
JOB	Batch IDAPS Initiator
EXEC	Operator
Data Definition (DD)	Data
SYSIN	
Delimiter /*	

The JCL cards perform the following functions:

- Establish the user's job, including name, job number, and run time.

- Define input and output images.

- Provide a delimiter to signify the end of the IDAPS Control cards.

Several of the parameters of each JCL card are constant and are of no concern to the average user. Only those parameters which require specification for each user job are described.

The IDAPS Control cards perform the following functions:

- Initiate the Batch IDAPS Control card series.

- Identify the selected IDAPS image processing operators.

- Provide additional data and tables as required beyond the basic operator parameters.

Figure 3-1 presents a typical deck set-up for a Batch IDAPS run. The deck as shown consists of the following cards:

DELIMITER /* CARD

BATCH IDAPS OPERATOR & DATA CARDS

BATCH IDAPS INITIATOR CARD

SYSIN CARD

DATA DEFINITION (DD) CARDS FOR OUTPUT TAPES

DATA DEFINITION (DD) CARDS FOR INPUT TAPES

EXEC CARD

JOB CARD

JOB CARD
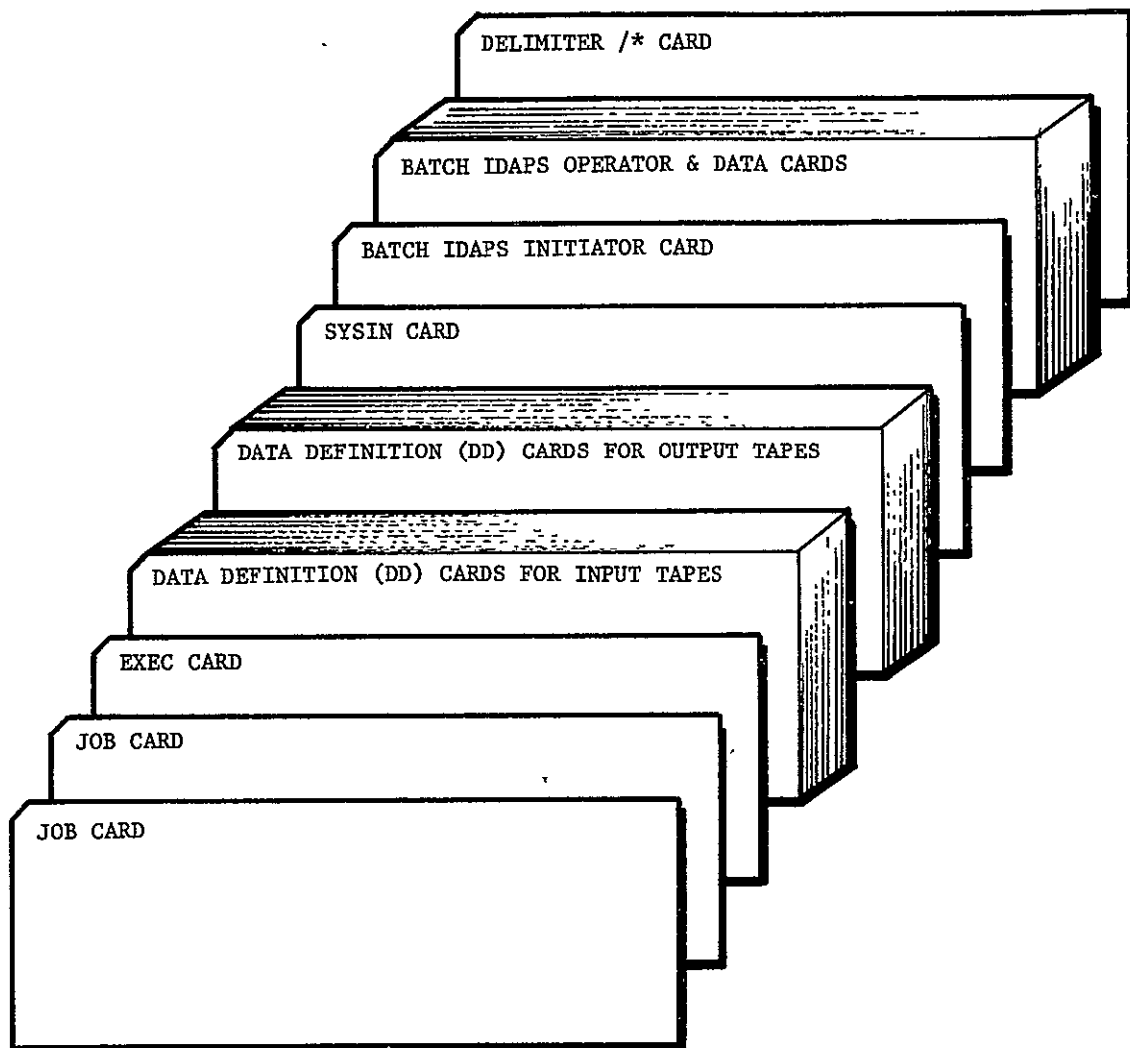
Figure 3-1.   Typical Deck Set-Up for Batch IDAPS Run

JOB

EXEC

Data Definition (DD)

SYSIN

Batch IDAPS Initiator

Batch IDAPS Operator

Batch IDAPS Data

Delimiter /*

The JCL and IDAPS Control cards are discussed in the following paragraphs in the order in which they occur in the Batch IDAPS run deck. The number of characters used to specify a parameter may be less than that shown in the examples. For example, the user's bin number may be A2 which requires only two character spaces. In general, however, strict adherence to the character spacing shown in the example of JCL cards should be maintained. All control card parameters start in column one and each parameter is separated by a comma unless otherwise noted.

3.4 JOB CARDS

The first two cards in the Batch IDAPS run deck are JOB cards. They are punched identically. The first JOB card is used by computer operations personnel for job control; the second is used for job accounting.


```
//A11,20,10),1HNTSVSE3000USERNAME,MSGLEVEL=(1,1)
   ①  ②            ③      ④
```
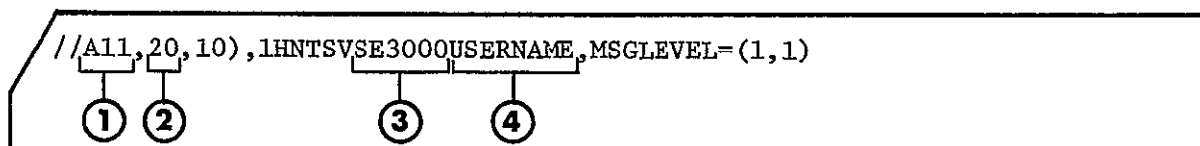

The variable parameters on the JOB cards, underlined and numbered above, are:

1. Bin Number   --   The bin in which the output of the job will be
                           deposited. The job output will normally consist of
                           the user run deck plus the job print out. Bin
                           numbers are three spaces. (See computer control
                           desk personnel.)

2. CPU Time Limit -   The number of minutes (integer) of CPU time that
                           the job is allowed to run. It should be the sum of
                           the estimated CPU times for each use of the operators
                           in the run deck. (See Appendix B for estimated
                           operator times.) There is no digit limitation on
                           this parameter.

3. Charge Number   --   The accounting number against which the job will be
                           charged. (See Mr. D. T. Thomas, EF32, Data Systems
                           Laboratory.) Charge numbers are six characters.

4. Name   --   The job identification (maximum of eight characters).

3.5 EXEC CARD

The EXEC card invokes Batch IDAPS.

```
//BATCH EXEC IDAPS,TIME.GO=20
```

The variable parameter is the CPU time limit, which should be the same as
entered on the JOB card.

3.6 DATA DEFINITION (DD) CARDS

For each input and output image there must be a corresponding DD card. The
DD cards provide the required image input and output information such as
reel number and file number. The format for the Input Image DD card is as
follows:

```
//GO.TAPE1F01 DD UNIT=TAPE9,LABEL=(1,NL,,IN),VOL=SER=SDC008,DISP=OLD
           └┘                         └┘                    └──────┘
           ①                         ②                        ③
```

The characters "DD" must have leading and trailing blanks as in the example.
The variable parameters on the Input Image DD card are:

1. Image number   –   The sequential index to the image files to be input
                         via the INPUT (INP) operator during the run. Image
                         number 01 corresponds to the first use of INP, 02 to
                         the second INP, etc,, in a run deck. This parameter
                         requires that two character spaces be used to specify
                         the image number.

2. File number   –   The tape file number of the image data to be input
                         from the tape identified below. There is no character
                         limitation on this parameter.

3. Tape ID   –   This parameter tells the computer operator which
                         input tape to mount. It may be the reel number (in
                         the case of IBM 360 library tapes) or the tape label
                         ID (in the case of a user tape). A maximum of six
                         characters may be used for reel number identification.

The format of the Output Image DD card is as follows:

```
//GO.TAPE2F01 DD UNIT=TAPE9,LABEL=(1,NL),VOL=SER=XXXXX,DISP=NEW
           └┘                      └┘                 └───┘
           ①                      ②                     ③
```

The characters "DD" must have leading and trailing blanks as in the example.
The variable parameters on the Output Image DD card are:

1. Image number   –   The sequential index to the image files to be output
                       via the OUTPUT (OUT) operator during the run. Image
                       number 01 corresponds to the first use of OUT, 02 to
                       the second OUT, etc,, in a run deck. This parameter
                       requires that two character spaces be used to specify
                       the image number.

2. File number   –   The tape file number of the output image data to be
                       recorded on the tape below. There is no character
                       limitation on this parameter.

3. Tape ID   –   File Identification as specified on the Output Tape
                       Label (Tape Save Label). It identifies the tape on
                       which the output image data is to be recorded. A
                       maximum of six characters may be used.

3.7 SYSIN CARD

```
//GO.SYSIN DD *
```

The SYSIN card identifies the subsequent cards as being the IDAPS operator
cards that belong to the current job.

3.8 BATCH IDAPS INITIATOR CARD

This IDAPS Control card indicates to the IDAPS Control Program that the job
is a Batch IDAPS job as opposed to an Interactive IDAPS job.

```
BATCH RUN
```

3.9 BATCH IDAPS OPERATOR CARDS

A free field format is used for Batch IDAPS Operator cards. The general
form of a Batch IDAPS Operator card is:

COL. 4

```
                                        Par    Par    Par ... Par
    OPERATOR CODE[SPACE](File Name(s))   1,     2,     3,      n
```

OR

COL. 4

```
                      Par    Par    Par ... Par
    OPERATOR CODE[SPACE] 1,   2,     3,      n   (File Name(s))
```
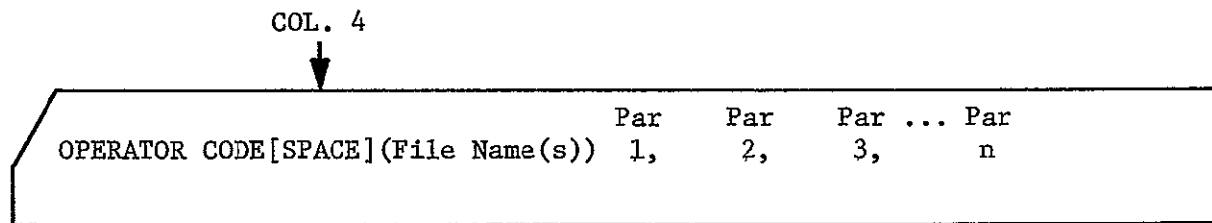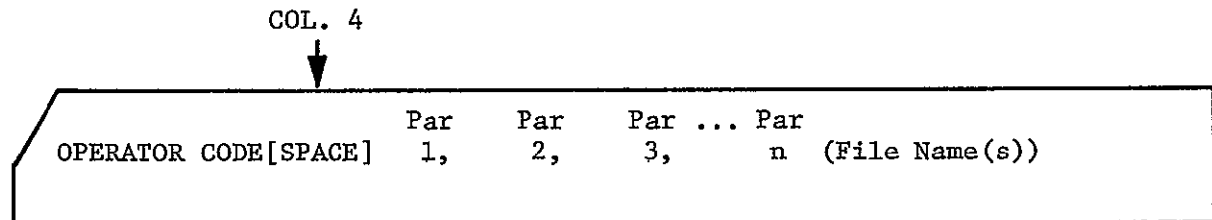
For convenience, file name(s), which appear enclosed within parentheses, may
precede or follow the parameter string.

3.9.1 Operator Code

Each IDAPS operator is identified by a three letter code which is usually
the first three letters of the operator name. For instance, the operator
code for the AVERAGE operator is AVE. This code is used to designate the
operators that the user wishes to apply to his data. The three letter
operator code is punched on the operator card beginning in column 1 of the
card. The three letter code must be followed by a blank in column 4. The
proper operator code for every operator in Batch IDAPS is presented in
Appendix A.

3.9.2 Operator Parameters

Most IDAPS operators require the specification of more information than just
the operator code. Such information as starting line and column or the size
of an area to be processed must be supplied by the user through parameter
values on the Operator card.

Parameters are of three types:

- Integer values
- Real values
- Flags

Integer values consist of a sign (a plus is implied if no sign is specified)
and 1-8 decimal digits (i.e. 3; -6; .89; 57691832). Real values are written
with a sign, decimal point, and 1-8 decimal digits (i.e. -.37; 1.5916371;
-10015.). Flags are generally single alphabetic characters which are used
to select one of several options.

Parameters are specified on the operator card following the operator code
and a blank in column 4. Parameters are separated from each other by commas
as in the following example:

COL. 4

```
AUT  256,256,101,245,C,A,36,,251.
```

Because the IDAPS system checks the number of parameters that the user
specifies for an operator against the number required for the operator, it
is important that there be an entry for every parameter on the operator
card. Note that no comma precedes or follows the parameter string.

3.9.3 File Name

File names are assigned by the Batch IDAPS system to designate and keep
track of input and output images during a run. File names are assigned to
the output of an operator using the convention that a file is based on the
operator code of the operator that created it and the sequence of operator
use. For example, the first time the INPUT (INP) operator is used, its
output file is designated 1INP. The next time the INPUT operator is used,
its output will be 2INP and so on. This convention simplifies the problem
of keeping track of files in IDAPS.

When an operator creates a new file it is assigned a name by the above
convention and stored on disk for future use during the run. To use an
IDAPS file that has been stored on disk, the user refers to it by its assigned
name. In preparing the Batch IDAPS Operator card, the user may or may not
specify an input file or files. If he does wish to specify an input file(s),
he does so by enclosing its name in parenthesis following the operator code
(separated by the blank in column 4) or following the last specified parameter.
For example:

COL. 4

AUT (1INP)256,256,101,245,C,A,36.,251.

OR

COL. 4

AUT 256,256,101,245,C,A,36.,251. (1INP)

For those operators that require more than one input file, the user must
specify all input files as in the following example:

COL. 4

AVE (1INP,1EXT,2ALT)

For those operators which require only one input file, the user may elect
not to specify an input file on his Operator card. In this case a default
condition occurs in which the Batch IDAPS system assumes that the last file
created by the user is desired to be the input for the next operation. This
case is often true and the default capability can simplify the user control
deck considerably.

3.10   BATCH IDAPS DATA CARDS

Many operators require the input of data or tables in addition to the para-
meters on the Operator card. Such Data cards are included in the Batch
IDAPS run deck immediately following their associated Operator card. Data
cards begin with a table name followed by an equal sign followed by the data
values separated by commas followed by a dollar sign. Since the system does
not check the name of the operator but simply looks for the equal sign, the
actual name of the data set is unimportant and may be chosen by the user to
satisfy his own identification needs.

A free field format is used for the data values. This means that the user
does not have to be concerned with numbers of columns of a card in which a
data value is punched. The user simply punches his data values in sequence,
separating the values with commas. Multiple entries of the same value may
be indicated by specifying the number of times the value is repeated, followed
by an asterisk (*), followed by the desired value. For example, to repeat
the value 1 ten times, the following format is used:

                ....,,10*1,....

The last value in the data table must be followed by a dollar sign ($).
Data may be written in any card column and multiple cards may be used. Care

should be taken to include the correct number of values and to signal the
end of the data table with the dollar sign.

Data may be integer or floating point depending on the requirements of the
particular operator. Integer data may be as large as eight digits while
floating point data should be restricted to sixteen characters including
plus and minus signs, decimal points, numerals, and the letter E for scienti-
fic notation..

The following examples illustrate Data card formats:

```
RUN3-2=0.,1.,6.,16.,36.8,19.,12.3,6.,1.25,.86$
```

```
GROUP=32*1,32*2,32*3,32*4,32*5,32*6,32*7,32*8$
```

```
60,60,2*61,2*62,2*63,2*64,2*65,2*66,193*255$

39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,

K1=10*0,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,
```

One exception to the general Data card format above is the use of a Data
card to specify alphabetic character strings used in such operators as
FRAME. An explanation of the format required for such exceptions is included
in the operator descriptions in Section 4 of this manual.

3.11 DELIMITER /* CARD

```
/*
```
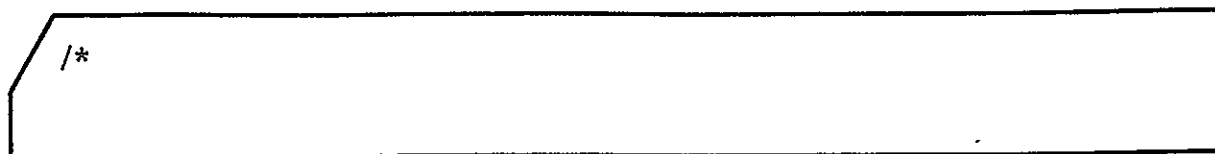
The Delimiter /* card signifies the end of the IDAPS Control cards. It is
the last card in the Batch IDAPS run deck.

3.12 TYPICAL SET OF BATCH IDAPS CONTROL CARDS

A typical set of Batch IDAPS Control cards, consisting of the Initiator
card, Operator cards, and Data cards, is shown in Figure 3-2. The cards are
numbered from one to eleven for discussion. These sample cards would control
the Batch IDAPS system as follows:

1. Identify job as a Batch job (Initiator card)

2. Input an image from tape into the system (INPUT Operator card)

3. Extract a specific subframe from the image (EXTRACT Operator card)

4. Prepare an isogram of the extracted subframe (ISOGRAM Operator
    card)

5. Data for the isogram (Data card for ISOGRAM operator)

6. Subtract the isogram from the extracted subframe (MATH Operator
    card)

7. Linearly scale the results between 0 and 255 (AUTO SCALE Operator
    card)

Figure 3-2. Typical Set of Batch IDAPS Control Cards
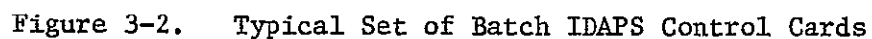
8.   Prepare a presentation frame with appropriate annotation (FRAME
      Operator card)

9.   The top label (Data card for FRAME Operator)

10.   The bottom label (Data card for FRAME Operator)

11.   Write the results on magnetic tape (OUTPUT Operator card)

3.13 JOB SUBMITTAL

Once the job deck has been set up, there are additional steps prior to
submittal, such as completing the Job Submittal card and preparing tape
labels.

3.13.1 Job Submittal Card

CORE SIZE ___ K	BIN NO ___	CLOCK NO ___		
OUTPUT ITEMS	YES	NO	OPER NO	RUN ___ OF ___
PUNCH $		(3)		INPUT TAPES
PLOTS		(4)		(5)
COMMENTS				

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(6)

AP11121 BSC   PUN CARD NO 2

The Job Submittal card for a Batch IDAPS job is completed as indicated. The
only variables are entries 2, 5, and 6:

1 - Core Size - enter 335K

2 - Bin Number - enter assigned bin number

3 - Punch $ - check "No"

4 - Plots - check "No"

5 - Input Tapes - list the tape identification for each input tape

6 - Output Tapes - list the tape identification for each output tape.
If the user wishes return of any user supplied tapes (either input or
output) along with his job output, he should request it by special note
in this space. Checkout of IBM 360 tape on which his output may have
been recorded must be arranged through the IBM 360 control desk.

Refer to "MSFC 360 Operations Bulletin Number 1", available at the IBM 360
control desk, for further information.

3.13.2 Output Tape Labels

Each output tape, as indicated by the DD cards, must have an associated tape
label. The Output Tape Label (Tape Save Label) is completed as indicated.

MSFC/SCC **TAPE SAVE LABEL**		REEL No.	
PROGRAMMER (LAST & INITIAL) ①		ACCOUNT No. ②	
DATE CR	DEN	REEL REEL OF	FILE NAME
FILE IDENTIFICATION ③			
RET CODE ④	CH/UN	SEQ No	No FILES	CREATED ON
TRACKS/PARITY	BACKUP REEL No		MSFC SCC

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1 - Programmer - enter your last name and initial

2 - Account Number - enter change number; must agree with JOB card

3 - File Identification - enter output tape identification; must agree
    with DD card

4 - RET Code - enter retention code as follows:

Class	Period
2	14 days
3	30 days
4	90 days
5	180 days

3.13.3 Job Submission

Batch IDAPS jobs are submitted to the IBM 360 control desk personnel in the
west end of the basement of building 4708.

3.14 IMAGE DATA INPUT/OUTPUT

When operating under Batch IDAPS, image data is entered into and removed
from the system on magnetic tapes. For IDAPS image input, this means that
film images must be scanned off-line and stored on tape in the format described
in the paragraph below. For picture output, the OUTPUT operator will prepare
a magnetic tape which may be analyzed at an off-line viewer. The magnetic
tape format for image data input is the same as for image data output and
the format required for magnetic tape I/O for Batch IDAPS is the same as for
Interactive IDAPS. This means that input tapes may be prepared by Inter-
active IDAPS which can be submitted to and processed by Batch IDAPS, and that
the results of Batch IDAPS runs may be saved for analysis or further processing
using Interactive IDAPS.

The required magnetic tape format is as follows: Magnetic tape should be a
nine-track, 800 BPI standard half-inch computer tape. The tape may be
contained in reels up to and including 10 inches in diameter. Image data on
the tape should not be preceded by a label. Each frame of picture data
shall constitute one tape file and each file shall be made up of a number of
tape records. The number of records contained in a file shall be the same
as the number of scanned lines in the image data array;.that is, the first
record in a file shall correspond to the first scanned line of picture data;
the second record, to the second scan line and so on. Each record shall
consist of a number of 8-bit binary codes or data bytes. Each picture
element (pixel) in the scanned image array shall occupy one byte and shall
correspond to one of 256 possible transmittance values. Several frames of
picture data may be stored on a magnetic tape provided care is taken to mark
the end of each file with an EOF code.

3.15 IMAGE FILE SIZE

In most cases, the user can keep track of his image file sizes; however,
there are certain operators which calculate the output image-size based on
input parameters in which case the exact size of a particular output file is
not known. Operators ROTATE and REGISTER are in this category.

For those operators which request "Number of Lines" and "Number of Columns"
in the parameter string and this information is not known, a default capabi-
lity is provided to allow the user to omit the file size specification. To
omit the file size specification from the parameter string, replace Number
of Lines and/or Number of Columns with a null field. For example, if size
parameters are known to be 512 lines by 512 columns, the user might specify

        ISO (1ALT) 512,512,1,1,0

If the size parameters are not known, he might specify

        ISO (1ALT) ,,1,1,0

where the null fields are indicated by commas.

3.16 IMAGE STORAGE FOR SUBSEQUENT RUN

If the user wishes to save image files from one run to the next, the files
must be dumped to tape by using the OUTPUT operator. Thus, they can be re-
input on a subsequent run by using the INPUT operator. It is the user's
responsibility to know what each output file consist of since there is no
automatic labeling of the files by the system when they are dumped to tape.

3.17 ABNORMAL JOB TERMINATION

Certain conditions can cause abnormal termination of a job, such as:

- Illegal operator name
- Undefined file specification
- Violation of column 4 on Operator card
- No data table where required
- Out-of-bounds parameters

Abnormal termination is indicated on the user's printed output with a brief
explanation of the error condition. Special notice of the stated restrictions
for a particular operator will help the user avoid abnormal job termination.

4.0 BATCH IDAPS OPERATORS

The following section contains descriptions of each operator available to the Batch IDAPS user.

4.1 OPERATOR DESCRIPTIVE FORMAT

Each operator is described in the format presented below.

Name: Name of the operator and the three-letter identification code.

Purpose: A brief explanation of the purpose of the operator. An explanation of the technique used is included if required to clarify the purpose of the operator.

Card Format: Illustration of the Operator card image.

    Identification Code (Input File) Parameter 1, Parameter 2, ...Parameter n

Parameter Definitions: Definition of each parameter.

Data Card Format: Example and Explanation.

    Data Table = N_1, N_2, N_3, ... $N_n$$

A written statement explaining the Data card and any limitations are included if required to clarify the Data card input.

Output Data Type: The number of files produced and whether those files are integer or floating point.

Input Data Type: The type of file input to the operator.

Restrictions: Brief outline of pertinent data that may be important to the
user. Any limitations on image size, operator capacities or formats are
noted.

Notes: Comments on the technique used by the operator, accuracies, and
special features which may be of interest to the user.

4.2 OPERATOR DESCRIPTIONS

The operator descriptions are presented in alphabetic order. This manual
will be updated periodically to include new Batch IDAPS operator descriptions
as they are developed.

NAME: ALTER(ALT)

PURPOSE: The ALTER operator modifies the gray scale value of each element in
           a picture in accordance with a table of values supplied by the
           user. The original gray values in the input array are used as an
           index and the appropriate values in the table are substituted by
           the ALTER operator for the original values and appear in the output
           array.

CARD FORMAT:

ALT (Input File Name)

DATA CARD FORMAT: The table of alteration values (table ALT) is input
                    immediately following the ALTER Operator card. The first
                    entry on the ALT data table card will replace gray value
                    0 (black) in the input image, the second will replace
                    gray value 1, etc.

ALT=255,252,3*248,244,....,,3,2,1,0$

                    The ALT table contains 256 integer values. In the above
                    example, all gray values of 0 (black) in the input picture
                    will be replaced by 255's (white); all 1's by 252; 2's,
                    3's, and 4's by 248; 5's by 244; etc.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

RESTRICTIONS: 256 values must be accounted for in the data table.

NAME: AUTOMATIC SCALE(AUT)

PURPOSE: The AUTOMATIC SCALE operator scales an image file to values between 0 and 255 based on a selected scaling curve. The user may specify upper and lower limits of the gray scale range on which the scaling will take place. The output of AUTO SCALE is an array of values between 0 and 255.

CARD FORMAT:

```
AUT (Input File Name) NL,NC,SL,SC,KF,LF,BC,TC
```

PARAMETER DEFINITIONS: NL - Number of lines to be processed (may be null).

NC - Number of columns to be processed (may be null).

SL - Starting line.

SC - Starting column.

KF - Type of scaling:

    KF = A - Linear.

    KF = B - Logarithmic.

    KF = C - Square root.

    KF = D - Cube root.

    KF = E - Square.

LF - Clipping flag.

    LF = A - No clipping.

    LF = B - Clip outside TC and BC.

BC - Lower clipping level. Values below BC (floating point or integer) will be set to 0.

TC - Upper clipping level. Values above TC (floating point or integer) will be set to 255.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Floating point or integer

NAME: AVERAGE(AVE)

PURPOSE: The AVERAGE operator creates an image which is the average of a
          number of input images. This operator is useful for smoothing
          images which have a high degree of noise.

CARD FORMAT:

AVE (From 2 to 5 Input File Names)

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

RESTRICTIONS AND LIMITATIONS: 1) Maximum of 5 files may be averaged.

                                2) All input images must be the same size
                                and registered. (The EXTRACT, REGISTER, or
                                ROTATE operators may be used to accomplish
                                sizing and registration.)

NAME: DELETE(DEL)

PURPOSE: The DELETE operator, on user request, deletes files maintained by
the File Manager in the File Directory and thereby frees disk space
for reuse by subsequent operators.

CARD FORMAT:

DEL (From 1 to 5 Input File Names)

NOTES: If more than five files are to be deleted, DEL must be used
repetitively.

NAME: EXTRACT SUBFRAME(EXT)

PURPOSE: The EXTRACT SUBFRAME operator extracts a specified rectangular
           portion of an image from an input file.

CARD FORMAT:

```
EXT (Input File Name) NL,NC,SL,SC
```

PARAMETER DEFINITIONS: NL - Number of lines to be extracted.
                          NC - Number of columns to be extracted.
                          SL - Starting line.
                          SC - Starting column.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

RESTRICTIONS AND LIMITATIONS: Number of lines or columns plus starting line
                                or column must not exceed size of input
                                image.

NAME: FAST FOURIER TRANSFORM(FFT)

PURPOSE: The FAST FOURIER TRANSFORM operator performs a two-dimensional
          Fourier transformation on the input array (file) and produces two
          output arrays (files) which contain the complex components in the
          frequency domain. The output arrays (files) may be in the form of
          real and imaginary components or in the form of magnitude and
          phase components.

CARD FORMAT:

```
FFT (Input File Name) OF,NM,KW,KT
```

PARAMETER DEFINITIONS: OF - Output format:

                              OF = A - Real/imaginary, DC term at location
                                         1, 1.

                              OF = B - Real/imaginary, DC term centered.

                              OF = C - Magnitude/phase, DC term at
                                         location 1,1.

                              OF = D - Magnitude/phase, DC term centered.

                        NM - Normalization option:

                              NM = A - Normalize.

                              NM = B - Do not normalize.

                        KW - Window option:

                              KW = A - Apply window.

                              KW = B - Do not apply window.

                        KT - Window type:

                              KT = A - Hanning.

                              KT = B - Hamming.

OUTPUT DATA TYPE: Floating point

INPUT DATA TYPE: Floating point or integer

RESTRICTIONS AND LIMITATIONS: 1) The number of rows (and columns) in the
                                input file must be a power of 2.
                                2) The input file must have at least 64 rows
                                and columns, but not more than 1024 rows and
                                columns.

NOTE: The normalized transform is obtained by dividing the frequency
         terms by the volume under the curve and reversing the sign of
         alternate terms.

NAME: FILTER GENERATOR (FGN)

PURPOSE: To generate filter files to be used with the convolutional filter
operator in the spatial domain or the Fourier filter in the frequency
domain. A symmetrical filter is generated from internally generated
or user input (via data tables) x-z plane normalized frequency
domain profile. A non-symmetrical filter is generated from x-z
plane and y-z plane normalized frequency domain profiles by using an
elliptical fit algorithm to produce the filter surface.

CARD FORMAT:

```
FGN ISYM,KXZ,AXZ,BXZ,KYZ,AYZ,BYZ,AMAX,AMIN,KTYPE,NSIZ,KINV,FMAX
```

PARAMETER DEFINITIONS: ISYM   —   Symmetry function.

                                       ISYM = A — Rotationally symmetric
                                                  filter

                                       ISYM = B — Elliptically fit non-symmetric
                                                  filter

                            KXZ   —   Type of filter cross section in x-z
                                       plane.

                                       KXZ = A — Circular aperture diffraction
                                                 function

                                       KXZ = B — Modified exponential function

                                       KXZ = C — Gaussian distribution

                                       KXZ = D — Quarter wave, zero order Bessel
                                                 function

                                       KXZ = E — Defocused perfect lens modulation
                                                 transfer function

                                       KXZ = F — Low pass filter

KXZ = G - High pass filter

KXZ = H - Band pass filter

KXZ = I - Band reject filter

KXZ = J - Circular aperture modulation
          transfer function

KXZ = K - Data card input

AXZ   - For KXZ = A,B,C,D or E, AXZ is the normal-
          ized frequency at which the
          x-z plane profile equals zero.

For KXZ = F,G,H or I, AXZ is the initial
          transition point for the filter
          profile.

Fox KXZ = J, AXZ is aperture diameter
          (in pixels)

BXZ   - For KXZ = A,B,C or D, this input value is
          not used.

For KXZ = E, BXZ is the defocus factor.

For KXZ = F,G,H, I or J, BXZ is the
          final transition for the
          filter profile.

KYZ   - Type of filter cross section in the y-z
          plane (see description of KXZ for options).

AYZ   - For KYZ = A,B,C,D or E, AYZ is the nor-
          malized frequency at which the
          y-z plane profile equals zero.

For KYZ = F,G,H or I, AYZ is the initial
          transition point for the filter
          profile.

BYZ   - For KYZ = A,B,C or D, this input value is
          not used.

For KYZ = E, BYZ is the defocus factor.

For KYZ = F,G,H or I, BYZ is the final transition point for the filter profile.

AMAX - Maximum amplitude which will be assigned to the value of 1. in the normalized profile(s).

AMIN - Minimum amplitude which will be assigned to the value of 0. in the normalized profile(s).

KTYPE - Type of filter to be generated.

　　　　KTYPE = A - Frequency domain filter (Fourier)

　　　　KTYPE = B - Spatial domain filter (convolution)

NSIZ - Size of filter array to be generated.

KINV - Inversion option

　　　　KINV = A - Filter array will not be inverted.

　　　　KINV = B - Filter array will be inverted.

FMAX - If inversion is selected, FMAX is the maximum allowable value in the inverted filter array.

DATA CARD FORMAT:　　　The tabular values of the x-z plane and y-z plane profiles as required) are input immediately following the FILTER GENERATOR operator card in the format of the following example:

```
FGN2 = 1.0, .95, .86, .71, .46, .16, .11, .07, .04, .02, .01, 241* 0.$

FGN1 = 1.0, .99, .92, .79, .61., .39, .12, .03, .02, .01, 241* 0.$
```

NOTE: In the above example a non-symmetrical filter has been selected and
          therefore both profiles must be input. The values for the x-z plane
          profile are input in table FGN1 and correspond to the values of the
          modulation transfer function at .004 intervals of the normalized
          frequency. The first value corresponds to a frequency of 0.0, the
          second to a frequency of 0.004, etc. There must be 251 values in
          the table. The values for the y-z plane profile are input in table
          FGN2 in the same format as the x-z plane profile.

METHOD: In the case of rotational symmetry, the x-z plane profile is gener-
          ated internally using input parameters or from the user supplied
          profile in table FGN1. The normalized profile is then altered
          according to

$$P_1 = (AMAX - AMIN)x + AMIN$$

where P_1 is the scaled profile value and x is the normalized profile
value. If the filter is to be inverted this is accomplished in the
following manner

$$P_2 = \frac{1}{P_1} \text{ if } P_2 \leq FMAX$$

$$P_2 = FMAX, \text{ if } \frac{1}{P_1} > FMAX$$

where P_2 is the inverted profile value and P_1 is the scaled profile
value. The resulting profile is then either rotated about the axis
of symmetry to give a frequency domain filter or used by the JPL
"WTGEN" package to generate a set of spatial domain weights for use
in convolutional filtering.

In the case of elliptically fit non-symmetrical filters, the y-z
plane profile must also be generated internally using input param-
eters or the user supplied profile in table FIL2. The normalized
profile is scaled and, if required, inverted. The resulting profiles

are then used to generate a frequency domain filter surface where
intersections of a constant magnitude result in elliptical cross
sections in the z plane. This surface is used directly as a frequency
domain filter. The spatial domain filter weights used in convolu-
tional filtering are generated by the JPL "WTGEN" package from the
unnormalized x-z plane and y-z plane profiles.

The internally generated circular aperture diffraction function is
generated by the equation

$$x = \frac{2}{\pi} \left[\cos^{-1}\left(\frac{f}{AXZ}\right) - \frac{f}{AXZ}\left(1 - \left(\frac{f^2}{AXZ^2}\right)\right)^{\frac{1}{2}} \right]$$

where $0. \leq f \leq AXZ$, and
   $x = 0.$, where $f > AXZ$
and $0. < AXZ \leq 1.$

The internally generated modified exponential function is generated by the
equation

$$x = \left[\frac{e^{(1 - \frac{f}{AXZ})} - 1}{e - 1} \right]$$

where $0 \leq f \leq AXZ$, and
      $x = 0$, where $f > AXZ$
and $0. < AXZ \leq 1.$

The internally generated Gaussian distribution function is generated by the
equation

$$x = e^{-\frac{1}{2}\left(\frac{3f}{AXZ}\right)^2}$$

where $0. < AXZ \leq 1.$

The internally generated quarter wave, zero order Bessel function is generated by the equation

$$x = J_o\left(\frac{2.4048f}{AXZ}\right)$$

where $0 \le f \le AXZ$, and

      $x = 0$, where $f > AXZ$,

and $0. < AXZ \le 1.$

The internally generated defocused perfect lens function is generated by the equation

$$x = \frac{2}{\pi}\left[\cos^{-1} F - F\sqrt{1 - F^2}\right]\left[\frac{2J_1(k)}{k}\right]$$

where $k = 8\pi(BXZ)f(1-F)$,

       $F = \dfrac{f}{AXZ}$ for $0 \le f \le AXZ$, and

       $x = 0$ for $f > AXZ$,

and $0. < AXZ \le 1.$, $0 < BXZ < 1.6$

The internally generated low pass filter is generated by the equation

    $x = 1$ where $f < AXZ$

$$x = \left[\sin\left(\frac{\pi}{2}\left(\frac{f - BXZ}{AXZ - BXZ}\right)\right)\right]^2 \text{ where } AXZ \le f \le BXZ$$

    $x = 0$ where $f > BXZ$

and

•

The internally generated high pass filter is generated by the equation

$$x = 0 \quad \text{where } f < AXZ,$$

$$x = \left[\cos\left(\frac{\pi}{2}\left(\frac{f-BXZ}{AXZ-BXZ}\right)\right)\right]^2 \quad \text{where } AXZ \leq f \leq BXZ, \text{ and}$$

$$x = 1 \quad \text{where } f > BXZ$$

and

$$0. \leq AXZ < 1., \quad 0. < BXZ \leq 1., \quad \text{and } AXZ < BXZ$$

The internally generated band pass filter is generated by the equation

$$x = 0 \quad \text{where } f < AXZ,$$

$$x = \left[\sin\left(\pi\left(\frac{f-BXZ}{AXZ-BXZ}\right)\right)\right]^2 \quad \text{where } AXZ \leq f \leq BXZ, \text{ and}$$

$$x = 0 \quad \text{where } f > BXZ$$

and

$$0. \leq AXZ < 1., \quad 0. < BXZ \leq 1., \text{ and } AXZ < BXZ$$

The internally generated band reject filter is generated by the equation

.

$$x = 1 \quad \text{where } f < AXZ,$$

$$x = \left[\cos\left(\pi\left(\frac{f - BXZ}{AXZ-BXZ}\right)\right)\right]^2 \quad \text{where } AXZ \leq f \leq BXZ, \text{ and}$$

$$x = 1 \quad \text{where } f > BXZ$$

$$0. \leq AXZ < 1., \quad 0. < BXZ \leq 1., \text{ and } \quad AXZ < BXZ$$

The internally generated circular aperture modulation transfer function is generated by the equation

$$x = \frac{2J_1(k)}{k}$$

$$\text{where } k = \frac{\pi f\ (AXZ)}{2}$$

The internally generated profiles for the y-z plane are generated by the same equations substituting AYZ for AXZ and BYZ for BXZ.

OUTPUT DATA TYPE: Floating Point

NAME: FOURIER FILTER(FOU)

PURPOSE: The FOURIER FILTER operator multiplies a two-dimensional frequency
           domain filter by the magnitude component of a Fourier transformed
           input image and inverse transforms the resulting file with the
           corresponding phase component file to give a filtered image file.

CARD FORMAT:

> FOU (Image File Name, Filter File Name)KW,KT

PARAMETER DEFINITIONS: KW - Window option:

                             KW = A - Apply window.

                             KW = B - Do not apply window.

                        KT - Window type:

                             KT = A - Hanning.

                             KT = B - Hamming.

OUTPUT DATA TYPE: Floating point

INPUT DATA TYPE: Floating point or integer

RESTRICTIONS AND LIMITATIONS: 1) The input file must be square.
                               2) The number of rows (and columns) in the
                               input file must be a power of 2.
                               3) The input file must have at least 64 rows
                               and columns, but not more than 1024 rows and
                               columns.

NOTES: 1) The input file names must be specified in the order shown.
         2) The image file name may be replaced with a magnitude component
         file name for a previously transformed image file. In this case

the Fourier transform step is omitted, the filter is multiplied by
the magnitude component file, and the resulting file with the
corresponding phase component file is inverse transformed to give
the filtered image file.

NAME: FRAME(FRA)

PURPOSE: The FRAME operator adds a gray scale step wedge to the right of the
            picture, a gray scale histogram below the picture, and tick marks
            around the picture border. Options are provided for a 32 X 32 pixel
            grid overlay of the picture, up to five lines of alphanumeric labels
            above and/or below the picture, and a user-specified rectangle
            superimposed on the picture. The FRAME background may be either
            black with white annotation or vice versa. The picture gray values
            may be reversed, if desired, to produce a negative or positive
            picture.

CARD FORMAT:

    FRA (Input File Name) NTL,NBL,G,GSI,FCOL,LLL,LLC,LRL,LRC

PARAMETERS DEFINITIONS: NTL   - Number of 80 character lines (5 maximum) for
                                  top label of frame.

                         NBL   - Number of 80 character lines (5 maximum) for
                                  bottom label of frame.

                         G   - Grid Option.
                                  G = A - No grid.
                                  G = B - Grid.

                         GSI   - Gray Scale Inversion.
                                  GSI = A - No inversion.
                                  GSI = B - Inversion.

                         FCOL - Frame Color.
                                  FCOL = A - Black.
                                  FCOL = B - White.

                         LLL   - Rectangle Option - Upper Line Number.

LLC – Rectangle Option – Left Column Number.

LRL – Rectangle Option – Lower Line Number.

LRC – Rectangle Option – Right Column Number.

LABEL CARD FORMAT:

(80 Characters of Label)

There should be one Label Card for every label line specified by
NTL and NBL above, and they should occur in top to bottom sequence.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

NOTES: 1) If no rectangle is desired, set LLL,LLC,LRL, and LRC=0.

2) Each label character requires a space of 10 pixels horizontally
and 14 lines vertically (including spacing).

3) The FRAME is generated around the input image which makes its
output file larger than its input. Care must be taken to account
for the size change. The number of columns in the output frame is
equal to the number of columns in the input frame plus 126, or 290,
whichever is larger. The number of lines in the output frame is
equal to the number of lines in the input frame plus 201, plus 14
times the total number of label lines provided.

4) The starting column of the label line in the frame of data is
determined by the number of columns left blank in front of the
label data on the Label Card.

NAME: H-D CORRECTION(HDC)

PURPOSE: The H-D CORRECTION operator applies a film correction curve to
           the input data or converts gray values to density or energy values
           depending on the input table used.

CARD FORMAT:

> HDC (Input File Name) NL,NC,SL,SC,J

PARAMETER DEFINITIONS: NL - Number of lines to be processed (may be null).

                        NC - Number of columns to be processed (may be null).

                        SL - Starting line.

                        SC - Starting column.

                        J   - Output data format option.

                               J = A - output file is floating point.

                               J = B - output file is integer.

DATA CARD FORMAT: The table of H and D values (table HDC) is input following
                   the HDC Operator card. The HDC table contains 256 floating
                   point energy or density values. In the following example
                   gray values of 0 are replaced by .1E-4, all 1's by .5E-4,
                   all 2's by 1.E-4 and all 255's by 1.E+3.

> HDC=.1E-4,.5E-4,1.E-4,...,1E+3$

OUTPUT DATA TYPE: Integer or floating point (optional)

INPUT DATA TYPE: Integer

NAME: INPUT(INP)

PURPOSE: The INPUT operator inputs image data from tape. The input image
           tape is read and converted from tape format into a format suitable
           for storage as an IDAPS file, a file name is assigned and the image
           is made available for processing by other IDAPS operators.

CARD FORMAT:

```
INP NL,NC,SL,SC
```


PARAMETER DEFINITIONS: NL   -   Number of lines to be processed.
                         NC   -   Number of columns to be processed.
                         SL   -   Starting line.
                         SC   -   Starting column.

OUTPUT DATA TYPE: Integer

RESTRICTIONS AND LIMITATIONS: 1) Input data tape must be 9 track, non-
                                labeled, unblocked, 800 bpi density.
                                2) For each use of the INPUT operator a DD card
                                must be provided (See Section 3).

NOTES: If the number of lines and/or columns on tape is less than NL or
         NC, the system file will be adjusted automatically to that of the
         tape dimensions.

NAME: INSERT SUBFRAME(INS)

PURPOSE: The INSERT SUBFRAME operator inserts a portion of one image (the
           overlay) into another image (the underlay). Facility is provided
           to place the resultant image into a background of constant speci-
           fied intensity.

CARD FORMAT:

INS (Overlay File Name, Underlay File Name) LU,KU,LSO,KSO,NLO,NKO,LLO,KLO,L,K,IB

PARAMETER DEFINITIONS: LU — Line location in output image at which upper left
                                corner of underlay is placed.

                         KU — Column location in output image at which upper
                                left corner of underlay is placed.

                         LSO — Starting line of overlay image section (with
                                respect to the original overlay file).

                         KSO — Starting column of overlay image section (with
                                respect to the original overlay file).

                         NLO — Number of lines in overlay image section.

                         NKO — Number of columns in overlay image section.

                         LLO — Line location in output image at which upper left
                                corner of overlay section is placed.

                         KLO — Column location in output image at which upper
                                left corner of overlay section is placed.

                         L   — Number of lines in output.

                         K   — Number of columns in output.

                         IB — Background intensity.

                                IB = A — Background intensity is 0.

                                IB = B — Background intensity is 255.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

NAME: INVERSE FAST FOURIER TRANSFORM(IFF)

PURPOSE: The INVERSE FAST FOURIER TRANSFORM operator transforms two input
           arrays (files) containing the complex components in the frequency
           domain into an output array (file) in the spatial domain. The
           input arrays (files) may be in the form of real and imaginary
           components or in the form of magnitude and phase components.

CARD FORMAT:

    IFF (Real or Magnitude File Name, Imaginary or Phase File Name) OF

PARAMETER DEFINITION: OF - Input format:

                        OF = A - Real/imaginary, DC term at location
                                   1,1.

                        OF = B - Real/imaginary, DC term centered.

                        OF = C - Magnitude/phase, DC term at location
                                   1,1.

                        OF = D - Magnitude/phase, DC term centered.

OUTPUT DATA TYPE: Floating point

INPUT DATA TYPE: Floating point or integer

RESTRICTIONS AND LIMITATIONS: 1) The input files must be the same size.
                                2) The number of rows (and columns) in the
                                input files must be a power of 2.
                                3) The input files must have at least 64 rows
                                and columns, but not more than 1024 rows and
                                columns.

NOTES: 1) The input file names must be specified in the order shown.

          2) If a real component file name is given, then the other file
             name must refer to an imaginary component file.

          3) If a magnitude component file name is given, then the other file
             name must refer to a phase component file.

NAME: INVERT(INV)

PURPOSE: The INVERT operator inverts (complements) the gray value of an image
file. The gray scale value of 0 is changed to 255, 1 is changed to
254, etc.

CARD FORMAT:

INV (Input File Name)

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

NAME: ISOGRAM(ISO)

PURPOSE: The ISOGRAM operator produces an image consisting of continous contour
          lines which separate the elements of the input picture into groups
          according to their gray scale value. The user may specify the number
          of contour lines used and the gray level intersections at which they
          occur.

CARD FORMAT:

```
  ISO (Input File Name) NL,NC,SL,SC,SM,NG,G1,G2,G3,G4,G5,G6,G7,G8,G9,G10
```

PARAMETER DEFINITIONS: NL   — Number of lines to be processed (may be null).

                         NC   — Number of columns to be processed (may be null).

                         SL   — Starting line.

                         SC   — Starting column.

                         SM   — Smoothing flag:

                                   SM = A — Smooth data.

                                   SM = B — Do not smooth data.

                         NG   — Number of contour levels.

                         G1,G10 — Levels at which the NG contours are to be
                                   drawn.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

RESTRICTIONS AND LIMITATIONS: All ten contour levels must be specified. If
                                less than ten are needed the remaining levels
                                are ignored and may be nulled out by repeated

commas. For example, if three contours are to
be drawn at gray scale values of 64, 128, and
192, the card format would be as follows:

ISO (1INP)512,512,1,1,A,3,64,128,192,,,,,,,,

NAME: LABEL(LAB)

PURPOSE: The LABEL operator inserts alphanumeric labels in a frame of data.

CARD FORMAT:

```
LAB (Input File Name) NLAB, LCOL
```

PARAMETER DEFINITIONS: NLAB - Number of labels.

                                     LCOL - Color of label:

                                                  A - white labels.

                                                  B - black labels.

DATA CARD FORMAT: The following two Data cards are required for each label:

CARD 1:

        COL. 6   COL. 12

```
      SL     SC
```

CARD 2:

```
80 columns of alphanumeric data
```
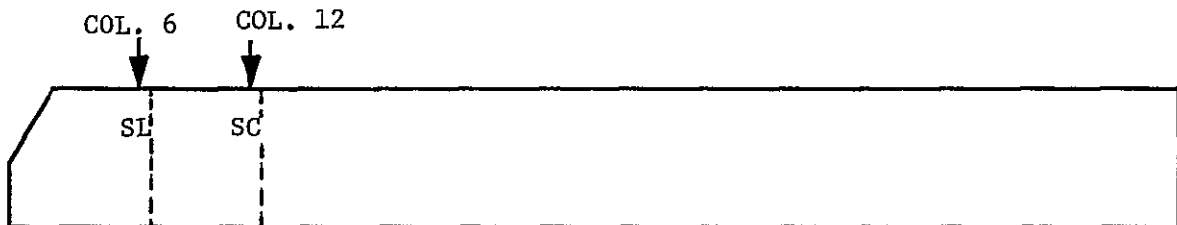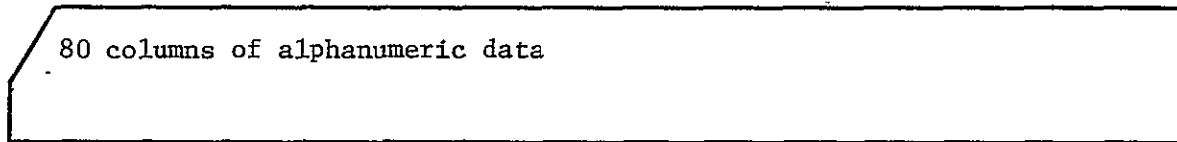
        SL - Starting line of the label.

        SC - Starting column of the label.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

NOTES: The starting column of the label line in the frame of data is
          determined by the number of columns left blank in front of the
          label data on Data card 2.

RESTRICTIONS AND LIMITATIONS: Each label is restricted to 80 characters;
                              however, a longer label may be written on one
                              line by specifying a maximum of three sets of
                              Data cards with the same starting line number.
                              The maximum number of characters that can be
                              written in one label is determined by the size
                              of the input file. Each alphanumeric character
                              requires 10 pixel horizontally (including 3
                              spaces), and 9 lines vertically. Printing a
                              full 80-character label thus requires an
                              input-file horizontal line of 800 pixels. If
                              the input file line is less than 800 pixels,
                              an 80-character label will be proportionately
                              truncated. A difference of at least 12 lines
                              should be specified between two vertically
                              spaced labels to provide spacing.

NAME: MATH(MAT)

PURPOSE: The MATH operator performs the following operations on files A and
           B: A+B, A-B, A*B, A/B, A+CN, A*CN, CN/A, A**CN where CN is a
           constant.

CARD FORMAT:

```
MAT (Input File A, Input File B) CN,KF
```

PARAMETER DEFINITIONS: CN — Constant.

                         KF — Operation flag:

           KF = A — A+B   KF = E — A+CN

           KF = B — A-B   KF = F — A*CN

           KF = C — A*B   KF = G — CN/A

           KF = D — A/B   KF = H — A**CN

OUTPUT DATA TYPE: Floating point

INPUT DATA TYPE: Floating point or integer

RESTRICTIONS: The mathematical operations are performed on corresponding
                picture elements of frames A and B. Care should be taken
                to properly register the frames if necessary.

NOTES: 1) If a pixel in File A is zero, CN/A = 0 for that element.
         2) If a pixel in File B is zero, A/B = A for that element.
         3) If KF = A, B, C, or D, CN must be specified but may be any
         integer value.
         4) If K = E, F, G, or H, it is not necessary to specify Input File
         B.

NAME: OUTPUT(OUT)

PURPOSE: The OUTPUT operator outputs image data to tape. The image file is
          recorded on magnetic tape in the same format as required for tape
          input images.

CARD FORMAT:

    OUT (Input File Name) NL,NC,SL,SC

PARAMETER DEFINITIONS: NL - Number of lines to processed (may be null).
                        NC - Number of columns to processed (may be null).
                        SL - Starting line.
                        SC - Starting column.

INPUT DATA TYPE: Integer

RESTRICTIONS AND LIMITATIONS: 1) Output data tape will be 9 track, non-
                               labeled, unblocked, 800 bpi density.
                               2) For each use of the OUTPUT operator a DD
                               card and Output Tape Label must be provided by
                               the user (See Section 3).

NAME: OVERLAY(OVE)

PURPOSE: The OVERLAY operator overlays lines (e.g., contours and grids) or
          portions of a supplemental image into a reference position in a
          primary image. In the inscribed-line application the operator
          obtains the line locations on a pixel-by-pixel basis from a supple-
          mental image. Several modes are provided to inscribe the lines in
          such ways as to ensure visibility of the inscribed features against
          a variety of backgrounds. In the image-overlay application the
          operator inserts sections of the supplemental image into the primary
          image. The image sections to be inserted are stored in the supple-
          mental image, and are inserted at locations in the primary image
          where the primary image pixel values are equal to a specified level.

CARD FORMAT:

```
OVE (1,2)SLI,SCI,NLI,NCI,SLM,SCM,NLM,NCM,RL,RC,SUBLEV,MODE,P1,P2
```

PARAMETER DEFINITIONS:

1	—	Primary File Name.
2	—	Supplemental File Name.
SLI	—	Starting line of primary image section.
SCI	—	Starting column of primary image section.
NLI	—	Number of lines in primary image section.
NCI	—	Number of columns in primary image section.
SLM	—	Starting line of supplemental image section.
SCM	—	Starting column of supplemental image section.
NLM	—	Number of lines in supplemental image section.
NCM	—	Number of columns in supplemental image section.
RL	—	Reference line in primary image section.
RC	—	Reference column in primary image section.
SUBLEV	—	Value of data points in the supplemental image (or in the primary image in the case of image section insertion

from the supplemental image) which are to trigger
substitution at the corresponding points in the primary
image. A single SUBLEV gray value between 0 and 255
must be specified.

MODE   — Key which indicates the mode of substitution.

MODE = A: The primary image is modified by adding the
           constant P1 to the primary image points
           which coincide with supplemental image
           points of value equal to SUBLEV. This mode
           might be used to draw lines which vary by a
           constant brightness from the background.

Mode = B: The primary image is modified by substitu-
           ting the constant P1 for the primary image
           points which coincide with supplemental
           image points of value equal to SUBLEV. This
           mode might be used to draw lines of constant
           intensity against a varying background.

MODE = C: The primary image is modified by alternately
           substituting one of the two constants P1 or
           P2 for the primary image points which coincide
           with supplemental image points of value
           equal to SUBLEV. If only one of the line or
           column coordinates of the point is odd, P1
           is substituted. Otherwise P2 is substituted.
           This mode produces lines of alternating
           intensity which maintain a constant appearance
           regardless of background.

MODE = D: The primary image is modified by substitu-
           ting point values from the supplemental
           image at every point where the primary image

is equal to the SUBLEV value. This mode
might be used to insert a feature on the
primary image against a background supplied
from the supplemental image.

MODE = E: The primary image is modified by substituting
P1 or P2 whenever the corresponding supple-
mental image points equal the SUBLEV value.
If the primary image point value is less
than 128, P1 is substituted; otherwise P2 is
used. This mode might be used to place
bright lines on a dark background and dark
lines on a bright background in a single
operation. It guarantees the visibility of
contours in all backgrounds, however the
contours may appear disjointed where the
primary image equals 128.

P1 & P2 —   These parameters have definitions which are different
for each mode.

MODE = A: P1 is the constant added to appropriate
image points.
P2 is ignored but must be set to some value.

MODE = B: P1 is the constant which is substituted for
appropriate image points.
P2 is ignored but must be set to some value.

MODE = C: P1 and P2 are constants which are alternately
substituted for appropriate image points.

MODE = D: P1 and P2 are ignored but must be set to
some values.

MODE = E: P1 is the constant substituted for appropriate
image points less than 128; P2 is substituted
otherwise.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

NAME: PICTURE DIFFERENCE(DIF)

PURPOSE: The PICTURE DIFFERENCE operator detects changes in registered

imagery. The registered images are adjusted for contrast. The

standard deviation of the gray values in the difference picture is

used as a threshold to detect changes and to account for non-

linearities in the contrast. The user may specify the standard

deviation coefficient which is used for the picture difference

threshold.

CARD FORMAT:

```
DIF (Input File 1, Input File 2) NL,NC,SL,SC,DSC
```

PARAMETER DEFINITIONS: NL — Number of lines to be processed (may be null).

NC — Number of columns to be processed (may be null).

SL — Starting line.

SC — Starting column.

DSC — Difference coefficient.

METHOD: The actual difference between input file 1 and input file 2 may be

determined by two secondary (SEC) output files. That is, the two

secondary output files indicate the features that are in input

file 1 that are not in input file 2, and vice versa, using the

picture difference threshold.

Pixel values in output file 1SEC are set to a gray value of 128 when,

d > D1 + DSC * SIGD where;

d   is an element in difference image,

D1   is the mean of the difference image,

DSC is the sigma coefficient, and

SIGD is the computed sigma of the difference image.

Thus output file 1SEC indicates features that are in input file 1 that are not in input file 2.

Pixel values in output file 2SEC are set to a gray value of 128 when,

d < D1 - DSC * SIGD

thus output file 2SEC indicates features that are in input file 2 that are not in input file 1.

INPUT DATA TYPE: Integer

RESTRICTIONS: 1) All input images must be the same size and registered. (The EXTRACT, REGISTER or ROTATE operators may be used to accomplish sizing and registration.)

NOTES: 1) The sigma coefficient typically ranges from 0.0 to 3.0.

2) The difference is calculated by subtracting File 2 values from corresponding File 1 values after contrast adjustment.

NAME: PRINT (PRI)

PURPOSE: The PRINT operator prints a specified portion of an image file on
           the IBM 360 line printer.

CARD FORMAT:

    PRI (Input File Name) NL,NC,SL,SC

PARAMETER DEFINITIONS: NL — Number of lines to be printed.
                         NC — Number of columns to be printed.
                         SL — Starting line.
                         SC — Starting column.

INPUT DATA TYPE: Integer or floating point

NOTES: 1) Integer data will be printed in array format, 32 columns per
          page.
          2) Floating point data will be printed in block format such that
          the specified number of columns will be printed as a block, 10
          columns per line.
          3) The user should avoid printing large portions of a file due to
          the large amount of output that may be generated.

NAME: PSF GENERATOR (PSF)

PURPOSE: The PSF GENERATOR operator allows the user to prepare a three-
           dimensional function which is an inverse of the Fourier transform
           of the point spread function of the S-056 system from input tables
           of data which represent the profile of the 3-D surface.

CARD FORMAT:

```
PSF NLO,ALIM,ISYM
```


PARAMETER DEFINITIONS: NLO - Size of PSF to be generated.
                         ALIM - Amplification limit (0.0 = No limit).
                         ISYM - Symmetry flag
                                 ISYM = A - Rotationally symmetric PSF.

DATA CARD FORMAT: The tabular values of the profile of the 3-D surface are
                    input immediately following the PSF GENERATOR operator
                    card in the format of the following example:

```
PSF = 1.,.2,.08,.03,.08,.01,.005,.002,.005,.001,246*0.$
```

NOTE: The data table must contain 256 floating point values. The first
        value will represent the intensity of the centermost point in the
        PSF. PSF data is usually normalized to make this value equal to
        unity. The second value in the data table corresponds to the
        relative intensity of the PSF at a radial distance of one pixel
        from the central point, and therefore is dependent on the sampling
        interval of the data. Succeeding values reflect the relative
        intensities of the PSF as samples at increasing distances from the
        central point.

METHOD: Using the input data table, a three-dimensional surface is produced
         which is a rotation of the PSF profile about the Z axis. The
         output of this process becomes an intermediate output file in
         IDAPS. Because the number of values in a PSF data table is limited
         to a maximum of 256, the maximum PSF array that can be produced by
         the operator is 512 x 512 values. For arrays smaller than this
         (N<512) only the first N/2+1 values in the data table are used and
         the remainder of the 256 are ignored. Output points which are at
         a radial distance from the center greater than N/2 pixels are
         automatically set to the same value as the N/2+1 value in the data
         table. Thus, for example, if a PSF is to be built that is 128 x 128
         array, only the first 65 terms will be used from the PSF data
         table and all others ignored.

         Once the PSF surface has been generated, it is transformed to the
         frequency domain as a complex array of magnitude and phase terms
         with the DC term at the center of the array $((2N+1),(2N+1))$. The
         transform output is normalized in such a way that the DC term will
         be unity.

         Each of the magnitude terms of the transformed PSF are examined
         for zero amplitude and if a term is not zero, its inverse value is
         calculated. The inverse of the term is then compared to the
         maximum Amplification Limit (if any). If the inverse of the term
         is greater than the limit, it is set equal to the limit. If not,
         it is left alone. If a frequency term is equal to zero, however,
         it is not inverted but is set either to the amplification limit
         (if one has been specified) or to an arbitrary limit of 10^{12}.
         The output of the PSF operator is two floating point files (magni-
         tude and phase, named nPSM and nPSP, respectively) and represents
         an inverse correcting filter for the given PSF.

OUTPUT DATA TYPE: Floating point

RESTRICTIONS AND LIMITATIONS: 1)   The size of the PSF generated must be a
                                     power of 2.
                                2)   The minimum size PSF is 64 and the maximum
                                     size PSF is 512.

NAME: REGISTER(REG)

PURPOSE: The REGISTER operator accomplishes registration of one image to
           another through application of a geometric transformation consisting
           of rotation, magnification and translation. The registration is
           specified by identification of the spatial coordinates of two
           points in the input image and the coordinates of corresponding
           points in the output to which the input pair are to be transformed.
           The amounts of rotation, magnification and translation required to
           achieve the specified transformation are computed automatically by
           the program.

CARD FORMAT:

```
REG (Input File Name)IN1L,IN1C,IN2L,IN2C,OUT1L,OUT1C,OUT2L,OUT2C
```

PARAMETER DEFINITIONS: IN1L   – Line coordinate of point 1 in input image.

                         IN1C   – Column coordinate of point 1 in input
                                   image.

                         IN2L   – Line coordinate of point 2 in input image.

                         IN2C   – Column coordinate of point 2 in input
                                   image.

                         OUT1L – Line coordinate of point 1 in output image
                                   to which point 1 in input is to be transformed.

                         OUT1C – Column coordinate of point 1 in output
                                   image to which point 1 in input is to be
                                   transformed.

                         OUT2L – Line coordinate of point 2 in output image
                                   to which point 2 in input is to be transformed.

                         OUT2C – Column coordinate of point 2 in output
                                   image to which point 2 in input is to be
                                   transformed.

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

NOTES: The geometric manipulations performed by the REGISTER operator are
           based solely on the point coordinate parameters supplied by the
           user. These may have been obtained by Interactive IDAPS operations
           or other techniques. No automatic cross correlations are performed
           by this operator.

NAME: ROTATE(ROT)

PURPOSE: The ROTATE operator rotates the image. The image is rotated a
           specified amount and enlarged by inserting zero values to produce
           an output file which contains the whole rotated image.

CARD FORMAT:

```
ROT (Input) THETA
```

PARAMETER DEFINITIONS: THETA   —   Angle of rotation in degrees counter-
                                     clockwise. $(-360 \leq THETA \leq 360)$

OUTPUT DATA TYPE: Integer

INPUT DATA TYPE: Integer

NAME: STONYHURST(STO)

PURPOSE: The STONYHURST operator creates a Stonyhurst grid of specified

size, grid, spacing, and orientation.

CARD FORMAT:

```
STO KSIZ,RLON,GSLON,RLAT,GSLAT,ROT,NL,NC
```

PARAMETER DEFINITIONS: KSIZ — Size of grid (i.e., diameter in pixels).

RLON — Longitude closest to observer (degrees).

GSLON — Longitude spacing of grid lines (degrees).

RLAT — Latitude closest to observer (degrees).

GSLAT — Latitude spacing of grid lines (degrees).

ROT — Rotation of N-S axis (+ is counter-clock-wise).

NL — Number of lines in output image.

NC — Number of columns in output image.

OUTPUT DATA TYPE: Integer

RESTRICTIONS AND LIMITATIONS: 1) Maximum size of Stonyhurst grid is $(1024)^2$.

2) Maximum value for RLAT is such that $|RLAT| \leq 7$.

NOTES: 1) The output file consists of a Stonyhurst grid for the full solar
disk, the diameter of which is KSIZ. (See CENTER/DIAMETER operator
in Interactive IDAPS.)

2) The output file is a background of 0's with grid lines of 255.

3) RLON and RLAT are determined from solar ephemeris tables based
on date and time of image exposure.

4) The Stonyhurst grid will be centered in the output image.

NAME: TRANSPOSE(TRA)

PURPOSE: The TRANPOSE operator is used to rotate a picture about its major
axis, minor axis, vertical axis, horizontal axis, +90 degrees, -90
degrees, or 180 degrees (plus angles are <u>clockwise</u> rotation).

CARD FORMAT:

> TRA (Input File Name) NL,NC,SL,SC,REV

PARAMETER DEFINITIONS: NL   -   Number of lines to be processed.

                                      NC   -   Number of columns to be processed.

                                        SL   -   Starting line.

                                        SC   -   Starting column.

                                    REV   -   Flag to indicate type of rotation:

                                              REV = A   -   Rotate about major axis.

                                              REV = B   -   Rotate +90 degrees.

                                              REV = C   -   Rotate -90 degrees.

                                              REV = D   -   Rotate about minor axis.

                                              REV = E   -   Rotate about vertical axis.

                                              REV = F   -   Rotate about horizontal axis.

                                              REV = G   -   Rotate 180 degrees.

OUTPUT DATA TYPE: Integer or floating point (depending on input data type).

INPUT DATA TYPE: Integer or floating point.

NOTES: The results of transposing the letter <u>J</u> illustrates the various
options:

A = ⌐⊃ (major axis)   E = ∪ (vertical axis)

B = ⊂⌐ (+ 90 degrees)   F = ⌐| (horizontal axis)

C = ⌐⊃ (– 90 degrees)   G = ∩ (180 degrees)

D = ⊂⌐ (minor axis)

APPENDIX A - BATCH IDAPS OPERATOR INDEX

The currently available IDAPS Operators are listed below in alphabetical
order with the three-letter identification code in parentheses. A brief
statement of purpose is included for each operator.

ALTER(ALT)

>   The ALTER operator modifies the gray scale value of each element in a
>   picture in accordance with a table of values supplied by the user. The
>   original gray values in the input array are used as an index and the
>   appropriate values in the table are substituted by the ALTER operator
>   for the original values and appear in the output array.

AUTOMATIC SCALE(AUT)

>   The AUTOMATIC SCALE operator scales an image file to values between 0
>   and 255 based on a selected scaling curve. The user may specify upper
>   and lower limits of the gray scale range on which the scaling will take
>   place. The output of AUTO SCALE is an array of values between 0 and
>   255.

AVERAGE(AVE)

>   The AVERAGE operator creates an image which is the average of a number
>   of input images. This operator is useful for smoothing images which
>   have a high degree of noise.

CONVOLUTIONAL FILTER(CON)

>   The CONVOLUTIONAL FILTER operator numerically convolves an image array
>   with a filter array. An option is provided for limiting the application
>   of the filter to only those regions designated by a filter map. The
>   filter array may be obtained from user supplied cards, system files, or
>   generated internally.

DELETE(DEL)

>   The DELETE operator, on user request, deletes files maintained by the
>   File Manager in the File Directory and thereby frees disk space for reuse
>   by subsequent operators.

DEPENDENT ALTER(DEP)

    The DEPENDENT ALTER operator modifies the gray scale values of each
pixel in an input image in accordance with its relative position in the
field of view of the telescope and as a function of a polynominal
(A+Bx) for which the user supplies the coefficients.

EXTRACT SUBFRAME(EXT)

    The EXTRACT SUBFRAME operator extracts a specified rectangular portion
of an image from an input file.

FAST FOURIER TRANSFORM(FFT)

    The FAST FOURIER TRANSFORM operator performs a two-dimensional Fourier
transformation on the input array (file) and produces two output arrays
(files) which contain the complex components in the frequency domain.
The output arrays (files) may be in the form of real and imaginary
components or in the form of magnitude and phase components.

FILTER GENERATOR(FGN)

    The FILTER GENERATOR operator generates filter files to be used with
the convolutional filter operator in the spatial domain or the Fourier
filter in the frequency domain. A symmetrical filter is generated from
internally generated or user input (via data tables) x-z plane normalized
frequency domain profile. A non-symmetrical filter is generated from
x-z plane and y-z plane normalized frequency domain profiles by using
an elliptical fit algorithm to produce the filter surface.

FOURIER FILTER(FOU)

    The FOURIER FILTER operator multiplies a two-dimensional frequency
domain filter by the magnitude component of a Fourier transformed input
image and inverse transforms the resulting file with the corresponding
phase component file to give a filtered image file.

FRAME(FRA)

    The FRAME operator adds a gray scale step wedge to the right of the
picture, a gray scale histogram below the picture, and tick marks
around the picture border. Options are provided for a 32 X 32 pixel
grid overlay of the picture, up to five lines of alphanumeric labels
above and/or below the picture, and a user-specified rectangle super-
imposed on the picture. The FRAME background may be either black with

white annotation or vice versa. The picture gray values may be re-
versed, if desired, to produce a negative or positive picture.

H-D CORRECTION(HDC)

The H-D CORRECTION operator applies a film correction curve to the
input data or converts gray values to density or energy values depending
on the input table used.

INPUT(INP)

The INPUT operator inputs image data from tape. The input image tape
is read and converted from tape format into a format suitable for
storage as an IDAPS file, a file name is assigned and the image is made
available for processing by other IDAPS operators.

INSERT SUBFRAME(INS)

The INSERT SUBFRAME operator inserts a portion of one image (the overlay)
into another image (the underlay). Facility is provided to place the
resultant image into a background of constant specified intensity.

INVERSE FAST FOURIER TRANSFORM (IFF)

The INVERSE FAST FOURIER TRANSFORM operator transforms two input arrays
(files) containing the complex components in the frequency domain into
an output array (file) in the spatial domain. The input arrays (files)
may be in the form of real and imaginary components or in the form of
magnitude and phase components.

INVERT(INV)

The INVERT operator inverts (complements) the gray value of an image
file. The gray scale value of 0 is changed to 255, 1 is changed to
254, etc.

ISOGRAM(ISO)

The ISOGRAM operator produces an image consisting of continuous contour
lines which separate the elements of the input picture into groups
according to their gray scale value. The user may specify the number
of contour lines used and the gray level intersections at which they
occur.

LABEL(LAB)

The LABEL operator inserts alphanumeric labels in a frame of data.

MAGNIFY(MAG)

The MAGNIFY operator performs a geometric transformation which expands
or reduces the size of an image. Four way linear interpolation is used
to provide values from the input array which are not at the exact
location of an input pixel.

MATH(MAT)

The MATH operator performs the following operations on files A and B:
A+B, A-B, A*B, A/B, A+CN, A*CN, CN/A, A**CN where CN is a constant.

OUTPUT(OUT)

The OUTPUT operator outputs image data to tape. The image file is
recorded on magnetic tape in the same format as required for tape input
images.

OVERLAY(OVE)

The OVERLAY operator overlays lines (e.g., contours and grids) or
portions of a supplemental image on a primary image. In the inscribed-
line application, the operator obtains the line locations on a pixel-
by-pixel basis from a supplemental image. Several modes are provided
to inscribe the lines in such ways as to ensure visibility of the
inscribed features against a variety of backgrounds. In the image-
overlay application, the operator inserts sections of the supplemental
image into the primary image. The image sections to be inserted are
stored in the supplemental image and are inserted at locations in the
primary image where the primary image pixel values are equal to a
specified level.

PICTURE DIFFERENCE(DIF)

The PICTURE DIFFERENCE operator detects changes in registered imagery.
The registered images are adjusted for contrast. The standard devi-
ation of the gray values in the difference picture is used as a thres-
hold to detect changes and to account for non-linearities in the contrast.
The user may specify the standard deviation coefficient which is used
for the picture difference threshold.

PRINT(PRI)

> The PRINT operator prints a specified portion of an image file on the
> IBM 360 line printer.

REGISTER(REG)

> The REGISTER operator accomplishes registration of one image to another
> through application of a geometric transformation consisting of rotation,
> magnification and translation. The registration is specified by identi-
> fication of the spatial coordinates of two points in the input image
> and the coordinates of corresponding points in the output to which the
> input pair are to be transformed. The amounts of rotation, magnifica-
> tion and translation required to achieve the specified transformation
> are computed automatically by the program.

ROTATE(ROT)

> The ROTATE operator rotates an image file. The image is rotated a
> specified amount and enlarged by inserting zero values to produce an
> output file which contains the whole rotated image.

STONYHURST(STO)

> The STONYHURST operator creates a Stonyhurst grid of specified size,
> grid, spacing, and orientation.

TRANSPOSE(TRA)

> The TRANSPOSE operator is used to rotate a image about its major axis,
> minor axis, vertical axis, horizontal axis, +90 degrees, -90 degrees,
> or 180 degrees (plus angles are <u>clockwise</u> rotation).

APPENDIX B - BATCH IDAPS OPERATOR CPU TIME REQUIREMENTS

The estimated number of minutes of CPU time that each operator requires is
provided in the figure below. The sum of the estimated run times for those
operators to be executed should be entered on the JOB card and the EXEC card
in the Batch IDAPS run deck as the CPU Time Limit, unless experience or
specific information indicates otherwise. As indicated, the estimated CPU
run time is dependent on the size of the image array. For operators with
one or more options, the times given are for the worst case.

BATCH IDAPS OPERATOR CPU TIME REQUIREMENTS

OPERATOR CODE	CPU Run Time in Minutes		
	$(256)^2$	$(512)^2$	$(1024)^2$
ALTER(ALT)	.24	.46	1.20
AUTOMATIC SCALE(AUT)	.46	1.45	6.36
AVERAGE(AVE)	.36	1.12	4.47
CONVOLUTIONAL FILTER(CON)	4.75	18.93	—
DELETE(DEL)	.02	.02	.02
DEPENDENT ALTER(DEP)	.31	.97	3.45
EXTRACT SUBFRAME(EXT)	.22	.48	1.58
FAST FOURIER TRANSFORM(FFT)	.91	3.53	—

BATCH IDAPS OPERATOR CPU TIME REQUIREMENTS (Continued)

OPERATOR CODE	CPU Run Time in Minutes		
	$(256)^2$	$(512)^2$	$(1024)^2$
FILTER GENERATOR(FGN)			
SYMMETRIC	.12	.42	1.71
NON-SYMMETRIC	1.27	4.76	18.31
FOURIER FILTER(FOU)	2.13	7.51	--
FRAME(FRA)	.94	1.25	2.73
H-D CORRECTION(HDC)	.45	.64	1.23
INPUT(INP)	.10	.22	.55
INSERT SUBFRAME(INS)	.35	.94	3.86
INVERSE FAST FOURIER TRANSFORM(IFF)	.98	3.69	--
INVERT(INV)	.13	.38	1.25
ISOGRAM(ISO)	.39	1.49	5.79
LABEL(LAB)	.60	.87	1.61
MAGNIFY(MAG)	.70	4.92	--

BATCH IDAPS OPERATOR CPU TIME REQUIREMENTS (Continued)

OPERATOR CODE	CPU Run Time in Minutes		
	$(256)^2$	$(512)^2$	$(1024)^2$
OUTPUT(OUT)	.10	.21	.55
OVERLAY(OVE)	.53	1.20	4.45
PICTURE DIFFERENCE(DIF)	1.09	3.56	11.61
PRINT(PRI)	(.05 Minutes Per Page)		
REGISTER(REG)	1.06	5.81	--
ROTATE(ROT)	.90	5.47	--
STONYHURST(STO)	.27	.83	3.00
TRANSPOSE(TRA)	.23	.95	6.56

IMAGE DATA PROCESSING SYSTEM
(IDAPS)

USER MANUAL

S-056 EXPERIMENT

INTERACTIVE IDAPS
VOLUME III

CONTRACT NO. NAS8-30740

31 MARCH 1975

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VOLUME III

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1.0 INTRODUCTION

The Interactive IDAPS User Manual provides instructions for setting up and
controlling the interactive run, summarizes the capabilities of the interac-
tive system, and describes the characteristics of the equipment available to
the interactive user. The Interactive Manual, Volume III, is a companion
document to Volume II, the Batch Manual. Volume I describes the general
features and capabilities of the IDAPS concept, hardware, and software.

Interactive IDAPS is designed to provide on-line, interactive control of
image processing operations. User control procedures and tutorial aids are
built into the system to assist the user in setting up and executing his
image processing jobs. The potential user, however, must be familiar with
hardware and software facilities provided by Interactive IDAPS and must
understand the control and use procedures. Prior to using Interactive IDAPS
it is recommended that the beginning user complete the four steps of the
Training Plan outlined in Volume I, Section 2, as follows:

IDAPS Orientation   _____

Step 1 - Read Volume I

Step 2 - Attend an IDAPS Orientation Demonstration (approximately 30 minutes)

Step 3 - Read Volume III

Step 4 - Attend an Interactive IDAPS Training Session (approximately two
hours)

Interactive IDAPS should be used to set up and optimize image processing
runs, to prepare longer jobs to be run under Batch IDAPS, and to review the
results obtained from previous runs. Large, time-consuming jobs should not
be run with Interactive IDAPS because such use ties up the resources of the
interactive system at the expense of other users. Specifically, the following
general procedure should be followed:

1. Study the image processing job. Identify those tasks which may be
    run in Batch IDAPS, those tasks which may be run in Batch IDAPS
    but which must be set up through Interactive IDAPS, and those
    tasks which must be done in Interactive IDAPS.

2. Prepare a work plan for Interactive IDAPS processing. Identify
    the techniques required, the data to be processed interactively,
    and the preparations which must be made through the use of Interac-
    tive IDAPS for processing larger runs in Batch IDAPS.

3. Schedule time on the Interactive IDAPS. Time is scheduled through
    the MSFC Data Systems Lab.

4. Make the interactive run. Interactive IDAPS has capabilities that
    are not available in Batch IDAPS. Plan to take full advantage of
    these capabilities during the interactive run.

5. Use the results of Interactive IDAPS runs as a guide to-processing
    larger amounts of data in Batch IDAPS. By exploring procedures on
    a sample of data in Interactive IDAPS, an optimum series of operations
    may be derived for batch processing. This approach not only
    reduces the requirements for use of the IDAPS facility but also
    reduces the computer time required for processing large jobs. The
    user's own operating time is also reduced.

This manual has three major sections:

●   A Glossary to acquaint the user with Interactive IDAPS nomenclature.

●   A Control and Use section to describe the user procedures for
    normal interactive operation of the system.

●   An Equipment Description section to describe the Interactive IDAPS
      hardware, including set-up and operation, principles of operation,
      and capability specification.

Host computer Error Messages are defined in Appendix A and a detailed explana-
tion of how to use each interactive operator is presented in Appendix B.
Cross-reference indices of the operators by Operator (listed alphabetically)
and by Submenu Category are provided in the first section of Appendix B.

2.0 <u>GLOSSARY</u>

Array — A rectangular array of picture elements; an image file.

Batch IDAPS — The high-capacity data processing mode of IDAPS requiring minimum user interaction.

Clipping — Defines the upper and lower limits of gray values on which a process is to be performed. All signals outside the clipping limits are set equal to either the maximum or minimum gray value (0 or 255).

Column — A one-dimensional vertical array of picture elements. The first column of a picture is designated as column 1.

Data Card — Provides data for the operator in addition to the parameters.

Density (D) — Log to base 10 of the inverse of the transmittance.

EOF Code — End of File code is an electronic mark on magnetic tape which is used to signal the end of a data file.

File Identification — A parameter which tells the computer operator which tape to mount. (Same as Tape Identification)

File Name   — A unique identification label automat-
                             ically assigned to each image file used
                             or produced by the IDAPS system.

File Number   — The Tape File Number.

Flags   — Alphabetic characters used to signify
                             options in an IDAPS operator.

Floating Point   — Numeric values containing a decimal
                             point.

Frame   — An image or data file.

Gray Scale   — A value (0-255) assigned to a picture
                             element to indicate its degree of gray-
                             ness.

IDAPS   — Image Data Processing System.

Image   — Same as image data array.

Image Data Array   — A rectangular array of picture elements;
                             an image file.

Image File   — A two-dimensional array of numbers filed
                             on disk or tape representing the gray
                             levels of pixels in a digitized picture.

Image Generation Time   — The time required to record an image; a
                             function of the number of points in the
                             array, exposure levels, resolution mode,
                             and the number of overlays.

.

Image Number   —   The sequential index to the image files
                                    to be input by the INP Operator or
                                    output by the OUT Operator.

Input Tape   —   The image data tape which is the source
                                    of data for the Batch IDAPS run.

Interactive IDAPS   —   The operating mode of IDAPS which provides
                                    interactive user control of image proces-
                                    sing.

Intersample Spacing   —   Horizontal or vertical distance between
                                    pixels.

Line   —   A one-dimensional horizontal array of
                                    picture elements. The first line of a
                                    picture is designated as line 1.

Line and Column Coordinates   —   A pair of integer numbers used to describe
                                    the location of a single picture element
                                    within a frame of data; the row and
                                    column numbers of a picture element.

Operator   —   A single image processing technique or
                                    control process. It may be a subroutine
                                    or a collection of subroutines, called
                                    by an identifying name, which carries
                                    out a specific task.

Operator Code   —   The unique three letter code for each
                                    IDAPS operator.

Orthogonality (0)   —   A measure of image geometric accuracy, a
                                      percentage of the matrix diagonals M_1
                                      and M_2 where

$$0 = \pm \left[\frac{M_1 - M_2}{M_1 + M_2} \right] \times 100$$

Output Tape   —   The tape on which the image output of
                                      the Batch IDAPS run is written for
                                      permanent record.

Parameters   —   Variables which define and control a
                                      process.

Picture Element   —   The smallest unit of a digitized picture
                                      representing the average gray level (0-
                                      255) of a single area sample of an
                                      image.

Pixel   —   Picture element.

RET Code   —   Retention code, used on output tape
                                      labels.

Row   —   A line.

Scan Line Straightness   —   Ratio of deviation of a scan line from
                                      the best fit straight line to the length
                                      of the scan line.

Scanner   —   Refers to the on-line Dicomed Film
                                      Digitizer or similar off-line film
                                      digitizing device.

Scanning Aperture   —   The effective circular diameter of the
                                  scanning spot.

Size   —   The vertical and horizontal dimensions
                                  of an array expressed in terms of picture
                                  elements. A 320 X 480 image has 320
                                  pixels in the vertical line and 480
                                  pixels in the horizontal line. Size
                                  should not be confused with the physical
                                  dimensions of an image on film.

Table   —   A one-dimensional array of real or
                                  integer data used as input to the IDAPS
                                  system for use by an operator. Tables
                                  are input to the computer by data cards.

Tape Identification   —   A parameter which tells the computer
                                  operator which tape to mount. (Same as
                                  File Identification)

Trackball   —   A device for entering or retrieving
                                  pixel position data on a display by hand
                                  positioning a floating ball.

Transmittance   —   Ratio of light transmitted through a
                                  medium to the light incident to the
                                  medium.

3.0 INTERACTIVE CONTROL AND USE

This section describes the operations involved in setting up and using Interactive IDAPS. The procedures are described in the proper order for normal operation, and illustrations are provided as required. Typical Interactive IDAPS runs consist of the following basic steps:

- Run Preparation – to prepare the data and appropriate equipment for interactive operations.

- Log In – to initialize the Interactive IDAPS system and identify the user.

- Operator Selection – to select desired Interactive IDAPS operators.

- Parameter Specification – to specify the necessary parameters and controls for the selected operators.

- Special Functions – to apply special Interactive IDAPS user aids for setting up and/or analyzing image processing runs.

- Operator Execution – to carry out the specified operations.

- Log Out – to clear system records and obtain user run data.

3.1 RUN PREPARATION

The Interactive IDAPS facility is maintained by the Marshall Space Flight Center as a service to the researcher who wishes to process image data from the S-056 experiment. The following devices are normally maintained in a "powered up" condition to be available for the Interactive IDAPS user:

- Interactive IDAPS Minicomputer
- Minicomputer Disk Storage
- Digital Television Disk, Power Supplies, and Display Generator
- User Keyboard
- Trackball

Should any of these devices fail to be in an operating condition, the user should request help from one of the operations personnel.

A number of Interactive IDAPS devices may or may not be ready for immediate use. Depending on the operations which the user intends to carry out, the following devices should be turned on and made ready by the user (see Section 4.0):

- Digital Television Displays
- Film Scanner
- Image Recorder
- Video Facsimile Copier
- Card Reader
- Printer
- Magnetic Tape Units

The video facsimile copier and film scanner require about twenty minutes "warm up" for proper operation.

The user should prepare his image data for input into IDAPS. If he plans to use the on-line film scanner, he should place his film in one of the available film holding fixtures. Careful attention should be paid to cleanliness in handling and loading film in the recorder. If the image data has been prescanned, the scan tape should be mounted on an available drive and made ready for use (see Section 4.0). If the user intends to write data onto tape during his operations, a blank tape may be mounted and made ready at this time.

The Interactive IDAPS host computer is operated on a predetermined shift
basis by MSFC operations personnel. Due to the shift allocation and because
of "down" time resulting from system modification, hardware malfunction, or
preventive maintenance, the host computer is not always available for the
Interactive IDAPS user. The host computer status is constantly monitored by
the minicomputer and displayed on the Interactive IDAPS Master Monitor in
the upper left corner of the screen. The following status messages are
provided:

- 360 STATUS READY - means that the host computer is properly
  functioning, is "on-line" to the minicomputer and is available for
  Interactive IDAPS operations.

- 360 STATUS BUSY - means that the host computer is temporarily
  occupied in processing an Interactive IDAPS run. This may or may
  not inhibit local operation of the Interactive IDAPS user terminal,
  depending on whether or not terminal equipment is involved in the
  host computer operations.

- 360 STATUS DOWN - means that, for any of a number of reasons, the
  host computer is not available for Interactive IDAPS operations.

3.2 LOG IN

Figure 3-1 is the Interactive IDAPS LOG IN display. It should be the first
display presented to the user at the beginning of his run. Failure by a
previous user to properly LOG OUT the system will leave Interactive IDAPS in
an improper initial condition. Before the user can proceed, he must LOG OUT
any previous, unterminated run using the procedures in Section 3.7. The
purpose of LOG IN is to provide initial instructions to the user, to provide
a mechanism for identifying the user to the system, and to give the user the
opportunity to reinitialize the system to its default status. If the reini-
tialize option is chosen, the system resets the default parameters and

restores all data tables to the system default values. Also, the 360 file

directory is purged and all associated parameters are set to initial values.

The user identification which is entered is carried through the run to

provide proper identification of output data at the end of the run.
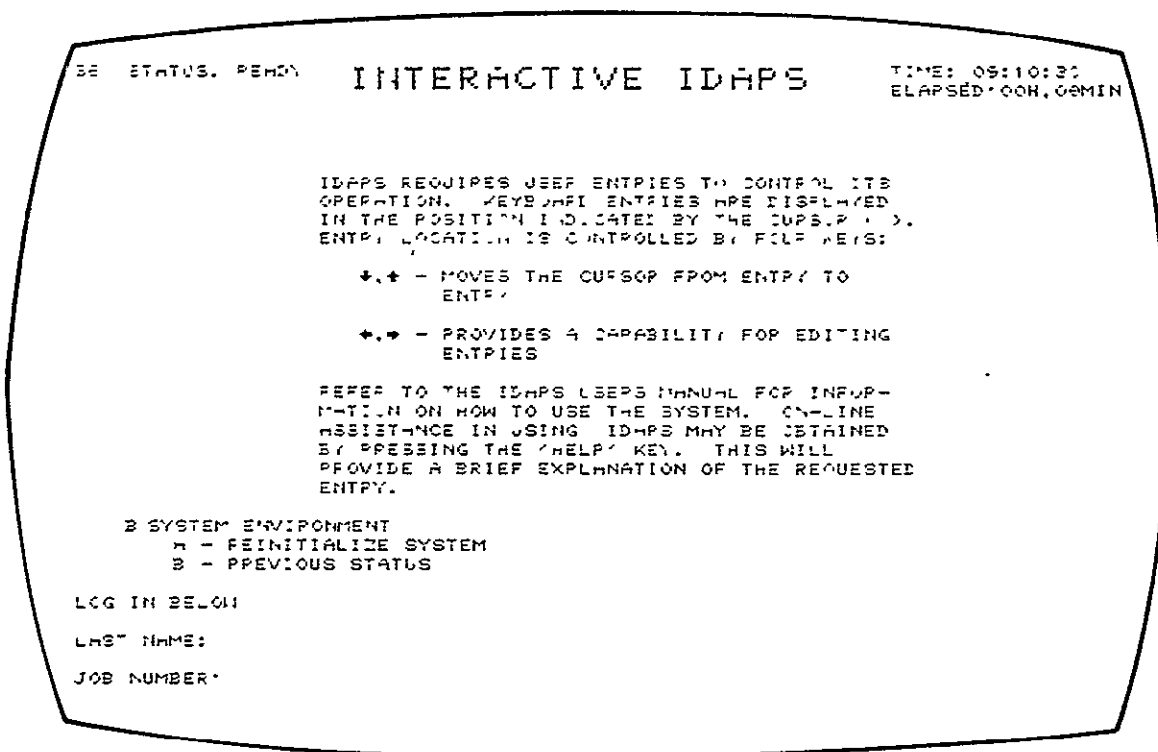
3.3 OPERATOR SELECTION

Figure 3-2 is the Interactive IDAPS Master Menu, which is provided immediately

following the LOG IN display. The Master Menu is a list of the major cate-

gories of image processing operations available to the interactive user.

The Master Menu is the logical starting point for all Interactive IDAPS

operations. It is displayed at the completion of each Interactive IDAPS

operation, or whenever the RETURN TO MASTER key is pressed. The user

selects the category of image processing operations that he wishes to use by

pressing the appropriate key on the keyboard. Changes may be made by pressing
a different key. Once a selection is made the user proceeds by pressing the
EXEC key. For experienced users of the system who know the three letter
mnemonics associated with each parameter specification display, the capability
is provided to input the three letters and skip the submenu display.

Figures 3-3 through 3-13 are the Submenu displays provided by Interactive
IDAPS which can be selected by the user from the Master Menu. Each Submenu
lists the available Interactive IDAPS operators which are appropriate to the
category selected. If the user is not certain in which category a particular
operator may be found, he may select a likely category as a trial--using the
RETURN TO MASTER MENU key as often as necessary--or he may consult the

INTERACTIVE IDAPS   TIME: 16:33:15
                                                     ELAPSED:96H,36MIN

IMAGE INPUT/OUTPUT

OUTPUT TO:

	DISPLAY	TAPE	FILM	PRINTER	SYSTEM
SCANNER	A (S-D)	B (S-T)	C (S-F)	D (S-P)	E (SCA)
TAPE	F (T-D)	G (T-T)	H (T-F)	I (T-P)	J (INP)
SYSTEM	K (DIS)	L (OUT)	M (FIL)	N (PRI)	

INPUT

FROM:

OPTION =

Figure 3-3.   Image Input/Output Submenu

IEG STATUS. READY   INTERACTIVE IDAPS   TIME: 09:53:55
FILE NAME: IMAN   ELAPSED:00H,40MIN

FUNCTION GENERATION

IMAGE PROCESSING OPERATOR

    A - HAND DRAWN SHAPES (HAN)

    B - FILTER GENERATION (FGN)

    C - TABLE MODIFICATION (DTE)

OPTION =

Figure 3-4.   Function Generation Submenu

```
DE STATUS  READ        INTERACTIVE  IDAPS        TIME  03:51.2
FILE NAME  IMA                                   ELAPSED: 00H.41MIN

GRAY SCALE ADJUSTMENT

IMAGE PROCESSING OPERATOR

    A - ALTER (ALT)                   ,

    B - DEPENDENT ALTER (DEP)

    C - AUTOMATIC SCALE (AUT)

    D - INVERT GRAY SCALE (INV)

    E - MATH (MAT)

    F - HAND DRAWN SHAPES (HAN)

    G - H-D CORRECTION (HDC)

OPTION =
```
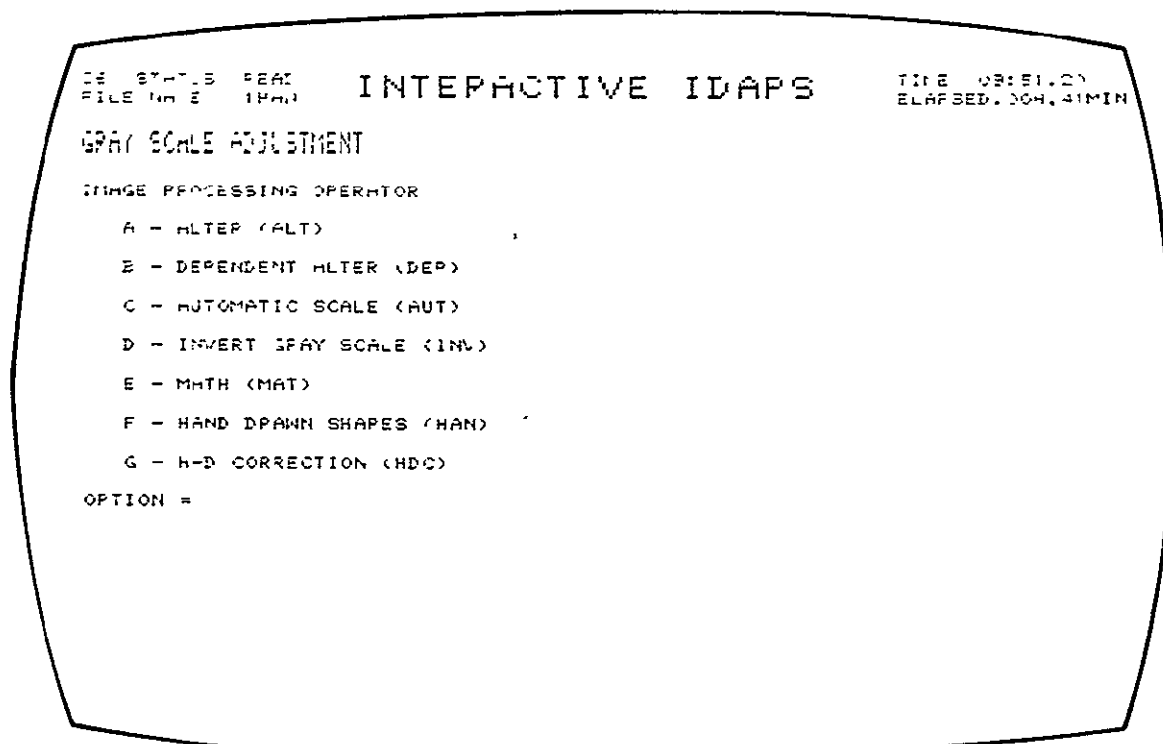
Figure 3-5.   Gray Scale Adjustment Submenu

```
BOI STATUS. READ       INTERACTIVE  IDAPS        TIME  09:46:1
FILE NAME.  HAN                                  ELAPSED: 00H.36MIN

MANUAL IMAGE MODIFICATION

IMAGE PROCESSING OPERATOR

    A - EXTRACT SUBFRAME (EXT)

    B - INSERT SUBFRAME (INS)

    C - TEST IMAGE GENERATION (IMA)

OPTION =
```
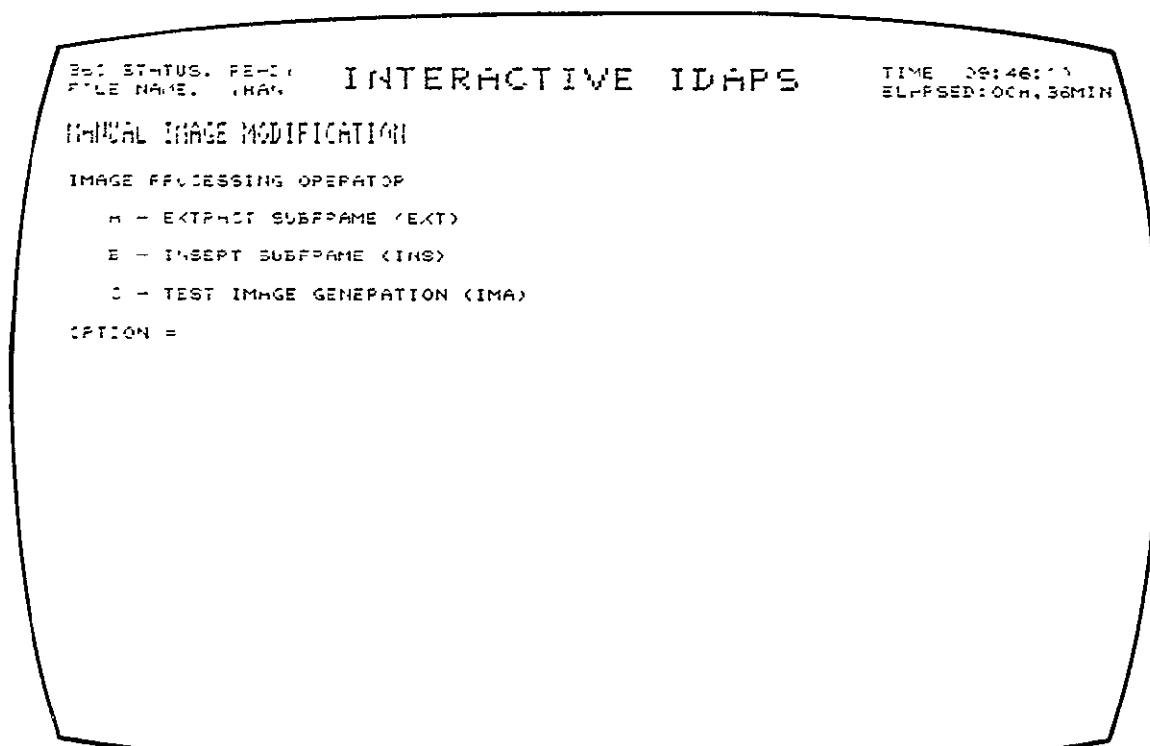
Figure 3-6.   Manual Image Modification Submenu

360 STATUS: READY   INTERACTIVE IDAPS   TIME: 09:20:45
FILE NAME: 1HHN   ELAPSED:00H.10MIN

FILTER OPERATIONS

IMAGE PROCESSING OPERATOR

    A - CONVOLUTIONAL FILTER <CON>

    B - FOURIER FILTER <FOU>

    C - FFT <FFT>

    D - IFFT <IFF>

    E - FILTER GENERATION <FGN>

OPTION =

Figure 3-7.   Filter Operators Submenu

360 STATUS: FEMI   INTERACTIVE IDAPS   TIME: 10:30:30
FILE NAME: 1ALT   ELAPSED:00H,05MIN

GEOMETRIC OPERATIONS

IMAGE PROCESSING OPERATOR

    A - ROTATE <ROT>

    B - TRANSPOSE <TRA>

    C - REGISTER <REG>

    D - EXTRACT SUBFRAME <EXT>

    E - INSERT SUBFRAME <INS>

    F - MAGNIFY <MAG>

OPTION =

Figure 3-8.   Geometric Operations Submenu

```
360 STATUS: DOWN        INTERACTIVE  IDAPS          TIME: 11:37:10
                                                    ELAPSED:00H,17MIN

CLASSIFICATION/PATTERN RECOGNITION

IMAGE PROCESSING OPERATOR

    A - CORRELATE FFT

    B - SIMILARITY

    C - SUBSET

    D - INSIDE

OPTION =
```
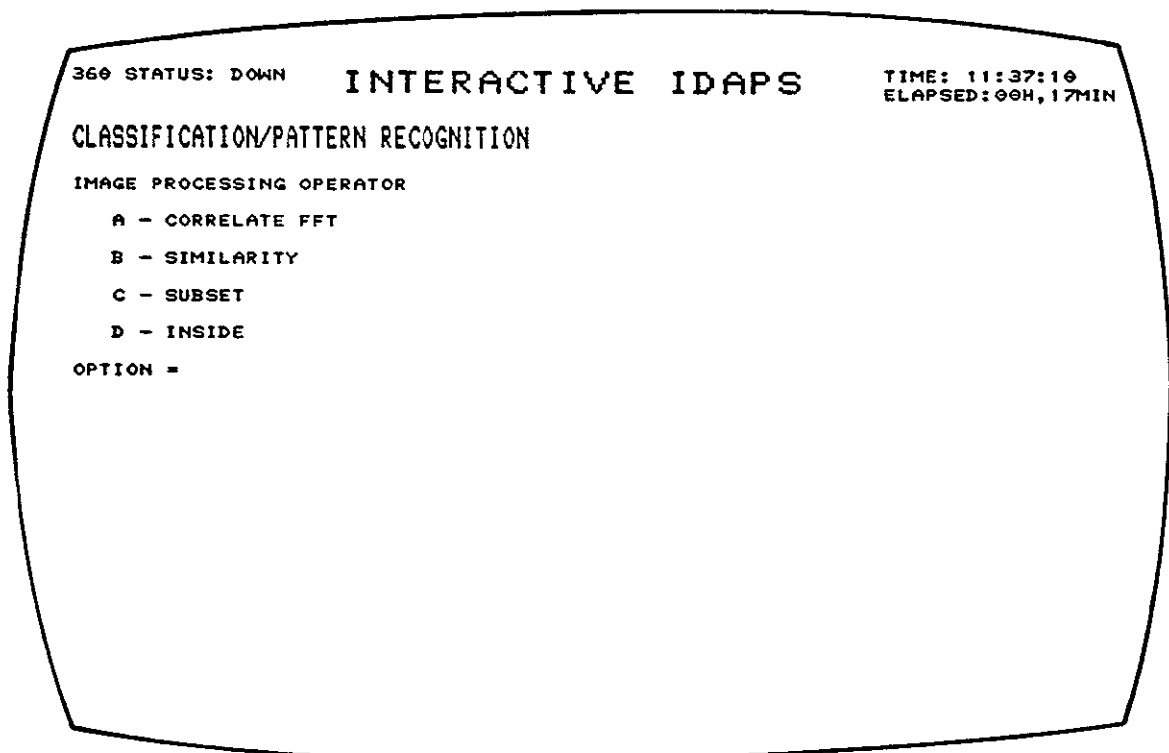
Figure 3-9.　　Classification/Pattern Recognition Submenu

```
                        INTERACTIVE  IDAPS          TIME: 16:29:40
                                                    ELAPSED:06H,32MIN

MATH/LOGIC

IMAGE PROCESSING OPERATOR

    A - AVERAGE

    B - FFT

    C - IFFT

    D - MATH

    E - DERIVATIVE

OPTION =
```
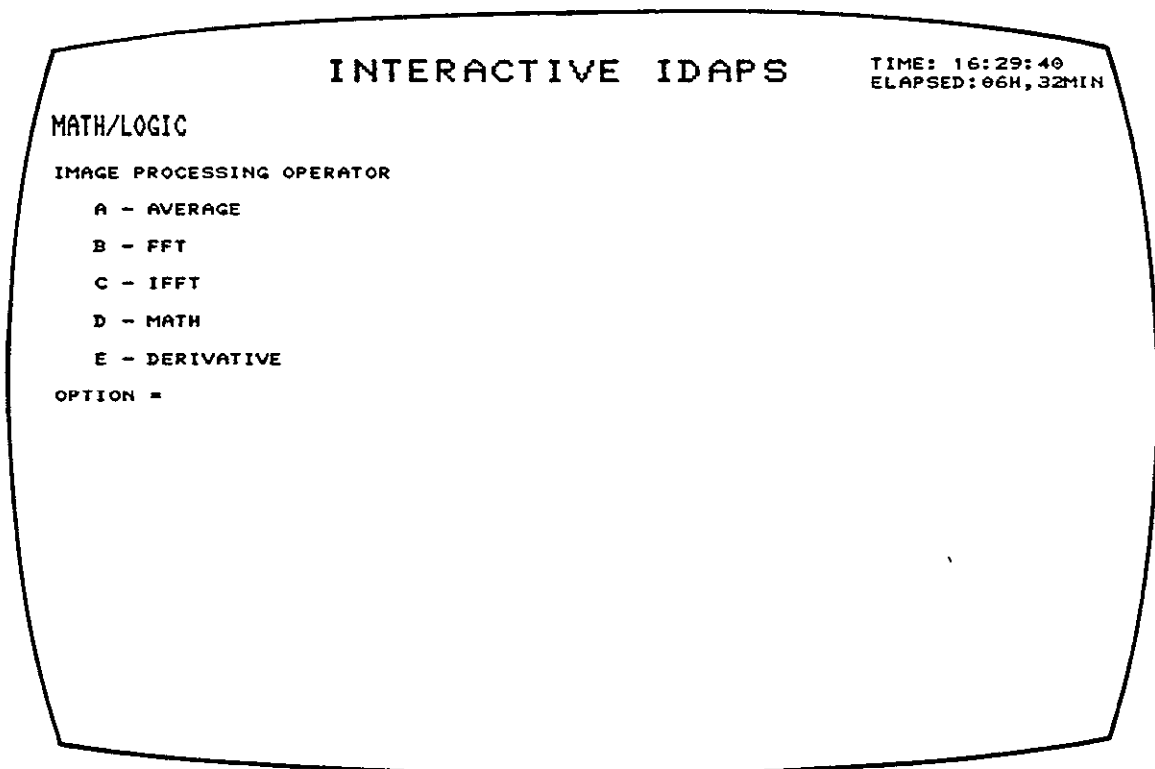
Figure 3-10.　　Math Logic Submenu

INTERACTIVE IDAPS

TIME: 16:30:35
ELAPSED:06H,33MIN

IMAGE ANALYSIS

IMAGE PROCESSING OPERATOR

A — AREA (ARE)

B — DISTANCE (DIS)

C — SPECTRUM (SPE)

D — CENTER/DIAMETER (CED)

E — HISTOGRAM (HIS)

F — ISOGRAM (ISO)

G — MOMENT (MOM)

H — OVERLAY (OVE)

I — DIFFERENCE (DIF)

OPTION =

Figure 3-11.   Image Analysis Submenu

INTERACTIVE IDAPS

TIME: 16:31:15
ELAPSED:06H,34MIN

PSEUDOCOLOR

OUTPUT TO:

INPUT
FROM:

	DISPLAY	FILM
SCANNER	A	B
TAPE	C	D
SYSTEM	E	F

OPTION =

Figure 3-12.   Pseudocolor Submenu

```
          INTERACTIVE  IDAPS      TIME: 16:32:00
                                  ELAPSED:06H,35MIN
IMAGE DATA PRESENTATION

IMAGE PROCESSING OPERATOR

    A - FRAME

    B - LABEL

    C - MULTIPLE DISPLAY

    D - PLOT

    E - 2-D PLOT

    F - STONYHURST

OPTION *
```

Figure 3-13.   Image Data Presentation Submenu

is provided with an appropriate scenario which assists the user in establish-
ing the necessary parameters for a specific need. A variety of techniques
are used in this man/machine dialogue, including explanatory messages,
multiple choice lists, and blanks to be filled in. Figure 3-14 is an

```
360 STATUS: DOWN    INTERACTIVE IDAPS      TIME: 11:29:35
                                           ELAPSED:00H,00MIN

IMAGE INPUT/OUTPUT - SCANNER TO DISPLAY (S-D)

PLACE FILM IN SCANNER

OPTION |  PARAMETER DESCRIPTION          ||OPTION|   PARAMETER DESCRIPTION

   A     SCALING FACTOR                           THE SCANNER CAN ADDRESS ANY POINT
          A - FUNCTION OF DENSITY (LOG)           IN AN ARRAY OF 2048X2048 ADDPESS
          B - FUNCTION OF TRANSMIT-               LOCATIONS.  USING THE TRACKBALL,
              TANCE (LINEAR)                       LOCATE THE UPPER LEFT CORNER OF
                                                  THE AREA TO BE SCANNED OR ENTER
   A     SCAN POLARITY                            FROM THE KEYBOARD: **
          A - NORMAL
          B - COMPLEMENT                    64        UPPERMOST SCAN ADDRESS
                                            64        LEFTMOST SCAN ADDRESS
   C     SAMPLING INTERVAL (MICROMETERS)
          A - 17.5  (2048 PTS/LINE MAX)     8    ILLUMINATION LEVEL
          B - 35    (1024 PTS/LINE MAX)
          C - 70    (512  PTS/LINE MAX)     0    LOWER CLIPPING LIMIT
          D - 140   (256  PTS/LINE MAX)
                                            8    UPPER CLIPPING LIMIT
   B     INTEGRATION TIME (MICROSECONDS)
          A -   20  (28 DB S/N)             2    DISPLAY MONITOR (1, 2, R, G, B)
          B -   80  (34 DB S/N)
          C -  320  (40 DB S/N)
          D - 1280  (46 DB S/N)
                                            ** NOTE: TRACKBALL INPUT OF
   A     FILTER                                  THESE VALUES IS BASED ON
          A - NEUTRAL                            QUICK-LOOK SCAN.
          B - RED
          C - GREEN
          D - BLUE
          E - MANUAL/CURRENT SETTING
```

Figure 3-14.   Sample Interactive IDAPS Operator Scenario

example of an Interactive IDAPS operator scenario. It is typical of most of
the parameter specification scenarios and should be referred to in the
following discussion of operator specification procedures. Illustrations of
all Interactive IDAPS operator parameter specification scenarios are provided
in alphabetical order in Appendix B of this volume along with other pertinent
information. Information and data required by IDAPS for control of an
operator typically fall into three categories:

- Input File Name(s)
- Parameters
- Input Data

3.4.1 File Name Assignment and Usage

File names are assigned by Interactive IDAPS to designate and keep track of
input and output images. File names are assigned to the output of an operator
using the convention that a file is named after the operator code of the
operator that created it and after the sequence of operator use.

The operator code is a three character code assigned to each operator. It
is usually the first three letters of the operator name and is displayed in
parenthesis on the operator scenario at the right of the operator name.

The leading character in a file name signifies the number of output files
that have been generated during a run by a specific operator. For example,
the first time the SCANNER-TO-SYSTEM (SCA) operator is used, its output file
is designated 1SCA. The next time the SCANNER-TO-SYSTEM (SCA) operator is
used, its output file is designated 2SCA, and so on. This convention simpli-
fies the problem of keeping track of files in IDAPS.

When an operator creates a new file it is assigned a name by the above
convention and stored on the host computer disk for future use. For all
operators which require a single input file, IDAPS provides a default Input
File Name which is the last generated file. The user may accept this "default"
parameter, or change it to another file name as desired. New entries are
entered from the keyboard and will appear at the location of the red cursor.
Cursor positioning is controlled by the ARROW keys in the lower-right
portion of the keyboard.

Some operators require more than one input file and therefore the default
file name feature cannot be applied. Multiple input file operators require
the user to specify all input file names.

3.4.2 Parameter Assignment

IDAPS operators are designed to apply a specific processing technique to an
input image. The techniques often involve a number of decision points which
must reflect the nature of the input data itself and the desires of the
user. Therefore, most Interactive IDAPS operator scenarios contain a
number of control parameter fields which must be provided prior to execution.
As in the case of the Input File Name parameters, a convention of default
parameter values is provided by Interactive IDAPS. Such default parameters
reduce the number of keyboard entries that a user must make and therefore
streamline the interactive control process. Several conventions are used
for providing default parameters. In many cases the default values are
simply the IDAPS designers "guess" as to what the user will normally want to
enter. In such cases, whenever default values are changed by user input,
the user input values are stored and used by IDAPS as the default value for
that parameter in all subsequent applications of the operator.

Control parameters are of three general types:

- Options
- Numeric Information
- Character Strings

3.4.2.1 Options

The ability to select one of several possible options is provided by display-
ing the name of the parameter along with the possible options. The Scaling
Factor parameter in Figure 3-14 is such a parameter. The user is asked to
specify the scaling factor as a function of density or as a function of
transmittance. In this case the system defaults to Option A. Should the
user wish to use the other default selection, he simply places the cursor
beneath the default value and enters Option B by keyboard.

3.4.2.2 Numeric Information

Many IDAPS operators require that certain information be supplied in numeric form. In Figure 3-14 the Illumination level is an example of a numeric parameter. A value of 8 is provided as the system default. The user may change this value through keyboard entry as desired. Although keyboard entry is the normal means for inputting numeric parameters, some operators allow the use of the trackball for this purpose. In such cases, specific instructions are provided as a part of the operator scenario.

3.4.2.3 Character Strings

Such operators as LABEL and FRAME require that the user input strings of alphanumeric characters. In such cases the user composes his input one line at a time using the RIGHT and LEFT ARROW keys to control cursor position along the line. When the DOWN ARROW key is pressed, the cursor automatically goes to the initial position of the next line. Returning to a previously composed line for corrections is not allowed after the user moves the cursor to a lower line.

3.4.3 Data Input

Some IDAPS operators require the input of sizable tables of data. Interactive IDAPS features a Default Data Table option whereby prestored tables may be transmitted to the host computer by the minicomputer in lieu of user input data. This allows the user to employ operators for which he has not prepared his own special data table. A default data table is provided by Interactive IDAPS for every operator which requires data table input.

3.4.3.1 Card Data Input

If the user wishes to provide his own input data table, he may do so by entering properly formatted data through the user terminal card reader, user keyboard, or in some cases through the graphic trackball. User supplied data tables replace the IDAPS default data table values for a specific operator so that all subsequent uses of that table reflect the user supplied data instead of the default values.

Because of the volume of data that often may be required, user input of data
is normally by punched cards. As illustrated in Figure 3-15, the user

```
360 STATUS: DOWN      INTERACTIVE  IDAPS      TIME: 11:40:20
                                                           ELAPSED:00H,20MIN

PSEUDOCOLOR - SCANNER TO DISPLAY

OPTION |   PARAMETER DESCRIPTION            |OPTION|    PARAMETER DESCRIPTION

   A       TABLE SOURCE                              THE SCANNER CAN ADDRESS ANY POINT
             A - SYSTEM DEFAULT                      IN AN ARRAY OF 2048X2048 ADDRESS
             B - TRACK BALL                          LOCATIONS.  USING THE TRACKBALL,
             C - CARDS                               LOCATE THE UPPER LEFT CORNER OF
                                                     THE AREA TO BE SCANNED OR ENTER
   A       SCALING FACTOR                            FROM THE KEYBOARD: **
             A - LOG
             B - LINEAR                         0      UPPERMOST SCAN ADDRESS
                                                0      LEFTMOST SCAN ADDRESS
   B       SAMPLING INTERVAL (MICROMETERS)
             A - 17.5                           8    ILLUMINATION LEVEL
             B - 35
             C - 70                             0    LOWER CLIPPING LEVEL
             D - 140
                                                8    UPPER CLIPPING LEVEL
   A       INTEGRATION TIME (MICROSECONDS)
             A -    20
             B -    80
             C -   320
             D -  1280
                                                ** NOTE: TRACKBALL INPUT OF
                                                         THESE VALUES IS BASED ON
                                                         QUICK-LOOK SCAN.
```

Figure 3-15.   Sample Data Table Entry

specifies card data input on the operator scenario at the parameter Table
Source. He then loads his data cards into the card reader and readies the
card reader for operation before proceeding any further (see Section 4.0 for
card reader instructions). Once the operator begins executing, the mini-
computer reads the cards, checks their format, stores the data in the appro-
priate operator data table, and then uses the modified table as input for
the operator. Some operators require more than one input data table. In
such cases, the data cards for all tables may be placed in the card reader
at the same time, taking care to keep them in proper order.

The proper format for data cards for all Interactive IDAPS operators that
have data table input is provided in Appendix B of this volume.

card reader instructions). Once the operator begins executing, the mini-
computer reads the cards, checks their format, stores the data in the appro-
priate operator data table, and then uses the modified table as input for
the operator. Some operators require more than one input data table. In
such cases, the data cards for all tables may be placed in the card reader
at the same time, taking care to keep them in proper order.

The proper format for data cards for all Interactive IDAPS operators that
have data table input is provided in Appendix B of this volume.

3.4.3.2 Trackball Data Input

Such operators as the PSEUDOCOLOR operators allow data table entry by
trackball (see Figure 3-15). In the case of PSEUDOCOLOR, trackball data
entry is accomplished by pointing to a color which is displayed on the Color
Monitor and pressing the trackball ENTER key. Trackball position is then
obtained by the minicomputer and is used to derive the color components
(red, green, blue) to be assigned to a specific gray value. Such color
component data is then stored in the PSEUDOCOLOR data table for use by the
operator. Specific instructions for using the trackball for data input are
provided on an appropriate television monitor.

3.4.3.3 Data Table Edit

A facility for reviewing the contents of a specific data table and for
editing the data values is provided by Interactive IDAPS. The DATA TABLE
EDIT operator may be found in the Function Generation Submenu. Selecting
the DATA TABLE EDIT operator results in a display of the names of every data
table for every Interactive IDAPS operator. From this display, the user may
select a specific data table by name. Figure 3-16 is an example of the

```
360 STATUS  READY       INTERACTIVE   IDAPS          TIME. 08:10:25
FILE NAME:   2AUT                                    ELAPSED:00H.06MIN
FUNCTION GENERATION - TABLE MODIFICATION                TABLE NAME : PRED

        0      0   0   0   0   0   0   0   0   0   0
        10     0   0   0   0   0   0   0   0   0   0
        20     0   0   0   0   0   0   0   0   0   0
        30     0   0   0   0   0   0   0   0   0   0
        40     0   0   0   0   0   0   0   0   0   0
        50     0   0   0   0   0   0   0   0   0   0
        60     0   0   0   0   0   0   0   0   0   0
        70     0   0   0   0   0   0   0   0   0   0
        80     0   0   0   0   0   0   0   0   0   0
        90     0   0   0   0   0   0   0   0   0   0
        100    0   0   0   0   0   0   0   0   0   5
        110    9   14  19  23  28  34  38  43  48  53
        120    58  63  73  79  84  89  95  100 106 111
        130    117 122 127 133 139 144 150 156 162 168
        140    174 180 185 191 192 193 193 194 195 195
        150    196 196 197 198 198 198 200 200 200 201
        160    201 202 203 203 204 205 205 206 207 207
        170    208 208 209 210 210 211 211 212 212 213
        180    214 214 215 215 216 217 217 218 218 219
        190    220 220 221 221 222 223 223 224 224 225
        200    225 226 226 227 228 228 229 229 230 231
        210    231 232 232 233 233 234 234 235 235 236
        220    236 237 237 238 238 239 239 240 240 241
        230    242 242 243 243 244 244 245 245 245 246
        240    247 247 248 248 249 249 250 250 251 251
        250    252 253 253 254 254 255 **
```

Figure 3-16.   Sample Data Table Edit

data table for the Alter operator. The table may also be displayed in

graphic format. In this example the data table consists of 256 integer

numbers. Any one or all of these displayed numbers may be modified by

keyboard entry using the data table EDIT keys at the upper right corner of

the user keyboard and optionally by the trackball. The red cursor is positioned

by the four edit cursor controls EDIT UP, EDIT DOWN, EDIT LEFT, and EDIT

RIGHT; the desired entries are then input from the alphanumeric keys. When

the table has been modified to the user's desire, it may be stored as the

default table by depressing the EDIT ENTER key. This terminates the editing

process. Another feature available is the ability to enter a series of

points and have the system interpolate between them, creating a smoothed

curve.

3.5 SPECIAL FUNCTIONS

Interactive IDAPS features a capability for carrying out certain operations
in direct response to keyboard entries under control of the minicomputer and
independent of the host computer. Such special functions enhance the overall
system by assisting the user in previewing and setting up runs, reviewing
the results of previous runs, and controlling local terminal operations
without having to go through the Menu Selection control process. Two cate-
gories of Special Functions are provided--operations functions, and processing
functions.

3.5.1 Operations Functions

Special Functions keys are provided to control and assist Interactive IDAPS
operations. The row of red keys along the top of the alphanumeric key set
have been assigned to this class of special function.

3.5.1.1 HELP

The HELP function provides explanatory messages about specific operator
parameters. The user positions the cursor at the parameter for which he
wishes help and presses the HELP Key. A brief message will then appear in
the space provided at the bottom of the screen and will remain until the
cursor is moved to another parameter. Appropriate messages are provided for
every parameter of every operator in the Interactive IDAPS.

3.5.1.2 Return to Master Menu

In the event the user has addressed an operator scenario or is performing
some operation involving the minicomputer and wishes to terminate his opera-
tions and return the control to the Master Menu, he may press the RETURN TO
MASTER MENU key. He should be aware, however, that if he terminates an
operation, such as TAPE TO SYSTEM which has established a system file, that
system file will remain in the host computer in its incomplete form.

3.5.1.3 Special Function Exit

The SPECIAL FUNCTION EXIT key is provided as a means for terminating a
special function operation without returning control to the Master Menu.

3.5.2 Processing Functions

A number of simple image processing and display functions may be carried out
using the Special Function capabilities of the minicomputer. The group of
18 keys at the left of the user keyboard control such operations. The user
presses the appropriately labeled key and then usually indicates the monitor
on which the object picture is to be displayed. Since these special functions
are performed by the minicomputer using actively displayed data, they may be
exercised independently of most host computer operations.

3.5.2.1 COORDINATES

The COORDINATES Special Function allows the user to obtain a display of the
gray values of a specific region of a picture along with the line and
column location. The trackball cursor is used to indicate the points for
which gray values and locations are desired.

3.5.2.2 HISTOGRAM

Using the trackball cursor with the HISTOGRAM special function, the user
first defines a rectangular area on a displayed picture. The minicomputer
calculates a HISTOGRAM of the frequency of gray value occurrence and displays
it at the left of the picture. The gray value maximum, minimum, mean, and
sum are also calculated and displayed. A printout of the total values for
each gray scale value may be obtained before exiting the HISTOGRAM special
function.

3.5.2.3 SLICE

Using the SLICE operator, the user first defines a line segment on a dis-
played picture by locating its end points with the trackball cursor. The
minicomputer prepares and displays a plot of gray value vs. position along
the line segment.

3.5.2.4 QUICK LOOK SCAN

The QUICK LOOK SCAN Special Function causes the on line film scanner to scan
its entire field of view at its lowest resolution and highest speed settings.
The resulting image is displayed on one of the display monitors. This
special function is used as a reference for control of the on line digitizer
in defining the area to be scanned.

3.5.2.5 RESTORE

Whenever a picture is displayed on one of the monitors by an operator, a
digital representation of the image is also stored on the minicomputer disk.
The RESTORE Special Function causes a specific monitor to be erased and
rewritten from the minicomputer disk. This is useful for clearing the
display when a number of Special Functions such as SLICE and HISTOGRAM have
been performed.

3.5.2.6 ERASE

This Special Function simply erases all information from a specified monitor.

3.5.2.7 GRAY SCALE WEDGE

When comparing pictures on the display monitors or as a simple reference of
the gray values within a picture, the GRAY SCALE WEDGE function may be used.
This special function writes a gray scale step wedge along the left hand
border of the displayed pictures on both black and white display monitors.

3.5.2.8 LIST FILES

This Special Function displays the names of any 360 files which are displayed
on the terminal monitors.

3.5.2.9 REPEAT

Whenever multiple entries from the same keyboard key are to be made, it is
helpful to use the REPEAT Function. The user presses the REPT key first and
then the key for which multiple entries are desired.

3.6 OPERATOR EXECUTION

Once an Interactive IDAPS operator has been selected through menu selection,
all necessary parameters indicated, and preparations made for data table
input, the operator may be executed. This causes the minicomputer to accept
the user supplied control information, convert it to proper format, and
transmit it to the host computer along with the input file identification.
Several checks are made by the minicomputer during this initial setup phase
and by the host computer during operator execution. Should a malfunction
occur, the operation is suspended and an error status message is generated.

3.6.1 Normal Operation

Under normal conditions, an operator may be executed by either pressing the
DOWN ARROW Key after the cursor is at the last parameter position or, if the
cursor is not in the last parameter position, by simply pressing the EXEC
key. Once the host computer begins executing the operator and if the minicom-
puter is not actively involved in the operator being exercised, the terminal
control reverts to the Master Menu. .

3.6.2 Error Conditions

If, for some reasons, an error is detected by the minicomputer, further
operations are suspended and an error message is dipslayed at the bottom of
the Master monitor. Minicomputer generated error messages indicate the
nature of the error and provide instructions for correcting the error condi-
tion. In the event that an error is detected by the host computer, an error
code is transmitted to the user terminal for display. The host computer
error codes must be interpreted by the user. A list of host computer error
codes along with their interpretations is included as Appendix A to this
volume.

To continue processing following detection of an error, the user must correct
the condition that caused the error. In most cases this is done by entering
a legal value or by adjusting a hardware device, followed by depressing the

EXEC Key. Under a few specific error conditions it is not possible to
recover without reinitializing the minicomputer. Such recovery is accom-
plished by depressing the INT Key on the minicomputer console panel, Figure
3-17.
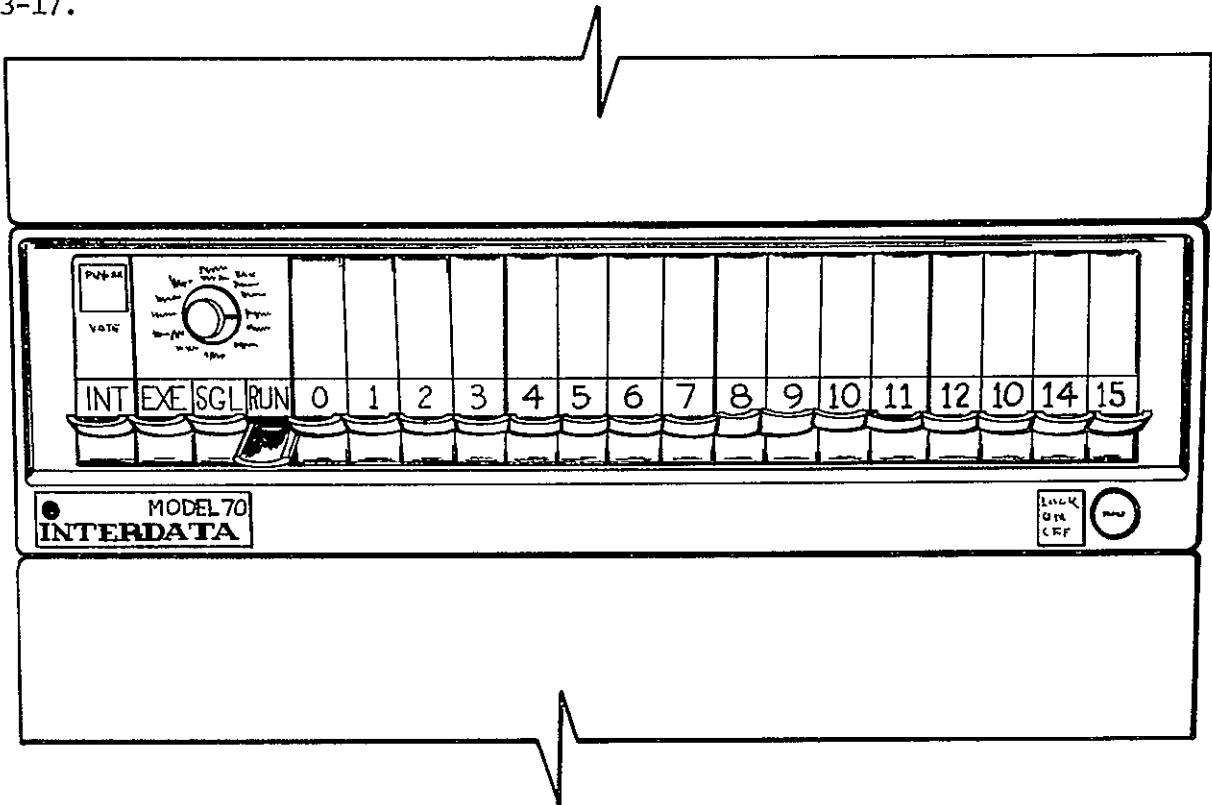
Figure 3-17.   Terminal Minicomputer Console Panel

3.7 LOG OUT

At the end of an interactive image processing run, the user should always
log out. He does this from the Master Menu by selecting the LOG OUT Option
and then pressing the EXEC key. He is then given instructions listing any
devices which must be turned off as illustrated in Figure 3-18.

```
/ 36+ STATUS: PEADY    INTERACTIVE IDAPS      TIME: 09:09:59
  FILE NAME:  6FEA                             ELAPSED:00H.2.MIN

  LOGOUT

  OPTION |    P-PAMETER DESCRIPTION
  _____
    A    | PRINT OPTION
         |    A - NO
         |    B - YES
      '  |
    A    | OUTPUT MEDIA           -
         |    A - NONE
         |    B - TAPE 1
         |    C - TAPE 2

  NOTICE:  VEPIFY THAT THE HIGH VOLTAGE POWER SUPPLY ON THE PECORDER IS OFF. .

  TO ShUT THE SYSTEM DOWN FOR AN EXTENDED PERIOD OF TIME (OVERNIGHT) THESE
  PROCEDURES SHOULD BE FOLLOWED:

     1.   TUPN OFF THE FOLLOWING PERIPHERALS
               A.   TAPE DRIVES 1 AND 2
               B.   CARD READER
               C.   PRINTER    '
               D.   RECORDER
               E.   SCANNER
               F.   HARD CCPY UNIT
               G.   TELETYPE
               H.   DISPLAYS

     2.   TURN 360 INTERFACE SWITCHES TO OFF POSITION AND NOTIFY 360 OPERATORS
          THAT YOU ARE LEAVING.
```

Figure 3-18.   Interactive IDAPS LOGOUT Display

Because all image file data may be deleted when the next user logs in, the
user may make provisions for retaining any data that he wants to keep. The
normal procedure is to use the SYSTEM-TO-TAPE operator to store the image
files on magnetic tape. In this way, image data may be re-entered into the
system at a later time using the TAPE-TO-SYSTEM operator and further image
processing may then be done. A record of his 360 operations may be obtained
either on tape or on the printer if he so desires.

4.0 EQUIPMENT DESCRIPTION

This section describes the following interactive IDAPS equipment:

- Digital Television Displays
- Film Scanner
- User Console Keyboard
- Graphic Trackball
- Card Reader
- Printer
- Magnetic Tape Units
- Video Facsimile Copier
- Image Recorder

Each of these hardware components is shown in an illustration and described in an introductory paragraph, followed, as appropriate, by a discussion of principles of operation, capability specification, and set-up and operation. Additional Interactive IDAPS equipment, which is not directly operated by the user, is briefly discussed in a final paragraph.

4.1 DIGITAL TELEVISION DISPLAYS

A digital television system is provided by Interactive IDAPS to provide high quality displays of image data. Four video monitors are provided, two color (Master Monitor and Color Monitor) and two black-and-white (Monitors 1 and 2). The Master Monitor serves the user in controlling and monitoring his image processing operations. The Master Menu, Submenus, Operator Parameter Specification Scenarios, and Data Cards are all displayed on the Master Menu for user interactive control. While system control information is being displayed on the Master Monitor, the user may view before-and-after results of his image processing runs on the two black-and-white monitors. When working with color data, the user may monitor the color image on the Color Monitor. The Digital Television Displays are shown in Figure 4-1.
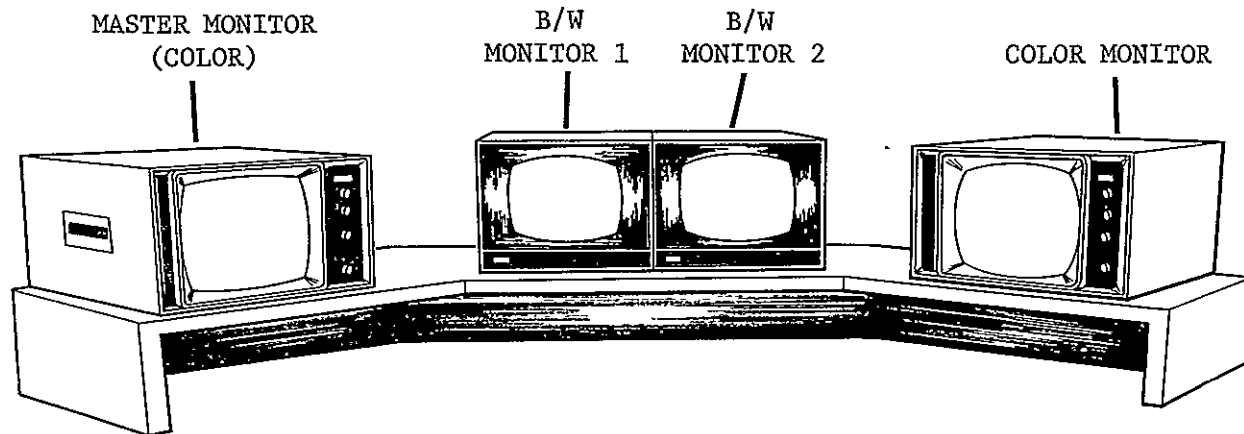
Figure 4-1.   Digital Television Displays

4.1.1 Set-Up and Operation

Operation of the digital television is controlled automatically by the
system with the exception of the ON/OFF, INTENSITY, and CONTRAST controls on
the monitors themselves. The INTENSITY and CONTRAST controls may be adjusted
to suit the users desires. The user should not attempt to adjust any other
monitor controls, particularly in the color monitors.

Occasionally, a timing error will require that the digital display generator
be reset. When this occurs, a message will be displayed on the master
monitor instructing the user to press the CLEAR button on the display
generator. The display generator is housed in the second from the left
equipment rack in the Interactive IDAPS Terminal Room.

4.1.2 Principles of Operation

Data that is to be displayed on the digital television system is first
converted to a proper format by the Interactive IDAPS minicomputer and
transmitted through interface and control electronics to a high-speed digital
disk. The data is stored on the disk in a format which allows it to be read
off as a standard television raster, but in digital form. Additional elec-
tronic circuitry is used to superimpose a cursor on the television displays.
The cursor is electronically coupled to the graphic trackball discussed in
Paragraph 4.4.

Sufficient storage is provided to refresh sixteen frames of binary imagery.
The first twelve of the binary image channels are used for displaying picture
data. Binary channels 0-5 are used to refresh one of the two black and
white television monitors, and binary channels 6-11 are used to refresh the
other black and white monitor. To make more efficient use of the digital
television refresh disk, the color image monitor is refreshed from the same
twelve binary channels as the two black and white monitors. The red color
gun is refreshed from channels 0-3, the green color gun from channels 6-9, .
and the blue color gun from channels 4, 5, 10, and 11. In this way, Inter-
active IDAPS provides displays of black-and-white as well as full color
images.

4.1.3 Capability Specification

The digital television displays have the following capability:

Displays   - Four commercial grade 14-inch diagonal television
                                     monitors. Two black-and-white and two color
                                     monitors.

B/W Monitors   - Conrac monitors with P40 phosphor.

Color Monitors   — Miratel shadow mask monitors with R.G.B. input.

Viewing Area   — Approximately 8 X 10 inches.

Refresh Rate   — Thirty frames per second.

Resolution   — 480 lines X 640 columns (480 X 480 used for
                               image display).

4.2 FILM SCANNER

The film scanner (Figure 4-2) included in the interactive IDAPS is electri-
cally and operationally integrated into the interactive system and is capable
of satisfying the major requirements for digitizing S-056 images. However,
some scanning requirements may exceed the capabilities of the on-line scanner;
in such cases, the user should be prepared to employ a high resolution, high
accuracy, off-line film scanner. The user can establish a basis for judgement
of the adequacy of the on-line scanner for his particular application by
review of the principles of operation and capabilities description which
follow.

4.2.1 Set-Up and Operation

The on-line film scanner has a field of view of 35 X 35 mm. Film holders
are provided for scanning individual 2 X 2 inch mounted frames and a roll
film transport is available for scanning 35 mm film on reels up to eight
inches in diameter. A swing-down mirrow is provided to aid positioning of
the film in the scanner. The on-line film scanner is operated as follows
(refer to Figure 4-2):

1. Turn on the scanner with the key lock switch.

2. Place the scanner in the operate mode by pressing the OPERATE
    switch-light.
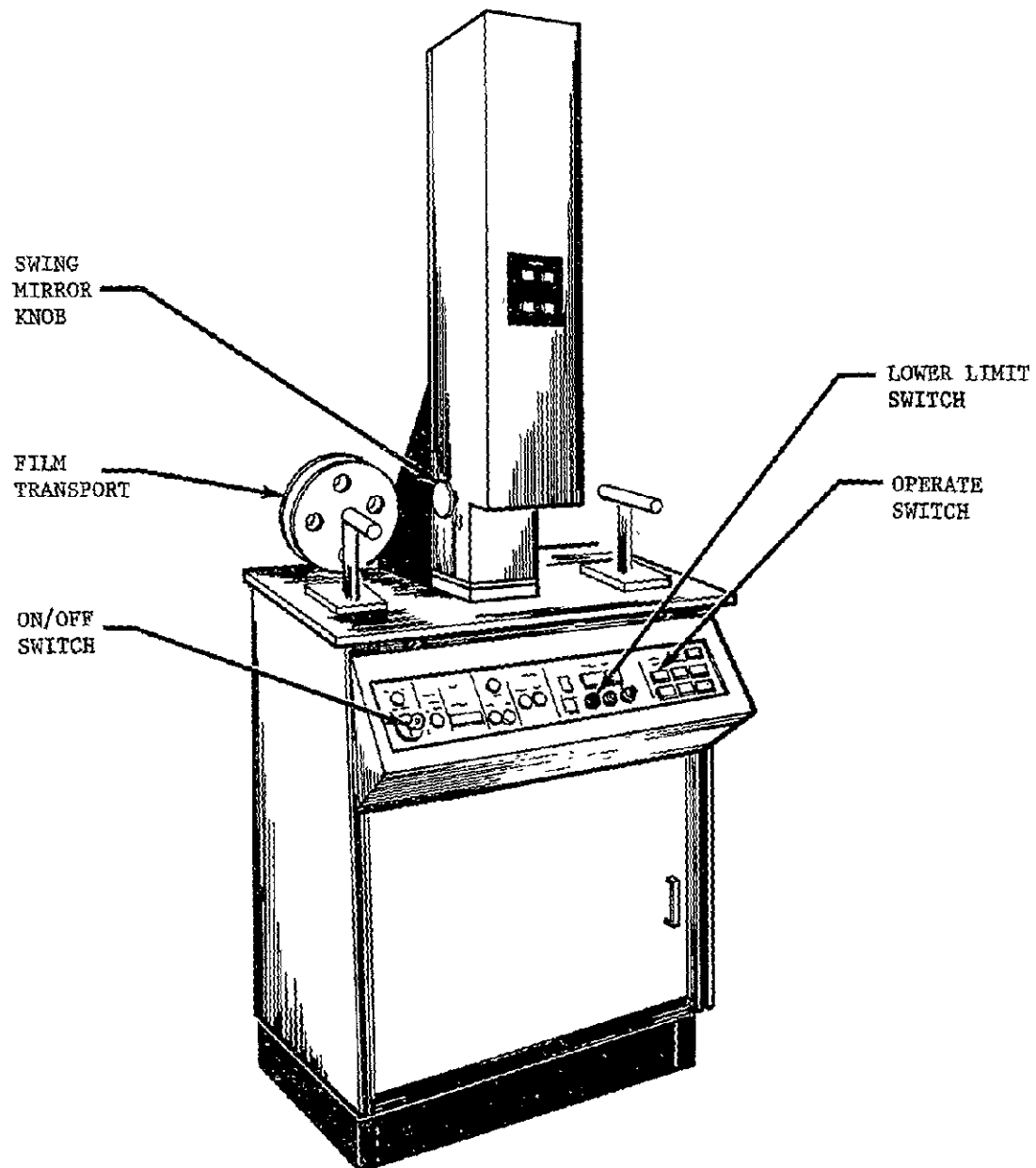
Figure 4-2.   Film Scanner

3. Swing the view mirror back, using the knobs on either side of the
    dissector tube housing.

4. Position the film in the scanner. (With the film positioned in
    the scanner, normal scanning takes place from left to right and
    top to bottom of the film as viewed from above.) When using the
    hand-driven film transport, care should be taken to keep tension
    on the film at all times to prevent scratching of the film through
    contact with the holder.

5. Place the LOWER LIMIT switch in either the 0 or VER positions. In
    the 0 position a gray level of zero will normally correspond to a
    fixed, high density. In the VER position, a gray level of zero
    may be shifted slightly under control of the control on the digi-
    tizer control panel. When scanning in a log mode, the control
    capability is particularly useful for adjusting out background
    noise by setting the gray level zero slightly above the film noise
    level.

6. Return the view mirror to the down position.

Because the on-line film scanner is completely computer controlled, the user
need not be concerned with manual controls other than the initial set-up
described above.

4.2.2 Principles of Operation

The on-line film scanner is an electro-optical device which employs an image
dissector tube as its central element. The image dissector is similar to a
standard television vidicon in that it produces an analog voltage proportional
to the intensity of light at a point in an image. The analog output of the
dissector is converted electronically to digital form, buffered into appro-
priate data blocks, and transmitted to the computer through an electrical

interface. Electronic control circuitry is provided so that samples may be taken in a rectangular matrix pattern. Computer controls of such parameters as the point-to-point spacing of the sampled data, the region of the film to be digitized, and the intensity of the film illumination source are also provided. The exact controls provided by the on-line scanner are presented on the scanner control parameter specification displays which are discussed in Section 3.0.

4.2.3 Capability Specification

The on-line film scanner has the following capabilities:

Film Density   — Diffuse density range of 2.45 density units.
                            Actual densities corresponding to gray levels 0
                            to 255 depend on factors such as illumination
                            intensity and clipping levels.

Scan Image Size   — 35 X 35 mm at film plane.

Output Data   — 8 bits to the minicomputer (256 gray levels)
                            codes are linearly proportional to film trans-
                            missivity, except when operating in log mode;
                            then codes are approximately proportional to
                            the inverse of film density.

Scanning Aperture   — Effective circular diameter of 36 μm.

Intersample Spacing   — 256 X 256 resolution = 137 μm
                            512 X 512 resolution = 66 μm
                            1024 X 1024 resolution = 33 μm
                            2048 X 2048 resolution = 16 1/2 μm

Effective Bit Precision   -   Scan Speed 1 = 93%
(Percentage of codes   Scan Speed 2 = 64%
which are within ± 1   Scan Speed 3 = 32%
code of the mean)   Scan Speed 4 = 16%

Scan Line Straightness   -   Curvature Less than 0.15%.

Signal Amplitude   -   Maximum deviation over a circulr area with a
Uniformity   diameter equal to 80% of the scan-area diagonal
                                  is within ± 10%.

4.3 USER CONSOLE KEYBOARD

The major interactive user control instrument is an extended alphanumeric
keyboard which interfaces with the Interactive IDAPS minicomputer. The user
console keyboard layout is presented in Figure 4-3. The left hand group of
eighteen keys of the keyboard are assigned to control special function
operations. The right hand group of fourteen keys are used primarily for
cursor control and operator execution. The top row of the middle section of
keys is dedicated to the control of system operations. The remaining keys
are used for input of alphabetic or numeric data.
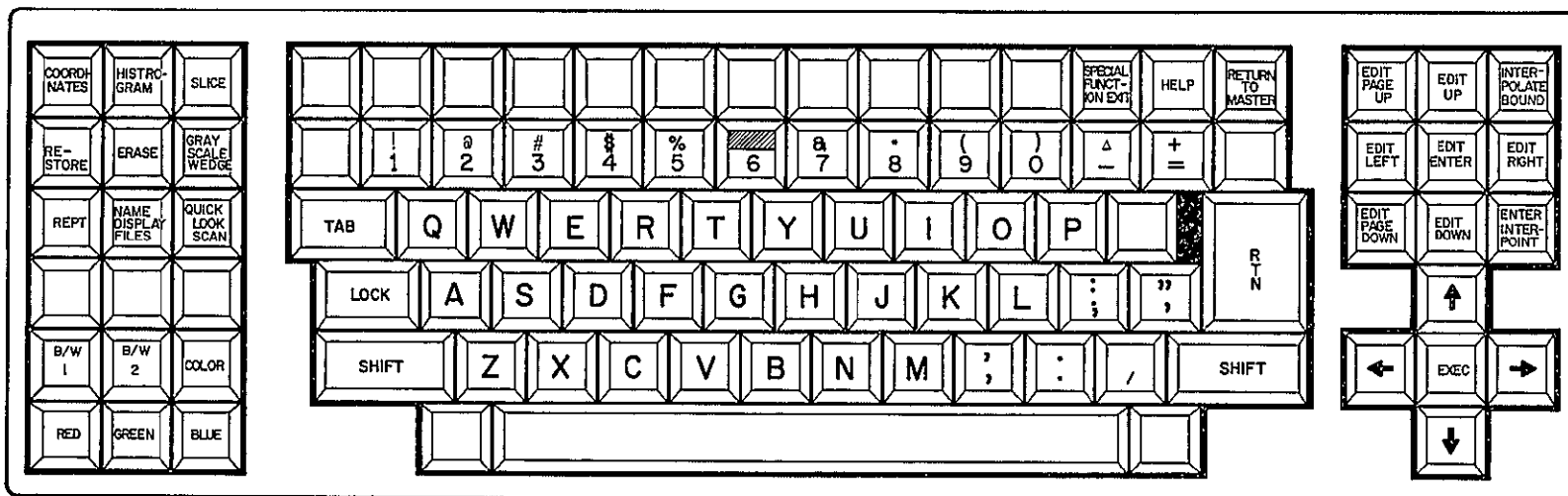
Figure 4-3.   User Console Keyboard Layout

4.4 GRAPHIC TRACKBALL

Image processing operations often require that the user specify point loca-
tions within an image array. A graphics trackball (Figure 4-4) is provided
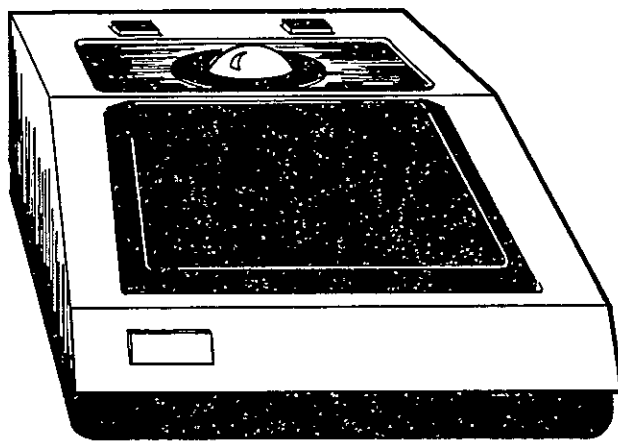
Figure 4-4. Graphic Trackball

for this purpose. With the trackball, the user can identify points within a
picture which is being displayed on one of the digital television monitors
and can transmit the line and column coordinates of the points to the Inter-
active IDAPS minicomputer.

4.4.1 Set-Up and Operation

The following procedure is recommended for locating and transmitting a point
to the minicomputer:

1. Identify the cursor on the television monitor. Occasionally, it
may be helpful to adjust the monitor intensity and contrast

controls in order to give the cursor sufficient contrast to be
seen. Pressing the HOME button on the trackball returns the
cursor to the upper left corner of the screen.

2. Move the cursor to the desired location on the monitor by "rolling"
    the trackball in the direction of desired cursor movement. Once
    the cursor is in the desired position, its location may be trans-
    mitted to the system by pressing the ENTER button.

4.4.2 Principles of Operation

When the trackball is moved by the user, sensors within the device detect
the movement and cause electronic counters to be either incremented or
decremented--depending on the direction of movement. The numbers contained
in the counters correspond to the position of the cursor on the screen.
When the trackball ENTER key is pressed, the contents of the counters are
fed to the minicomputer as the x and y location of a point. Additional
circuitry connects the trackball counters directly to the digital television
electronics to control the position of the displayed cursor described in
Paragraphs 4.1.2 and 4.4. The HOME button resets both the x and y counters
which causes the counters to go to zero and the cursor to return to the
upper left corner of the display monitors.

4.5 CARD READER

Control of image processing operators in IDAPS often requires that the user
supply data in tabular form. This requirement is facilitated by the card
reader (Figure 4-5).

OUTPUT
STACKER

INPUT
HOPPER

POWER

START

MOTOR
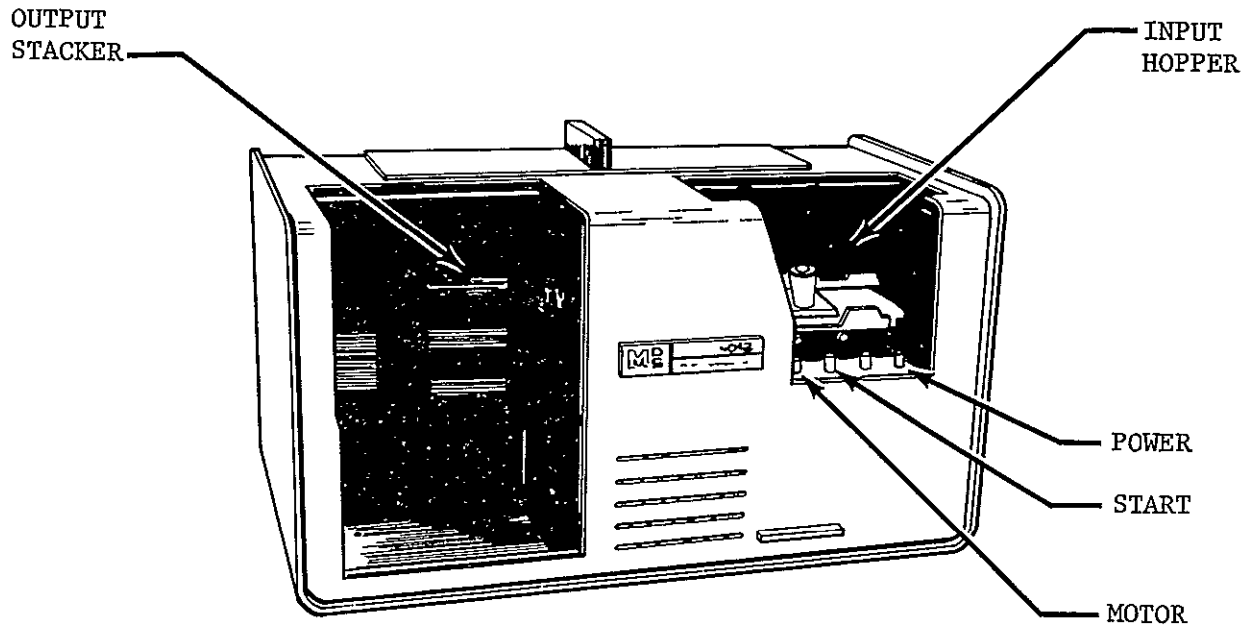
Figure 4-5.   Card Reader

4.5.1   Set-Up and Operation

Data contained on punched cards is read as follows:

1.   Place the deck in the input hopper such that the first card in the
     deck is on the bottom, and the top edge of all cards is toward the
     front of the reader. Place the plastic card weight on top of the
     deck with the black weight to the left.

2.   Press the card reader POWER button.

3.   Press the card reader MOTOR button.

4.   Press the card reader START button.

Should a card jam or other abnormal condition occur, the condition will be
signalled by one of the red check (CK) lights on the reader.

4.5.2 Capability Specification

The card reader has the following capability:

Card Read Rate   - 400 cards per minute.

Capacity   - Up to 500 cards in input hopper and output
                              stacker.

Card Format   - Standard 80-column cards, 12 zones per column.

Character Codes   - IBM 029 punch character set.

4.6 PRINTER

Printed copy of alphanumeric data is provided through the Interactive IDAPS
printer (Figure 4-6). The printer is interfaced to and controlled by the
minicomputer.
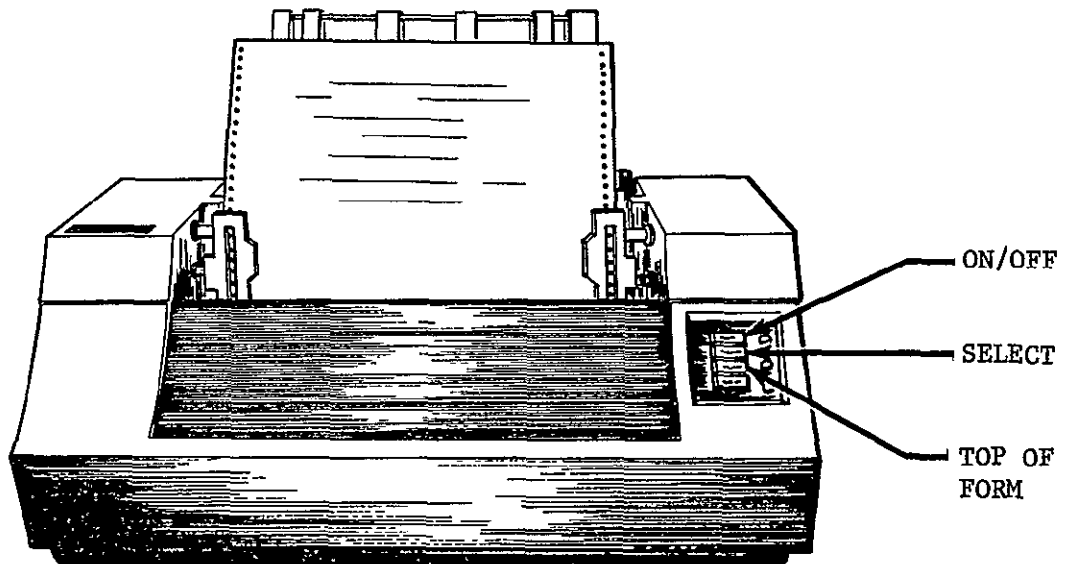
Figure 4-6.   Printer

4.6.1 Set-Up and Operation

The printer is operated as follows:

1. Turn on the printer by pressing the ON/OFF switch-light.

2. Press the SELECT switch-light to place the printer on-line.

3. To remove printout from the printer, press the TOP OF FORM switch-light to eject the page.

Should the printer run out of paper, an audible tone will be sounded and the PAPER OUT light will light. Operations personnel will install new paper in the printer on request.

4.6.2 Capability Specification

The printer has the following capability:

Printing Method	– Dot matrix. Each letter is a 5 X 7 inch array of dots.
Print Rate	– 165 characters/second; 60 lines/minute with 132 characters.
Input Language	– USASCII – 64 characters.
Paper	– Standard, fan fold, sprocketed paper 14 7/8 inches wide.
Printing Structure	– 132 characters/line; 6 lines per inch.

4.7 MAGNETIC TAPE UNITS

Two magnetic tape units (Figure 4-7) are provided to input image data which

SUPPLY
REEL

UPPER
TENSION
PULLEYS

HEAD
SLOT

LOWER
TENSION
PULLIES

TAKEUP
REEL
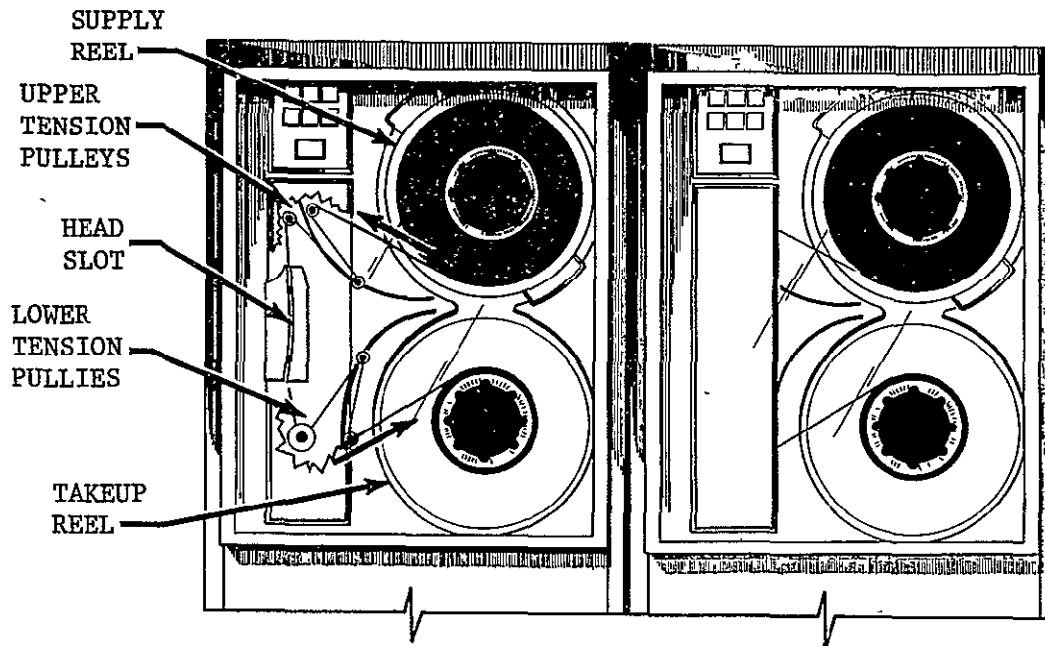
Figure 4-7.   Magnetic Tape Units

has been scanned on an off-line film scanner and to remove image data from
the system in a computer-compatible form for processing and/or analysis at a
later date.

4.7.1 Set-Up and Operation

The two tape units are designated Tape No. 1 and Tape No. 2. As the user
faces the tape units, the unit on the left is Tape No. 1. The user should
become familiar with the following procedures:

- Mounting a tape on a drive.
- Preparing the drive for use.

- Manually rewinding a tape.
- Removing a tape from a drive.

Tape is mounted on a drive as follows (refer to Figure 4-7):

1. With power on the drive, place the reel on the supply reel hub and lock in place by pressing on the metal tab in the center of the hub.

2. Thread the tape through the upper tension pulleys, through the read/write head slot, under the capstan, through the lower tension pulleys, and over the take up reel. A threading diagram is on the inside of the tape drive doors.

3. Holding the end of the tape against the hub of the take up reel, rotate the take-up reel clockwise through three revolutions.

To prepare the drive for use:

1. Press the LOAD switch-light. This causes the tension arms to move to the operating position--applying tension to the tape.

2. Press the LOAD switch a second time, the drive will advance the tape to the reflective load point marker.

3. Press the ON LINE switch to place the drive on line with the minicomputer.

At this point the LOAD, ON LINE, WRT EN, and HI DEN lamps should be lit. The HI DEN lamp signifies that the drive is set to read 800 BPI tapes. The WRT EN lamp signifies that the supply tape reel has a "Write Ring" in place. The Write Ring is necessary if the drive is to be used for writing data on

the tape. The Write Ring is a plastic ring which fits in a groove on the
back side of a tape reel. It is used to prevent accidental writing on a
magnetic tape. Its presence is mechanically sensed by the drive when the
tape is mounted.

To rewind a tape using the manual drive controls:

1. Press the ON LINE switch to take the drive off-line from the
    minicomputer.

2. Press the REWIND switch. The tape will rewind to the reflective
    load point marker and the LOAD lamp will light.

3. Press the ON LINE switch to make the drive ready for use.

To remove a mounted tape from a drive:

1. Rewind the tape to its load point marker using the procedure
    above, but do not press the ON LINE switch.

2. Press the REWIND switch. This will rewind the tape past its load
    point and remove the tension arms.

3. Remove the tape from the drive hub.

4. Remove the Write Ring if protection from accidental overwriting on
    the tape is desired.

5. Prepare a tape label and affix it to the reel for future identifi-
    cation.

4.7.2 Capability Specification

Each magnetic tape unit has the following capability:

Tape Speed   - 45 IPS; rewind 200 IPS.

Recording Format   - 9 track NRZI IBM compatible.

Tape Capacity   - Up to 2400 feet.

Inter-record Gap   - 0.75 inch nominal.

Bit Density   - 800 bits per inch.

4.8 VIDEO FACSIMILE COPIER

A video facsimile copier (Figure 4-8) is provided to make quick-look hard-
copies of images displayed on one of the black and white monitors.
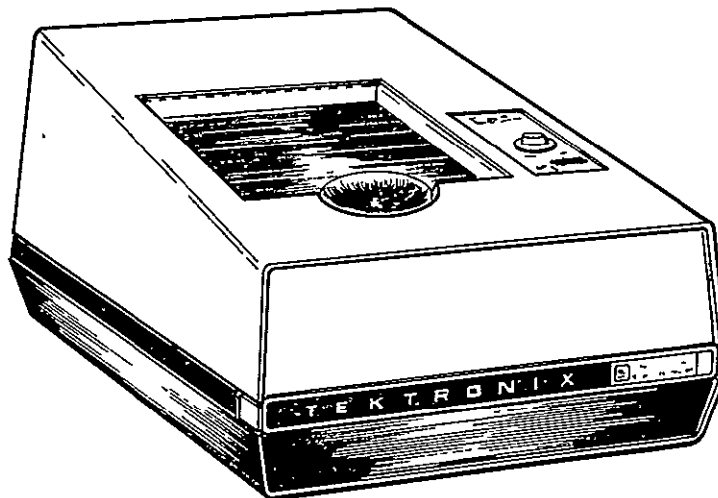
Figure 4-8.   Video Facsimile Copier

4.8.1 Set-Up and Operation

1. Turn the hardcopy unit ON/OFF switch to ON and allow approximately twenty minutes for warm up.

2. Rotate the LIGHT-DARK knob to the twelve o'clock position.

3. With the desired picture displayed on Monitor 2, press the COPY switch.

4. If the copy is too light or too dark adjust the LIGHT-DARK knob and repeat step 3.

4.8.2 Principles of Operation

When the copy operation is initiated, an analog television tube within the hardcopier exposes a piece of photosensitive paper. The exposed paper is moved past a heat bar which causes the latent image to appear. The hardcopy is then automatically cut from the supply roll and deposited in the device output tray.

4.8.3 Capability Specification

Resolution   — 480 X 640 matrix--the same as the television monitor.

Hardcopy Size   — Approximately 8 1/2 X 11 inches.

Number of Effective
Gray Levels   — Approximately twelve.

Recording Time   — Approximately 15 seconds.

Controls   - ON/OFF switch. COPY switch. LIGHT-DARK contrast
                                 control to adjust black/white ratio.

4.9 IMAGE RECORDER

The ability to reproduce processed digital image data on photographic film
is provided by the on-line image recorder (Figure 4-9). With this device,
the interactive IDAPS user can obtain photographic hardcopy of his image
data on either Polaroid or a number of wet-process films in color or black
and white. The resolution and accuracy of the device is adequate for most
S-056 applications and the speed is sufficient to provide a high rate of
throughput.

4.9.1 Set-Up and Operation

Set-up and operation of the image recorder requires user familiarity with
the following procedures:

- Loading Polaroid Film.
- Loading Cut Film.
- Loading Roll Film.
- Calibrating the Recorder.
- Preparing the Recorder for Use.

4.9.1.1 Loading Polaroid Film

Polaroid film is useful for obtaining quick photographic prints from the
system. A Polaroid Film Adapter (Figure 4-10) is provided. The adapter
accepts 4 X 5 inch film packets of the following film types:

EXPOSURE
CONTROL

OPERATE
SWITCH

ON/OFF
SWITCH

HIGH VOLTAGE
SWITCH

EXPOSURE
READOUT
DISPLAY

EXPOSURE
TRIM

EXPOSURE
CALIBRATION
SWITCH
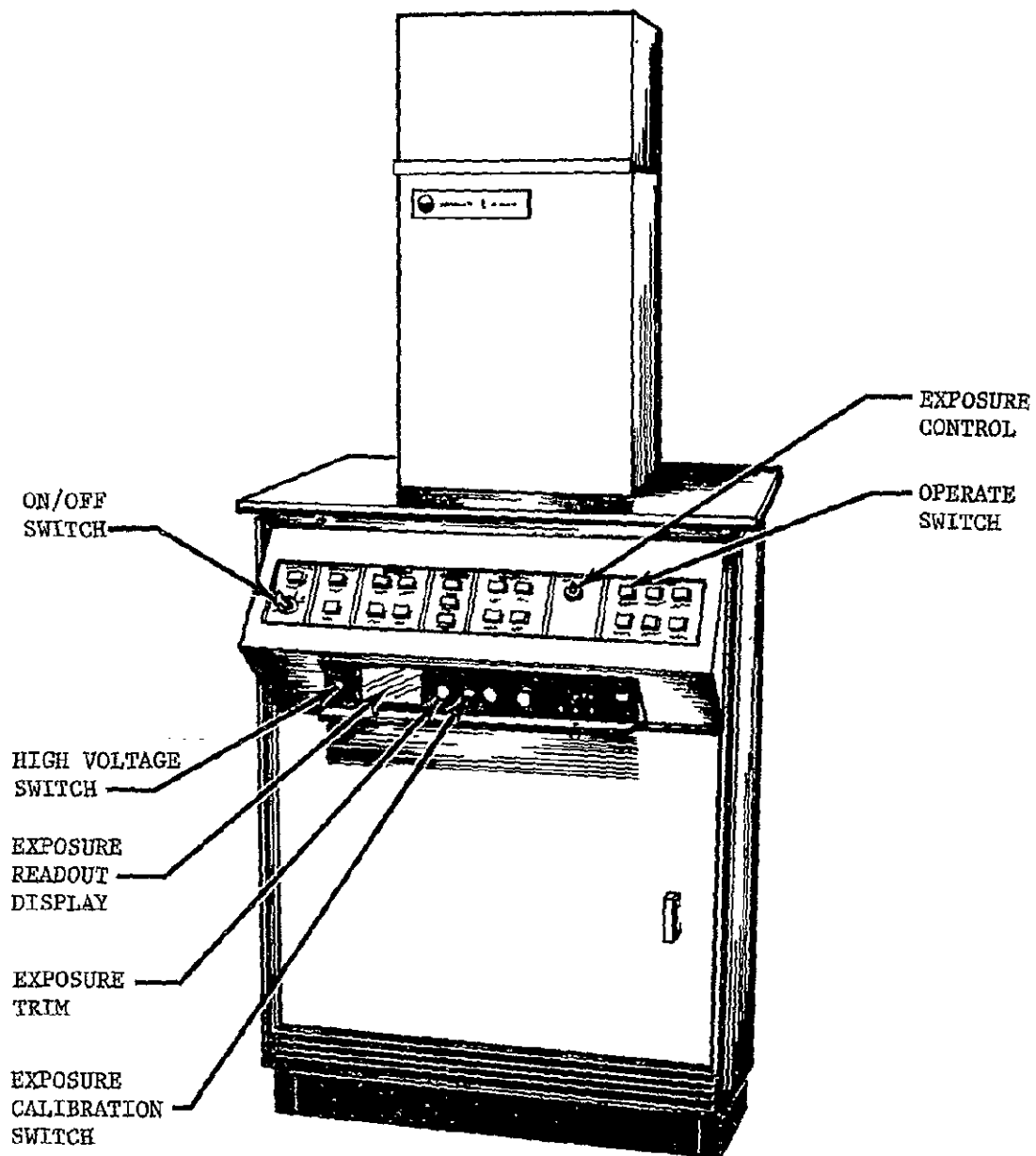
Figure 4-9.   Image Recorder

LOAD/PROCESS
LEVER (IN
PROCESS
POSITION)

POLAROID
FILM
PACKET

FILM HOLDER
ASSEMBLY

DICOMED

POLAROID
FILM
HOLDER
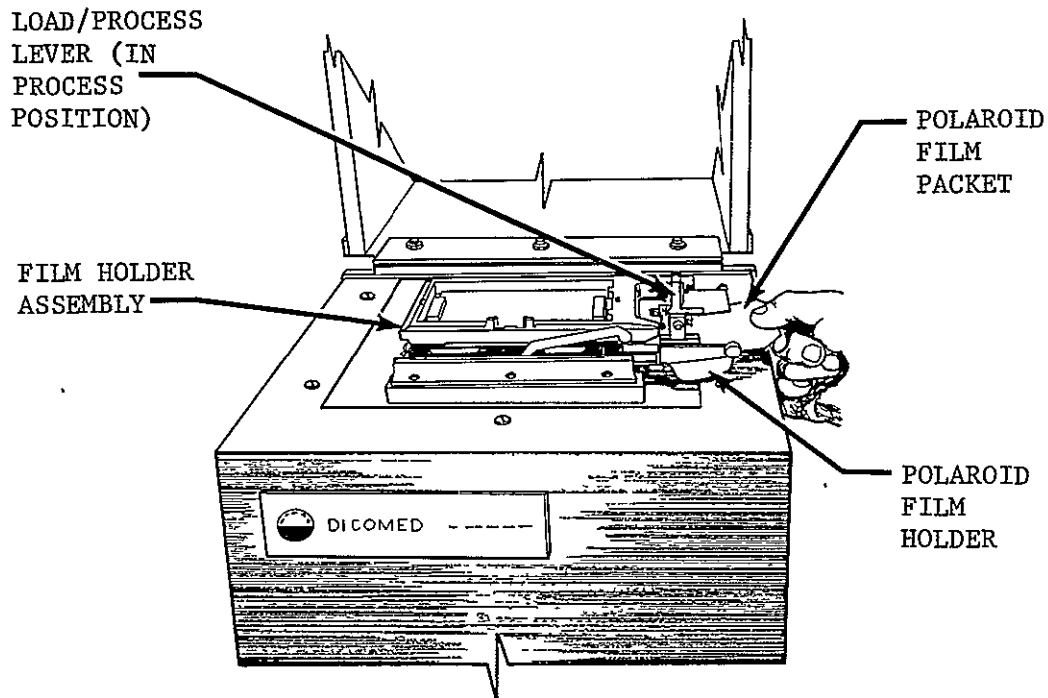
Figure 4-10.   Polaroid Film Adapter

- Type 52 for black-and-white prints.

- Type 55 for black-and-white negatives (Requires wet stabilizier solution).

- Type 58 for color prints.

The following procedure applies to all types of 4 X 5 inch Polaroid films:

1.   Lift the film holder assembly and insert the Polaroid film adapter from the right (See Figure 4-10).

2.   Move the film adapter load/process lever to the LOAD position.

3. Insert a film packet with the side which says "This Side Toward
    Lens" down. Take care to push the packet completely into the film
    holder to engage the metal clip of the packet in the film holder
    mechanism.

4. Pull the packet out of the holder as far as possible with moderate
    pressure. This withdraws the light protective paper cover from
    the sensitive film.

5. After the digital film recording is complete, push the packet back
    into the film holder and move the load/process lever to the PROCESS
    position.

6. Grasping the film packet by its exposed tabs, pull the film with
    moderate speed out of the holder.

7. Follow the instructions for film development printed on the packet.

4.9.1.2 Loading Cut Film

Standard 4 X 5 inch cut film in double sided cut-film holders are loaded
into the film recorder by simply inserting the holder under the spring
loaded, ground glass viewplate and then withdrawing the plastic film slide.

4.9.1.3 Loading Roll Film

A roll film holder (Figure 4-11) is provided for using 120 roll film. This
holder allows up to ten full size images to be recorded on a roll of 120
film. The roll film holder is loaded by the following procedure:

STEP A   STEP B

STEP C   STEP D
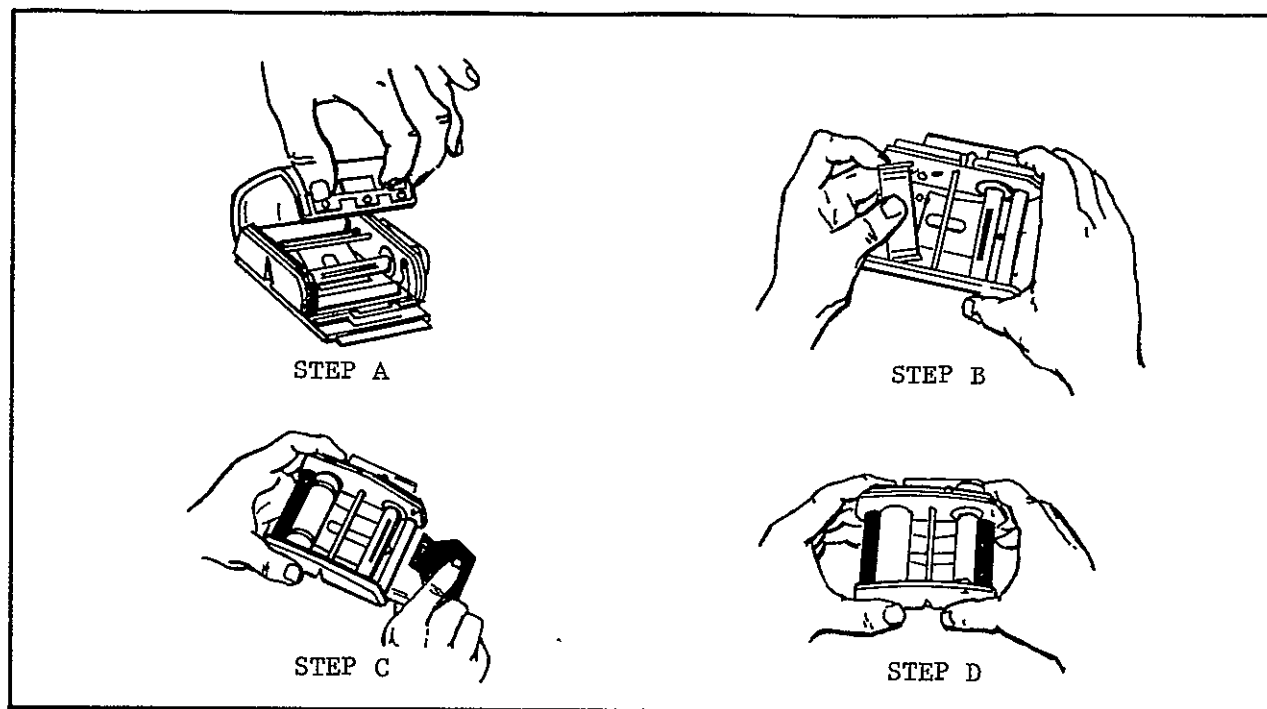
Figure 4-11.   Roll Film Holder and Loading Procedure

1.   Actuate the advance level until the last number on the exposure
     counter passes the white index dot and the counter no longer
     turns.

2.   Open the holder by squeezing both release latches together and
     lifting the cover (Figure 4-11A). The carriage can now be removed.

3.   Hold the full spool of film so that the paper leader will unwind
     counter-clockwise and place on the spring loaded stud on the left
     (supply) side. Press down until the spool can be snapped into
     place (Figure 4-11B).

4.   Break the seal on the film and unwind enough paper leader to pass
     around the front of the carriage and into the take-up spool.
     Insert the paper tab into the wider slot on spool (Figure 4-11C).
     Actuate the advance lever approximately 1/2 stroke to make one
     complete turn of the take-up spool. The paper must wind evenly
     between the two flanges of the spool. Continue to actuate the
     lever until the starting marker on the film is opposite the arrow
     inside the carriage (Figure 4-11D).

5.   Rotate the exposure counter in the direction of the arrow until it
     "clicks" into place near "S" and resists further turning. Do not
     attempt to rotate beyond this point.

6.   Replace the carriage in the holder and press down firmly on the
     cover to close, engaging both latches.

7.   Actuate the advance lever until it locks. Initial winding is now
     completed and the exposure counter is set at "1".

8.   The advance lever locks automatically after each exposure to
     prevent accidental film transport and overlapping exposure. To
     bring film into position for the next exposure, move the release
     lever to the left, then wind the film with a full stroke of the
     advance lever. Follow this sequence for all exposures. When the
     last exposure has been made, again move release lever to the left.
     Actuate the advance lever--it is now "free wheeling"--until drag
     on the take-up spool is no longer felt. Film is now fully wound.
     Remove the full spool and transfer the empty spool to the take-up
     position. Carriage is ready for reloading.

4.9.1.4 Calibrating the Recorder

The image recorder must be calibrated prior to use because different films
have different light sensitivities and because the film recorder "drifts"
with the passage of time. An accurate digital readout of the exposure index
is provided by the Test and Calibration panel. Exposure index values for a
number of recommended film types are tabulated in Figure 4-12. The

Film Type	Nominal Exposure Level	Nominal Calibration
Black/White Super XX 4142	6	190
Black/White Polaroid Type 52	0	120
Color Polaroid Type 58	10	310
Color Ektachrome 6115	10	310
Type 55 Positive	5	175
Type 55 Negative	10	310

Figure 4-12.   Film Exposure Index Values

procedure for exposure calibration is as follows (see Figure 4-9):

1. Verify that the recorder power is on, that the high voltage is
    off, and that the recorder is in the OPERATE mode.

2. Select a reference filter on the image recorder. The exposure
    index for a given type of film must be referenced to a particular
    filter.

3. Press the EXPOSURE CALIBRATE switch. After a delay the lamp will
    light and the exposure index will be displayed on the readout.

4. Adjust the EXPOSURE control on the Operator Control Panel to the
    indicated value for the film in use.

5. Adjust the EXPOSURE TRIM dial to arrive at the tabulated exposure
    index given on the exposure chart.

6. Press the EXPOSURE CALIBRATE switch to return the recorder to
    operational status.

4.9.1.5 Preparing the Recorder for Use

Once the recorder is properly calibrated, it is prepared for use as follows:

1. Verify that the recorder POWER is on, and that the desired film is
    properly loaded.

2. Press the OPERATE switch. The OPERATE lamp should light.

3. Verify that the plastic slide has been removed from in front of
    the film or that the Polaroid film packet has been withdrawn as
    described in Paragraph 4.9.1.1.

4. Turn on the HIGH VOLTAGE switch.

NOTE: Because it is possible for a minor malfunction to turn on the electron
beam in the recorder CRT and burn the faceplate of the CRT, it is advisable
to maintain the recorder with the HIGH VOLTAGE off except when the recorder
is being used. Therefore, the user should turn off the high voltage when he
has completed his recording tasks.

4.9.2 Principles of Operation

Digital image data is formatted by the minicomputer and transmitted, a line at a time, to the recorder. The data is buffered, converted to analog voltages, and applied to a high resolution cathode ray tube to modulate its election beam intensity and hence to control the brightness of each pixel of light emitted. The image produced on the CRT is focused onto the photographic film contained in a light-tight housing. Color filters may be inserted to produce red, green, and blue components for exposing color film.

4.9.3 Capability Specification

The capability of the image recorder is as follows:

Spot Size	— 1.3 mils (33 microns) diameter on face of CRT.
Orthogonality	— $\pm$ 0.5%.
Line Curvature	— $\pm$ 0.15%.
Image Generation Time	— Black and White = 1 1/2 minutes; color = 4 1/2 minutes.
Exposure Range	— 2.0 diffuse density units measured on 6115 film.
Exposure Levels	— 256 levels with either a linear or $\log_{10}$ relation to input gray codes.
Image Format	— 57 X 57 mm area maximum exposure field.
Film Format	— 4 X 5 inch film pack or sheets; 4 X 5 inch Polaroid packets; and 120 roll film. Film can be either black and white or color.

4.10   EQUIPMENT NOT DIRECTLY OPERATED BY THE USER

In addition to the hardware described above, which is directly manipulated
or operated by the user, Interactive IDAPS uses the following additional
equipment:

- Minicomputer mainframe, I/O, and memory
- Disk Drive
- Host Computer Interface
- Host Computer
- Digital Television Display Generator
- D/A Video Driver/Distributor
- Teletype

These items are discussed in Section 3.0 as required to describe their
control and use in Interactive IDAPS.

APPENDIX A

HOST COMPUTER ERROR MESSAGES.

IDAPS ERROR CODES (S/360)

Code	Operator	Condition
101	- - -	Column 4 nonblank in command card.
102	- - -	Operator not found in directory.
103	- - -	Error in file name specification.
104	- - -	File names neither first nor last in parameter list.
105	- - -	More than 5 files input.
106	- - -	Incorrect number of parameters for operator.
107	- - -	More than 8 characters in a command parameter.
108	- - -	ASCII to EBCDIC conversion error.
109	- - -	ASCII to EBCDIC conversion error, number of columns less than or equal zero.
110	- - -	EBCDIC to ASCII conversion error.
111	- - -	EBCDIC to ASCII conversion error, number of columns less than or equal zero.
112	- - -	End of data in batch mode.
113	- - -	Attempt to run batch mode without BATCH RUN card.
114	- - -	NOP out of range in INIT.
201	- - -	Number of files input is greater than number expected by operator.
202	- - -	Attempt to use more than 36 files for an operator.
203	- - -	Input file name not in directory.
204	- - -	All files in directory are in use.
205	- - -	All pixel files are in use.
206	- - -	All floating point files are in use.
207	- - -	Attempt to delete a file when there are no active files.

Code	Operator	Condition
208	– – –	Attempt to delete a pixel file whose logical unit is out of range.
210	– – –	Attempt to delete a floating point file whose logical unit is out of range.
301	– – –	Incorrect data length.
302	– – –	Record too long.
303	– – –	Incorrect LRC.
304	– – –	S/360 hardware detected error.
305	– – –	Front-end detected error.
306	– – –	Illegal function code.
307	– – –	DCB not open in ITRANS.
308	– – –	DCB not open in INTFAC.
309	– – –	S/360 hardware detected error.
310	– – –	Front-end detected error.
311	– – –	ITRANS error not in directory.
312	– – –	Transfer length error.
313	– – –	Cannot enable front-end.
401	– – –	Data card format error.
402	– – –	More than 24 columns in multiple value data.
403	– – –	More than 8 columns in multiplier.
404	– – –	More than 16 columns in data value.
405	– – –	Incorrect number of data values.
406	– – –	Error expecting type 3 message.
407	– – –	Error converting ASCII to EBCDIC.
501	– – –	Error echoing HELLO.
502	– – –	Data input out of sequence.
503	– – –	Image-file-ready message out of sequence.
504	– – –	Image-file-record message out of sequence.
505	– – –	End-of-file out of sequence.
506	– – –	Operation complete message from ID-70.
507	– – –	Error echoing GOOD-BYE.
508	– – –	Message type not supported.

Code	Operator	Condition
509	- - -	Error sending operation complete message.
1001-1013	SCA	Interface error sending image file ready message (See Note).
1014	SCA	Message out of sequence, expecting type 4.
1015	SCA	Message out of sequence, expecting type 5 or 6.
1021-1033	SCA	Interface error transmitting image data (See Note).
2001-2013	INP	Interface error sending image file ready message (See Note).
2014	INP	Message out of sequence, expecting type 4.
2015	INP	Message out of sequence, expecting type 5 or 6.
2016	INP	End-of-file skipping to starting record in batch mode.
2017	INP	Starting column greater than or equal to number of columns on tape.
2021-2033	INP	Interface error transmitting image data (see Note).
3001-3013	DIS	Interface error sending image file ready message (See Note).
3014	DIS	System to display called in batch mode.
3015	DIS	Attempt to display more lines than in input file.
3016	DIS	Attempt to display floating point file, use automatic scale operator to convert to image data format.
3021-3033	DIS	Interface error transmitting image data (See Note).
3041-3053	DIS	Interface error sending end-of-file message (See Note).

Code	Operator	Condition
4001-4013	OUT	Interface error sending image-file-ready message (See Note).
4014	OUT	Segment requested exceeds limits of input file.
4015	OUT	Attempt to write floating point file on tape, use automatic scale to convert to image data format.
4021-4033	OUT	Interface error transmitting image data (See Note).
4041-4053	OUT	Interface error sending end-of-file message (See Note).
5001-5013	FIL	Interface error sending image-file-ready message (See Note).
5014	FIL	Attempt to record more lines than in input file.
5015	FIL	Attempt to record floating point file on film, use automatic scale to convert to image data format.
5021-5033	FIL	Interface error transmitting image data (See Note).
5041-5053	FIL	Interface error sending end-of-file message (See Note).
6001-6013	PRI	Interface error sending image-file-ready message (See Note).
6014	PRI	Segment requested exceeds limits of input file.
6015	PRI	Attempt to print floating point file on ID-70.
6021-6033	PRI	Interface error transmitting image data (See Note).
6041-6053	PRI	Interface error sending end-of-file message (See Note).

Code	Operator	Condition
9002	DIF	Segment requested exceeds limits of input file.
11001	AUT	Segment requested exceeds limits of input file.
12001	EXT	Segment requested exceeds limits of input file.
13001	INS	Task not executed--input specification exceeds bounds.
15001	LAB	Label message is not type 3.
15002	LAB	ASCII to EBCDIC error converting label message.
15003	LAB	ASCII to EBCDIC error in label preparation.
17001	MAT	Attempt to divide by zero--output value set to input value.
19001	TRA	Segment requested exceeds limits of input file.
20001	FRA	Frame message is not type 3.
20002	FRA	ASCII to EBCDIC error converting frame message.
20003	FRA	ASCII to EBCDIC error in frame preparation.
21001	AVE	Segment requested exceeds limits of input file.
21002	AVE	Attempt to average a floating point file.
22001	HDC	Segment requested exceeds limits of input file.

NOTE: Interface errors which occur during the use of input and output operators (SCA, INP, DIS, OUT, FIL, PRI) are reported as errors in the appropriate operator. These will occur if an input/output operator is aborted before the task is completed. Any other occurrence of interface errors should be reported to IDAPS system programmers.

Code	Operator	Condition
9002	DIF	Segment requested exceeds limits of input file.
11001	AUT	Segment requested exceeds limits of input file.
11002	AUT	Attempt to scale a file whose minimum and maximum are equal.
12001	EXT	Segment requested exceeds limits of input file.
13001	INS	Task not executed--input specification exceeds bounds.
15001	LAB	Label message is not type 3.
15002	LAB	ASCII to EBCDIC error converting label message.
15003	LAB	ASCII to EBCDIC error in label preparation.
17001	MAT	Attempt to divide by zero--output value set to input value.
19001	TRA	Segment requested exceeds limits of input file.
20001	FRA	Frame message is not type 3.
20002	FRA	ASCII to EBCDIC error converting frame message.
20003	FRA	ASCII to EBCDIC error in frame preparation.
21001	AVE	Attempt to average a floating point file.
22001	HDC	Segment requested exceeds limits of input file.
28001	FEA	No subsets occur within given threshold limits.
32001	ARE	Feature point is outside the sphere, correction is impossible.
33001-13	BOR	Interface error transmitting border points (See Note 1).
34001	CON	A set of weights with more than 15 X 15 elements has been specified.

Code	Operator	Condition
35001	SIM	Window does not fit on image 1.
35002	SIM	Window does not fit on image 2.
38001	FFT	Attempt to Fourier transform a file smaller than 64 by 64.
39001	IFF	Input files to IFFT are not square.
39002	IFF	Input files to IFFT are not same size.
39003	IFF	Attempt to Inverse Fourier transform a file smaller than 64 by 64.
40001	FOU	Attempt to Fourier filter a file smaller than 64 by 64.
42001	FGN	$A \leq 0.0$ or $A > 1.0$.
42002	FGN	$B < 0.0$ or $B > 1.6$.
42003	FGN	$A \leq B$ for pass filter.
42004	FGN	$A < 0.0$ for pass filter.
42005	FGN	$B > 1.0$ for pass filter.
42006	FGN	Order of Bessel function is negative.
42007	FGN	Argument to Bessel function ≤ 0.0.
42008	FGN	Required accuracy in fitting algorithm not obtained.
42009	FGN	Range of N compared to X not correct in Bessel function.
42010	FGN	Elliptical fit did not converge in 5000 iterations.
42011	FGN	Elliptical fit did not converge, UPLIM = X.
42012	FGN	Input profiles are not both monotonic.
42013	FGN	Input profiles are not the same type.
42014	FGN	Requested spatial domain filter larger than 41 by 41.
42015	FGN	Requested frequency domain filter less than 64 by 64 or larger than 1024 by 1024.

NOTE 1:   Interface errors which occur during the use of input and output
operators (SCA, INP, DIS, OUT, FIL, PRI) are reported as errors in the
appropriate operator. These <u>will</u> occur if an input/output operator is
aborted before the task is completed. Any other occurrence of interface
errors should be reported to IDAPS system programmers.

NOTE 2:   A 600 level error which occurs while attempting to write a file
indicates that the write operation was not successful and any attempt to use
that file will result in erroneous results. Repeat the operator and if the
error persists report the error to the IDAPS systems programmers. A 600
level error which occurs while attempting to read a file indicates that the
read operation was not successful and the operator being executed was aborted.
Repeat the operator and if the error persists repeat the operator(s) which
generated the input file(s). If the problem still exists report the condi-
tion to the IDAPS systems programmers.

APPENDIX B

INTERACTIVE IDAPS OPERATORS

1.0 OPERATOR CROSS-REFERENCE INDEX

1.1 OPERATOR VS. SUBMENU CATEGORY

1.2 SUBMENU CATEGORY VS. OPERATOR

2.0 INTERACTIVE IDAPS OPERATORS

1.0 OPERATOR CROSS REFERENCE INDEX

1.1 OPERATOR VS. SUBMENU CATEGORY CROSS-REFERENCE INDEX

OPERATOR NAME (CODE)	SUBMENU CATEGORY (CODE)	PAGE
Alter (ALT)	Gray Scale Adjustment (C)	B-8
Automatic Scale (AUT)	Gray Scale Adjustment (C)	B-9
Average (AVE)	Math/Logic Functions (H)	B-11
Center Radius (CEN)	Image Analysis (I)	B-12
Convolutional Filter (CON)	Filter Operations (E)	B-12a
Dependent Alter (DEP)	Gray Scale Adjustment (C)	B-12c
Distance (DIS)	Image Analysis (I)	B-12e
Extract Subframe (EXT)	Manual Image Modification (D)	B-13
Fast Fourier Transform (FFT)	Filter Operations (E)	B-13a
Feature Analysis (FEA)	Image Analysis (I)	B-13b
Filter Generation (FGN)	Filter Operations (E)	B-13d
Fourier Filter (FOU)	Filter Operations (E)	B-13f
Frame (FRA)	Image Data Presentation (K)	B-14
Hand Drawn Shapes (HAN)	Function Generation (B)	B-15a
H-D Correction (HDC)	Gray Scale Adjustment (C)	B-16
Insert Subframe (INS)	Manual Image Modification (D)	B-18
Inverse Fast Fourier Transform (IFF)	Filter Operations (E)	B-18a
Invert (INV)	Gray Scale Adjustment (C)	B-19
Isogram (ISO)	Image Analysis (I)	B-20
Label (LAB)	Image Data Presentation (K)	B-21
Magnify (MAG)	Geometric Operations (F)	B-21a
Math (MAT)	Math/Logic Functions (H)	B-22
Overlay (OVE)	Image Analysis (I)	B-23
Picture Difference (DIF)	Image Analysis (I)	B-25

BATCH IDAPS OPERATOR CPU TIME REQUIREMENTS (Continued)

OPERATOR CODE	CPU Run Time in Minutes		
	$(256)^2$	$(512)^2$	$(1024)^2$
OUTPUT(OUT)	.10	.21	.55
OVERLAY(OVE)	.53	1.20	4.45
PICTURE DIFFERENCE(DIF)	1.09	3.56	11.61
PRINT(PRI)	(.05 Minutes Per Page)		
PSF GENERATOR (PSF)	1.82	7.06	--
REGISTER(REG)	1.06	5.81	--
ROTATE(ROT)	.90	5.47	--
STONYHURST(STO)	.27	.83	3.00
TRANSPOSE(TRA)	.23	.95	6.56

1.2 SUBMENU CATEGORY VS. OPERATOR CROSS-REFERENCE INDEX

SUBMENU CATEGORY (OPTION CODE)	OPERATOR NAME (CODE)	PAGE
Image Input/Output		
(A)	Scanner to Display (S-D)	B-28
(B)	Scanner to Tape (S-T)	B-36
(C)	Scanner to Film (S-F)	B-30
(D)	Scanner to Printer (S-P)	B-34
(E)	Scanner to System (SCA)	B-35
(F)	Tape to Display (T-D)	B-47
(G)	Tape to Tape (T-T)	B-53
(H)	Tape to Film (T-F)	B-49
(I)	Tape to Printer (T-P)	B-51
(J)	Tape to System (INP)	B-52
(K)	System to Display (DIS)	B-39
(L)	System to Tape (OUT)	B-44
(M)	System to Film (FIL)	B-41
(N)	System to Printer (PRI)	B-43
Function Generation		
(A)	Hand Drawn Shapes (HAN)	B-15a
(B)	Filter Generation (FGN)	B-13d
(C)	Table Modification (DTE)	B-45
Gray Scale Adjustment		
(A)	Alter (ALT)	B-8
(B)	Dependent Alter (DEP)	B-12c
(C)	Automatic Scale (AUT)	B-9
(D)	Invert Gray Scale (INV)	B-19
(E)	Math (MAT)	B-22
(F)	Hand Drawn Shapes (HAN)	B-15a
(G)	H-D Correction (HDC)	B-16

1.2 SUBMENU CATEGORY VS. OPERATOR CROSS-REFERENCE INDEX (Cont'd.)

SUBMENU CATEGORY (OPTION CODE)	OPERATOR NAME (CODE)	PAGE
Manual Image Modification		
(A)	Extract Subframe (EXT)	B-13
(B)	Insert Subframe (INS)	B-18
(C)	Test Image Generation (IMA)	
Filter Operations		
(A)	Convolutional Filter (CON)	B-12a
(B)	Fourier Filter (FOU)	B-13f
(C)	FFT (FFT)	B-13a
(D)	IFFT (IFF)	B-18a
(E)	Filter Generation (FGN)	B-13d
Geometric Operation		
(A)	Rotate (ROT)	B-27
(D)	Transpose (TRA)	B-54
(E)	Register (REG)	B-26
(D)	Extract Subframe (EXT)	B-13
(E)	Insert Subframe (INS)	B-18
(F)	Magnify (MAG)	B-21a
Classification/Pattern Recognition		
(A)	Feature Analysis (FEA)	B-13a
(B)	Similarity (SIM)	B-37a
Math/Logic Functions		
(A)	Average (AVE)	B-11
(B)	FFT (FFT)	B-13a

1.2 SUBMENU CATEGORY VS. OPERATOR CROSS-REFERENCE INDEX (Cont'd.)

SUBMENU CATEGORY (OPTION CODE)	OPERATOR NAME (CODE)	PAGE
(C)	IFFT (IFF)	B-18a
(D)	Math (MAT)	B-22
Image Analysis		
(A)	Feature Analysis (FEA)	B-13a
(B)	Distance (DIS)	B-12e
(C)	Center/Radius (CEN)	B-12
(D)	Isogram (ISO)	B-20
(E)	Overlay (OVE)	B-23
(F)	Picture Difference (DIF)	B-25
Pseudocolor		
(A)	Scanner to Display	B-29
(B)	Scanner to Film	B-32
(C)	Tape to Display	B-48
(D)	Tape to Film	B-50
(E)	System to Display	B-40
(F)	System to Film	B-42
Image Data Presentation		
(A)	Frame (FRA)	B-14
(B)	Label (LAB)	B-21
(C)	Stonyhurst Grid (STO)	B-38

SECTION 2.0 INTERACTIVE IDAPS OPERATORS

(In alphabetical order by name)

ALTER (ALT)

This operator modifies the gray values of an input image array by a technique
of table look-up in accordance with a data table supplied by the user. This
operator may be used for such purposes as contrast enhancement, pseudocon-
touring, or masking of specific gray levels.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY        INTERACTIVE  IDAPS      TIME:  08:31:25
FILE NAME:  1SCA                                 ELAPSED: 00H, 03MIN

GRAY SCALE ADJUSTMENT - ALTER (ALT)

OPTION |   PARAMETER DESCRIPTION
-------|------------------------
 1SCA  | INPUT FILE NAME
       |
   B   | DATA SOURCE
       |   A - SYSTEM DEFAULT (ALT )
       |   B - CARDS
```

Data Card Format: The data source must be specified by card input of 256
integer values in the following format:

```
ALT=255,252,3*248,244,....,3,2,1,0$
```

In the above example, all gray vaues of 0 in the input picture will be
replaced by 255's; all 1's by 252; 2's, 3's, and 4's by 248; 5's by 244;
etc.

Note:
1. The input file for this operator must be integer.

AUTOMATIC SCALE (AUT)

This operator automatially scales integer or floating point image data to a
range of 0-255 integers. The operator is particularly useful in presenting
a floating-point image array as a picture. Scaling may be specified to one
of a number of standard curves between user-selected upper and lower limits.

Both the host computer and the terminal minicomputer are required by this
operator.

```
360 STATUS: READY    INTERACTIVE IDAPS        TIME: 08:07:49
FILE NAME:  2AUT                               ELAPSED:00H,03MIN

GRAY SCALE ADJUSTMENT - AUTOMATIC SCALE (AUT)

  OPTION  |  PARAMETER DESCRIPTION   || OPTION |    PARAMETER DESCRIPTION
  2SCA      INPUT FILE NAME              A       PRINT OPTION
                                                 A - PRINT CONVERSION TABLE
  1         STARTING LINE NUMBER                 B - RETURN TO MASTER MENU

  1         STARTING COLUMN NUMBER

  291       NUMBER OF LINES

  296       NUMBER OF COLUMNS

  A         FUNCTION FLAG
            A - LINEAR
            B - LOGARITHMIC            MINIMUM VALUE =  .00000000 E  0
            C - SQUARE ROOT
            D - CUBE ROOT              MAXIMUM VALUE =  .20499700 E  3
            E - SQUARE
                                       SPREAD =         .20499700 E  3
  A         LIMIT FLAG
            A - NO LIMITS              STEP SIZE =      .80391900 E  0
            B - LIMIT ARE IMPOSED

  0.0       LOWER LIMIT

  255.      UPPER LIMIT
```

Note:
1. Specifying the Starting Line, Starting Column, Number of Lines and
Number of Columns allows the user to apply this operator to any subframe of
the input file.

2. When specified, one of the following operations is used for automatic
scaling:

Linear: $n = \left(\dfrac{f - b}{a - b}\right) 255$

Cube Root; $n = \left(\dfrac{f^{1/3} - b^{1/3}}{a^{1/3} - b^{1/3}}\right) 255$

Logarithmic; $n = \left(\dfrac{\text{Log}_{10}\,(f/b)}{\text{Log}_{10}\,(a/b)}\right) 255$

Square; $n = \left(\dfrac{f^2 - b^2}{a^2 - b^2}\right) 255$

AUTOMATIC SCALE (Continued)

Note (Continued):

Square Root; $n = \left(\dfrac{f^{1/2} - b^{1/2}}{a^{1/2} - b^{1/2}} \right) 255$

Where: a = maximum value in the date set or upper limit.
        b = minimum value in the data set or lower limit.
        f = original input value.
        n = computed output value (0-255).

AVERAGE (AVE)

This operator averages several frames of image data. This operation is
often helpful in reducing the signal-to-noise ratio where a number of nearly
identical frames exist, but which individually are corrupted by random
noise.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY      INTERACTIVE  IDAPS        TIME: 08:37:15
FILE NAME:  1SCA                                 ELAPSED:00H,09MIN

MATH/LOGIC FUNCTIONS - AVERAGE

OPTION|   PARAMETER DESCRIPTION
  2   | NUMBER OF IMAGES TO BE AVERAGED (MAXIMUM OF 5)
      | INPUT FILE NAME
      | INPUT FILE NAME
```

Note:
1. A maximum of five files may be averaged.

2. All input files must be the same size and registered (the EXTRACT,
REGISTER, or ROTATE operators may be used to accomplish sizing and registra-
tion).

3. The input files must be integer.

CENTER DIAMETER (CED)

This operator calculates the location of the center and the length of the
diameter of the solar disk based on the location of three points. The user
supplies the line and column coordinates for three points on the apparent
limb of the sun.

The host computer is not required by this operator.

```
360 STATUS: DOWN      INTERACTIVE  IDAPS        TIME: 11:38:20
                                                ELAPSED:00H,18MIN

IMAGE ANALYSIS - CENTER DIAMETER

OPTION |    PARAMETER DESCRIPTION
───────┼──────────────────────────────
  0    | LINE POINT 1
 239   | COLUMN POINT 1
 239   | LINE POINT 2
  0    | COLUMN POINT 2
 479   | LINE POINT 3
  0    | COLUMN POINT 3
```

Note:
1. The three points must not be colinear.

2. For maximum accuracy, the three points should be approximately evenly
spaced around the solar limb.

EXTRACT SUBFRAME (EXT)

This operator extracts a subframe from a larger input image array, creating
a new output file of reduced size.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY     INTERACTIVE  IDAPS        TIME: 08:33:55
FILE NAME:  1SCA                                ELAPSED:00H,05MIN

MANUAL IMAGE MODIFICATION - EXTRACT SUBSET (EXT)

OPTION |   PARAMETER DESCRIPTION
-----------------------------------------------------------------------
1SCA   | INPUT FILE FROM WHICH PICTURE SUBSET IS EXTRACTED.

  1    | STARTING LINE.

  1    | STARTING COLUMN.

 480   | NUMBER OF LINES.

 480   | NUMBER OF COLUMNS.
```

Note:
1. The input file for this operator must be integer.

FAST FOURIER TRANSFORM (FFT)

This operator performs a two-dimensional Fourier transformation on the input
array (file) and produces two output arrays (files) which contain the complex
components in the frequency domain. The output arrays (files) may be in the form
of real and imaginary components or in the form of magnitude and phase components.

Both the host computer and the terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is required.

```
369 STATUS: READY     INTERACTIVE  IDAPS       TIME: 08:48:30
FILE NAME.  1MAT                                ELAPSED:00H,05MIN

FILTER OPERATIONS - FAST FOURIER TRANSFORM (FFT)

OPTION |    PARAMETER DESCRIPTION
-----------------------------------------------------------------------
 1MAT  | INPUT FILE NAME
       |
   D   | OUTPUT FORMAT
       |    A - REAL/IMAGINARY - DC TERM AT LOCATION 1,1
       |    B - REAL/IMAGINARY - DC TERM CENTERED
       |    C - MAGNITUDE/PHASE - DC TERM AT LOCATION 1,1
       |    D - MAGNITUDE/PHASE - DC TERM CENTERED
       |
       |    NOTE:  FFT PRODUCES TWO OUTPUT FILES WHICH REPRESENT THE REAL
       |           AND IMAGINARY OR THE MAGNITUDE AND PHASE COMPONENTS
       |           OF THE TRANSFORM.
       |
   B   | NORMALIZATION OPTION
       |    A - NORMALIZED BY DIVIDING FREQUENCY TERMS BY THE VOLUME UNDER
       |        THE CURVE AND REVERSING THE SIGN OF ALTERNATE TERMS.
       |    B - NOT NORMALIZED
       |
   B   | WINDOW OPTION
       |    A - APPLY WINDOW FUNCTION TO INPUT FILE
       |    B - DO NOT APPLY WINDOW FUNCTION
       |
   A   | TYPE OF WINDOW
       |    A - HANNING
       |    B - HAMMING
```

Note:
1. The number of rows (and columns) in the input file must be a power of 2.

2. The input file must have at least 64 rows and columns, but not more than
1024 rows and columns.

3. The "image to be analyzed" may or may not be the same as the "input
file" and may be either integer or floating point format. Typically the
"input file" will be an integer picture while the "image to be analyzed"
will be a floating point file which has been "H and D" corrected.

4. An intermediate output is generated which is the feature map. The
feature map may be displayed on either of the B/W console monitors. Since
the feature map is in the standard output format, it may be used again if an
analysis is desired of other features within the map. This is done by
choosing option "B" for the second parameter.

FILTER GENERATION (FGN)

This operator generates filter files to be used with the convolutional
filter in the spatial domain or the Fourier filter in the frequency domain.
Rotationally symmetric filters are generated by rotating the input x-z plane
profile about the z-axis. Non-symmetric filters are generated by elliptically
fitting the filter surface to input x-z and y-z plane profiles. The input
profile(s) may be input via cards or default tables or internally generated
using one of the optional algorithms.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
ESC STATUS: READY    INTERACTIVE  IDAPS      TIME: '3.53.1
FILE NAME:  7IMA                              ELAPSED:00H.49MIN

FILTER OPERATORS - FILTER GENERATION (FGN)

 PTION     PARAMETER DESCRIPTION        || OPTION   PARAMETER DESCRIPTION
 ─────────────────────────────────────────────────────────────────────
 B        SYMMETRY FUNCTION             || 1.       MAXIMUM AMPLITUDE
          A - ROTATIONAL SYMMETRY       ||
          B - ELLIPTICAL FIT            || 0.       MINIMUM AMPLITUDE

 C        FILTER CROSS SECTION IN X-Z PLANE || A     TYPE OF FILTER
                                        ||          A - FREQUENCY DOMAIN
 C        FILTER CROSS SECTION IN Y-Z PLANE ||       B - SPATIAL DOMAIN
          A - CIRCULAR APERTURE DIFFRACT.||
          B - MODIFIED EXPONENTIAL      || 512      SIZE OF FILTER (NXN)
          C - GAUSSIAN DISTRIBUTION     ||
          D - ZERO ORDER BESSEL FUNCTION|| B        INVERSION OPTION
          E - DEFOCUSED LENS MTF        ||          A - DO NOT INVERT FILTER
          F - LOW PASS FILTER           ||          B - INVERT FILTER
          G - HIGH PASS FILTER          ||
          H - BAND PASS FILTER          || 5.       INVERSION LIMIT (MAXIMUM)
          I - BAND REJECT FILTER        ||
          J - CARD INPUT                ||
          K - DATA TABLES (FGN1,FGN2)   ||

 .75      X-Z PLANE 3 SIGMA POINT(0.<A<1.) ||

 .9       Y-Z PLANE 3 SIGMA POINT(0.<A<1.) ||
```

Data Card Format: The data source may be specified by card input of 251
floating point values corresponding to the normalized amplitudes at normalized
frequency values of 0., .004, .008, ..., .992, .996, 1.0. One table is
required for symmetric filters and two tables are required for non-symmetric
filters. The table formats are given in the example below:

```
FGN2=1.0,.95,.86,.71,.46,.16,.11,.07,.04,.02,.01,241*0.$

FGN1=1.0,.99,.92,.79,.61,.39,.12,.03,.02,.01,241*0.$
```

Note:

1. Both input profiles for non-symmetric filters must be monotonic and either increasing or decreasing.

2. The filter size is limited to 1024 by 1024 for frequency domain filters and 15 by 15 for spatial domain filters.

FOURIER FILTER (FOU)

This operator applies a two-dimensional frequency domain filter to an image
file by multiplying the magnitude component of a Fourier transformed image
by the filter file and inverse transforming the resulting file with the
corresponding phase component file to give a filtered image file. ·

Both the host computer and the terminal computer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY      INTERACTIVE  IDAPS        TIME: 08:50:55
FILE NAME:  1MAT                                 ELAPSED:00H,07MIN

FILTER OPERATIONS - FOURIER FILTER (FOU)

OPTION |   PARAMETER DESCRIPTION
-------+----------------------------------------------
 1MAT  | INPUT IMAGE NAME

 1FGN  | FILTER NAME

   B   | WINDOW OPTION
       |   A - APPLY WINDOW FUNCTION TO INPUT FILE
       |   B - DO NOT APPLY WINDOW FUNCTION

   A   | TYPE OF WINDOW
       |   A - HANNING
       |   B - HAMMING
```

Note:
1. If the input image name references an image file, that file will be
Fourier transformed before the filter is applied. If the input image has
previously been Fourier transformed, then that step may be skipped by speci-
fying the magnitude component (e.g., 1FFM) as the input image name.

FRAME (FRA)

This operator adds user annotations to an image file to identify the image,
to explain the processing which it has undergone, and to call attention to
regions of special interest. Such annotations are helpful in preparing
processed pictures for final hardcopy output. The operator also provides a
reference gray scale wedge, reference tick marks around the border, a histogram
of gray values within the image, and an optional rectangular grid overlay.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY     INTERACTIVE  IDAPS        TIME: 08:38:50
FILE NAME:  1SCA                                ELAPSED:00H,10MIN

IMAGE DATA PRESENTATION - FRAME (FRA)

OPTION |  PARAMETER DESCRIPTION        | OPTION |   PARAMETER DESCRIPTION
-------+-------------------------------+--------+-------------------------
 1SCA  | INPUT FILE NAME               |   A    | RECTANGLE OPTION
       |                               |        |    A - NO RECTANGLE
  A    | GRAY SCALE INVERSION          |        |    B - RECTANGLE AS SPECIFIED
       |    A - NO INVERSION           |        |
       |    B - PICTURE IS INVERTED    |        | RECTANGLE COORDINATES
       |                               |   0    |    UPPER LINE NUMBER
  B    | FRAME COLOR                   |   0    |    LEFT COLUMN NUMBER
       |    A - BLACK                  |   0    |    LOWER LINE NUMBER
       |    B - WHITE                  |   0    |    RIGHT COLUMN NUMBER
       |                               |        |
  A    | GRID OPTION                   |        |
       |    A - NO GRID                |        |
       |    B - 32 X 32 SECTORS        |        |

  0       NUMBER OF LINES IN TOP LABEL (80 CH/LINE, 5 LINES MAXIMUM)



  0       NUMBER OF LINES IN BOTTOM LABEL (80 CH/LINE, 5 LINES MAXIMUM)
```

Note:
1. Since the FRAME is generated around the input image, the output file is
larger than the input by 126 columns and at least 201 lines. An additional
14 lines must be added for each label provided in the FRAME.

2. The input picture may be gray scale inverted before output and the user
has the option of a white frame (255's) with black labels (0's) or a black
frame with white labels.

3. The user may specify overlay of a rectangle on the image to aid identifi-
cation of a region of interest.

FRAME (Continued)

Note (Continued):

4. Labels are entered directly from the user keyboard and appear at the top or bottom of the scenario, as specified.

5. The following character set is available:
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-(),/=.'*(space)

H-D CORRECTION (HDC)

This operator converts image data group values to energy or intensity values
using the proper film characteristic data and scanner calibration. The user
must provide a set of calibration data, which should be obtained at the time
the image data is scanned.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY   INTERACTIVE IDAPS          TIME: 08:33:30
FILE NAME:  1SCA                               ELAPSED:00H,05MIN

GRAY SCALE ADJUSTMENT - H-D CORRECTION (HDC)

OPTION     PARAMETER DESCRIPTION          OPTION     PARAMETER DESCRIPTION

  A      H-D CORRECTION SOURCE              A      SCALING FACTOR
         A - SCAN FILM SAMPLES                     A - FUNCTION OF DENSITY(LOG)
         B - CARDS                                 B - FUNCTION OF TRANSMIT-
         C - DATA TABLES (HDC1,HDC2)                   TANCE (LINEAR)

 1SCA    INPUT FILE NAME                    A      SCAN POLARITY
                                                   A - NORMAL
  1      STARTING LINE                             B - COMPLEMENT

  1      STARTING COLUMN                    B      INTEGRATION TIME (MICROSECONDS)
                                                   A -    20 (28 DB S/N)
 480     NUMBER OF LINES                           B -    80 (34 DB S/N)
                                                   C -   320 (40 DB S/N)
 480     NUMBER OF COLUMNS                         D -  1280 (46 DB S/N)

                                            A      FILTER
                                                   A - NEUTRAL
                                                   B - RED
                                                   C - GREEN
                                                   D - BLUE
                                                   E - MANUAL/CURRENT SETTING

                                            6      ILLUMINATION LEVEL

                                            0      LOWER CLIPPING LIMIT

                                            8      UPPER CLIPPING LIMIT
```

Note:
1. H-D correction data may be generated on-line if the on-line scanner is
used for image input. The user scans a set of sensitometry strips (e.g.,
five to twenty) using the same scanner settings used for the input image
scan and then specifies the energy/ intensity corresponding to each step.
Interpolation is automatically performed to derive a table of 256 floating
point values which relate gray value directly to energy/ intensity.

2. The user may supply H-D correction data by card or keyboard input. The
data format is shown on the following page.

H-D CORRECTION (Continued)

```
/ 360 STATUS: READY   INTERACTIVE IDAPS      TIME: 08:15:35
/ FILE NAME:  2AUT                           ELAPSED:00H,11MIN
|
| GRAY SCALE ADJUSTMENT - H-D CORRECTION (HDC)
|
| PLACE FILM IN SCANNER, CHECK MIRROR DOWN.
|
| OPTION     PARAMETER DESCRIPTION
|        |───────────────────────────
|        | THE SCANNER CAN ADDRESS ANY POINT
|        | IN AN ARRAY OF 2048X2048 ADDRESS
|        | LOCATIONS. USING THE TRACKBALL,
|        | LOCATE THE UPPER-LEFT CORNER AND
|        | LOWER-RIGHT CORNER OF THE AREA TO
|        | BE SCANNED, OR ENTER FROM THE
|        | KEYBOARD: **
|
|  1112   | UPPERMOST SCAN ADDRESS      ** NOTE: TRACKBALL INPUT OF
|   616   | LEFTMOST SCAN ADDRESS          THESE VALUES IS BASED ON
|  1168   | LOWERMOST SCAN ADDRESS         QUICK-LOOK SCAN.
|   664   | RIGHTMOST SCAN ADDRESS
|
|         | GRAY SCALE VALUE =    0
|
|  0.     |        ENTER ENERGY/TRANSMITTANCE VALUE,
|         |        THEN "UP ARROW" TO REPEAT OR "DOWN ARROW" TO TERMINATE.
|
|  A      | DATA PRINT OPTION
|         |    A - NO
|         |    B - YES
|
|  A      | OUTPUT FILE FORMAT
|         |    A - FLOATING POINT
|         |    B - INTEGER
|         |    C - NONE
```

Note (Continued):
3. The scenario displayed above is used when Scan Film Samples is chosen for
the H-D correction source. The user may scan up to 256 sensitometry strips
and enter the same number of energy values, repeating the process until he
presses the "down arrow". The values thus entered are stored in the data
tables (HDC1 and HDC2). The gray values as well as the energy/intensity
values are averages for the strip scanned.

Data Card Format:

```
/ HDC1=20,62,125,197,236$
|
|
```

```
/ HDC2=3.6,92,273.7,9.63E2,1.635E04$
|
|
```

The first gray value of HDC1 corresponds to the first energy/intensity value
of HDC2, etc.

HAND DRAWN SHAPES (HAN)

This operator is employed to create an image file which contains up to five
user-input shapes. The user traces the boundary of the shape with the
trackball. He is given the option of setting the insides and outsides of
the shapes to either a specified gray scale value or to the gray scale value
of an existing 360 image.

Both the host computer and terminal minicomputer are required by this operator.

Note:
1. The example HAND DRAWN SHAPES scenario shown above is for the case where
the user wishes to define a shape with a specified gray scale value inside
and overlay the shape on an existing 360 file.

2. Intermediate output files are generated by the BORDER, AVERAGE, and
FEATURE ANALYSIS operators during the course of execution of the HAND DRAWN
SHAPES operator.

INSERT SUBFRAME (INS)

This operator inserts a portion of one image (the overlay) into another
image (the underlay). The user has the option of specifying where the
overlay is to be inserted in the underlay.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY    INTERACTIVE  IDAPS      TIME:  08:34:20
FILE NAME:  1SCA                             ELAPSED:00H.06MIN

MANUAL IMAGE MODIFICATION - INSERT SUBFRAME


OPTION |   PARAMETER DESCRIPTION        |OPTION|    PARAMETER DESCRIPTION

          UNDERLAY IMAGE SPECIFICATION          OUTPUT IMAGE SPECIFICATION

             FILE NAME                             NUMBER OF LINES

   1         LINE LOCATION IN OUTPUT               NUMBER OF COLUMNS

   1         COLUMN LOCATION IN OUTPUT     A       BACKGROUND INTENSITY
                                                     A = 0
          OVERLAY IMAGE SPECIFICATION                B = 255

             FILE NAME

   1         STARTING LINE

   1         STARTING COLUMN

             NUMBER OF LINES

             NUMBER OF COLUMNS             (

   1         LINE LOCATION IN OUTPUT

   1         COLUMN LOCATION IN OUTPUT
```

Note:
1. The user controls the position in the output array of both the underlay
and overlay input images.

2. Specifying the Starting Line, Starting Column, Number of Lines and
Number of Columns allows the user to extract the overlay image from a larger
file.

3. The output array may be specified as larger than the input image combina-
tion in which case a black or white background is included in the output
file.

INVERSE FAST FOURIER TRANSFORM (IFF)

This operator transforms two input files containing the complex components
in the frequency domain into an output file in the spatial domain. The
input files may be in the form of real and imaginary components or in the
form of magnitude and phase components.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

Note:
1. The input files must be the same size.

2. The number of rows (and columns) in the input files must be a power
of 2.

3. The input files must have at least 64 rows and columns, but not more
than 1024 rows and columns.

4. The output file is in floating point format.

INVERT (INV)

This operator reverses the gray scale relationships within an image array.
All 0's become 255's; 1's become 254's; 2's become 253's; etc.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY     INTERACTIVE IDAPS     TIME: 08:32;30
FILE NAME:  1SCA                            ELAPSED:00H,04MIN

GRAY SCALE ADJUSTMENT - INVERT (INV)

OPTION |   PARAMETER DESCRIPTION

 1SCA  | INPUT FILE NAME
```

Note:
1. The input file for this operator must be integer.

ISOGRAM (ISO)

This operator produces a graphic plot of the locus of the intersection of
gray scale bands specified by the user. In order to reduce the point content
of the input data, a low pass filter operation may be performed prior to
calculating the isogram.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
 I5  STATUS  READY      INTERACTIVE IDAPS        TIME: 15.23..:
 FILE NAME.  IRAN                                ELAPSED 00H.13MIN

 IMAGE ANAL/SIS - ISOGRAM (ISO)

 OPTION I   PARAMETER DESCRIPTION
 ─────────┬──────────────────────────────────
  IRAN    │ INPUT FILE NAME

   128    │ NUMBER OF LINES

   126    │ NUMBER OF COLUMNS

    1     │ STARTING LINE

    1     │ STARTING COLUMN

    A     │ INPUT
          │   A - SMOOTH DATA
          │   B - DO NOT SMOOTH DATA

    5     │ NUMBER OF CONTOURS

   65     │ GRAY VALUE OF FIRST CONTOUR
   75     │ GRAY VALUE OF SECOND CONTOUR
   85     │ GRAY VALUE OF THIRD CONTOUR
   95     │ GRAY VALUE OF FOURTH CONTOUR
  200     │ GRAY VALUE OF FIFTH CONTOUR
```

LABEL (LAB)

This operator superimposes alphanumeric labels directly on an image.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY      INTERACTIVE  IDAPS        TIME: 08:39:45
FILE NAME:  1SCA                                 ELAPSED:00H,11MIN

IMAGE DATA PRESENTATION - LABEL

OPTION |  PARAMETER DESCRIPTION

 1SCA  |  INPUT FILE NAME

   B   |  COLOR OF LABEL
       |    A - BLACK
       |    B - WHITE

   1   |  STARTING LINE NUMBER (14 LINES/CH)

   1   |  STARTING COLUMN NUMBER (10 COLUMNS/CH)


ENTER LABEL BELOW, 80 CH MAX.  AN UP ARROW ALLOWS UP TO 12 LINES OF LABELS. A
DOWN ARROW PRODUCES AUTOMATIC LINE INCREMENTATION. THE EXECUTE KEY WILL INITIATE
360 EXECUTION.
```

Note:
1. The following character set is available:
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-(),/=.'*(space)

2. A maximum of 12 lines of label may be specified.

MAGNIFY (MAG)

This operator performs a geometric transformation which expands or reduces the
size of an image. Four way linear interpolation is used to provide values from
the input array which are not at the exact location of an input pixel.

Both the host computer and terminal minicomputer are required by this operator until
the operator goes into execution, then only the host computer is required.

```
  360 STATUS: READY     INTERACTIVE  IDAPS        TIME: 09:21:45
  FILE NAME:  1HAN                                ELAPSED:004,11MIN

  GEOMETRIC OPERATION - MAGNIFY (MAG)

        OPTION              PARAMETER DESCRIPTION

    1HAN                  INPUT FILE NAME

    1.                    MAGNIFICATION FACTOR


        VALUE               COMPUTED PARAMETERS

    128                   NUMBER OF LINES IN OUTPUT

    128                   NUMBER OF COLUMNS IN OUTPUT

  PRESS "UP ARROW" TO CHANGE PARAMETERS,
  PRESS "EXEC" OR "DOWN ARROW" TO PROCEED.
```

Note:
1. After the user specifies the input file and magnification factor, the number
of lines and columns in the output is computed and displayed before the magnifi-
cation is actually executed. This allows the user to adjust his magnification
factor to make the output file a specific size.

2. The size of the output is constrained to be less than or equal to 2048 X
2048 samples. An expansion factor which would otherwise, produce a larger out-
put will yield an output of the upper left hand 2048 X 2048 portion of the
magnified image.

3. Size reductions are obtained by specifying a magnification factor M
where $0 < M < 1$.

MATH (MAT)

This operator performs a number of ordinary arithmetic operations on one or
two input image arrays.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
ЭЄ  ЭTлT.Э: FEADY   INTERACTIVE IDAPS      TIME: Э9 5Э:1 Е
FILE ЛЛГE.  ТI1Л                           ELAPSED·ООН,4ЭMIЛ

ЛTh/LCЫC - ПАTH (ПЛT)

     OPTIЈЛ    PлFлMETEP DESCPIPTIЭЛ

       A       OPEPATIЭЛ FLAG
               л - л+B
               B - A-B
               C - A*B
               C - A/B
               E - л+CN
               F - A*CN
               G - CN/A
               H - Aл*CN
               I - LN(A)
               J - EXP(A)

               INPUT FILE NAME - FILE A
```

Note:
1. The following definitions apply:

    X - First input file specified.
    Y - Second input file specified.
    CN - A user-specified constant.

2. Operations A, B, C, and D result in a displayed request for a second
input file and the respective operation is performed between corresponding
pixels of the two arrays (X & Y).

3. Operations E, F, G, H, I, and J result in a displayed request for keyboard
specification of the constant (CN).

4. Although the input files may be integer or floating point, the output of
this operator is always in floating point format.

OVERLAY (OVE)

Several modes are available to produce output files in which the pixels of
the primary image are replaced by values controlled by the overlay image.
The image is a standard, integer image file. The primary image is a standard,
integer image file. The overlay image is either a bilevel map or an image
in which a specified Substitution Level acts as a flag to cause pixels in
the primary image to be set to a value determined by the mode and the user
specified constants.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
  DEV STATUS  READY    INTERACTIVE IDAPS       TIME: 10:03:45
  FILE NAME:  "IM"                             ELAPSED.00H,52MIN

  IMAGE ANALYSIS - OVERLAY (OVE)

  OPTION |  PARAMETER DESCRIPTION         |OPTION|    PARAMETER DESCRIPTION
  ----------------------------------------------------------------------------
  1IMP   | IMAGE FILE NAME                | 255  | SUBSTITUTION LEVEL
  1      | STARTING LINE                  | E    | MODE
  1      | STARTING COLUMN                |      |   A - CONSTANT ADDITION
                                          |      |   B - CONSTANT SUBSTITUTION
  301    | NUMBER OF LINES                |      |   C - TWO LEVEL SUBSTITUTION
                                          |      |       POSITION CONTROLLED
  300    | NUMBER OF COLUMNS              |      |       DOTTED CONTOURS
                                          |      |   D - OVERLAY INSERTION
  'FEM   | OVERLAY FILE NAME              |      |   E - TWO LEVEL SUBSTITUTION
  1      | STARTING LINE                  |      |       INTENSITY CONTROLLED
  1      | STARTING COLUMN                |      |
  301    | NUMBER OF LINES                |      |
  300    | NUMBER OF COLUMNS              |      |
         | REFERENCE POSITION IN IMAGE FILE     |
  1      |    REFERENCE LINE              |      |
  1      |    REFERENCE COLUMN            |      |
```

Note:
1. The Substitution Level specifies a gray value in the overlay image for
modes A, B, C, & E and in the primary image for Mode D. Wherever a pixel
equals the Substitution Level, the overlay is performed.

2. The user must specify either one or two constant values, depending on
the mode. A description of the required constant appears after all of the
parameters shown above have been specified.

OVERLAY (Continued)

Note (Continued):

3. The following overlay modes are provided:

A - A constant value is added to the gray value of the primary image wherever the Substitution Level is found in the overlay image.

B - A constant is substituted for the primary image pixels wherever the Substitution Level is found in the overlay image.

C - Two constants are alternately substituted for the primary image pixels wherever the Substitution Level is found in the overlay image.

D - Wherever a Substitution Level gray value occurs in the image the corresponding pixel value is substituted from the overlay image.

E - Wherever the Substitution Level is found in the overlay image, either of two constants is placed in the primary image, depending on the primary image pixel gray value.

PICTURE DIFFERENCE (DIF)

This operator detects differences in two registered images. The registered
images are adjusted for contrast. The standard deviation of the gray values
in the difference picture is used as a threshold to eliminate insignificant
differences from the output and to account for nonlinearities in contrast.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY      INTERACTIVE  IDAPS      TIME: 08:38:30
FILE NAME:  1SCA                                ELAPSED:00H,10MIN

IMAGE ANALYSIS - PICTURE DIFFERENCE


OPTION |   PARAMETER DESCRIPTION
 3.0   |  SIGMA COEFFICIENT
       |  REFERENCE INPUT FILE NAME
  1    |  STARTING LINE
  1    |  STARTING COLUMN
       |  NUMBER OF LINES
       |  NUMBER OF COLUMNS
       |  SUBTRAHEND INPUT FILE
```

Note:
1. A coefficient (n) of the standard deviation (sigma) is used as a threshold.
Picture differences which are different from the mean value of all pixel
differences by no more than n (sigma coefficient) are excluded from the
output. The Sigma Coefficient typically ranges from 0.1 to 5.0.

2. Both input files must be the same size and in integer format.

3. Two secondary output files are available for specific information about
the picture difference. Output file 1SEC contains those features that are
in the reference image but not in the subtrahend input image. Output file
2SEC contains those features that are in the subtrahend image but not in
the reference image.

REGISTER (REG)

This operator performs the necessary translation, rotation, and size adjust-
ment to position one frame in registration with another. The registration
is specified by identifying the spatial coordinates of two points in the
input image and the coordinates of corresponding points in the output image
to which the input pair are to be transformed. The amounts of rotation,
magnification and translation required to achieve the specified transformation
are computed automatically.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
/360 STATUS:  READY      INTERACTIVE  IDAPS      TIME:  08:36:40
 FILE NAME:  1SCA                                 ELAPSED:00H,08MIN

 GEOMETRIC OPERATION - REGISTER (REG)

        OPTION              PARAMETER DESCRIPTION

      1SCA              INPUT FILE NAME

      1.0               INPUT   POINT 1  - LINE COORDINATE

      1.0                                - COLUMN COORDINATE

      1.0                       POINT 2  - LINE COORDINATE

      1.0                                - COLUMN COORDINATE

      1.0               OUTPUT POINT 1   - LINE COORDINATE

      1.0                                - COLUMN COORDINATE

      1.0                       POINT 2  - LINE COORDINATE

      1.0                                - COLUMN COORDINATE

      VALUE            COMPUTED PARAMETERS      VALUE      COMPUTED PARAMETERS

   .00000000 E  0     ANGLE OF ROTATION    .00000000 E  0  COLUMN TRANSLATION

   .00000000 E  0     MAGNIFICATION             1         NO. OF LINES OUTPUT

   .00000000 E  0     LINE TRANSLATION          1         NO. OF COLUMNS OUTPUT
```

Note:
1. Parameter specification is simplified if one thinks of the input and
output points as being the location of two points in the input file before
registration and after registration. Only the input file is actually modified
by this operator.

2. The size of the input file is automatically adjusted by a border of
zeros so that after it is registered the entire image is still visible.

3. After the calculations of rotation, translation, and size adjustment are
made, based on the registration point parameters, the calculated results are
displayed for visual verification and general user information.

ROTATE (ROT)

This operator rotates an image through a user-specified angle. The image
size is automatically adjusted by inserting zeros to produce an output file
which contains the whole rotated image.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY     INTERACTIVE  IDAPS          TIME: 08:35:55
FILE NAME:  1SCA                                  ELAPSED:00H,07MIN

GEOMETRIC OPERATION - ROTATE (ROT)

        OPTION              PARAMETER DESCRIPTION
     _____      _____

       1SCA          | INPUT FILE NAME
                     |
       0.0           | ANGLE OF ROTATION (DEGREES COUNTERCLOCKWISE)


        VALUE               COMPUTED PARAMETERS
     _____      _____

                     | NUMBER OF LINES IN OUTPUT
                     |
                     | NUMBER OF COLUMNS IN OUTPUT
```

Note:
1. The angle should be specified in degrees measured positively counter-
clockwise $\pm$ 360°.

SCANNER TO DISPLAY (S-D)

This operator scans image data from film using the film scanner and displays
the image on one of the display monitors. The displayed picture consists of
480 lines by 480 columns of image data.

The host computer is not required by this operator.

```
360 STATUS: DOWN        INTERACTIVE  IDAPS        TIME: 11:20:35
                                                  ELAPSED: 00H,00MIN

IMAGE INPUT/OUTPUT - SCANNER TO DISPLAY (S-D)

PLACE FILM IN SCANNER

OPTION |   PARAMETER DESCRIPTION       |OPTION|    PARAMETER DESCRIPTION

  A     SCALING FACTOR                          THE SCANNER CAN ADDRESS ANY POINT
          A - FUNCTION OF DENSITY (LOG)          IN AN ARRAY OF 2048X2048 ADDRESS
          B - FUNCTION OF TRANSMIT-              LOCATIONS.  USING THE TRACKBALL,
              TANCE (LINEAR)                     LOCATE THE UPPER LEFT CORNER OF
                                                 THE AREA TO BE SCANNED OR ENTER
  A     SCAN POLARITY                            FROM THE KEYBOARD: **
          A - NORMAL
          B - COMPLEMENT                  64        UPPERMOST SCAN ADDRESS
                                          64        LEFTMOST SCAN ADDRESS
  C     SAMPLING INTERVAL (MICROMETERS)
          A - 17.5  (2048 PTS/LINE MAX)    8     ILLUMINATION LEVEL
          B - 35    (1024 PTS/LINE MAX)
          C - 70    (512  PTS/LINE MAX)    0     LOWER CLIPPING LIMIT
          D - 140   (256  PTS/LINE MAX)
                                           8     UPPER CLIPPING LIMIT
  B     INTEGRATION TIME (MICROSECONDS)
          A -    20  (28 DB S/N)           2     DISPLAY MONITOR (1, 2, R, G, B)
          B -    80  (34 DB S/N)
          C -   320  (40 DB S/N)
          D -  1280  (46 DB S/N)
                                              ** NOTE: TRACKBALL INPUT OF
  A     FILTER                                    THESE VALUES IS BASED ON
          A - NEUTRAL                            QUICK-LOOK SCAN.
          B - RED
          C - GREEN
          D - BLUE
          E - MANUAL/CURRENT SETTING
```

Note:
1. The Sampling Interval parameter determines the number of data values
scanned from a unit area of the film and therefore the portion of the total
film displayed.

2. The more Integration Time that is used in sampling a single spot on the
film, the more accurate and noise free will be the sampled data. A trade
off must be made between sampling accuracy and total scan time.

3. The portion of the film displayed is determined by the Scan Address.
The "Quick Look Scan" Special Function is helpful in locating the required
Scan Address.

4. The Clipping Limit parameters allow the user to select the range of film
densities between which the gray values will be scaled. An integer value
between 0-8 should be specified.

SCANNER TO DISPLAY (PSEUDOCOLOR)

This operator is employed to scan image data from black and white film,
assign selected colors to input pixel gray values, and display the output on
the color monitor.

The host computer is not required by this operator.

```
360 STATUS: DOWN   INTERACTIVE  IDAPS    TIME: 11:40:20
                                         ELAPSED:00H,20MIN

PSEUDOCOLOR - SCANNER TO DISPLAY

OPTION |  PARAMETER DESCRIPTION      |OPTION|   PARAMETER DESCRIPTION

  A      TABLE SOURCE                        THE SCANNER CAN ADDRESS ANY POINT
           A - SYSTEM DEFAULT               IN AN ARRAY OF 2048X2048 ADDRESS
           B - TRACK BALL                   LOCATIONS.  USING THE TRACKBALL,
           C - CARDS                        LOCATE THE UPPER LEFT CORNER OF
                                            THE AREA TO BE SCANNED OR ENTER
  A      SCALING FACTOR                      FROM THE KEYBOARD: **
           A - LOG
           B - LINEAR               0        UPPERMOST SCAN ADDRESS
                                    0        LEFTMOST SCAN ADDRESS
  B      SAMPLING INTERVAL (MICROMETERS)
           A - 17.5                 8      ILLUMINATION LEVEL
           B - 35
           C - 70                   0      LOWER CLIPPING LEVEL
           D - 140
                                    8      UPPER CLIPPING LEVEL
  A      INTEGRATION TIME (MICROSECONDS)
           A -   20
           B -   80
           C -  320
           D - 1280
                                           ** NOTE: TRACKBALL INPUT OF
                                                    THESE VALUES IS BASED ON
                                                    QUICK-LOOK SCAN.
```

Data Card Format:

```
PBLU=0,32,64,96,128,160,192,224,248*255$
PGRN=128*0,32,64,96,128,160,192,224,171*255$
PRED=64*0,32,64,96,128,160,192,224,185*255$
```

Three tables must be specified: PRED,PGRN, and PBLU. Each table contains
256 integer values which control the red, green and blue components of the
colors which are assigned to the 256 possible input gray values. The first
value in each data table corresponds to zero gray value in the input.

Note: See Notes for SCANNER TO FILM (PSEUDOCOLOR).

SCANNER TO FILM (S-F)

This operator scans image data from film using the film scanner and records
the digital image data on photographic film using the image recorder.

The host computer is not required by this operator.

```
/ 360 STATUS: DOWN      INTERACTIVE  IDAPS      TIME: 11:09:25
/                                               ELAPSED:03H,03MIN
|  IMAGE INPUT/OUTPUT - SCANNER TO FILM (S-F)   PAGE 1 OF 2
|
|  PLACE FILM IN SCANNER
|
|  OPTION |  PARAMETER DESCRIPTION       | OPTION |   PARAMETER DESCPIPTION
|
|    A     SCALING FACTOR                          THE SCANNER CAN ADDRESS ANY POINT
|          A - FUNCTION OF DENSITY (LOG)           IN AN ARRAY OF 2048X2048 ADDRESS
|          B - FUNCTION OF TRANSMIT-               LOCATIONS.  USING THE TRACKBALL,
|              TANCE (LINEAR)                      LOCATE THE UPPER LEFT CORNER OF
|                                                  THE AREA TO BE SCANNED OR ENTER
|    A     SCAN POLARITY                           FROM THE KEYBOARD: **
|          A - NORMAL
|          B - COMPLEMENT                    0     UPPERMOST SCAN ADDRESS
|                                            0     LEFTMOST SCAN ADDRESS
|    C     SAMPLING INTERVAL (MICROMETERS)
|          A - 17.5   (2048 PTS/LINE MAX)         LOCATE THE LOWER RIGHT CORNER OR
|          B - 35     (1024 PTS/LINE MAX)         ENTER FROM THE KEYBOARD: **
|          C - 70     (512  PTS/LINE MAX)
|          D - 140    (256  PTS/LINE MAX)   2047   LOWERMOST SCAN ADDRESS
|                                           2047   RIGHTMOST SCAN ADDRESS
|    B     INTEGRATION TIME (MICROSECONDS)
|          A -   20   (28 DB S/N)             8    ILLUMINATION LEVEL
|          B -   80   (34 DB S/N)
|          C -  320   (40 DB S/N)             0    LOWER CLIPPING LIMIT
|          D - 1280   (46 DB S/N)
|                                             8    UPPER CLIPPING LIMIT
|    A     FILTER
|          A - NEUTRAL
|          B - RED
|          C - GREEN                       ** NOTE: TRACKBALL INPUT OF
|          D - BLUE                           THESE VALUES IS BASED ON
|          E - MANUAL/CURRENT SETTING         QUICK-LOOK SCAN.
```

Note:
1. The Sampling Interval parameter determines the number of data values
scanned from a unit area of the film and therefore the amount of data that
will result from scanning the selected area of the film.

2. The more Integration Time that is used in sampling a single spot on the
film, the more accurate and noise free will be the sampled data. A trade
off must be made between sampling accuracy and total scan time.

3. The portion of the film that is to be digitized and recorded on film is
determined by the Scan Address. The "Quick Look Scan" Special Function is
helpful in locating the required Scan Address.

4. The Clipping Limit parameters allow the user to select the range of film
densities between which the gray values will be scaled. An integer value
between 0-8 should be specified.

SCANNER TO FILM (Continued)

```
360 STATUS: DOWN       INTERACTIVE   IDAPS        TIME: 11:09:40
                                                  ELAPSED:03H,03MIN
IMAGE INPUT/OUTPUT - SCANNER TO FILM (S-F)     PAGE 2 OF 2

PLACE FILM IN RECORDER AND VERIFY
   · RECORDER POWER ON
   · RECORDER IN OPERATE MODE
   · PROPER EXPOSURE CONTROL

OPTION | PARAMETER DESCRIPTION       | OPTION |   PARAMETER DESCRIPTION
   A     RECORDER FILTER                        IMAGES ARE NORMALLY RECORDED IN
           A - NEUTRAL DENSITY                  THE UPPER LEFT CORNER OF
           B - RED                              2048X2048 ADDRESSABLE FILM
           C - GREEN                            LOCATIONS.  TO SPECIFY AN ALTER-
           D - BLUE                             NATE FILM POSITION, ENTER
           E - MANUAL/CURRENT SETTING
                                          0     UPPER FILM ADDRESS
   A     EXPOSURE CHARACTERISTIC        0     LEFT FILM ADDRESS
           A - LOG
           B - LINEAR

   A     RECORDING POLARITY
           A - NORMAL
           B - COMPLEMENTED

   B     RECORDING RESOLUTION
           A - LOW
           B - MEDIUM
           C - HIGH
```

Note:
1. The <u>Exposure Characteristic</u> determines the relationship between the input gray values (0-255) and the film exposure.

    Log   - relates film exposure to gray value as the Log_{10} (Gray Value).

    Linear- relates film exposure linearly to image data gray values.

2. <u>Recording Resolution</u> determines the area of the film exposed by each input gray value. Since a maximum 57 mm X 57 mm film area may be exposed, this parameter determines the size of the picture produced by a given input array. The maximum array size for each resolution setting which will result in recording of the entire array is as follows:

    Low   -   512 X 512
    Medium - 1024 X 1024
    High   - 2048 X 2048

SCANNER TO FILM (PSEUDOCOLOR)

This operator is employed to scan image data from black and white film,
assign selected colors to input pixel gray values, and record the output on
color film.

The host computer is not required by this operator.

```
 _____
/                                                                \
|           I N T E R A C T I V E   I D A P S     TIME: 16:48:20   |
|                                                 ELAPSED:00H,14MIN|
| PSEUDOCOLOR - SCANNER TO FILM   (PAGE 1 OF 2)                    |
|  OPTION |  PARAMETER DESCRIPTION      |OPTION|  PARAMETER DESCRIPTION
|    A     TABLE SOURCE                         THE SCANNER CAN ADDRESS ANY POINT
|          A - DATA TBLS(PRED,PGRN,PBLU)        IN AN APRAY OF 2048X2048 ADDRESS
|          B - TRACKBALL                        LOCATIONS.  USING THE TRACKBALL,
|          C - CARDS                            LOCATE THE UPPER LEFT CORNER OF
|                                               THE AREA TO BE SCANNED OR ENTER
|    A     SCALING FACTOR                       FROM THE KEYBOARD: **
|          A - LOG
|          B - LINEAR                     0        UPPERMOST SCAN ADDRESS
|                                         0        LEFTMOST SCAN ADDRESS
|    B     SAMPLING INTERVAL (MICROMETERS)
|          A - 17.5  (2048 PTS/LINE MAX)       LOCATE THE LOWER RIGHT CORNER OR
|          B - 35    (1024 PTS/LINE MAX)       ENTER FROM THE KEYBOARD:
|          C - 70    (512  PTS/LINE MAX)
|          D - 140   (256  PTS/LINE MAX)  2047     LOWERMOST SCAN ADDRESS '
|                                         2047     RIGHTMOST SCAN ADDRESS
|    A     INTEGRATION TIME (MICROSECONDS)
|          A -   20  (28 DB S/N)          8     ILLUMINATION LEVEL
|          B -   80  (34 DB S/N)
|          C -  320  (40 DB S/N)          0     LOWER CLIPPING LEVEL
|          D - 1280  (46 DB S/N)
|                                         8     UPPER CLIPPING LEVEL
|
|                                         ** NOTE: TRACKBALL INPUT OF
|                                                  THESE VALUES IS BASED ON
|                                                  QUICK-LOOK SCAN.
_____/
```

Data Card Format: See SCANNER TO DISPLAY (PSEUDOCOLOR)

Note:
1. All PSEUDOCOLOR operators share the same data tables. This means that a
color scheme defined by cards or trackball in one operator may be used for
other operators by specifying Data Tbls for Table Source.

2. When using the trackball for defining a color scheme, a palette of more
than 1000 colors is displayed on the color monitor. The user then uses the
trackball to point to the colors that he wishes assigned to specific gray
levels. By pressing the trackball "enter" the color is stored and the gray
value assignment index is incremented by an increment factor (n). The
factor n may be modified from the color monitor using the trackball as a
pointer.

SCANNER TO FILM (Continued)

```
       INTERACTIVE IDAPS        TIME: 16.27·45
                                ELAPSED: 43H, 33MIN

FSEUDOCOLOR - SCANNER TO FILM  (PAGE 2 OF 2)

OPTION     PARAMETEP DESCRIPTICN
   ──────────────────────────────────────────────────

   B       RECOPDEP EXPOSURE CHARACTERISTIC
               A - LOG
               B - LINEAR

   B       RECORDER RESOLUTION
               A - LOW
               B - MEDIUM
               C - HIGH

           IMAGES ARE NOPMALLY PECORDED IN
           THE UPPER LEFT CORNER OF
           2048X2048 ADDRESSABLE FILM
           LOCATIONS.   TO SPECIFY AN
           ALTEPNATE FILM POSITION. ENTER

   0           UPPEP FILM ADDRESS
   0           LEFT FILM ADDRESS

           EXPOSURE SETTING ON THE PECORDER
           IS A MANUAL PPOCESS AND SHOULD
           BE SET BASED ON THE FILM TYPE.
           IT MAY ALSO BE DESIPABLE TO
           ADJUST EXPOSUPE FOP EACH COLOR.

   A           EXPOSUPE ADJUSTMENT
                   A - CONSTANT FOP ALL 3 COLORS
                   B - VARIABLE
```

SCANNER TO PRINTER (S-P)

This operator scans image data from film using the film scanner and prints
out the gray values of a selected region of the film on the IDAPS printer.

The host computer is not required by this operator.

```
/ 360 STATUS: DOWN      INTERACTIVE  IDAPS      TIME: 11:10:00        \
/                                                ELAPSED:03H,04MIN     \
|  IMAGE INPUT/OUTPUT - SCANNER TO PRINTER (S-P)                        |
|                                                                       |
|  TURN PRINTER ON                                                      |
|                                                                       |
|  OPTION |   PARAMETER DESCRIPTION        |OPTION|    PARAMETER DESCRIPTION  |
|                                                                       |
|    A      SCALING FACTOR                     THE SCANNER CAN ADDRESS ANY POINT |
|           A - FUNCTION OF DENSITY (LOG)      IN AN ARRAY OF 2048X2048 ADDRESS  |
|           B - FUNCTION OF TRANSMIT-          LOCATIONS.  USING THE TRACKBALL,  |
|               TANCE (LINEAR)                 LOCATE THE UPPER LEFT CORNER OF   |
|                                              THE AREA TO BE SCANNED OR ENTER   |
|    A      SCAN POLARITY                      FROM THE KEYBOARD: **             |
|           A - NORMAL                                                          |
|           B - COMPLEMENT               0       UPPERMOST SCAN ADDRESS         |
|                                        0       LEFTMOST SCAN ADDRESS          |
|    C      SAMPLING INTERVAL (MICROMETERS)                                     |
|           A - 17.5  (2048 PTS/LINE MAX)  8   ILLUMINATION LEVEL               |
|           B - 35    (1024 PTS/LINE MAX)                                       |
|           C - 70    (512  PTS/LINE MAX)  0   LOWER CLIPPING LIMIT             |
|           D - 140   (256  PTS/LINE MAX)                                       |
|                                          8   UPPER CLIPPING LIMIT            |
|    B      INTEGRATION TIME (MICROSECONDS)                                     |
|           A -   20  (28 DB S/N)         32   NUMBER OF LINES                  |
|           B -   80  (34 DB S/N)                                              |
|           C -  320  (40 DB S/N)         32   NUMBER OF COLUMNS                |
|           D - 1280  (46 DB S/N)                                              |
|                                                                              |
|    A      FILTER                                                             |
|           A - NEUTRAL                    ** NOTE: TRACKBALL INPUT OF         |
|           B - RED                           THESE VALUES IS BASED ON         |
|           C - GREEN                         QUICK-LOOK SCAN.                 |
|           D - BLUE                                                           |
\          E - MANUAL/CURRENT SETTING                                         /
```

Note:
1. The Sampling Interval parameter determines the number of data values
scanned from a unit area of the film and therefore the amount of data that
will result from scanning the selected area of the film.

2. The more Integration Time that is used in sampling a single spot on the
film, the more accurate and noise free will be the sampled data. A trade
off must be made between sampling accuracy and total scan time.

3. The portion of the film that is to be digitized and printed is determined
by the Scan Address. The "Quick Look Scan" Special Function is helpful in
locating the required Scan Address.

4. The Clipping Limit parameters allow the user to select the range of film
densities between which the gray values will be scaled. An integer value
between 0-8 should be specified.

5. A maximum of 96 lines and 32 columns may be printed with each application
of this operator.

SCANNER TO SYSTEM (SCA)

This operator scans image data from film using the film scanner and sends it
to the host computer where it is established as an IDAPS user file.

Both the host computer and terminal minicomputer are required by this operator.

```
360 STATUS: DOWN      INTERACTIVE  IDAPS        TIME: 11:10:30
                                                ELAPSED:03H,04MIN

IMAGE INPUT/OUTPUT - SCANNER TO SYSTEM (SCA)

PLACE FILM IN SCANNER

OPTION |   PARAMETER DESCRIPTION        |OPTION|    PARAMETER DESCRIPTION

  A      SCALING FACTOR                         THE SCANNER CAN ADDRESS ANY POINT
         A - FUNCTION OF DENSITY (LOG)          IN AN ARRAY OF 2048X2048 ADDRESS
         B - FUNCTION OF TRANSMIT-              LOCATIONS.  USING THE TRACKBALL,
             TANCE (LINEAR)                     LOCATE THE UPPER LEFT CORNER OF
                                                THE AREA TO BE SCANNED OR ENTER
  A      SCAN POLARITY                          FROM THE KEYBOARD: **
         A - NORMAL
         B - COMPLEMENT                    0       UPPERMOST SCAN ADDRESS
                                           0       LEFTMOST SCAN ADDRESS
  C      SAMPLING INTERVAL (MICROMETERS)
         A - 17.5   (2048 PTS/LINE MAX)         LOCATE THE LOWER RIGHT CORNER OR
         B - 35     (1024 PTS/LINE MAX)         ENTER FROM THE KEYBOARD: **
         C - 70     (512  PTS/LINE MAX)
         D - 140    (256  PTS/LINE MAX)  2047     LOWERMOST SCAN ADDRESS
                                        2047     RIGHTMOST SCAN ADDRESS
  B      INTEGRATION TIME (MICROSECONDS)
         A -   20   (28 DB S/N)           8      ILLUMINATION LEVEL
         B -   80   (34 DB S/N)
         C -  320   (40 DB S/N)           0      LOWER CLIPPING LIMIT
         D - 1280   (46 DB S/N)
                                          8      UPPER CLIPPING LIMIT
  A      FILTER
         A - NEUTRAL
         B - RED
         C - GREEN
         D - BLUE                        ** NOTE: TRACKBALL INPUT OF
         E - MANUAL/CURRENT SETTING            THESE VALUES IS BASED ON
                                               QUICK-LOOK SCAN.
```

Note:
1. The Sampling Interval parameter determines the number of data values
scanned from a unit area of the film and therefore the amount of data that
will result from scanning the selected area of the film.

2. The more Integration Time that is used in sampling a single spot on the
film, the more accurate and noise free will be the sampled data. A trade
off must be made between sampling accuracy and total scan time.

3. The portion of the film that is to be digitized and established as an
IDAPS user file in the host computer is determined by the Scan Address. The
"Quick Look Scan" Special Function is helpful in locating the required Scan
Address.

4. The Clipping Limit parameters allow the user to select the range of film
densities between which the gray values will be scaled. An integer value
between 0-8 should be specified.

SCANNER TO TAPE (S-T)

This operator scans image data from film using the film scanner and stores
the digital image data on magnetic tape on one of the user console magnetic
tape units.

The host computer is not required by this operator.

```
360 STATUS: DOWN       INTERACTIVE  IDAPS        TIME: 11:08:45
                                                 ELAPSED:03H,02MIN

IMAGE INPUT/OUTPUT - SCANNER TO TAPE (S-T)    PAGE 1 OF 2

PLACE FILM IN SCANNER AND BLANK TAPE ON DRIVE

OPTION |   PARAMETER DESCRIPTION          |OPTION|    PARAMETER DESCRIPTION

  A      SCALING FACTOR                            THE SCANNER CAN ADDRESS ANY POINT
         A - FUNCTION OF DENSITY (LOG)             IN AN ARRAY OF 2048X2048 ADDRESS
         B - FUNCTION OF TRANSMIT-                 LOCATIONS.  USING THE TRACKBALL,
               TANCE (LINEAR)                      LOCATE THE UPPER LEFT CORNER OF
                                                   THE AREA TO BE SCANNED OR ENTER
  A      SCAN POLARITY                             FROM THE KEYBOARD: **
         A - NORMAL
         B - COMPLEMENT                       0       UPPERMOST SCAN ADDRESS
                                              0       LEFTMOST SCAN ADDRESS
  C      SAMPLING INTERVAL (MICROMETERS)
         A - 17.5   (2048 PTS/LINE MAX)           LOCATE THE LOWER RIGHT CORNER OR
         B - 35     (1024 PTS/LINE MAX)           ENTER FROM THE KEYBOARD: **
         C - 70     (512  PTS/LINE MAX)
         D - 140    (256  PTS/LINE MAX)      2047    LOWERMOST SCAN ADDRESS
                                            2047    RIGHTMOST SCAN ADDRESS
  B      INTEGRATION TIME (MICROSECONDS)
         A -   20   (28 DB S/N)               8    ILLUMINATION LEVEL
         B -   80   (34 DB S/N)
         C -  320   (40 DB S/N)               0    LOWER CLIPPING LIMIT
         D - 1280   (46 DB S/N)
                                              8    UPPER CLIPPING LIMIT
  A      FILTER
         A - NEUTRAL
         B - RED
         C - GREEN                          ** NOTE: TRACKBALL INPUT OF
         D - BLUE                              THESE VALUES IS BASED ON
         E - MANUAL/CURRENT SETTING           QUICK-LOOK SCAN.
```

Note:
1. The Sampling Interval parameter determines the number of data values
scanned from a unit area of the film and therefore the amount of data that
will result from scanning the selected area of the film.

2. The more Integration Time that is used in sampling a single spot on the
film, the more accurate and noise free will be the sampled data. A trade
off must be made between sampling accuracy and total scan time.

3. The portion of the film that is to be digitized and stored on tape is
determined by the Scan Address. The "Quick Look Scan" Special Function is
helpful in locating the required Scan Address.

4. The Clipping Limit parameters allow the user to select the range of film
densities between which the gray values will be scaled. An integer value
between 0-8 should be specified.

SCANNER TO TAPE (Continued)

```
 360 STATUS: DOWN      INTERACTIVE  IDAPS       TIME: 11:09:05
                                                ELAPSED:03H,03MIN

 IMAGE INPUT/OUTPUT - SCANNER TO TAPE (S-T)   PAGE 2 OF 2

 OPTION |   PARAMETER DESCRIPTION
 ──────────────────────────────────────────────────────────────────────────
    2   | TAPE DRIVE NUMBER (1 OR 2)
        |
    0   | OUTPUT FILE NUMBER
        |   NOTE: A '0' ENTRY WILL RESULT IN THE IMAGE BEING WRITTEN AS THE NEXT
        |         FILE.  ANY OTHER INTEGER ENTRY WILL CAUSE THE TAPE TO BE REWOUND
        |         AND N-1 FILES SKIPPED TO POSITION THE TAPE.
        |
```

Note (Continued):

5. Tape drive No. 1 is the left hand drive of the two IDAPS user terminal tape drives.

STONYHURST GRID (STO)

This operator generates a spherical-coordinate reference grid for use as an
overlay to S-056 images. Such overlays are useful in locating points and
determining distances.

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
        ┌───────────────────────────────────────────────────────┐
        │                                                        │
        │          INTERACTIVE  IDAPS        TIME: 16:52:15      │
        │                                    ELAPSED:00H,18MIN   │
        │                                                        │
        │  IMAGE DATA PRESENTATION - STONYHURST GRID (STO)       │
        │                                                        │
        │      OPTION        PARAMETER DESCRIPTION               │
        │     ─────────────────────────────────────────────     │
        │      480       │ SIZE OF GRID                          │
        │                │                                       │
        │      0.0       │ LONGITUDE CLOSEST TO OBSERVER (DEGREES)│
        │                │                                       │
        │      10.0      │ LONGITUDE GRID SPACING (DEGREES)       │
        │                │                                       │
        │      0.0       │ LATITUDE CLOSEST TO OBSERVER (DEGREES) │
        │                │                                       │
        │      10.0      │ LATITUDE GRID SPACING (DEGREES)        │
        │                │                                       │
        │      0.0       │ ROTATION OF SPIN AXIS WITH RESPECT TO IMAGE (DEGREES)│
        │                                                        │
        └───────────────────────────────────────────────────────┘
```

Note:
1. The Stonyhurst Grid generated by this operator is composed of white
(255's) lines on a black (0's) background.

2. An entire spherical map is produced. If a Stonyhurst overlay is desired
for a smaller array, the user should use the EXTRACT operator.

3. If a Stonyhurst is to be overlayed on a full solar disk, it should be
inserted into a black background using INSERT to make the total size equal
to the image on which it is to be overlayed.

4. In normal operation, the user should limit Latitude Closest to Observer
to $\pm$ 7 degrees.

SYSTEM TO DISPLAY (DIS)

This operator takes image data stored on the host computer disk and displays
the image on one of the IDAPS display monitors.

Both the host and user terminal computers are required by this operator.

```
360 STATUS: READY    INTERACTIVE  IDAPS    TIME: 08:40:30
FILE NAME:  1SCA                            ELAPSED:00H,12MIN

IMAGE INPUT/OUTPUT - SYSTEM TO DISPLAY (DIS)

OPTION |   PARAMETER DESCRIPTION
_____

 1SCA  | FILE NAME

   1   | STARTING LINE

   1   | STARTING COLUMN

  480  | NUMBER OF LINES

  480  | NUMBER OF COLUMNS

   1   | DISPLAY MONITOR (1, 2, R, G OR B)

   0   | IMAGE SIZE ADJUSTMENT FACTOR
       |    0 - AUTOMATIC SIZE ADJUSTMENT TO FIT DISPLAY SCREEN
       |    1 - NO SIZE ADJUSTMENT
       |    N - REDUCTION FACTOR
```

Note:
1. A digital image of up to 480 lines and 480 columns may be displayed. If
the system image file is larger than this, the user may select a subset for
display with no reduction of the image array or he may select the Size
Adjustment feature to reduce the image so that it will fit on the display
monitor. Automatic size adjustment may be selected which will automatically
reduce the image file by an integer factor sufficient to allow it to be
displayed on one of the display monitors.

SYSTEM TO DISPLAY (PSEUDOCOLOR)

This operator is employed to pseudocolor an image file stored on the host
computer disk, or displayed on one of the B/W monitors. Selected colors are
assigned to input pixel gray values and displayed on the color monitor.

Both the host computer and the terminal minicomputer are required by this
operator.

```
                INTERACTIVE  IDAPS      TIME: 16:50:10
                                        ELAPSED:00H,16MIN

PSEUDOCOLOR - SYSTEM TO DISPLAY

OPTION |    PARAMETER DESCRIPTION
_____
  A    | TABLE SOURCE
       |    A - DATA TBLS(PRED,PGRN,PBLU)
       |    B - TRACK BALL
       |    C - CARDS
       |
       | FILE NAME OR MONITOR KEY
       |
  1    | STARTING LINE
       |
  1    | STARTING COLUMN
       |
       | NUMBER OF LINES
       |
       | NUMBER OF COLUMNS
       |
  0    | SIZE ADJUSTMENT FACTOR
       |    0   - AUTOMATIC SIZE ADJUSTMENT
       |    1   - NO SIZE ADJUSTMANT
       |    2-N - REDUCTION FACTOR
```

Data Table Format: See SCANNER TO DISPLAY (PSEUDOCOLOR)

Note:
1. All PSEUDOCOLOR operators share the same data tables. This means that a
color scheme defined by cards or trackball in one operator may be used for
other operators by specifying Data Tbls for Table Source.

2. When using the trackball for defining a color scheme, a palette of more
than 1000 colors is displayed on the color monitor. The user then uses the
trackball to point to the colors that he wishes assigned to specific gray
levels. By pressing the trackball "enter" the color is stored and the gray
value assignment index is incremented by an increment factor (n). The
factor n may be modified from the color monitor using the trackball as a
pointer.

3. A system file name may be specified as the input source or a picture
displayed on B/W monitor No. 1 or No. 2 may be specified.

SYSTEM TO FILM (FIL)

This operator takes image data stored on the host computer disk and records
it on film using the image recorder.

Both the host and user terminal computers are required by this operator.

```
360 STATUS:  READY      INTERACTIVE IDAPS      TIME: 08:41:15
FILE NAME:  1SCA                               ELAPSED:00H.13MIN

IMAGE INPUT/OUTPUT - SYSTEM TO FILM (FIL)

OPTION |    PARAMETER DESCRIPTION       |OPTION|    PARAMETER DESCRIPTION

 1SCA  | FILE NAME                      |      | IMAGES ARE NORMALLY RECORDED IN
                                               | THE UPPER LEFT CORNER OF
  1    | STARTING LINE                  |      | 2048X2048 ADDRESSABLE FILM
                                               | LOCATIONS.  TO SPECIFY AN ALTER-
  1    | STARTING COLUMN                |      | NATE FILM POSITION, ENTER

 480   | NUMBER OF LINES                |  0   |      UPPER FILM ADDRESS
                                          0    |      LEFT FILM ADDRESS
 480   | NUMBER OF COLUMNS              |

  A    | RECORDER FILTER
       |     A - NEUTRAL DENSITY
       |     B - RED
       |     C - GREEN
       |     D - BLUE
       |     E - MANUAL/CURRENT SETTING

  A    | EXPOSURE CHARACTERISTIC
       |     A - LOG
       |     B - LINEAR

  A    | RECORDING POLARITY
       |     A - NORMAL
       |     B - COMPLEMENTED

  A    | RECORDING RESOLUTION
       |     A - LOW
       |     B - MEDIUM
       |     C - HIGH
```

Note:
1. The Exposure Characteristic determines the relationship between the
input gray values (0-255) and the film exposure.

   Log   - relates film exposure to gray value as the Log_{10}(Gray Value).

   Linear- relates film exposure linearly to image data gray values.

2. Recording Resolution determines the area of the film exposed by each
input gray value. Since a maximum 57 mm X 57 mm film area may be exposed,
this parameter determines the size of the picture produced by a given input
array. The maximum array size for each resolution setting which will result
in recording of the entire array is as follows:

    Low   - 512 X 512
    Medium - 1024 X 1024
    High   - 2048 X 2048

SYSTEM TO FILM (PSEUDOCOLOR)

This operator is employed to pseudocolor an image file stored on the host computer disk or displayed on one of the B/W monitors. Selected colors are assigned to input pixel gray values and recorded on color film.

Both the host computer and the terminal minicomputer are required by this operator.

```
        INTERACTIVE IDAPS         TIME· 16:50:50
                                  ELAPSED:00H.16MIN

PSEUDOCOLOR - SYSTEM TO FILM

OPTION|  PARAMETER DESCRIPTION    |OPTION|   PARAMETER DESCRIPTION

  A     TABLE .SOURCE                    IMAGES ARE NORMALLY RECORED IN
          A - DATA TBLS<PRED,PGRN,PBLU>  THE UPPER LEFT COPNER OF
          B - TRACK BALL                 2048X2048 ADDRESSABLE FILM
          C - CARDS                      LOCATIONS. TO SPECIFY AN
                                         ALTERNATE FILM POSITION, ENTER
        FILE NAME OR MONITOR KEY                          >
                                    0    UPPER FILM ADDRESS
  1     STARTING LINE               0    LEFT FILM ADDRESS

  1     STARTING COLUMN                  EXPOSURE SETTING ON THE RECORDEP
                                         IS A MANUAL PROCESS AND SHOULD
        NUMBER OF LINES                  BE SET BASED ON THE FILM TYPE.
                                         IT MAY ALSO BE DESIPABLE TO
        NUMBER OF COLUMNS                ADJUST EXPOSURE FOR EACH COLOR.

  A     EXPOSURE CHARACTERISTIC     A    EXPOSURE ADJUSTMENT
          A - LOG                          A - CONSTANT FOR ALL 3 COLORS
          B - LINEAR                       B - VARIABLE

  B     RECORDING RESOLUTION
          A - LOW
          B - MEDIUM
          C - HIGH
```

Data Card Format: See SCANNER TO DISPLAY (PSEUDOCOLOR)

Note:
1. All PSEUDOCOLOR operators share the same data tables. This means that a color scheme defined by cards or trackball in one operator may be used for other operators by specifying Data Tables for Table Source.

2. When using the trackball for defining a color scheme, a palette of more than 1000 colors is displayed on the color monitor. The user then uses the trackball to point to the colors that he wishes assigned to specific gray levels. By pressing the trackball "enter" the color is stored and the gray value assignment index is incremented by an increment factor (n). The factor n may be modified from the color monitor using the trackball as a pointer.

3. A system file name may be specified as the input source or a picture displayed on B/W monitor No. 1 or No. 2 may be specified.

SYSTEM TO PRINTER (PRI)

This operator takes a selected region of digital image data stored on the
host computer disk and prints out the gray values on the IDAPS line printer.

Both the host and user terminal computers are required by this operator.

```
360 STATUS: READY      INTERACTIVE  IDAPS        TIME: 08:41:35
FILE NAME:  1SCA                                 ELAPSED:00H,13MIN

IMAGE INPUT/OUTPUT - SYSTEM TO PRINTER (PRI)

TURN PRINTER ON

OPTION |    PARAMETER DESCRIPTION
-------|----------------------------------------------------------------
 1SCA  | FILE NAME
   1   | STARTING LINE
   1   | STARTING COLUMN
  32   | NUMBER OF LINES
  32   | NUMBER OF COLUMNS
```

Note:
1. A maximum of 96 lines and 32 columns may be printed with each application
of this operator.

SYSTEM TO TAPE (OUT)

This operator takes image data stored on the host computer disk and records
it on magnetic tape.

Both the host and user terminal computers are required by this operator.

```
360 STATUS: READY     INTERACTIVE  IDAPS        TIME: 08:40:50
FILE NAME:  1SCA                                ELAPSED:00H,12MIN

IMAGE INPUT/OUTPUT - SYSTEM TO TAPE (OUT)

PLACE BLANK TAPE ON DRIVE

OPTION |   PARAMETER DESCRIPTION
_____|_____
 1SCA   | FILE NAME

   1    | STARTING LINE

   1    | STARTING COLUMN

  480   | NUMBER OF LINES

  480   | NUMBER OF COLUMNS

   2    | TAPE DRIVE NUMBER (1 OR 2)

   0    | OUTPUT FILE NUMBER
        |    NOTE: A '0' ENTRY WILL RESULT IN THE IMAGE BEING WRITTEN AS THE NEXT
        |          FILE.  ANY OTHER INTEGER ENTRY WILL CAUSE THE TAPE TO BE REWOUND
        |          AND N-1 FILES SKIPPED TO POSITION THE TAPE.
```

TABLE MODIFICATION (DTE)

This operator serves two purposes. First, it allows a user to review the
contents of a specific data table for an operator. Second, it allows the
user to modify individual values, whole sections of the table, and complete
tables through keyboard, trackball and tape entry.

```
ESC STATUS  READ·     INTERACTIVE  IDAPS        TIME: 09:15:05
FILE NAME:  TFEM                                ELAPSED:00H,05MIN
FUNCTION GENERATION - TABLE MODIFICATION
                                                      TABLE NAME : ALT

               0      0    3    6    9   12   15   18   21   24   27
              10     30   33   36   39   42   45   48   51   54   57
              20     60   62   65   68   71   74   77   8.   83   86
              30     89   91   94   97  100  103  106  109  111  114
  B EDIT INPUT 40    117  119  122  125  127  130  133  135  138  140
    ─ ─ ·B     50    143  145  148  150  153  155  158  160  162  164
    B ─ ·B+TB  60    165  167  168  168  169  169  169  169  168  166
               70    165  163  161  159  157  155  153  152  151  149
  H MON. NUM   80    149  149  149  150  151  152  154  156  158  160
    A ─ B/W 1  90    162  164  166  167  169  170  171  171  171  170
    B ─ B/W 2  100   168  167  164  162  160  157  155  153  151  149
              110   148  143  147  148  149  150  152  154  156  158
              120   160  163  164  166  168  169  169  170  169  168
              130   166  165  163  160  158  156  153  151  150  148
              140   147  147  147  147  148  150  152  154  156  158
              150   160  163  165  167  168  169  170  171  171  170
              160   168  167  164  162  160  157  155  152  150  149
              170   147  147  147  148  149  151  154  157  160  163
              180   166  163  170  170  170  169  166  162  157  153
              190   149  146  143  142  142  143  144  146  149  152
              200   155  153  150  148  145  143  140  138  135  132
              210   130  127  124  122  119  116  114  111  108  105
              220   103  100   97   94   91   88   86   83   80   77
              230    74   71   68   65   62   59   56   53   51   48
              240    45   42   39   36   33   30   27   24   21   18
              250    15   12    9    6    3    0
```

Both integer and real tables may be displayed in tabular format (as shown above) and, if desired, in graphic display (see below). Integer tables are scaled between 0 and 255. Real tables are scaled between the maximum and minimum values found in the table, with one exception: the tables used for the Function Generation operator (FGN1 and FGN2) are automatically scaled between 0. and 1.
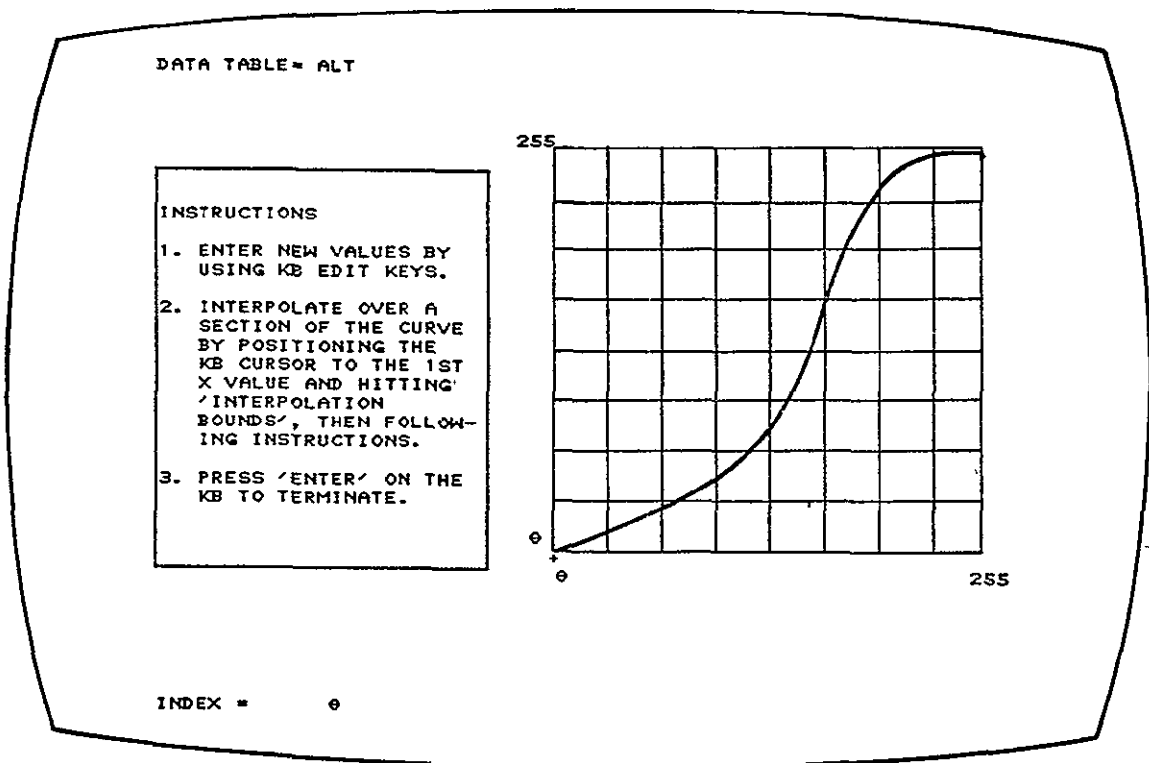
When the keyboard is chosen as the desired method of modification, any changes may be made by using the regular edit keys (EDIT UP, EDIT DOWN, EDIT RIGHT, EDIT LEFT, EDIT PAGE UP, EDIT PAGE DOWN, and ENTER), as described in the main instruction display for TABLE MODIFICATION.

```
360 STATUS: READY     INTERACTIVE IDAPS      TIME: 08:52:35
FILE NAME.  1MAT                              ELAPSED:00H,09MIN
FUNCTION GENERATION - TABLE MODIFICATION
                                                  TABLE NAME :

INTERACTIVE MODIFICATION OF DATA TABLES MAY BE ACCOMPLISHED THROUGH USE OF THE
EDIT KEYS.  POSITION CURSOR TO DESIRED ENTRY USING EDIT RIGHT,  EDIT LEFT,
EDIT DOWN AND EDIT UP KEYS.  CHANGE ENTRY TO DESIRED VALUE AND REPOSITION
CURSOR.  WHEN LAST ENTRY HAS BEEN MODIFIED, PRESS EDIT ENTER.
```

OPERATOR	TABLE NAME(S)	NUMBER OF ENTRIES	
		MINIMUM	MAXIMUM
PSEUDOCOLOR (ALL)	PRED, PGRN, PBLU	256	256
ALTER	ALT	256	256
H AND D CORRECTION	HDC1, HDC2	2	256
CONVOLUTIONAL FILTER	CON	2	256
DEPENDENT ALTER	DEPA, DEPB	101	101
FILTER GENERATION	FGN1, FGN2	251	251
USER GEN. OPERATOR	USEI, USEF	1	256

```
            TABLE NAME : ALT
```

When the keyboard and trackball modification mode is chosen, a monitor must be selected for graphics display of the desired table. The display does not alter the image data which is stored on the display file and may be re-displayed with the RESTORE special function.

The user may step through the values in the table with the regular EDIT keys, modifying them by using the keyboard as described above.

If a section of the table is to be modified, rather than entering each new value individually from the keyboard, the user may choose to enter only selected points and have the system interpolate them to produce a smoothed curve. To do this, he must first position the keyboard cursor to the value he wishes to use as his lower bounds and hit the key labeled "INTERPOLATE

BOUND". Then, following the displayed instructions, he must similarly
indicate the upper bounds. Interior points may be entered either by 1)
positioning the cursor and changing the value by keyboard and then hitting
the key labeled "ENTER INTERPOLATE POINT", or 2) with the trackball, posi-
tioning the trackball cursor to the relative graphic location and hitting
the trackball ENTER key. When all points to be interpolated have been
input, the user must hit the edit key marked "ENTER" to begin the interpola-
tion procedure. The new values resulting from the interpolation are stored
as the current data table values and may be examined by the Table Modification
operator.

Copies of whole data tables may be saved on tape or restored from tape. A
table is saved by writing it to the indicated tape drive in consecutive 80
character card images. No file marks are used to separate multiple tables
on the tape. To restore a table from tape, the first card image of each
stored table is read and the table name is checked against the requested
name. When a match is found, the table is read in and permanently stored as
the current version of the table. No rewinds are made.

Note:
1. Each IDAPS operator which requires data table input will contain default
values supplied by the system until modified by the user through either
keyboard, card, or trackball input. Once the user inputs data values by
such means, the data tables will retain those values throughout the Interac-
tive IDAPS session until further modified by the user. When a new user logs
in, the default values may be restored to all tables.

2. The interpolation scheme used is the SPLINE interpolation method. The
SPLINE curve fitting technique is designed for use with data which has no
discontinuities. The algorithm forces the function which is fitted to the
input points to be continuous and to have continuous first and second deriva-
tives. Approximate values of the first and second derivatives at each of
the input points are calculated. These values and a weighting factor are
adjusted after each iteration until the sum of the weighting factors is
within a specified limit. At this point these parameters define a continuous
function and interpolation using these parameters gives the value of the
curve at each point in the table.

3. A maximum of 32 points, including both boundaries, may be entered for
interpolation.

4. The boundary point values may be changed only if they are the first and
last physical values in the table. This is allowed in order to permit
complete regeneration of a table by a single interpolation procedure.

5. The modified values are not stored permanently until the "ENTER" key has
been hit.

6. Both linear and non-linear interpolation may occur, but the two modes
may not be mixed. In order to effect a linear interpolation between two
points, the first point must be the lower bounds, the second point must be
the upper bounds, and there should be no interior points.

7. Interpolation results for integer tables which fall beyond the limits 0
and 255 are forced to those limits.

TAPE TO DISPLAY (T-D)

This operator transfers digital image data stored on magnetic tape to one of
the IDAPS digital television monitors for display.

The host computer is not required by this operator.

```
360 STATUS: DOWN       INTERACTIVE  IDAPS        TIME: 11:11:00
                                                 ELAPSED:03H,05MIN

IMAGE INPUT/OUTPUT - TAPE TO DISPLAY (T-D)

OPTION |   PARAMETER DESCRIPTION
_____

   1   |   INPUT TAPE DRIVE NUMBER (1 OR 2)

   0   |   FILE POSITION
       |      0   - NEXT FILE ON TAPE
       |      1-N - FILE NUMBER

   1   |   STARTING RECORD WITHIN FILE

   1   |   STARTING PIXEL WITHIN RECORD

   0   |   IMAGE SIZE ADJUSTMENT FACTOR
       |      0 - AUTOMATIC SIZE ADJUSTMENT TO FIT DISPLAY SCREEN
       |      1 - NO SIZE ADJUSTMENT
       |      N - REDUCTION FACTOR

   1   |   DISPLAY MONITOR (1, 2, R, G OR B)
```

Note:
1. The Starting Record and Pixel determine the upper left corner of the
digital image stored on tape that will be displayed.

2. A digital image of up to 480 lines and 480 columns may be displayed. If
the image stored on tape is larger than this, only a 480 X 480 subset will
be displayed unless the image size is adjusted. If specified, the Automatic
Size Adjustment will reduce the image by an integer factor to allow the
image to be displayed on one of the display monitors.

TAPE TO DISPLAY (PSEUDOCOLOR)

This operator is employed to read image data from tape, assign selected
colors to input pixel gray values, and display the output on the color
monitor.

The host computer is not required by this operator.

```
360 STATUS: DOWN        INTERACTIVE  IDAPS       TIME: 11:40:55
                                                  ELAPSED:00H,20MIN

PSEUDOCOLOR - TAPE TO DISPLAY

OPTION |    PARAMETER DESCRIPTION
  A    | TABLE SOURCE
       |   A - SYSTEM DEFAULT
       |   B - TRACK BALL
       |   C - CARDS

  1    | INPUT TAPE DRIVE NUMBER (1 OR 2)

  0    | FILE NUMBER

  1    | STARTING RECORD WITHIN FILE

  1    | STARTING PIXEL WITHIN RECORD

  1    | SIZE ADJUSTMENT FACTOR
       |   0   - AUTOMATIC SIZE ADJUSTMENT
       |   1   - NO SIZE ADJUSTMENT
       |   2-N - REDUCTION FACTOR
```

Data Card Format: See SCANNER TO DISPLAY (PSEUDOCOLOR)

Note:
1. All PSEUDOCOLOR operators share the same data tables. This means that a
color scheme defined by cards or trackball in one operator may be used for
other operators by specifying Data Tbls for Table Source.

2. When using the trackball for defining a color scheme, a palette of more
than 1000 colors is displayed on the color monitor. The user then uses the
trackball to point to the colors that he wishes assigned to specific gray
levels. By pressing the trackball "enter" the color is stored and the gray
value assignment index is incremented by and increment factor (n). The
factor n may be modified from the color monitor using the trackball as a
pointer.

TAPE TO FILM (T-F)

This operator takes selected regions of image data stored on magnetic tape
and records the image on photographic film using the on-line image recorder.

The host computer is not required by this operator.

```
360 STATUS: DOWN       INTERACTIVE  IDAPS       TIME: 11:12:05
                                                ELAPSED:03H,06MIN

IMAGE INPUT/OUTPUT - TAPE TO FILM

PLACE FILM IN RECORDER AND VERIFY
   . RECORDER POWER ON
   . RECORDER IN OPERATE MODE
   . PROPER EXPOSURE CONTROL

OPTION | PARAMETER DESCRIPTION          |OPTION|   PARAMETER DESCRIPTION

   1   | INPUT TAPE DRIVE NUMBER (1 OR 2)|  B   | RECORDING RESOLUTION
       |                                 |      |    A - LOW
   0   | FILE POSITION                   |      |    B - MEDIUM
       |    0    - NEXT FILE ON TAPE     |      |    C - HIGH
       |    1-N  - FILE NUMBER           |      |
       |                                 |      | IMAGES ARE NORMALLY RECORDED IN
   1   | STARTING RECORD WITHIN FILE     |      | THE UPPER LEFT CORNER OF
       |                                 |      | 2048X2048 ADDRESSABLE FILM
   1   | STARTING PIXEL WITHIN RECORD    |      | LOCATIONS.  TO SPECIFY AN ALTER-
       |                                 |      | NATE FILM POSITION, ENTER
   A   | RECORDER FILTER                 |      | NUMBER OF LINES TO BE TRANSFERRED
       |    A - NEUTRAL DENSITY          |  0   |    UPPER FILM ADDRESS
       |    B - RED                      |  0   |    LEFT FILM ADDRESS
       |    C - GREEN                    |      |
       |    D - BLUE                     |      |
       |    E - MANUAL/CURRENT SETTING   |      |
       |                                 |      |
   A   | EXPOSURE CHARACTERISTIC         |      |
       |    A - LOG                      |      |
       |    B - LINEAR                   |      |
       |                                 |      |
   A   | RECORDING POLARITY              |      |
       |    A - NORMAL                   |      |
       |    B - COMPLEMENTED             |      |
```

Note:
1. The Exposure Characteristic determines the relationship between the
input gray values (0-255) and the film exposure.

    Log   -   relates film exposure to gray value as the Log_{10}(Gray Value).

    Linear-   relates film exposure linearly to image data gray values.

2. Recording Resolution determines the area of the film exposed by each
input gray value. Since a maximum 57 mm X 57 mm film area may be exposed,
this parameter determines the size of the picture produced by a given input
array. The maximum array size for each resolution setting which will result
in recording of the entire array is as follows:

    Low   -   512 X 512
    Medium -   1024 X 1024
    High   -   2048 X 2048

TAPE TO FILM (PSEUDOCOLOR)

This operator is employed to read image data from tape, assign selected colors
to input pixel gray values, and record the output on color film.

The host computer is not required by this operator.

```
 _____
/                                                                \
|         I N T E R A C T I V E   I D A P S     TIME: 16:49:15     |
|                                               ELAPSED:00H,15MIN  |
| PSEUDOCOLOR - TAPE TO FILM                                      |
|                                                                 |
| OPTION|   PARAMETER DESCRIPTION     |OPTION|  PARAMETER DESCRIPTION |
|                                                                 |
|   A    TABLE SOURCE                        IMAGES ARE NORMALLY RECORDED IN |
|        A - DATA TBLS(PRED,PGRN,PBLU)       THE UPPER LEFT CORNER OF |
|        B - TRACKBALL                       2048X2048 ADDRESSABLE FILM |
|        C - CARDS                           LOCATIONS.  TO SPECIFY AN |
|                                            ALTERNATE FILM POSITION, ENTEP |
|   1    TAPE DRIVE NUMBER (1 OR 2)                                |
|                                     0      UPPER FILM ADDRESS    |
|   1    FILE NUMBER                  0      LEFT FILM ADDRESS     |
|                                                                 |
|   1    STARTING RECORD WITHIN FILE         EXPOSURE SETTING ON THE RECORDER |
|                                            IS A MANUAL PROCESS AND SHOULD |
|   1    STARTING PIXEL WITHIN RECORD        BE SET BASED ON THE FILM TYPE. |
|                                            IT MAY ALSO BE DESIRABLE TO |
|  2048  NUMBER OF RECORDS                   ADJUST EXPOSURE FOR EACH COLOR. |
|                                                                 |
|  2048  NUMBER OF PIXELS              A     EXPOSURE ADJUSTMENT   |
|                                            A - CONSTANT FOR ALL 3 COLORS |
|   A    EXPOSURE CHARACTERISTIC             B - VARIABLE         |
|        A - LOG                                                   |
|        B - LINEAR                                               |
|                                                                 |
|   B    RESOLUTION                                               |
|        A - LOW                                                  |
|        B - MEDIUM                                               |
|        C - HIGH                                                 |
_____/
```

Data Card Format: See SCANNER TO DISPLAY (PSEUDOCOLOR)

Note:
1. All PSEUDOCOLOR operators share the same data tables. This means that a
color scheme defined by cards or trackball in one operator may be used for
other operators by specifying Data Tbls for Table Source.

2. When using the trackball for defining a color scheme, a palette of more
than 1000 colors is displayed on the color monitor. The user then uses the
trackball to point to the colors that he wishes assigned to specific gray
levels. By pressing the trackball "enter" the color is stored and the gray
value assignment index is incremented by an increment factor (n). The
factor n may be modified from the color monitor using the trackball as a
pointer.

TAPE TO PRINTER (T-P)

This operator takes a selected region of digital image data stored on magnetic
tape and prints out the gray values on the IDAPS line printer.

The host computer is not required by this operator.

```
360 STATUS: DOWN       INTERACTIVE  IDAPS        TIME: 11:19:20
                                                 ELAPSED:03H,13MIN

IMAGE INPUT/OUTPUT - TAPE TO PRINTER (T-P)

TURN PRINTER ON

OPTION |   PARAMETER DESCRIPTION
-------+----------------------------------------------------------
   1   | INPUT TAPE DRIVE NUMBER (1 OR 2)

   0   | FILE POSITION
       |    0  - NEXT FILE ON TAPE
       |   1-N - FILE NUMBER

   1   | STARTING RECORD WITHIN FILE

   1   | STARTING PIXEL WITHIN RECORD

  32   | NUMBER OF LINES

  32   | NUMBER OF COLUMNS
```

Note:
1. A maximum of 96 lines and 32 columns may be printed with each application
of this operator.

TAPE TO SYSTEM (INP)

This operator transfers digital image data from magnetic tape to the host
computer where it is stored on disk and established as a system file.

Both the host and terminal minicomputer computers are required by this
operator.

```
360 STATUS: DOWN       INTERACTIVE  IDAPS        TIME: 11:22:30
                                                 ELAPSED:00H,02MIN

IMAGE INPUT/OUTPUT - TAPE TO SYSTEM (INP)

OPTION |  PARAMETER DESCRIPTION

   1   | INPUT TAPE DRIVE NUMBER (1 OR 2)

   0   | FILE POSITION
       |    0    - NEXT FILE ON TAPE
       |    1-N  - FILE NUMBER

   1   | STARTING RECORD WITHIN FILE

   1   | STARTING PIXEL WITHIN RECORD

 2048  | NUMBER OF LINES

 2048  | NUMBER OF COLUMNS
```

Note:
1. If the Number of Lines and/or Number of Columns specified is greater
than are actually stored on the tape, the operator will only transmit the
data stored on the tape and the file that is established will be adjusted
correspondingly.

TAPE TO TAPE (T-T)

This operator transfers digital image data from one magnetic tape to another.
The operation may be used to reduce the number of reels needed to store
several image files or to extract one file from several previously stored on
a single tape.

The host computer is not required by this operator.

```
               INTERACTIVE  IDAPS        TIME: 16:36:00
                                          ELAPSED:00H,02MIN

IMAGE INPUT/OUTPUT - TAPE TO TAPE

OPTION |   PARAMETER DESCRIPTION
-------+----------------------------------------------------------------
   1   |   INPUT TAPE DRIVE NUMBER (1 OR 2)
       |
   0   |   INPUT FILE POSITION
       |      0   - NEXT FILE ON TAPE
       |      1-N - FILE NUMBER
       |
   1   |   STARTING RECORD WITHIN FILE
       |
   1   |   STARTING PIXEL WITHIN RECORD
       |
   0   |   OUTPUT FILE NUMBER
       |      NOTE: A '0' ENTRY WILL RESULT IN THE IMAGE BEING WRITTEN AS THE NEXT
       |            FILE.  ANY OTHER INTEGER ENTRY WILL CAUSE THE TAPE TO BE REWOUND
       |            AND N-1 FILES SKIPPED TO POSITION THE TAPE.
```

TRANSPOSE (TRA)

This operator performs a number of useful axial transpositions on an input
image array (plus angles are <u>clockwise</u> rotation).

Both the host computer and terminal minicomputer are required by this operator
until the operator goes into execution, then only the host computer is
required.

```
360 STATUS: READY      INTERACTIVE  IDAPS        TIME: 08:36:15
FILE NAME:  ISCA                                 ELAPSED:00H,08MIN

GEOMETRIC OPERATIONS - TRANSPOSE

OPTION |    PARAMETER DESCRIPTION

 ISCA  |  INPUT FILE NAME

   1   |  STARTING LINE.

   1   |  STARTING COLUMN.

  480  |  NUMBER OF LINES.

  480  |  NUMBER OF COLUMNS.

   A   |  TRANSPOSITION OPTION
       |     A - ROTATE ABOUT MAJOR AXIS
       |     B - ROTATE +90 DEGREES
       |     C - ROTATE -90 DEGREES
       |     D - ROTATE ABOUT MINOR AXIS
       |     E - ROTATE ABOUT VEPTICAL AXIS
       |     F - ROTATE ABOUT HORIZONTAL AXIS
       |     G - ROTATE 180 DEGREES
```

Note:
1. The results of transposing the letter <u>J</u> illustrates the various options.

A = ⌐⌐⌐⌐) (major axis)	E = ⌊⌋ (vertical axis)
B = ⊂⎯⎯ (+ 90 degrees)	F = ⌐⌐ (horizontal axis)
C = ⎯⎯⊃ (-90 degrees)	G = ⌐⌐ (180 degrees)
D = ⊂⎯⎯ (minor axis)	

SDC