EARTH OBSERVATIONS DIVISION

EARTH RESOURCES DATA ANALYSIS CAPABILITIES

(REVISION B)

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JSC EARTH RESOURCES DATA ANALYSIS CAPABILITIES AVAILABLE TO EOD REVISION B

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FOREWORD

This document was prepared by Lockheed Electronics Company Aerospace Systems Division in response to Action Document No. 63-0497-4353-01, Job Order 74-353, for the Data Requirements Branch, Earth Observations Division, NASA Johnson Space Center.

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ACRONYMNS

A/D	analog-to-digital
ACV/P	additive color viewer/printer
ADAS	auxiliary data annotation set
ASP	automatic sample processor
CCT	computer-compatible tapes
CMB	code matrix block
CRT	cathode ray tube
DAS	data analysis station
DRA	data reformatter assembly
DTL	Data Techniques Laboratory
EOD	Earth Observation Division
ERFP	Earth Resources Experimental Package
ERIPS	Earth Resources Interactive Processing System
ERTS	Earth Resources Technology Satellite
ERTS-A	Earth Resources Technology Satellite A
FM	frequency-modulated
GSA	Government Services Administration
IDSD	Institution Data Systems Division
IMD	image manipulation and display
ISD	Information Systems Division
IRIG-A	interrange instrument group A
HATS	Houston Area Test Site
JSC	Nasa Lyndon B. Johnson Space Center at Purdue University
LARS	Laboratory for Applications of Remote Sensing
M^{2}S	modular multispectral scanner
MCFV	multiband camera film viewing
MSDS	multispectral data system
MSS	multispectral scanner
MSTU	multisensor take up
PCM	pulse-code-modulation
PMIS	passive microwave imaging system
PMT	photomultiplier tube
RIMS	Regional Information Management System
RTCC	Real Time Computer Complex
RZ	return to zero
SEM	scanning electron microscope
SIS	scanning imaging spectroradiometer
TTY	teletype
TV	television

SECTION 1
INTRODUCTION

This document provides a summary of laboratory capabilities used by the Earth Observation Division (EOD) for processing Earth resources data and will be updated to reflect new capabilities as they are developed. It also provides the division analysis teams with a reference for planning purposes and an aid in the development of data handling and screening plans.

1.1 PURPOSE

The purpose of this document is to provide a list and summary description of all the NASA Lyndon B. Johnson Space Center (JSC) laboratory capabilities available to EOD personnel for processing Earth resources data. The bibliography at the end of each section provides further sources of information.

1.2 SCOPE

The scope of this document is concerned with electronic capabilities, photographic capabilities, and capabilities cross-reference tables. The electronic capabilities section pertains to those facilities and systems that use electronic products (magnetic tape, punched cards, paper tape, etc.) as input and electronic and/or photographic products as output. The photographic capabilities section pertains to equipment that uses photographic images as input and electronic and/or photographic products as output. The capabilities cross-reference table summarizes processing steps.

A general hardware description is presented for each of the data processing systems and the titles of computer programs are used to identify the capabilities and data flow.

SECTION 2
ELECTRONIC CAPABILITIES

2.1 THE JSC PURDUE TERMINAL FACILITY

2.1.1 General

The Purdue University remote-terminal data-communications facility provides the user with a direct link to an IBM-360/67 computer located in the Laboratory for Applications of Remote Sensing (LARS) at Purdue University. Evaluation of data submitted for processing under current LARSYS techniques Version III through punched card or keyboard input and punched card or printer listing output is available. (Magnetic tape output is available, but a 1-week mail delay is to be anticipated.)

Present equipment includes one IBM-2780-2 data terminal, two IBM-2741 data terminals, one Data Point 3300 data terminal, and one Hazeltine 2000 data terminal. Terminal communication is multiplexed; hence, all terminals may be operated simultaneously. (Future expansion includes leased-line communications to Government Services Administration (GSA) computer network, Dallas/Fort Worth region, which will have LARSYS version III available in the last quarter of 1974.)

Outputs are in the form of graphs, data histograms, and tables of printed data values. The terminals are operated on a nonscheduled basis; however, users should investigate available training sessions before attempting to use the facility. The facility is located in room 2062, building 17. Contact John Sargent, TF4, 483-6478 to schedule training sessions.

2.1.2 Sensor Capabilities

The sensor capabilities consist of any sensor data in LARSYS format.

2.1.3 Programs - LARSYS Version III

The LARSYS monitor program requests, initializes, and causes to be executed major processing functions as listed in A through F. Ancillary packages are listed in G through L. Figure 2-1 shows the overall organization of LARSYS.

A. Statistics processor (STASUP) - The statistics processor produces histograms, spectral plots, and mean and correlation matrices for given classes or fields.

B. Point classification processor (CLASUP) - This program, using a maximum-likelihood-classification rule classifies multispectral data on a point-by-point basis.

C. Print results processor (PRISUP) - This display program offers various ways of presenting classification results such as printouts, gray scale maps, outlines of test and training fields, tables of data, performance tables, user request summary, and results file listing.

D. Separability processor (SEPSUP) - This program provides for selection of the set of channels that will give the most accurate classification by the classify-points function.

E. Cluster processor (CLUSUP) - This program uses an unsupervised classification (clustering) algorithm to classify individual data points into a predefined number of clusters. The cluster processor output is a map of clustered arrays and/or punched cards of the same.

F. Sample classification processor (SAMSUP) - This program implements a statistical distance measure for classifying samples (test fields) from the multispectral image data tape.

G. Histogram processor (HISSUP)

H. Pictureprint function (PICSUP)

I. Graph function (GRHSUP)

J. Image display function (IMASUP)

K. Result function (RESSUP)

L. Function (FUNSUP)

2.1.4 Bibligraphy

LARSYS Users' Manual, Purdue Univ., June 1, 1973, vol. 1, LARSYS III Program Abstracts Manual; vol. 2, LARSYS III System Manual; and vol. 3, LARSYS III Users' Manual. This information is kept in the terminal area.

Flores, L. M.: Summary of Information Obtained Concerning the Purdue Remote Terminal, TM-642-467, May 1972.

LARSYS 0250 Program Name LARSPLAY Abstracts.

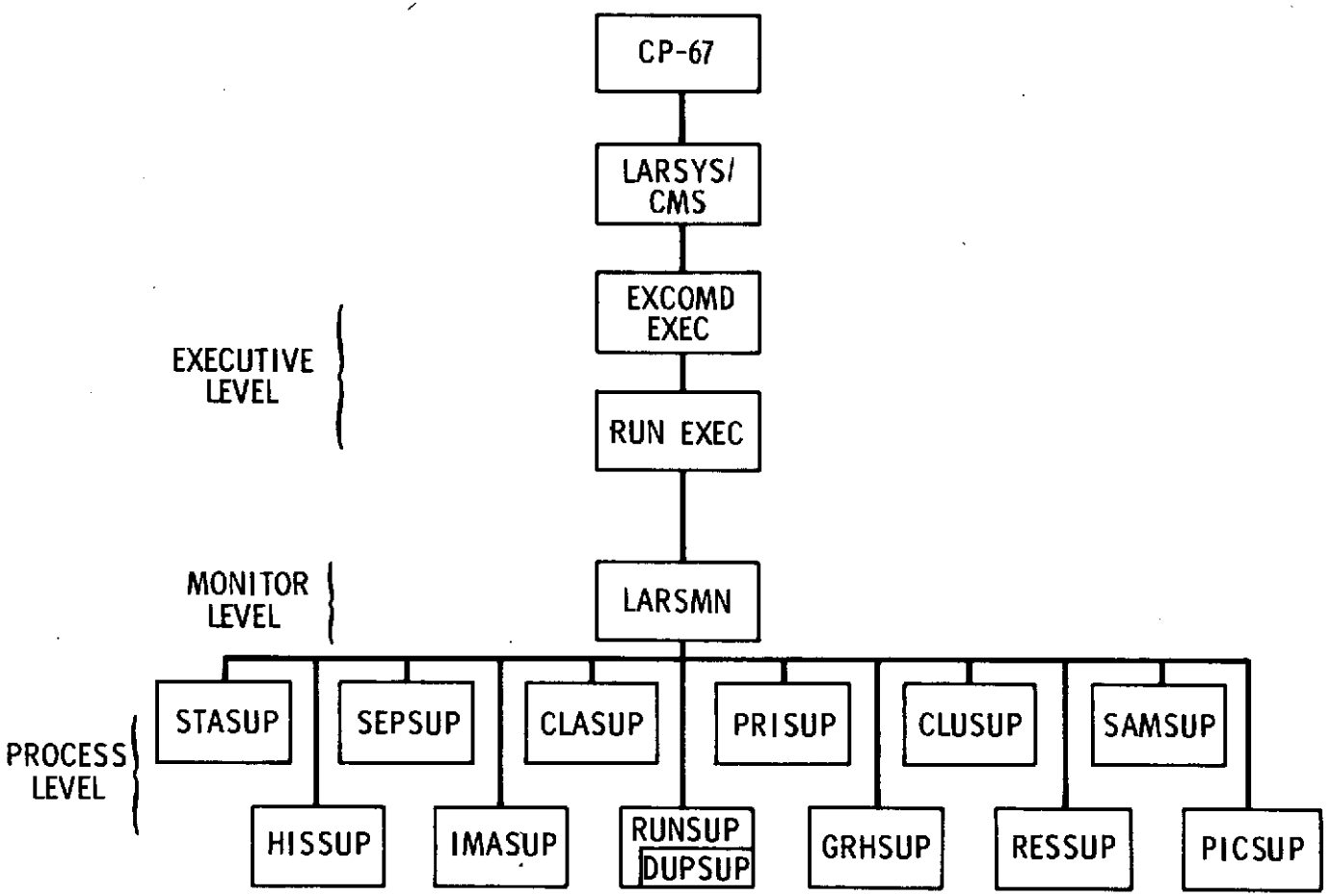

Figure 2-1.- LARSYS version III (NASA-S-74-3503).

2.2 THE JSC EARTH RESOURCES INTERACTIVE PROCESSING SYSTEM (ERIPS)

2.2.1 General

The ERIPS is an interactive graphics system implemented at the JSC to be used in the processing and investigation technique development for remotely sensed Earth resources data. This system allows the analyst to analyze data as it is being processed. The ERIPS presently handles 9-track, 800-bpi computer-compatible tapes (CCT) in the ERTS multispectral scanner (MSS) bulk, LARSYS and Universal formats. Universal format nine-track tapes, as well as printer listings, are available as output in addition to Polaroid color photographs and microfiche of image displays.

The ERIPS consists of an IBM-360/75 computer and two special-purpose interactive Hazeltine terminals located in the Real-Time Computer Complex (RTCC), building 30, JSC. Each terminal consists of a special-purpose keyboard, black-and-white image monitor (landscape) alphanumeric monitor (conversational) and a shared, color-image monitor. Two additional remote terminals are scheduled for installation in the building 17 Data Applications Laboratory.

2.2.2 Sensor Capabilities

The sensor capabilities include any sensor data in ERTS MSS bulk, LARSYS II, or universal format.

2.2.3 Special Capabilities

The capability of interaction between the computer and the user is developed through the conversational monitor. The monitor displays menus from which the user, through the keyboard and grafacon, can choose the many options involved in image registration and spectral pattern recognition. The user receives almost instantaneous response to his choices of channels, computations, et cetera. These choices and subsequent computer responses may then be hardcopied for future reference.

2.2.4 Program - Version ERIPS EOD V902D

Figure 2-2 shows the flow chart for the ERIPS version EOD V902D. The updated ERIPS software package EOD V903 was scheduled for availability approximately May 16, 1974.

2.2.4.1 Pattern recognition.- The pattern recognition application performs multispectral analysis of data. It has as a base the Purdue LARSYS program dated June 10, 1971. The pattern recognition program can

classify every picture element or group of elements (fields), including 60 user-defined classes.

2.2.4.2 Image registration.- Image registration, if desired, can be accomplished by two methods. One method is to conform an input image of a given scene to a reference image of the same scene (image/image). Another method is to map the input images onto predefined latitude/longitude grids (image/grid).

There may be three outputs obtained from the registration computation: a display of the final registered image located in the core on any of the landscape monitors, a microfiche output through normal ERIPS-associated hardware, and an output tape of the final registered image. An additional function of image composition may be used where image/image registration is being performed.

2.2.4.3 Load application.- The load application provides the ERIPS user with four different capabilities. First, it provides for loading image data from CCT in various formats (sec. 2.2.1) onto the system disk packs for analysis. Second, it provides image data transfer from disk to tape in the universal format for future use on ERIPS, or any other data system that can process the universal format (i.e., data analysis statation (DAS), Univac production film recorder). Third, it provides image viewing on the image screen directly from tape and the selection of an area of the total image to be loaded for further processing or analysis. Fourth, it generates, upon request, a report containing header information for any image.

2.2.4.4 Image creation application.- The image creation application allows the system user to take two images containing the same number of lines and pixels and combine them into one picture of two images. The most common use of this application will be to take two registered images and then combine them into one picture that can then be submitted to the pattern recognition processor for temporal/spectral analysis.

2.2.4.5 Image manipulation and display application.- The image manipulation and display (IMD) application displays an image on the landscape-television (TV) with a maximum of 16 shades of gray or 8 colors. In addition to displaying an image, the IMD provides the user with image manipulation capabilities to scroll and magnify.

2.2.4.6 Delog application.- The delog application allows the user to have a printed copy of his menus/reports generated after his run. The

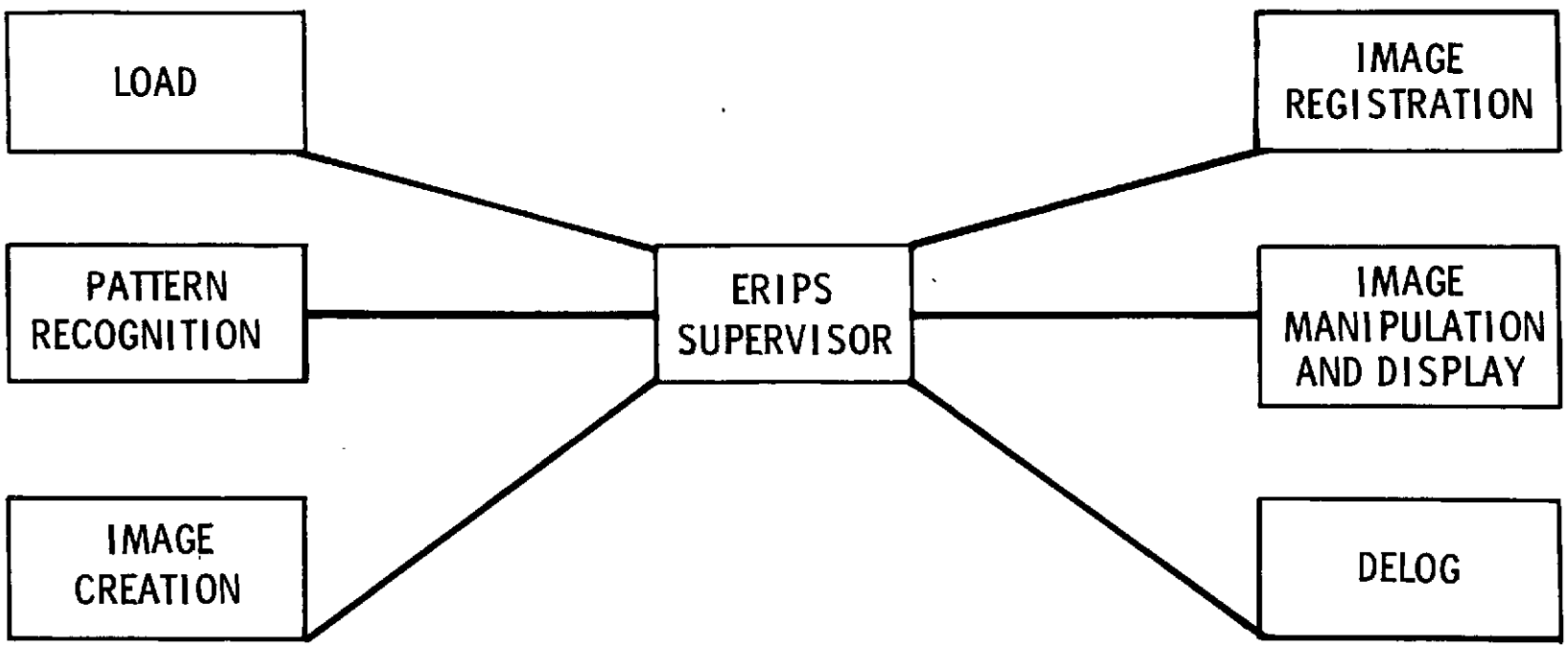

Figure 2-2.- ERIPS version EOD V902D (NASA-S-74-3499).

printed copy will be sent to the user to the address shown on the signon menu.

2.2.5 Bibliography

Users' Guide, vol. 1, NAS9-996

Interactive Earth Observations Display/Control System Performance Specifications, Philco Ford Corp., PHO-SE-09645A, Oct. 24, 1972.

Swain, Phillip H.: Pattern Recognition, A Basis for Remote Sensing Data Analysis, Purdue Univ., LARS information note 111572.

Remote Multispectral Sensing in Agriculture, Purdue Univ., Research bull. 844, Sept. 1968.

2.3 EARTH RESOURCES PRODUCTION PROCESSING FACILITY

2.3.1 General

The Earth resources production processing facility consists of equipment that is capable of taking Skylab 28-track instrumentation tape and aircraft 14-track instrumentation tape and outputting film images, plots, tabulations and universal formatted CCT. By inputting options to certain programs, a limited amount of analysis is possible (i.e., statistics can be obtained for some sensor data). This facility is located in building 30. Output products are available by submitting a data request form and supplementary sheet to John Sargent, TF4 713-483-6478.

2.3.2 Sensor Capabilities

This facility is designed to accept both aircraft and Earth Resources Experimental Package (EREP) sensor data.

2.3.3 Special Capabilities

The special capabilities are documented as standard data products.

2.3.4 Programs

The Earth resources production processing facility is committed to take aircraft and EREP sensor data and output certain standard data products; therefore, programs are sensor oriented and are well documented in the TR-523 and TR-524 documents.

2.3.5 Bibliography

Earth Resources Production Processing Requirements for Aircraft Electronic Sensors, TR-523.

Earth Resources Production Processing Requirements for EREP Electronic Sensors, TR-524.

Earth Resources Data Format Control Book, TR-543

Skylab Program EREP Investigators Information Book, MSC-07874.

Earth Resources Operations Handbook (EROH), LEC-0719.

2.4 MULTISPECTRAL SCANNER DATA ANALYSIS SYSTEM

2.4.1 General

The MSS DAS (fig. 2-3) features an SEL-810B computer-controlled hardware/software configuration, including a multichannel analog-to-digital (A/D) converter subsystem. The system can be used to display, screen, index, edit, or reformat multichannel imagery data. The inputs are pulse-code-modulation (PCM) encoded or frequency-modulated (FM) recorded analog magnetic tape, or nine-track CCT. The outputs are a three-channel black-and-white film record, a single-channel black-and-white film record, punched cards, alphanumeric display, visicorder, printer listing, and CCT. Digitizing is provided by the SEL-700 A/D subsystem. The MSS DAS is located in room 2062, building 17, and system time can be scheduled by John Sargent, TF4, 713-483-6478.

2.4.2 Sensor Capabilities

This system will accept multichannel imagery data recorded in PCM, analog data using direct or FM record techniques, or nine-track CCT. Existing software will process Earth Resources Technology Satellite A (ERTS-A), 24-band MSS, S-192, modular multispectral scanner (M²S), RS-7, RS-14 and Reconofax IV data. Processing of other sensor data may be available upon request. Existing software packages will process nine-track CCT in ERTS-A, multispectral data system (MSDS), LARSYS, universal, RS-14, or color study format.

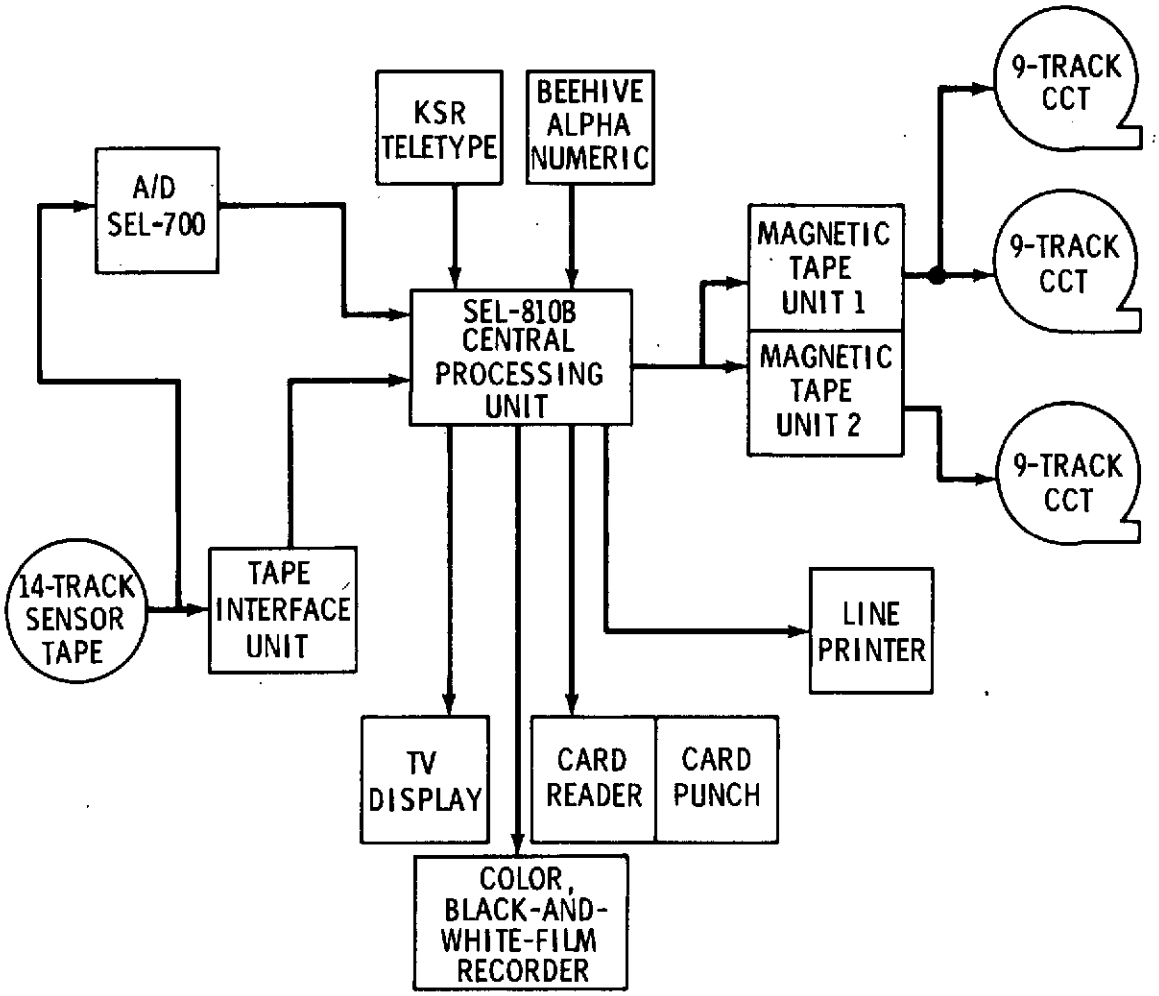

Figure 2-3.- MSS/DAS system block diagram (first of two data techniques laboratory facilities) (NASA-S-74-3500).

2.4.3 Special Capabilities

A 525 line by 700 element color TV monitor is used for display and screening of imagery data consisting of selected channel data. Screening is accomplished by data being selected by cursor for further analysis. Precision edits are made using coordinate selection from grid-overlayed imagery previously processed on film or visicorder output copy. Visicorder products are available on- or offline (sec. 2.10.)

2.4.4 Programs

2.4.4.1 Improved MSDS program for recording, editing, and screening (IMPRES).- The IMPRES program provides a moderately high-speed screening and editing capability for MSS data. The IMPRES has a basic sensor-tape color-screening rate of 7-1/2 ips black-and-white at 15 ips. Specific area editing maybe selected via cursor use or manual entry of the coordinate table through the teletype (TTY).

2.4.4.2 Superspeed screening program (SSSP) for viewing.- This program provides screening and film-edit capability for MSS and M²S data. Color display from sensor tape speed at 15 ips and black-and-white at 30 ips is featured. Simultaneous filming of two channels on black-and-white film at 15 ips is available. Coordinate grid overlay on the film or display imagery is optionally available. Annotation is accomplished by TTY or card-reader input.

2.4.4.3 The M²S screening and editing program.- This program has basic screening and editing capability for M²S data. The program can screen three channels at a sensor tape speed of 15 ips. It is also capable of transfering edited sensor data from PCM tape to digital CCT tape in LARSYS format.

2.4.4.4 S-192 screening and editing program (SES-192).- Basic screening is accomplished in single-channel black-and-white mode at 30 ips sensor tape speed. Editing is performed on a LARSYS output CCT. Edits of five channels or less take place at 15 ips. Up to 12 channels can be run at 3-3/4 ips. Two minutes of single-channel S-192 data can be output on one CCT, or 12 seconds of 12 channels.

2.4.4.5 S-192 line-straighting program (LRSCOR).- This program pseudo corrects the conical sensor sweep using a sine function to refit the data. A CCT of up to three channels of SES-192 data can be input for

processing. Output areas are selectable on a scan-line basis. Output data are in LARSYS format on nine-track CCT.

2.4.4.6 LARS-check program (LRSCHK).- This program provides color or black-and-white screening and black-and-white film editing of any LARSYS format tape. Gain, bias control, and channel selection is available through the operator TTY. Tapes are verified for proper formatting, including sequential record counts, and checked for possible parity errors. Coordinate grid overlay is optional.

2.4.4.7 LARSYS histogram program (LRSHST).- Input is LARSYS CCT. The operator controls channel selection and the area boundaries to be histogrammed via TTY input. Outputs consist of image display, film recorder, or line-printer listing. Summary listing is also provided.

2.4.4.8 MSDS histogram program (METH).- The MSDS histogram program functions the same as the LRSHST, except MSDS format data is input.

2.4.4.9 ERTS to LARSYS conversion (ELARS).- This program inputs and converts bulk ERTS-A MSS CCT tapes and outputs nine-track CCT in the LARSYS format for display via LARS-check and further processing. (Precision MSS format tapes cannot be used.)

2.4.4.10 ERTS-A to MSDS.- The ERTS-A to MSDS conversion program selectively converts to, and displays in MSDS format, bulk MSS imagery from the ERTS. (Precision MSS format tapes cannot be used.)

2.4.4.11 MSDS to LARSYS III imagery format conversion program (MSDSL3).- The MSDS to LARSYS III conversion program reformats entire MSDS edits to LARSYS III format to provide an input into the Univac large-scale computer facilities.

2.4.4.12 Bendix all-channel tape copy program (BACTC).- The BACTC extracts selected portions of the 14-track analog PCM S-192 imagery data tape and transfers these data to nine-track CCT. Operator parameter selection and processing control is achieved through the alphanumeric keyboard display and console interrupt switches. These reformatted data can then be submitted to the Univac large-scale computer system for further processing.

2.4.4.13 Keyboard inspect and change (KIC).- The keyboard inspect and change program is a programmer/operator aid that provides the capability of

inspecting and/or modifying core image contents via the KSR teleprinter.

2.4.4.14 S-192 universal formatter (S2UF).- The S2UF program inputs S-192 imagery data from nine-track CCT in the ACTC (or BACTC-PASS2) format, reformats it to imagery data universal format and creates another nine-tract CCT.

2.4.4.15 Verify (VRFY).- VRFY is a utility support program that compares records on an original and copy of nine-track CCT data to determine exact duplication.

2.4.4.16 Universal screening and editing program (USEP).- The USEP is used to display, display and film record partial width, or display and film record full-width image data. Input to the program is data collected from various Earth resources sensors (i.e., S-192 and MSS) written on 9-track, 800 bpi CCT in the imagery data universal format. False color is available through the linear transformation equation for each color.

$$LT = \left[G_1(C_1 + B_1) + G_2(C_2 + B_2) + G_3(C_3 + B_3)\right] + D$$

2.4.4.17 Duplicate (DUP1, DUP2).- Duplicate is a utility support program that transfers data from one media to another (i.e., tape to cards, cards to tape).

2.4.4.18 ITOS-D-VHRR scanner screening and editing program (VHRR).- Weather satellite analog VHRR data is input through the SEL-700 A/D system. Color TV display is provided for screening purposes. The edit mode outputs a LARSYS CCT. Extra calibration and annotation is included on the output tape. Special operator setup procedures are required. Both visible and infrared channel data are recorded. Backup mode option is also provided.

2.4.4.19 General-purpose digitizing program (GPDZ).- Various analog sensor data (i.e., RS-7, RS-14, Reconofax IV) are input through the SEL-700 A/D system. Capability exist for up to 12 channels of sensor data to be digitized and edited into LARSYS format output CCT. Black-and-white film and TV display output is also available. This program could potentially support the digitizing of any analog sensor data. Special operator setup procedures are required. Calibration elements are currently not provided on the output CCT.

2.4.4.20 LARSYS I to MSDS conversion (LIMSDS).- The LARSYS I to MSDS conversion program reformats LARSYS (version I) input CCT to the MSDS format CCT. Further processing may then be accomplished by use of the MSDS or MOPS programs.

2.4.4.21 LARSYS II results program description (LRSRES).- The LARSYS II results program converts the Purdue classification results input tapes to 9-track, 800 bpi universal format tapes.

2.4.4.22 The 24-channel display (24CHAN).- The 24-channel display program displays all 24 channels of data from an MSDS edit CCT in order to provide a quick-look assessment of the quality of the imagery on each of the 24 video channels. Black-and-white TV display is used. Tapes made with fewer than 24 channels will not display channels in proper order.

2.4.4.23 MSS housekeeping delog (MHD).- The MSS housekeeping delog program lists parameters from track 13 of an MSS PCM sensor tape. This delog can be printed for all scan lines or for a designated number of scan lines. The MHD program also has the capability of printing scan lines at a selected interval.

2.4.4.24 Universal format to LARSYS II conversion (UFLRS).- The universal format to LARSYS III conversion program converts universal format nine-track, CCT input tape to LARSYS (version III) nine-track, CCT output tape.

2.4.4.25 Universal format edit tape (UFET).- The universal format edit tape program was designed to provide a method of editing universal format CCT. The data to be edited are selected according to a designated start scan line number, stop scan line number, start pixel number, number of pixels, and channel numbers. The UFET program also has the capability of reversing the scan-line direction of the data if that feature is desired.

2.4.4.26 LARSYS III to MSDS conversion program.- The LARSYS III to MSDS conversion program is used to reformat LARSYS III FORMAT CCT to MSDS format screening and for analysis using the MSDS and MOPS program.

2.4.4.27 Multispectral edit tape print program (METP).- The METP is a support program designed to give a printed listing of data values for selected scan lines of imagery in the MSDS format.

2.4.4.28 S-192-band 13 multipoint smoothing program (MPS-13).- This program provides capability for smoothing low-frequency banding present in Skylab ERBE band 13, thermal data. Low-temperature calibration points are used to digitally adjust imagery data based on that reference. Input data are SES-192 LARSYS CCT. Output is LARSYS CCT.

2.4.5 Bibliography

Software capabilities of the building 17 Data Techniques Laboratory, Philco-Ford, Sept. 10, 1973.

Data Format Control Book, TR-543.

Screening and Data Handling Plan for ERTS-1 Computer Compatible Tapes and Aircraft 24-Band Scanner Data, EOD-294S.

2.5 ADDITIONAL DATA TECHNIQUES LABORATORY (DTL) PHOTOGRAPHIC CAPABILITIES

2.5.1 General

The DTL has a capability for converting image data to a television signal for processing and displaying of Earth resources data.

2.5.2 Multiband Camera Film Viewer Model 2000 (IIS)

The multiband camera film viewer (MCFV) (fig. 2-4) is a three-channel electronic-visual system capable of converting image data to a television signal and displaying that data on a 1000-line color display. Inputs can be roll film (70 millimeters or 5 by 5 inches) or any transparency from 16 millimeters to 5 by 5 inches. Outputs to the display can be false colored and photographed on 70-millimeter color film. This system is located in room 2062, building 17, and system time can be scheduled by John Sargent, TP4, 713-184-6478.

2.5.3 Bibliography

Tyler, J. L.: Multiband Camera Film Viewer Capabilities and operation, LEC-0599.

2.6 PRODUCTION FILM CONVERTER

2.6.1 General

The production film converter (FR-80) is a functional part of the Earth resources production processing system. The FR-80 will also accept universal-formatted magnetic CCT inputs from other sources,

including the existing DAS, the ERIPS, other Skylab and aircraft sensor data, Earth Resources Technology Satellite (ERTS) data, calibration data, and navigational data. Output products are filmed images on either 70-millimeter or 5-inch black-and-white and color film. A film converter is located in room 1087, administrative side of building 30, and output products are obtained by data request forms through John Sargent, TF4, 713-483-6478.

2.6.2 Sensor Capabilities

The FR-80 can process nine-track universal format CCT from the follcwing sensors:

A. S-192, MSS
B. MSS, 24-channel MSS
C. RS-14, dual channel scanner
D. Reconofax IV, infrared scanner

2.6.3 Special Capabilities

2.6.3.1 Print processing.- Processing can be provided to accommodate print and tabular listings on film.

2.6.3.2 Plot processing.- Plot processing can be provided to generate histograms, plots of calibration, trend and housekeeping data, and other X-Y functions.

2.6.4 Programs

2.6.4.1 Image processing.- Image processing can accommodate data derived from both linear scan and conical scan sensor systems, and will provide compensation for known geometric and radiometric errors because of sensor or production film converter characteristics.

2.6.5 Bibliography

Earth Resources Production Processing Requirements for Aircraft Sensors, TR-523.

Earth Resources Production Processing Requirements for EREP electronic Sensors, TR-524.

Earth Resources Data Format Control Book, TR-543.

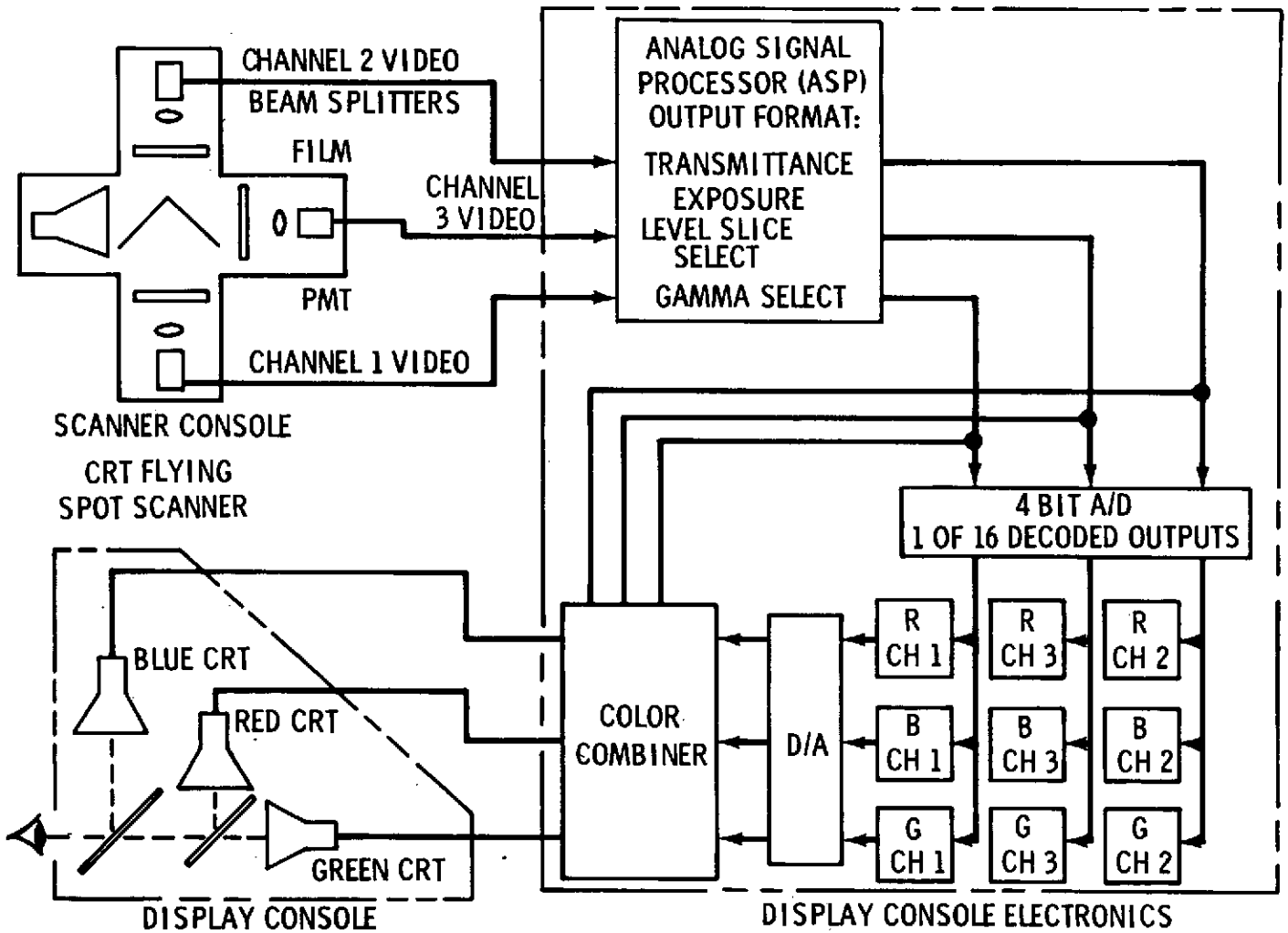

Figure 2-4.- Multiband camera film viewer (NASA-S-74-3501).

Production Film Converter Data Software Requirements SH-09819B for each sensor.

Production Film Converter Procurement Specification SP-09676D.

2.7 PASSIVE MICROWAVE IMAGING SYSTEM DATA ANALYSIS SYSTEM

2.7.1 General

The Passive microwave imaging system (PMIS/DAS (fig. 2-5) features an SEL-810B computer-controlled hardware/software configuration that will display, screen, index, edit, and reformat multichannel imagery data. The inputs are PCM-encoded magnetic tape or nine-track CCT. The outputs are black-and-white film, color film, punched cards, alphanumeric display, line printer, and CCT. This system is located in room 2062, building 17. System time can be scheduled by John Sargent, TF4, 713-483-6478.

2.7.2 Sensor Capabilities

This system will accept any multichannel imagery data recorded in PCM tape format or nine-track CCT. Existing software limits system processing of data to the ERTS-A, 24-band, MSS, M²S, S-192, PMIS, RS-14, and the scanning imaging spectroradiometer (SIS). (Software programs will process nine-track CCT in ERTS-A, MSDS, LARSYS, universal, RS-14, or color-study format.)

2.7.3 Special Capabilities

A 525 line by 480 element color TV monitor is used for display and screening of imagery data consisting of selected channel data on three color guns (red, green, and blue). Screening is accomplished by assigning desired channel data to the display guns. Imagery on film, visicorder paper, or display may be grid overlayed. Precision edits are made using coordinate selection from the grid overlay imagery. Coarse edits are made through use of the rectangular cursor. (See Computer Based Coordinate Grid Overlay, W. Eppler, EOD.)

2.7.4 Programs

2.7.4.1 MSDS on PMIS DAS (MOPS).- This program screens or edits MSS sensor data tapes or nine-track CCT in MSDS format. Color or black-and-white display is provided by linear transformation equation, $LT = Ax + B$. Film and tape-to-tape edits are also available.

2.7.4.2 Scanning image spectrometer - ocean mode (SISO).- This program converts the 14-track sensor-tape output of the Scanning imaging spectroradiometer (ocean mode) to a nine-track CCT that is compatible with the MSDS edit format.

2.7.4.3 Multispectral edit tape print program (METP).- The MPTP is a support program designed to give a printed listing of data values for selected scan lines of imagery in the MSDS format. Other modes of operation will allow error checking of MSDS data edited from sensor tapes, octal listings of data values, and selection of the edit to be listed.

2.7.4.4 Multispectral edit tape histogram (METH).- This program inputs MSDS CCT. The operator selects the area to be processed by pixel start, number of pixel scan line start, and number of lines. Output is line-printer listing showing data count distribution and summary sheet.

2.7.4.5 MSS housekeeping delog program (MHD).- The MSS housekeeping delog program lists parameters from track 13 of an MSS PCM sensor tape. This delog can be printed for all scan lines or for a designated number of scan lines. The MHD program also has the capability of printing scan lines at a selected interval.

2.7.4.6 All-channel tape copy program (ACTC).- This program extracts selected portions of the 14-track analog PCM S-192 imagery data tape and transfers these data to nine-track CCT in the ACTC format. Operator parameter selection and processing control is achieved through the alphanumeric keyboard display and console interrupt switches. These reformatted data can then be submitted to the Univac large-scale computer system for further processing.

2.7.4.7 Selection program (SELE).- The SELE screens S-192 sensor data to display imagery of nonstraightened scan-line data and to edit digital data tapes for subsequent use in scan conversion. The data input to SELE is the 28-channel, reformatted, 14-track data reformatter assembly (DRA) PCM data tape. Output is two CCT; the center of the image is written on one tape and the edge data are written on a second tape.

2.7.4.8 Correction program (CORR).- The CORR is a link between the SELE and the DSPL programs to complete the scan-straightening process for S-192 imagery data. Inputs to CORR are the two magnetic tapes output by SELE. These inputs are read by CORR, scan corrected, reformatted, and

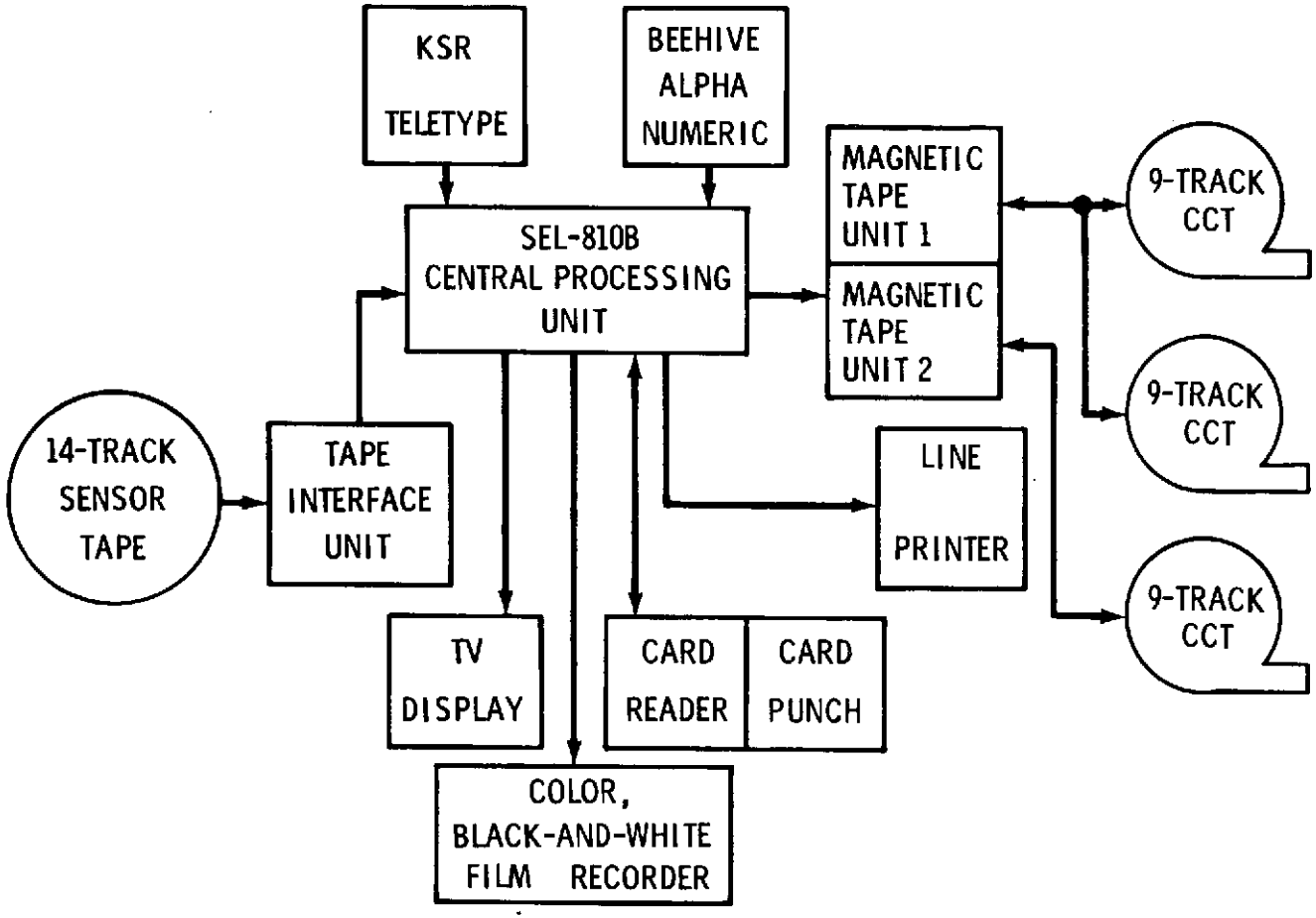

Figure 2-5.- PMIS/DAS system block diagram (second of two data techniques laboratory facilities) (NASA-S-74-3502).

written out on two output tapes, which are used by the DSPL program for display.

2.7.4.9 Display program (DSPL).- The DSPL takes CCT imagery data recorded on one or more digital tapes, merges, selects, combines, and processes these data and presents the data to the color display and strip-film recorder. Input tapes are from the CORR or SELE programs.

2.7.4.10 LARSYS correction program (LRSCOR).- This program pseudo corrects the conical sensor sweep using a sine function to refit the data. Up to three channels of data from CCT can be input for processing. Output areas are selectable on a scan-line basis. Output data are in LARSYS format on nine-track CCT.

2.7.4.11 LARSYS II check program (LRSCHK).- This program provides color or black-and-white screening and black-and-white film edit of any LARSYS format tape. Gain, bias control, and channel selection is available through the operator TTY. Tapes are verified for proper formatting, including sequential record counts and checked for possible parity errors. Coordinate grid overlay is optional. False color is available through the linear transformation equation for each color.

$$LT = \left[G_1(C_1 + B_1) + G_2(C_2 + B_2) + G_3(C_3 + B_3)\right] + D$$

2.7.4.12 Copy housekeeping and time (CHAT).- This program copies S-192 housekeeping data from the 14-track sensor tape and tags these data with the S-190 time. The output of this program is compatible with the Institution Data Systems Division (IDSD) phase I continuous data CCT. An auxiliary output of CHAT is a delog to the line printer of the output CCT.

2.7.4.13 Verify (VRFY).- VRFY is a utility support program that compares records on an original and a copy of nine-track CCT data to determine exact duplication.

2.7.4.14 Universal screening and editing program (USEP).- The universal screening and editing program (USEP) is used to display, display and film record partial width, or display and film record full-width image data. Input to the program is data collected from various Earth resources sensors (i.e., S-192 and MSSO written on 9-track, 800 bpi,

CCT in the imagery data universale format). False color is available through the linear transformation equation for each color.

$$LT = \left[G_1(C_1 + B_1) + G_2(C_2 + B_2) + G_3(C_3 + B_3)\right] + D$$

2.7.4.15 Universal histogram program (UHIST). The universal histogram program will accept universal format nine-track input tape and output a histogram and statistical information that includes the maximum value, the median, the mode, the mean, and the standard deviation. Input data is selected via the numeric display keyboard by selecting a scan line number and pixel position for specified channels or by linkage to USEP. Statistical information of up to four selected channels can be output simultaneously to the numeric display and percentage bargraph to the line printer. Up to three selected channels can be displayed simultaneously as a percentage bargraph to the color display.

2.7.4.16 Universal format edit tape (UFET).- The universal format edit tape program was designed to provide a method of editing universal format CCT. The data to be edited are selected according to a designated start scan-line number, stop scan-line number, start pixel number, number of pixels, and channel numbers. The UFET program also has the capability of reversing the scan-line direction of the data if that feature is desired.

2.7.4.17 Duplicate (DUP1, DUP2).- Duplicate is a utility support program that transfers data from one media to another (i.e., tape to cards, cards to tape).

2.7.4.18 LARSYS III to MSDS conversion program (L3MSDS).- The LARSYS III to MSDS conversion program is used to reformat LARSYS III digital tapes for analysis using the MSDS/MOPS programs and building 12 programs.

2.7.4.19 MSDS to LARSYS III conversion program (MSDSL3).- The MSDS to LARSYS III conversion program reformats entire MSDS edits to LARSYS III format to provide an input into the Univac large-scale computer facilities.

2.7.4.20 MSS to universal format conversion program (MSSUF).- The MSSUF screens, film records, and reformats raw MSS data to the imagery data universal format. Input is the 14-track MSS PCM tapes. Output of the edit mode is nine-track CCT. The program will not convert all of the data channels and pixels at once into universal; multiple edits are required because of core memory and time limitations. Options include

grid, grid color, shift value for each channel, and number of pixels for the display or film modes.

2.7.4.21 LARSYS II and III to universal conversion program (LMSDS).- The LARSYS III to MSDS conversion program is used to reformat LARSYS III format CCT to MSDS format screening and for analysis using the MSDS and MOPS program.

2.7.4.22 ERTS-A to universal format conversion program (EAUF).- The EAUF inputs ERTS-A 9-track CCT MSS bulk data of 810 elements per scan line and outputs 9-track CCT in universal format. Conversion takes place at approximately 15 scan lines per second, resulting in a total conversion time of less than 3 minutes for a 2340 scan-line reel.

2.7.4.23 Color-Study program.- The color-study program can input color-study CCT, TV display, display and half-width film record, or display and full-width film record image data tapes: (A) with normal or reversed scan lines (B) expanded as requested by a cursor overlay via the numeric keyboard, and (C) in color or black and white.

2.7.4.24 RS-14 program.- The RS-14 program can input RS-14 or color-study data from CCT and output it to: (A) display only, (B) display and partial-width film record, or (C) display and full-width film record. The output may be in black and white or color and may be: (A) output starting at the present position of the input tape and continuing until the program is told to stop via interrupt switch 3 or upon encountering an end of file, (B) output over a selected range of scan-line numbers, or (C) output as requested by a cursor overlay via the numeric keyboard.

2.7.4.25 Extract program.- The extract program inputs auxiliary data annotation set (ADAS) data and from the PMIS data from the PCM sensor tape. Interrange instrument group A (IRIG-A) time and voice channels are used to locate the area of interest to be displayed. Essential information is edited onto a digital tape for subsequent screening by the evaluate program. During this process, a geometrically corrected color image and an alphanumeric display of support data are made.

2.7.4.26 Evaluate program (EVAL).- The evaluate program inputs the digital tape data generated by the extract program and processes it into images, listings, and digital tapes of selected areas. The evaluate program has very flexible image-enhancement-manipulation abilities that

optimize its use as an analysis tool for microwave data. The evaluate program allows display and film recording of microwave radiometer image and support data after correcting the image data for geometric corrections because of scan cone, pitch, roll, and drift.

2.7.4.27 ADAS quick-look program.- The ADAS quick-look program provides a quick-look capability of ADAS data, on RZ-encoded PCM signal serially recorded on 1 of the 14 tracks of the PMIS mission tapes. This quick look should be especially useful in analysis of functional check flight data because no preprocessing is required and ADAS data is output to the line printer in an ordered, easy-to-read format. A heading giving date, mission, site, flight, line, and run is printed at the top of each page followed by appropriate subheadings and 34 lines of data.

2.7.4.28 DAS annotation program (ANNO).- The DAS annotation program (ANNO) provides the capability of generating alphanumeric and special characters for display and film annotation. Version 2.0 of ANNO accepts characters entered via the KSR keyboard or punched cards via the card reader.

2.7.4.29 S-192 band 13 multipoint smoothing program (MFS-13).- This program provides capability for smoothing low-frequency banding present in Skylab EREP band 13 thermal data. Low-temperature calibration points are used to digitally adjust imagery data based on that reference. Input data are SES-192 LARSYS CCT. Output is a LARSYS CCT.

2.7.5 Bibliography

Software capabilities of the Building 17 Data Techniques Laboratory, Philco-Ford, Sept. 10, 1973.

Data Format Control Book, TR-543.

Screening and Data Handling Plan for ERTS-1 Computer-Compatible Tape and Aircraft 24-Band Scanner Data, EOD-2945.

2.8 UNIVAC 1108 DATA PROCESSOR

2.8.1 General

The Univac 1108 processor is a large-scale batch computer system that will accept ERTS-1 MSS bulk, MSS DAS, LARSYS III, or universal format CCT. Analysis includes reformatting, classification, clustering,

image-data correlation, image-data registration, atmospheric corrections, and statistical analysis. Output tapes can be in LARSYS III, MSS DAS, or universal format. Output products include punched cards, plots, gray maps, printouts, histograms, and output tapes for the S-C 4060 unit to produce microfilm images. This computer facility is located in building 12 and scheduling information can be obtained from Tom Smith, TF4, 713-483-6478.

2.8.2 Sensor Capabilities

Any sensor data tape that is in one of the above formats can be run on this computer system.

2.8.3 Special Capabilities

Remote operation is available from terminals located in room 2062, building 17. Several statistical and utility programs are available for analysis. Abstracts for these programs are located in the building 12 tape/manual library.

2.8.4 Programs

2.8.4.1 LERTS (ERTS to LARSYS III) program.- The ERTS to LARSYS III program on the Univac 1108 system reformats ERTS-1 MSS bulk tapes to the LARSYS III format for further processing with such programs as SCERTS, ROTAR, ISOCLS, LARSYSAA (PATREC), et cetera. A complete ERTS tape may be reformatted to LARSYS III with LERTS in approximately 12 minutes.

2.8.4.2 EMBEDT (ERTS to MSS DAS) program.- The EMBEDT program converts the ERTS-1 MSS bulk tapes to the MSS DAS edit format, which is compatible with both DAS for screening and editing. The EMBEDT program reformats a maximum of 700 resolution elements per scan line. The EMBEDT program reformats a complete ERTS tape in approximately 8 minutes.

2.8.4.3 TABLE LOOKUP (TLU) program 0738.- The JSC table lookup data classification programs currently available on the Univac 1108 system may be used in place of the classify processor of LARSYSAA PATREC. The TLU approach was developed as a much faster computer implementation of the data classification step. Inputs are punched cards and LARSYS III or MSS DAS edit data tapes and outputs are alphanumeric gray map printouts, printouts of raw data, the MAPTAP tape for input to further screening, and PMIS color-study tape (only available for LARSYS III formatted input data).

2.8.4.4 ISOCLS (data clustering) program.- This algorithm is an interactive procedure for grouping multispectral data (per image point) into sets or clusters of similar data. The input is limited by program to a maximum of 50 clusters, 30 channels, and 20 fields. Inputs are punched cards and a LARSYS III data tape. Outputs are printouts of clustering data, map printouts, cluster covariance matrices printout, punched cards, and a cluster color-study nine-track tape (for the ERTS DAS).

2.8.4.5 PATREC (LARSYS4A) data classification.- The PATREC program allows a user to classify remote sensor data by spectral pattern recognition techniques. This is accomplished with the aid of four processors called STAT, SELECT, CLASSIFY, and DISPLAY.

A. STAT - The first step in the pattern-recognition process is to select training fields using the field coordinates obtained from one or more sources, including PICTOUT, SCERTS, ISOCLS, or the DAS. These coordinates are input to STAT in the form of punched cards. Also input to STAT is the raw LARSYS III tape. Outputs used for iterative analysis in the selection of homogeneous training fields include statistics such as the mean vectors, covariance matrix, correlation matrix, histograms, and spectral plots. Only the outputs consisting of the training field coordinates, class mean vectors, and class covariance matrix are used for continuation of the data flow into the SELECT and CLASSIFY processors. These data are in the form of punched cards. One alternative available for obtaining statistics for use in the SELECT and CLASSIFY processors is through use of the ISOCLS program described previously.

B. SELECT - The SELECT processor accepts the statistics in punched-card form and outputs the best channels to be used in the classification process. These are the minimum number of channels available that maintain the optimum separability of classes. This processor is important only for MSS data of greater than 4 bands (24 channels and 13 channels) since there is a maximum of only 4 channels per sensor on the ERTS. There are four different procedures for measuring the degree of separability of classes as reported in the reference concerning implementation of feature selection (reference 2.8-1).

C. CLASSIFY - The CLASSIFY processor accepts raw LARSYS III data, punched cards from STAT, and punched cards from SELECT to produce a per-point classification of all points within specified boundaries. The CLASSIFY processor on the Univac 1108 handles up to 30 channels and 30 classes and classifies up to 1000 pixels per

line. The outputs of CLASSIFY are a LARSYS classification tape (MAPTAP) and/or a classification printout.

D. DISPLAY - The DISPLAY processor accepts punched cards containing information on field coordinates and ground truth for use in developing a printout on the classification accuracy. In addition, the DISPLAY processor takes the point-by-point results of the classifier and displays them in a computer printout format similar to the PICTOUT map printout, except that each symbol represents a classified point. The DISPLAY processor can directly create a PMIS DAS color-study tape.

2.8.4.6 Image correlation (CORLAT) program.- This program does precise digital image registration in a semi-automatic mode. The CORLAT computes the cross-correlation functions between the two closely correlated images (referenced and overlaid to be registered over some preassigned grid structure). A fast FOURIER transform technique is used. The CORLAT program is intended for use on all types of remote-sensing data. The inputs to this program are program tape, one or two LARSYS III format tapes, and input parameters via punched cards. The outputs are two-dimensional correlation arrays printed in numerical 0 to 9 presentation where 9 indicates a maximum and 0 indicates a minimum, correlation coefficients, coordinates of the correlation maximum or minimum, and punched cards of the coordinates for input to the registration program.

2.8.4.7 Image registration (REGSTR) program.- The REGSTR uses correlation results from CORLAT to bring two images into precise spatial alignment. The REGSTR can be used on all types of remote-sensing data. The inputs to this program are the program tape, one or two input data tapes in the LARSYS III format (one of the input tapes can be mounted on the same drive after the program tape is loaded into the computer), input parameters via punched cards, and the correlation results which are input from CORLAT via punched cards. Outputs are a registered data tape in the LARSYS III or universal format with a given specified number of channels, a printed message of poor approximation if the specified registration error is exceeded in a certain region, and a printed list of all coefficients of the approximation polynomials in each region.

2.8.4.8 Atmospheric corrections (ROTAR).- The ERTS and camera data can be corrected for atmospheric absorption and scattering with the Univac 1108 program ROTAR (reconstruction of target reflectance). The ROTAR is a table lookup program which relates the sensor data to reflectance

values calculated for given Sun angles, optical depths, and atmospheric conditions. Two homogeneous optical layers are used to approximate the atmospheric scattering and attenuation characteristics. The ROTAR program outputs a corrected data tape, called a reflectance tape, that assigns a percent reflectance number (0 to 100) to each image element. This tape output is in LARSYS III format.

2.8.4.9 RCLASS.- This program has a computer gray-map printout option similar to LARSYS PICTOUT. Single-channel raw input data either in MSS DAS edit or LARSYS III format can be converted to a computer printout image using 30 alphanumeric symbols. Unlike LARSYS PICTOUT, however, there is no data histogram, and the user must select and input the display bin levels (on cards) without any such aid. The important thing to note here is that this is presently the only means available for directly generating a computer gray map of MSS DAS edit tape data.

2.8.4.10 ISOCLS (PRINT).- There are two outputs from this program: a line printer map and a color-study tape that may be displayed on the PMIS DAS.

2.8.4.11 PICTOUT (LARSYSAH).- The PICT function of the LARSYS PICTOUT subsystem on the Univac 1108 takes tape data in LARSYS III format and produces an alphanumeric printout or symbol map for screening and editing data (in a single band). Histogram and punched cards of training and test field displays are available with this program.

2.8.4.12 SCERTS (Q-840 gray map).- The SCERTS (screen ERTS) program on the Univac 1108 system accepts tapes in LARSYS III format. The output tapes are then input to the S-C 4060 unit to produce microfilm images of the data. Paper copies can then be obtained with any standard microfilm reader/printer. The Q-840 version of SCERTS has the limitations that only the first four channels of data are available and that all four channels must be mapped. The Q-840A single-channel version of SCERTS can map from any 1 channel up to 24 channels.

2.8.4.13 PREPS.- The PREPS (prediction of the response of Earth-pointed sensors) program calculates the sensor response for a given target reflectance and a set of given atmospheric conditions. It is used in conjunction with the ROTAR program.

2.8.4.14 LYKIT.- The program LYKIT reads a packed data tape in either LARSYS I or III formats, writes an unpacked data tape of equally spaced scans,

draws graphs on microfilm, and prints lists of the data miximum, mean, and minimum within these scans in all channels. Increased efficiency and reliability are achieved by using an unpacked tape; however, not every scan of data is available on it.

2.8.4.15 LUVIT.- The program LUVIT reads the unpacked data tape written by program LYKIT and produces the complete profiles of individual scans specified by the user by tabulating and graphing data within all channels.

2.8.4.16 LUMPIT.- The program LUMPIT reads the unpacked data tape from LYKIT, drives the correction polynomials for a particular scan line and channel, and outputs lumped and polynomial cards.

2.8.4.17 FIXIT.- The program FIXIT reads the original packed LARSYS III tape, uses the polynomial cards from LUMPIT, and outputs a corrected packed LARSYS III tape.

2.8.4.18 CLUSTD.- The CLUSTD is a single-pass clustering program and therefore is not limited with regard to the quantity of data that it can process. The program reads an input tape in LARSYS III format and outputs a nine-track tape of the cluster map to be used with the DAS color-study program. The output tape can contain up to 700 pixels per scan line and can cluster data containing from 1 to 36 channels of information.

2.8.4.19 S-190 scan tape conversion program - Z058 (CNV190).- The CNV190 program takes an S-190 scan data tape recorded by Patrick Air Force Base Imaging System Branch laser scanner system and outputs one LARSYS III formatted data tape. Both input and output tapes are nine-track tapes.

2.8.4.20 Multispectral scan angle correction program - Z053 (ACORN4).- The ACORN4 is designed to eliminate the variance in MSS data introduced by scan angle. The program computes either additive or multiplicative correction coefficients that can be applied to each sample of each channel. Input tape is LARSYS III MSS data and the output tape is a scan-angle-corrected LARSYS III MSS data tape.

2.8.4.21 DAS display tape program - 0855 (DASGEN).- The DASGEN program provides the capability to convert MSS classification results to a color display on the DAS. Input is a LARSYS III tape from the CLASSIFY

program and the output is a seven- or nine-track tape in LARSYS III format to be used on the DAS (requires a nine-track tape).

2.8.4.22 VIBAN3 - Q467.- The VIBAN3 program is used to perform a complete statistical and wave analysis for up to 16 time slices of time series data. This program is run during selected time periods to produce amplitude (dB) versus frequency plots. These plots can be used to check calibrations and noise levels of the data. The statistical analysis includes skew, kurtosis, probability density, chi-square test, and standard deviation.

2.8.4.23 REFORM - Q709.- This program reformats the University of Michigan A/D multispectral data tape to the LARSYS III format.

2.8.4.24 MICREF - Q683.- This program reads a 7-track, 200 bpi even-parity microdensitometer digital tape, reformats it, and outputs a LARSYS III tape that can be displayed using PICTOUT.

2.8.4.25 BENMSS - Q747.- This program was written for Information Systems Division (ISD) for engineering checkout. It calculates performance parameters associated with the MSS and outputs 4060 plots of probability density histograms, printed video data of selected scans, a listing of calibration data, and performance parameters. This program uses PREBEN - Q760 which edits the calibration data.

2.8.4.26 Multispectral gray map - Q769.- This program draws gray maps of specified levels of relative radiance within one channel of multispectral data. The map has up to 8 gray levels, 150 scans long, and flight width of up to 222 samples wide. Data are in the old LARSYS I format and output is on microfilm.

2.8.5 Bibliography

Earth Resources Data Format Control Book, TR-543.

Screening and Data Handling Plan for ERTS-1 Computer Compatible Tape (CCT) and Aircraft 24-Band Scanner Data, EOD-2945.

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Haskell, R. E.: CLUSTD - A New Program for the Nonsupervised Classification of Multispectral Data, JSC-08010.

Implementation of Feature Selection Via Dynamic Programming, LEC/HASD 640-TR-122, June 1972.

Gardner, C. T.: Computer Program Documentation DAS Display Tape Program, LEC, CPD-306.

Program Documentation, JSC Statistical and Wave Analysis Program (VIBAN3), DPD-0036.

2.8.6 References

2.8-1 Implementation of Feature Selection Via Dynamic Programming, LEC/HASD 640-TR-122, June 1972.

2.9 UNIVAC 1110

2.9.1 General

The Univac 1110 multiprocessor system is a large-scale batch mode and interactive computer system (EXEC 8) that has 15K more user core than the Univac 1108.

The Univac 1110 is located in building 12 and charge time information can be obtained from Tom Smith, TF4, 713-483-6478.

2.9.2 Sensor Capabilities

The Univac 1110 will accept ERTS-1 bulk, universal, and LARSYS III format 7 or 9 track 800 bpi CCT.

2.9.3 Special Capabilities

Programs can be run in the interactive mode.

2.9.4 Programs

2.9.4.1 ASTEP.- The ASTEP is a program that is used to gain understanding of the problems associated with processing multispectral Earth resources data and to test and evaluate processing algorithms. The major emphasis is to examine the statistical properties of the data and their impact upon classification algorithms. Character maps, gray-scale-type maps, histograms, statistics, program options, and data value printouts are available.

2.9.4.2 RCUS.- The Resources Capability Unit System (RCUS) is a forestry management information tool that enables a forest manager to evaluate if regional forests meet the requirements of the forest manager. Inputs are ground-truth data, production factors, cost factors, needs and demands, et cetera and outputs are management decisions such as to plant certain type trees, establish recreation areas, et cetera.

2.9.4.3 LARSYSAA.- The LARSYSAA program from the Univac 1108 has been converted to the Univac 1110, but it will not execute in the interactive mode because of tape drive limitations.

2.9.4.4 ISOCLAS.- The ISOCLAS program from the Univac 1108 has been converted to the Univac 1110, but it will not execute in the interactive mode because of tape drive limitations.

2.9.4.5 RIMS.- The Regional Information Management System (RIMS) is designed to provide extremely rapid access to Earth resources data-base information. It stores, retrieves, and displays information in 36 broad categories of land use. The RIMS was implemented at JSC on the Univac 1106 and 1110 computers using EXEC 8 and may be accessed from dialup terminals in several locations at the JSC. The RIMS is now serving the Houston Area Test Site (HATS) data base, which contains information for about 44 000 1-kilometer squares. The RIMS user may, in an interactive mode, select any subset of the data base by descriptor. For example, A 100.0 describes the subset which is 100-percent agriculture, U 50.0 indicates 50-percent urban, et cetera.

These subsets may be combined in any order using logic operators (and, not, inclusive or, exclusive or). With these operations, the user may describe a subset in virtually any manner. After the desired subset has been built, it may be displayed as verbal and numerical output on the CRT associated with the dialup terminal, or it may be extracted for further online or offline processing. An example is the map drawing routine executed on the PMIS DAS.

2.9.5 Bibliography

User's Guide and Software Documentation for the Algorithm Simulation List and Evaluation Program (ASTEP), JSC Internal Note 73-PM-71, May 4, 1973.

Allison, J. L.; Argo, W. V.; and Shelton, M. L.: Regional Information Management System (RIMS) Users Guide, LEC/HASD 640-TR-190.

Allison, J. L.; Argo, W. V.; and Shelton, M. L.: Regional Information Management System (RIMS) Program Logic Manual, LEC/HASD 640-TR-192.

2.10 TAPE TO FILM CONVERTER (VISICORDER)

2.10.1 General

The visicorder permits an investigator to screen MSS data and to determine training field coordinates without using the DAS. The low-cost hardware involved produces strip-film imagery of selected channels with a superimposed computer-compatible coordinate grid, which permits an investigator to locate any point on the flightline to the nearest scan line and element. The visicorder is located in room 2062, building 17 and is scheduled by John Sargent, TF4, 713-483-6478.

2.10.2 Sensor Capabilities

All 24 channels of MSS data can be screened. For example, film imagery with a superimposed coordinate grid can be made for all 24 channels of a 10 000 scan line mission on approximately 150 feet of film in less than 1 hour. The M²S, Reconofax IV, RS-7, RS-14, RS-18, U of M, and others may be used on this system.

2.10.3 Special Capabilities

Investigators who do not have ready access to the DAS or ERIPS can screen data and locate their own training and test fields. The field coordinates (specified in terms of beginning and ending scan line and element) can be used by the investigator to request a DAS edit tape or

to input directly to the LARS program on their own computer or the LARS remote terminal. This display capability supplements the computational capability provided by the LARS remote terminals and increases their potential usefulness.

2.10.4 Programs

The serial stream of digital values from one MSS channel is converted to analog form. These data are then used to intensity-modulate a CRT in the visicorder to produce a continuous-strip imagery. An additional capability has been developed for the visicorder to superimpose a scanner-coordinate grid system on the imagery. These grid lines are generated using digital logic circuits triggered by each scan line and by each element within a scan line. Because they are generated by the data itself, these grid lines are assured of being in spatial registration with the MSS imagery. The visicorder is capable of processing MSS data at a rate of 100 scan lines per second, compared with 2 scan lines per second for the DAS. The continuous strip imagery is 5 inches wide and is available in the form of (A) immediately available, dry-developed diazo paper, (B) conventional, wet-developed black-and-white film transparency, or (C) wet-developed black-and-white positive paper. The system is adjusted to display 150 elements per inch and 150 scan lines per inch on the output imagery. This is compatible with the visicorder CRT resolution, and allows 700 elements to be imaged on 5-inch-wide film. From an altitude of 2780 feet, it is approximately the same scale as the Hasselblad cameras equipped with 80-millimeter focal length lenses.

2.10.5 Bibliography

Eppler, W.; Reustle, J.; and Tragni, F.: Computer-Based Coordinate Grid for Multispectral Scanner Imagery, E0124.

For further information, consult the personnel in room 2062, building 17, or contact John Sargent, TF4, 713-483-6478.

2.11 TAPE TO FILM CONVERTER (TEXAS INSTRUMENTS)

2.11.1 General

The RFR-70 film recorder is capable of accepting a variety of data from an analog tape and converting it into an image with acceptable results. This constitutes a permanent visual record. It is located in room 2062, building 17, and can be scheduled by John Sargent, TF4, 713-483-6478.

2.11.2 Sensor Capabilities

The sensor capabilities consist of analog sensor data recorded from an airborne scanner or data from a magnetic tape recorder where the scan rate is greater than 50 Hertz but less than 350 scans per second.

2.11.3 Special Capabilities

The recorder paints a video image of Earth terrain onto a continuous strip of 70-millimeter photographic film.

2.11.4 Bibliography

For further information, consult the personnel in room 2062, building 17, and the Operating Instructions Manual for 70-mm Remote Film Recorder RFR-70 by Texas Instruments, Inc., Oct. 28, 1971, or contact John Sargent, TF4, 713-483-6478.

2.12 DATA TECHNIQUES LAB TERMINALS

2.12.1 General

The Data Techniques Laboratory has three remote terminals with the capability of interfacing with the JSC building 12 Univac 1106 or the Univac 1110 through a set of dedicated lines. The three terminals also have the capability to dial into any computer facility that has acceptable communication hardware. The terminals consist of the following.

A. A data point 3300 CRT with a standard teletype alphanumeric keyboard, a 30-character-per-second heat-sensitive printer, and a tape cassette with read/write capability.

B. A Hazeltine 2000 CRT with the same features as the data point 3300 CRT, except the Hazeltine has a dual-tape cassette instead of a single cassette.

C. A Teletype Corporation ASR 33 unit operating at 10 characters per second with an impact printer and a punch/read paper tape attachment.

These three terminals are located in room 2062, building 17, and further information can be obtained from John Sargent, TF4, 713-483-6478.

2.12.2 Sensor Capabilities

The sensor capability consists of sensor data that are in the correct format for CCT of the system dialed (LARSYS III at Purdue, etc.)

2.12.3 Special Capabilities

Computer facilities such as Purdue, Rice, Georgia Tech., Lewis, Atlanta GSA 1108, and the Goddard Space Flight Center can be dialed using these terminals.

2.12.4 Programs

A wide variety of programs can be used with this system such as the same as used with the Purdue Terminal described in section 2.1.

2.12.5 Bibliography

For further information please contact John Sargent, TF4, 713-483-6478.

SECTION 3
PHOTOGRAPHIC CAPABILITIES

3.1 GEOMETRIC ANALYSIS CAPABILITIES

3.1.1 General

The geometric analysis section has extensive capabilities to do research, analysis, and production processing on a very wide range of Earth resources data. Because of the flexibility of the group, almost any geometrically oriented problem can be considered. Analysis work can be discussed with M. J. Bender, TF5, 713-483-6287. The following equipment is used by this section to aid in analysis of geometric problems.

3.1.2 Wang 720B and HP9100B

The Wang 720B and the Hewlett Packard 9100B are self-contained programable electronic calculators that can accept taped programs. The outputs are numerical visual displays and hardcopies of printouts of programed data.

3.1.2.1 Wang programs.- The Wang calculator has programs available that will convert geographics to Universal Transverse Mercator, Lambert, or State Plane coordinates. Other programs include data adjustment, resection (compute spatial orientation for a specified aerial photo), image blur plotting for panoramic or frame camera images, and computation of lens distortion curve coefficients.

3.1.2.2 HP9100B programs.- The Hewlett Packard calculator has programs available that will convert Universal Transverse Mercator to geographic coordinates, local coordinates to geographic coordinates, geographic to local coordinates, compute the Lunar slant range and surface distances of images, and compute lens distortion curve coefficients (less than eight distortion coefficients).

3.1.3 Univac 1110 Registration Program

The geometric analysis section has an aircraft scanner correction program that geometrically corrects 7 or 9 track digital image data from the 24-channel MSS scanner. Output is a registered tape in LARSYS III or universal format.

3.1.4 RSS-400 Graphic Quantizer

The RSS-400 graphic quantizer is an example of the application of integrated circuitry for converting graphics to digital form. The 48-

by 72-inch coordinatograph table will accommodate maps, graphs, strip charts, design drawings, et cetera and any point or line on the graph can be digitally scaled and recorded. Measurements in the X-Y direction and areas can be recorded. The input can be any graph to be measured or the enclosed area to be calculated. The output is the visual digital reading or a printout of the readings. The printout shows the measurement in the X direction, followed by the measurement in the Y direction. This machine is located in room 1059, building 17, and information can be obtained from M. J. Bender, TF5, 713-483-6287.

3.1.5 Mann Comparator, Type 1210

The Mann comparator, type 1210, is a precision screw instrument designed specifically for measurement of distances on photographic materials to an accuracy of ±0.001 millimeter. This instrument outputs formatted data (X, Y coordinates, point identification, etc.) through a digitizer (data logger) onto punch cards for use in various computer programs. This instrument is best suited for performing mensuration on photographic film or glass plates regardless of imagery source. This instrument has a 9- by 18-inch measuring format (programs permit reconstruction of even larger photographic formats). This comparator is located in room 1059, building 17, and information can be obtained from M. J. Bender, TF5, 713-483-6287.

3.1.6 Bausch and Lomb Multiscale Stereo Point Marker

The multiscale is a device for stereoscopically transferring conjugate points from one set of photographic imagery to another. A continuous-zoom viewing system on this instrument allows matching of conjugate images using photography of widely varying scales (from approximately 2X to 48X). Points are burned into the emulsion by a thermal die to provide a permanent unambiguous record of the point. Diameter of the hole is approximately 40 micrometers. This machine is located in room 1059, building 17, and information can be obtained from M. J. Bender, TF5, 713-483-6287.

3.1.7 Wild B-8 Aviograph Stereoplotter

The B-8 Aviograph is a general-purpose photogrammetric instrument for accomplishing stereoscopic measurements from stereopairs of approximately vertical photographs (less than 5-degree tilt). The instrument is equipped with an enlarging/reducing pantograph (2:5X to 5:2X). Inputs consist of photographic transparencies (glass or film having formats up to 23 by 23 centimeters) acquired with wide/superwide angle cameras. It is most suitable for producing

small-to-medium scale maps (1:2,000 or smaller). This machine is located in room 1059, building 17, and information can be obtained from M. J. Bender, TF5, 713-483-6287.

3.1.8 Wild PUG-3 Point Transfer

The Wild PUG-3 is a stereoscopic point transfer device used for transferring conjugate points from one set of photographic imagery to another. The device drills a 23-micrometer-diameter hole in the emulsion of film or glass plate to provide a permanent, unambiguous record of the point. Transfer of data is restricted to photographic transparencies of approximately the same scale.

3.1.9 AS-11B1 Analytical Stereoplotter

The AS-11B1 is a stereophotogrammetric system using a programmable digital computer for real-time stereomodel computations and electromechanical control of a high-precision stereocomparator. Inputs to the system normally consist of stereopairs of photographs, positional information to reference these photos to a surface, and data to compensate for nonprojective effects (e.g., curvature, atmospheric refraction, lens distortion, image motion compensation, etc). The outputs include profiles/contour/planimetric plots, ground/model coordinates (three dimensional), photo coordinates, and orientation parameters of the photographs. Digital data are output via paper tape, magnetic tape, and teletype printout. Examples of the types of imagery (and their sources) which have been reduced using this system include conventional aerial cameras (metric cameras of various focal lengths), Apollo 70-millimeter Hasselblad (nonmetric cameras of various focal lengths), 16-millimeter movie cameras, close-range medical photography acquired with 70-millimeter Hasselblads and Wild Stereometric Cameras, and imagery acquired using a scanning electron microscope (SEM). This system is located in room 1059, building 17, and information can be obtained from M. J. Bender, TF5, 713-483-6287.

3.1.10 Giga-Zeiss Orthoprojector

The Giga-Zeiss Orthoprojector is a projection-type instrument used for the production of orthophotographs (photomaps). The instrument uses profile (cross-section) data generated by the AS-11B-1, analytical stereoplotter, to accomplish a strip-by-strip rectification of aerial photographs (transforming central perspective photographs into parallel projection images). Both color and black-and-white orthophotographs may be produced using this instrument. Photography acquired with cameras having focal lengths of 6, 12 and 8-1/4 inches

may be directly plotted with the projecting cameras presently available. Other focal lengths may be accommodated through the use of photographic techniques providing a wide selection of final orthophoto (photomap) scales. This instrument also possesses the capability of producing a dropped-line contour chart giving direct hypsographic information of the terrain being reproduced as an orthophoto (photomap). The Giga-Zeiss can accommodate photo formats of up to 9-1/2 by 9-1/2 inches, accepting either film or glass plates. The Giga-Zeiss is located in building 17, room 1059 in the Geometric Analysis Section, Mapping Sciences Branch. Scheduling of tasks on the instrument may be arranged by contacting M. J. Bender, TF5, 713-483-6287.

3.1.11 Wild A-40 Autograph

The A-40 is a stereoplotter used for reducing data acquired with the Wild C-120, C-40, and C-12 Stereometric cameras or similar cameras and phototheodolite pictures with parallel, or parallel-averted, axes. It is used primarily for close-range photogrammetric tasks such as accident investigations, medical photography or forensic photography.

The instrument will accept photographic plates with formats of up to 92 by 125 millimeters as inputs. Outputs consist of contour/profile/planimetric plots and point coordinates measurements. The A-40 is located in room 1059, building 17. Further information can be obtained through M. J. Bender, TF5, 713-483-6287.

3.1.12 B-8 Stereomat

The B-8 Stereomat is an automated B-8 Aviograph Stereoplotter. In addition to the usual manual stereoplotter operations, an image correlation unit also enables this system to perform the following operations automatically: relative orientations, profiling, contouring, digitizing of stereomodels, and exposing of orthophotographs (electronic). Inputs to the system consists of stereopairs of photographs with formats of up 9 by 9 inches. Photographic tilt limitations of the instrument are: phi and omega = ±5 grads (from normal), K = ±5 grads. Photography with focal lengths of 3 and 6 inches can be readily accommodated. Outputs from the system consist of contour/plani-metric/profile plots orthophotographs, digitized terrain models, and point coordinates. Digitized terrain models and point coordinates are formatted and recorded on seven-channel magnetic tape for use in computer programs. Plotted products (profiles, contours, etc.) and orthophotograph magnifications may vary

from 1.4X to 2.3X (from photo), depending upon the scale of the photographic inputs.

The B-8 Stereomat is located in room 1059, building 17. Further information can be obtained from M. J. Bender, TF5, 713-483-6287.

3.1.13 Mann Type 1205 Semi-automatic Stellar Comparator

The stellar comparator is a semi-automatic, precision lead-screw-type measuring instrument capable of automatically centering on symmetrical photographic images such as star images, reseavs, or holes drilled in the emulsion through the use of a photoelectric, closed-loop feedback servo-system. The incorporation of a small digital computer provides additional automatic functions to the system. The primary function is the automatic slewing to preselected coordinates in the near vicinity of a symmetrical image point, then automatically centering on the exact point, recording actual coordinates and moving on to the next point. In addition, the comparator can perform a self-calibration using an accurate reference grid (gridplate) with the computer printing out the deviations at each point. Coordinate measurements (X and Y) are output on paper tapes and printouts via a teletype system. The Mann Stellar Comparator is located in rrom 1059, building 17. Further information can be obtained from M. J. Bender, TF5, 713-483-6287.

3.1.14 Bibliography

Operating Manual for the RSS-400 Graphic Quantizer, H. Dell Foster Co., San Antonio, Tex. 78209.

Operating and Maintenance Manual for Type 1210 Comparator, David W. Mann Co.

Manual of Photogrammetry, 3rd ed., Am. Soc. of Photogrammetry.

Handbook for AS-11B1, Automated Analytical Stereoplotter, vol. 1-6 and Magnetic Tape Attachment Manual, Bendix Research Lab.

Precision Instruments for Photogrammetry, PI-904e-11.71, Wild-Heerbrug.

Prepositioning and Photoelectric Setting System Model 975 for Automatic Precision Stellar Comparator Type 1205B, Instruction Manual, David W. Mann Co., Burlington, Mass.

3.2 PHOTOINTERPRETATION CAPABILITIES

3.2.1 General

The photointerpretation section has extensive capabilities to view, read, print, and process imagery from Earth resources sensors. Work can be discussed with L. C. Wade, TP5, 713-483-3611. The following equipment is used by this section to aid in analysis of Earth resource data.

3.2.2 Model 91 Film Viewer/Printer

The model 91 viewer/printer is designed for convenient viewing of long rolls of film and making black-and-white negative prints of individual frames on demand. This machine accepts all film sizes from 35 millimeters to 9.5 inches. The input is the film to be viewed. The output is the visual display plus an 18- by 24-inch print of the scene viewed. Magnification can vary from 4X to 32X with three different lens settings. This machine is located in room 242, building 17.

3.2.3 Itek Additive Color Viewer/Printer (ACV/P)

The Itek ACVP is a photo-optical device which has the ability to enlarge, superimpose and register up to four separate black-and-white transparencies for viewing, printing, or color enhancement. The magnification ranges from 7.98X to 8.02X, with 8X being nominal. Inputs are transparencies up to 70-millimeter wide. The outputs are images from all four channels which are folded by two high-quality mirrors and converged onto the screen/printing plane to be viewed or for prints to be made. Color transparencies, or color negatives can be made and there is an adapter for Polaroid packs. This machine is located in room 233, building 17.

3.2.4 AR-109 Viewer/Printer, Projection, Photographic

The AR-109 viewer, projection, photographic machine is a film viewer with inputs of any size film from 35 millimeters through 9-1/2 inches. The outputs are the display screens for visual observations. Magnification of the film is possible at 2.5X, 5X, 10X, and 22X. Film annotation at the film gate or on the lighttable, ±180-degree rotation of the projected image, and image translation in the X and Y direction by joystick control are available. The lighttable has a mount that will accommodate any Bausch and Lomb stereoscope for detailed viewing. This machine is located in room 242, building 17.

3.2.5 Variable Width, Rear Projection Film Viewer, Model AM-4

The variable width, rear projection film viewer, model AM-4 is a roll film viewer that accepts any film from 35 millimeters to 9-1/2 inches in rolls up to 1000 feet long. The input is the film to be viewed. The output is the visual display, plus the capability of making a print of the frame being viewed. Magnification of the film is possible at 3X, 8X, 24X, and 32X. A 108-degree rotation of the projected image and image translation in the X and Y direction by joystick control is available. This machine is located in room 242, building 17.

3.2.6 Model V/R 100 Film Viewer/Reader

The Traid Model V/R-100 film viewer/reader is a self-contained system for viewing film images on the viewing screen. This machine accepts roll film of 16-, 35-, and 70-millimeter widths. The input is the film to be viewed. The output is a 20- by 24-inch visual display, plus a printout of X-Y coordinate measurements and frame numbers. A 180-degree rotation and an image translation in the X-Y direction is available. This machine is located in room 242, building 17.

3.2.7 Data Block Reader

The data block reader is intended to read and record only the code matrix block (CMB) data from the Apollo metric camera system. This system includes the metric camera and an attached stellar camera. The input is the film in which the data block is to be read. The output is a tape with the data block information. A printout of the tape lists the frame number, time, altitude, and shutter speed of each exposure. This machine is located in room 242, building 17.

3.2.8 Multisensor Takeup Table

The multisensor takeup (MSTU) table is a film viewing instrument with two separate film tracks. This machine will accept any size film up to 9-1/2 inches and will accommodate transparencies as large as 9 by 18 inches. The input is the film to be viewed, and the output is the visual display.

Each of the 4 10- by 20-inch viewing areas employs a vacuum mask assembly for holding the film flat on the illuminated surface. The MSTU can use any of three Bausch and Lomb optical stereoscopes (zoom 70, zoom 95, and the versatile stereoscope). There are three of these machines located in room 242, building 17.

3.2.9 Rear-Projection Film Reader System Model 705V

The rear-projection film-reader system model 705V provides high resolution rear-projection display of a variety of motion picture and still phototransparencies. This machine accepts film from 35 millimeters to 9-1/2 inches. The inputs are the transparencies to be viewed. The output is the visual display (magnification of 5X, 10X, or 27X) and the capability of measurements in the X-Y direction, plus a printout of the data. The printout records the frame number, the measurements in the X and Y direction, and also the rotation angle (up to 180 degrees). This machine is located in room 242, building 17.

3.2.10 Zoom Transferscope

The Bausch and Lomb zoom transferscope has the capability of using a photograph and map of the same area and by the use of light intensities superimposing the two and producing a single image to locate areas or points to be plotted. The inputs are photographs and maps. The outputs are the annotated maps having information from the photographs placed on the map. There is the capability of using lens changes to reduce the transparencies viewer by 0.2 and of enlarging the map viewer by 4X. There is also the capability of enlarging both images simultaneously from 1X through 7X. This machine is located in room 242, building 17.

3.2.11 Data Additive Color System

The data additive color system is a closed-circuit television system that displays black-and-white transparencies on a screen. Color can be added according to the densities expressed on the film, making it possible to determine areas that probably have the same or similar surface vegetation or cover. The input is a black-and-white film. The output is the visual display with color added. This machine is located in room 242, building 17.

3.2.12 IIS Model 6000 Color Additive Viewer

The model 6000 color additive viewer accepts 70-millimeter film chips and 9-1/2-inch multiband film and has a four channel (clear, red, blue, and green) color filter system to enhance the film being viewed. The inputs are black-and-white 70-millimeter film chips and 9-1/2-inch multiband roll film. The output is the visual display and there is the capability for making a negative or film transparency of the viewed scene. This machine is located in room 242, building 17.

3.2.13 Bibliography

Operation and Maintenance Manual for Model 91 Film Viewer/Printer, R. A. Morgan Co., Palo Alto, Calif.

Description and Operation of the Itek ACVP-Gary Kraus.

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Operating Instructions for the Data Block Reader, Fairchild Industries, Oct. 1971.

Operation Manual - Multi-Sensor Take-Up Table, Richards Corp., McLeon, Va.

Operation and Maintenance Instructions Rear-Projection Film Reader System Model 705V, Traid Corp., Dec. 1971.

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