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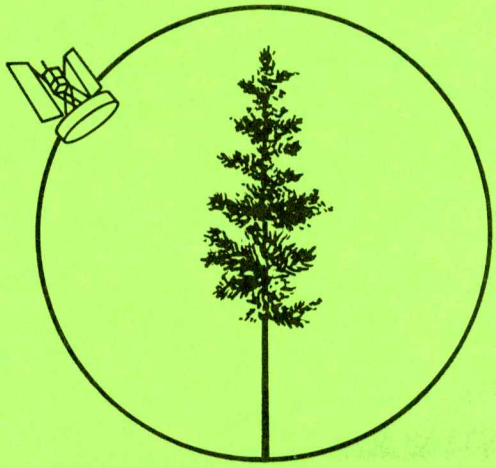

FRIS

FOREST RESOURCE INFORMATION SYSTEM

NASA ST. REGIS LARS

LARSFRIS USER'S MANUAL
Volume I

Purdue University
Laboratory for Applications
of Remote Sensing

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16. Abstract

This document contains user instructions for the proper use and application of the Software which comprises the LARSFRIS package. LARSFRIS represents a compilation of software developed over a number of years by the staff at Purdue University's Laboratory for Applications of Remote Sensing. The software packages are designed to help the user analyses digital image data such as that collected by the Landsat Multispectral scanner. This is one of five documents that comprise the LARSFRIS package.

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PREFACE

The documentation of the LARSFRIS system closely parallels existing LARSYS Version 3.1 documentation. The major differences are in the addition of certain program modules which provide the user greater flexibility in the analysis of multispectral data. The LARSFRIS documentation exists in three parts: LARSFRIS Program Abstracts, LARSFRIS System Manual, and LARSFRIS User's Manual.

The first of these contains the documentation of each Fortran and Assembler routine and each CMS Executive routine in LARSFRIS. These program abstracts are provided for programmers who are required to revise and/or maintain these routines.

The second manual, LARSFRIS System Manual, is directed primarily to programmers and analysts who maintain or revise the system or write new functions that must be interfaced with LARSYS. It contains detailed information of (and references to) the hardware and software framework upon which the system was built, the internal organization of the software, the organization of the data fields, and a discussion of special techniques that were used in the implementation of LARSFRIS.

This manual, LARSFRIS User's Manual, contains a comprehensive description of the functional organization of the system, the processing functions provided, and the manner in which the

functions are invoked and controlled. While it is written primarily for the system's user, a good knowledge of its contents is essential for any individual who intends to work with the system -- be he a user, an analyst, or a programmer.

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SECTION 1

INTRODUCTION

SECTION 1

INTRODUCTION

The Forest Resource Information System (FRIS) Project was a cooperative study involving the St. Regis Paper Company and the National Aeronautics and Space Administration (NASA). Purdue University's Laboratory for Applications of Remote Sensing (LARS), under contract to NASA, provided technical support to FRIS. The project was designed to assess the utility of satellite acquired and computer analyzed data as inputs to the management of industrial forest resources in the southeastern U.S.

Results from the first phases of the FRIS project demonstrated the benefits and multispectral data image processing to forest resource management. Based on these results, St. Regis management made a committment to support a stand alone image processing capability for the company. The LARSFRIS software implemented by St. Regis is a direct outgrowth of the FRIS project. This software system is a modified version of the LARSYS software developed at Purdue University.

LARSYS is a fully-documented software system for installation on a general purpose computer to provide tools for remote sensing research. LARSYS, a product of several years of research at Purdue University, uses pattern recognition

and interactive data handling techniques applied to remotely sensed multispectral and/or multispectral data.

Work toward the development of LARSYS started at Purdue University in 1964 when a research project co-sponsored by the National Aeronautics and Space Administration and the U.S. Department of Agriculture was established. The primary objective of this research was to develop remote sensing techniques and investigate their application to the field of agriculture. The early research efforts of this project led to the development of the concept of using machine processing techniques for applications of remote sensing in agriculture. By 1967 several of these techniques had been implemented and their feasibility demonstrated. These concepts were also shown to be useful for applications including geology, hydrology, and geography. Thus the scope of the research was expanded and the responsibility for remote sensing research at Purdue University was assigned to a laboratory known as the Laboratory for Applications of Remote Sensing (LARS).

The LARS system, LARSYS, uses multispectral data in image orientation as its primary input data. Originally an aircraft-mounted multispectral scanner, designed and flown by the University of Michigan, obtained the data input.

Later many other inputs have been used including: overlayed data from the various scanners flown in the single University of Michigan aircraft, digitized photography from spacecraft overlayed to create registered multispectral images, registered aircraft data collected at different times, multispectral data from the LANDSAT satellite, and other aircraft scanners.

The analysis algorithms used in LARSYS and applied to remote sensing were developed as pattern recognition techniques. The basic analysis concept consists of locating data points hypothesized to be representative of classes of interest, calculating the Gaussian statistics of these data points, using these statistics to classify a data set of interest, and evaluating the classification result. The data base used to calculate the statistics are called training data points, or more commonly in the context of LARSYS, training fields. The data points used to evaluate the classifiers are called test fields. Throughout this manual these terms, training fields and test fields, are used for this purpose. The pattern recognition algorithms implemented in LARSYS include an algorithm for calculating the statistics of training fields, a feature selection algorithm, a clustering algorithm, and two classification algorithms, as well as other Spectral and Spatial algorithms.

Since LARS' inception, a considerable effort has been devoted to the development of computer programs to facilitate the analysis of remote sensing data. Concentration on the interface between the research and the data and between the researcher and the analysis techniques have made an important contribution to the ability of researchers of every discipline to investigate the application of these techniques. By 1968 a considerable body of software had been developed; some of it of a very general nature, and other portions quite specialized. The principal analysis programs of a general nature were organized into a system called LARSYS. Other processing functions were later incorporated into the initial system to create LARSYS Version 2. By the end of 1971 it became apparent that the time had come to consolidate the considerable programming advances that had been made into a single "benchmark" or "checkpoint" system and to thoroughly document the results. No attempt was made to implement new remote sensing analysis programs. Thus a project was initiated in April of 1972 to consolidate a specified group of LARS programs into a new LARSYS Version 3 and to:

- Improve usability by adding terminal-oriented-user facilities.
- Improve usability by making external operation as easy as possible.

- Provide comprehensive documentation for the users to describe the concept and use of the facility available.
- Provide comprehensive documentation for the programmer to increase the ease of maintenance and evolution of new processing functions in the system.
- To provide a single, flexible, system framework for future development.

This three volume manual is the user documentation and reference for LARSFRIS, an updated version of LARSYS Version 3.1. It is designed to serve both as an introduction to LARSFRIS for the new user and as a reference manual for the more experienced user. It emphasizes the hands-on approach to using LARSFRIS. It is not expected that a user will read the majority of this information and then be ready to use LARSFRIS. Rather the manual is designed to be studied each time the user needs access to a new Processing Function or access to additional flexibility implemented in the system.

Every user of LARSFRIS will want to become acquainted with Section 2 of the manual where a complete description of the system is found.

Section 3 of the LARSFRIS User's Manual contains examples of operating the system. Users unfamiliar with interacting

principles implemented in LARSFRIS should follow these examples for initial orientation or refamiliarization with the operating principles.

Sections 4, 5, and 6 contain descriptions of the LARSFRIS Control Commands, Initialization Functions, and Processing Functions. Before initial use of any command or function in the system is attempted, reading of the appropriate subsection will help remove many of the roadblocks to successful use of LARSFRIS. The complete description of the commands and the functions can be easily located in the Table of Contents.

Volume three of the LARSFRIS User's Manual contains appendices which users will want to reference often after initial familiarization of the system.

SECTION 2

THE LARSFRIS ENVIRONMENT

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THE LARSFRIS ENVIRONMENT

This section describes LARSFRIS from the external, or user, point of view. It contains general information about the LARSFRIS organization, control mechanisms, processing functions, and computer equipment. More detailed information about the mechanics of operating LARSFRIS and about each command and function are presented in later sections.

There are five subsections in this section. The first of these provides a brief overall review of the major system capabilities. This is followed by a description of primary processing capabilities. The third subsection defines processing controls in LARSFRIS, followed by operating controls. The last subsection describes the computer equipment and its major operational features.

2.1 MAJOR SYSTEM CAPABILITIES

LARSFRIS is a multi-image data analysis system consisting of a software implementation of twenty-three Processing Functions. These Processing Functions provide techniques for handling or processing remotely sensed multispectral and multitemporal data. The primary input to the system is digital data transformed from measurements recorded by multispectral remote sensors mounted in aerospace platforms.

Communication between Processing Functions, simplicity of control, and commonality of data files in LARSFRIS enhance the usefulness of the system as a tool for research and development of remote sensing systems. The implementation of LARSFRIS on a general purpose computer with time sharing and remote terminal capabilities increases the system's value to a large group of users. The resulting processing facility provides (1) full user access, from the user's location, to both the data and the processing capability; (2) centralization of the expensive portions of the processing hardware at considerable cost advantage; (3) centralization of software maintenance, with additional cost advantage and updating flexibility; and (4) ease of training through standard data formats, terminology, and simplicity of communication.

The digital data input to LARSFRIS is in the form of a Multispectral Image Storage Tape. The content and format of the tape are described in Appendix IV. LARSFRIS will also accept as input a tape in Universal format, see Appendix VI. The measurements from the remote sensors (optical mechanical scanners, cameras, etc.) may be processed through several storage media before they are reformatted into the specific format of a Multispectral Image Storage Tape required by LARSFRIS. Each data element stored on the tape is a vector relating to measurements of the energy returned to the sensor in multiple wavelength bands or multiple measurement times. These measurements are from a small portion of the earth's surface and are associated with the resolution of the sensor system. The data vectors are stored on the Multispectral Image Storage Tape so that they retain their image orientation.

In general, an area on the earth's surface is represented on the Multispectral Image Storage Tape by a "run" of data consisting of an identification (ID) record, many data records, and an end-of-file record. Each data record contains one scan line of data from each of the recorded wavelength bands. The end-of-file record is the last record in the run. Several runs can be included on one tape. LARSFRIS maintains a catalog for the users of the runs stored on a large number of Multispectral Image Storage Tapes.

The twenty-three LARSFRIS Processing Functions are briefly identified here to give the reader an overall view of the remote sensing data processing that the system will perform. More complete descriptions of these functions are given in subsequent sections. Each of the functions are capitalized and underlined here to aid the reader in identifying the function name with the processing capability.

Six "utility" functions enable a user to extract or manipulate data from the Multispectral Image Storage Tapes. BIPLOT will allow the user to plot in the data in two dimensional space. CHANNELTRANSFORM will copy a run from one tape to another and make algebraic transformations to a subset of channels in order to provide a user with private access to a particular run. IDPRINT provides lists of the ID record information to aid users in identifying available data runs. MERGESTATISTICS will allow the user to merge multiple statistics decks into one deck and pool or delete classes. RATIOMEANS will allow the user to ratio means from user specified channels. TRANSFERDATA will extract data values from a run and print them in a listing, punch them into a card deck, or write them on a formatted tape.

Four functions assist the user in evaluating Multispectral Image Storage Tape data. LINEGRAPH prints a graph showing the relative magnitude of data points from lines stored in

a given run, and COLUMNGRAPH prints a similar graph of columns of data. HISTOGRAM calculates a histogram of data values for each requested channel for a specified area. GRAPHHISTOGRAM prints graphs of the resulting histogram.

Two functions assist in the selection of areas used to design and evaluate a classifier. PICTUREPRINT prints data in image orientation to enable a user to manually select subsets of data which will be useful as "training fields" for classifier design and as "test fields" for classification evaluation. Field Description Cards are used to specify the location of these areas to LARSFRIS in other processing functions. PICTUREPRINT also has the capability to histogram area, graph histograms, and print the location of previously defined training and test fields.

Three functions perform preliminary operations to assist the user in defining a classification urn. CLUSTER is an unsupervised classifier that groups data vectors into the number of classes specified by the user. STATISTICS calculates mean vectors and covariance matrices for each class specified by the user and produces this data as output in the form of the Statistics File and several printed formats. SEPARABILITY uses data from the Statistics file to measure the separability between classes of interest as a function of combinations of spectral bands

There are two supervised classification functions, both which require the Statistics File as input. SAMPLECLASSIFY classifies groups of points (areas defined by the user) by considering group statistical characteristics. CLASSIFYPOINTS performs the maximum likelihood classification on a point-by-point basis over an area specified by the user. It produces the Classification Results File for use by other processing functions. SECHO classifies through supervised extraction and classification of homogeneous objects.

Six functions enable the user to analyze or handle data from the Classification Results File. COMPARERESULTS allows the user to detect differences from two classification results files. COPYRESULTS duplicates the Classification Results File on magnetic tape. LISTRESULTS produces a formatted listing of identification information pertaining to the Classification Results File. PRINTRESULTS produces a number of printed outputs. These include performance tables for training classes and training fields and for text classes and text fields. Also, the results of classification can be printed in their image orientation. PUNCHSTATISTICS punches on cards (from the Classification Results File) the Statistics File that was used in the classification. SMOOTHRESULTS allows the user to enhance a classification results file by specifying parameters.

The above Processing Functions are supported by nine Initialization Functions that enable the user to alter portions of the printed output, change the control card input device, use uncataloged Multispectral Image Storage Tapes, and check his input deck for errors.

The Processing and Initialization Functions are controlled by the user primarily through his entries on the control file that comprise an input file. This deck specifies to LARSFRIS which functions are to be performed and which processing options are to be exercised, The file also may include data that is required as input by some of the Processing Functions.

Since the principal interface between LARSFRIS and the user is the input control file, considerable attention has been given to simplicity of its specification. A generally free-form format, the extensive use of English-like words for keywords and parameters, and the few simple rules of syntax and punctuation greatly simplify the user's preparation and use of input commands. In addition, extensive error-checking is provided. Two mechanisms are implemented which inform the user of errors and provide for corrections. One is the CHECKOUT Initialization Function that identifies syntax errors so an input file may be checked and corrected without executing the time consuming functions. The other is inter munication during processing so that errors are identified to the user, and certain errors are correctable through typewriter entries.

Another feature of LARSFRIS is the ease of system operation. The system is operated through a processing site which consists of a typewriter terminal, a card reader/punch unit, and a line printer. Through these units, the user has access to the LARSFRIS software and to the facilities in the LARS computer room which is required to perform his processing. LARSFRIS Control Commands are entered from the typewriter terminal to extablish system communication, set up the processing job(s) to be run, control the source of input and the destination of output, and obtain operation for new users, while others provide greater operative versatility for experienced users.

LARSFRIS is implemented on an IBM 3031 running under VM release 6, and the operating system is the Conversational Monitor System (CMS) Version 370. This combination of hardware and software provides shared access to LARSFRIS from remote sites. Each user enjoys access similar to that available at LARS when Version 1 was installed on a Model 44.

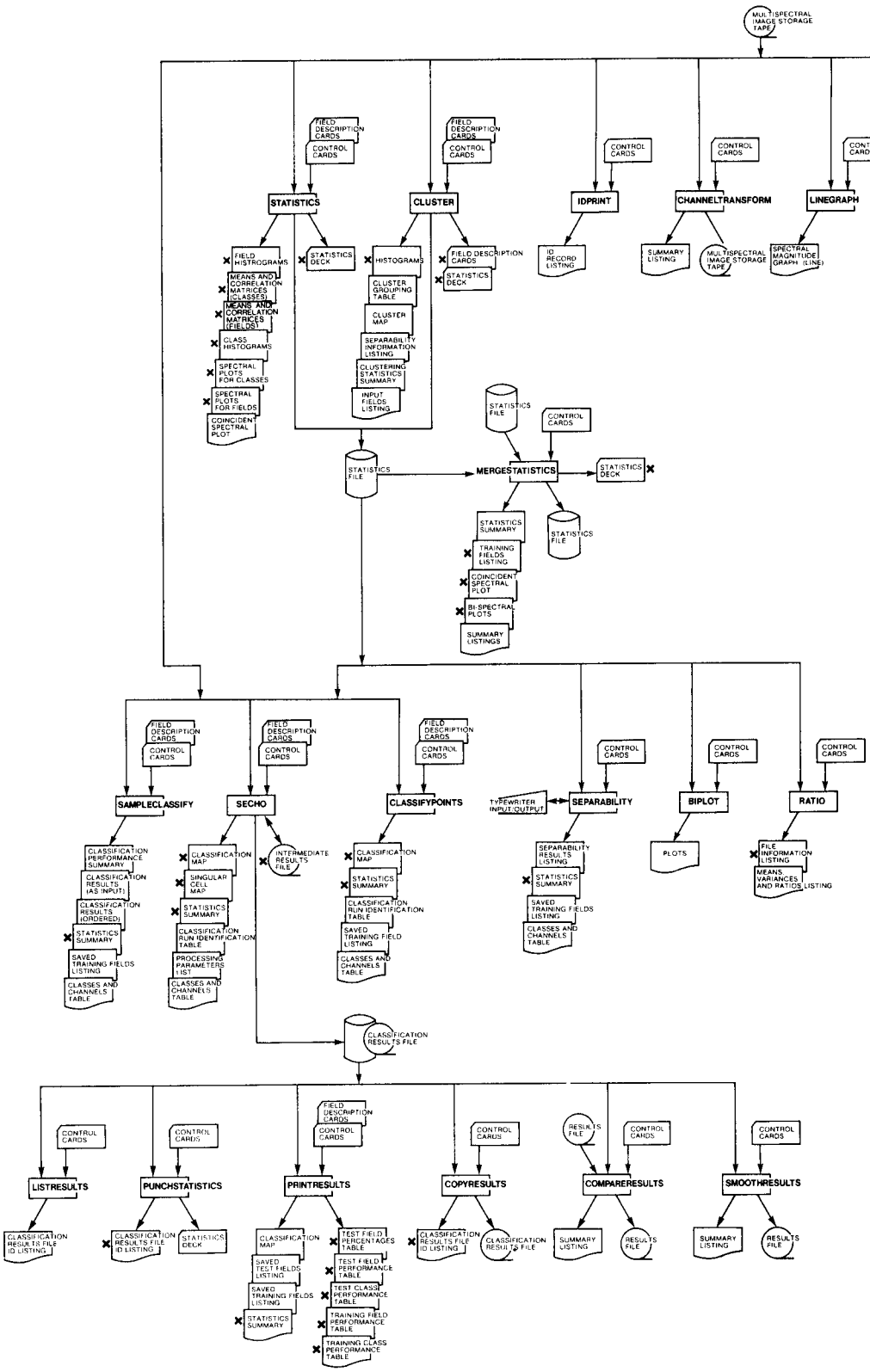
Various modes of access, the Interactive Mode, Batch Mode, or Disconnect Mode are available at the remote site. As the experience of the user increases, the advantages of each of these modes can be used to increase his effective use of the system. Although access is increased, the cost per user is decreased. The centralization of hardware, software maintenance and training methods coupled with resource sharing provides a cost effective system for remote sensing research and development.

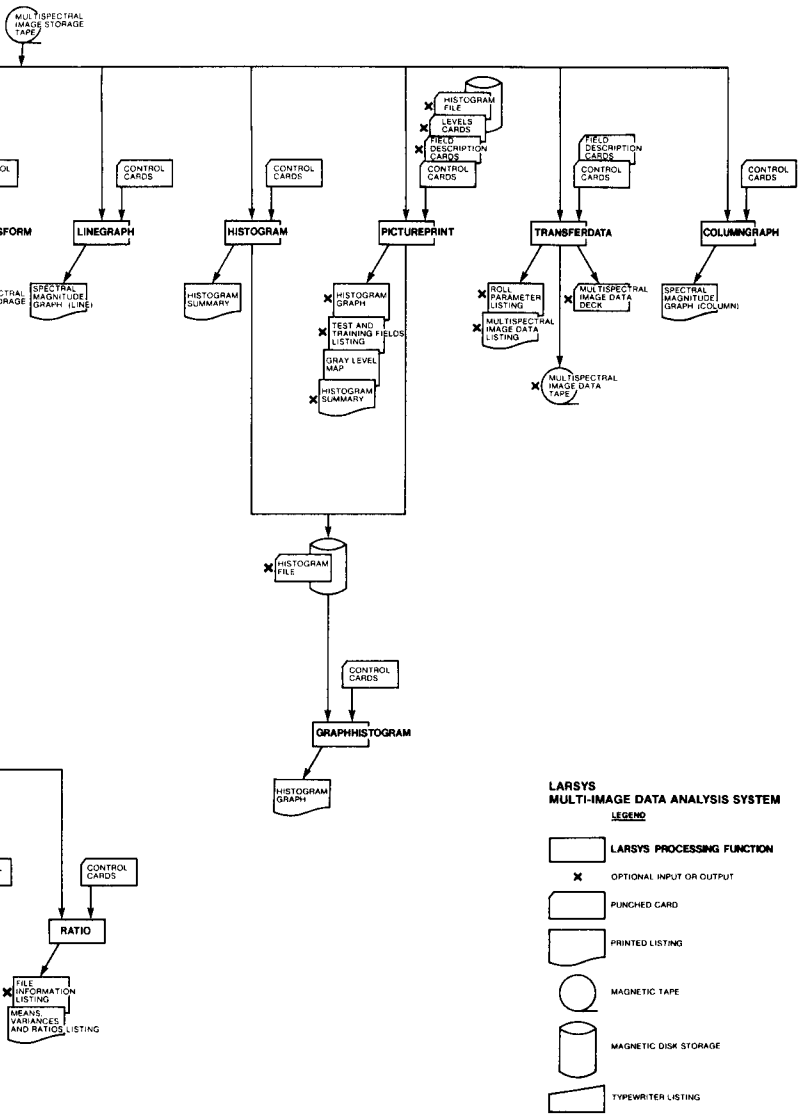
2.2 LARSFRIS PROCESSING ENVIRONMENT

LARSFRIS contains a set of Processing Functions that process remotely sensed data from a Multispectral Image Storage Tape. Figure 2-1 shows the system diagram of these processing functions and the interrelationships between them.

The diagram shows all of the inputs that are accepted by each function and the outputs that it produces. Refer to the key in the lower right hand corner for an explanation of the symbols that are used. Note that optional inputs and outputs are marked by a small letter "x" to the left of the symbol for the item. For instance, the Cluster function (upper left hand corner of the figure) has two card inputs, both of which are required; seven printed outputs, one of which is optional; and two punched outputs (Field Description Cards and Statistics Deck), both of which are optional. (The reader should refer to the detailed function descriptions in Section 6 for more information on how these optional products are requested.)

The remainder of this subsection will describe the major features and capabilities of LARSFRIS, as depicted in the Figure 1. The reader should locate each function on the figure as it is described and note its inputs and outputs and its relationships to other functions.


MULTISPECTRAL IMAGE STORAGE TAPE
STATISTICS
CLUSTER
IDPRINT
CHANNELTRANSFORM
LINEGRAPH
HISTOGRAM
FIELD DESCRIPTION CARDS
CONTROL CARDS
FIELD HISTOGRAMS
MEANS AND CORRELATION MATRICES (CLASSES)
MEANS AND CORRELATION MATRICES (FIELDS)
CLASS HISTOGRAMS
SPECTRAL PLOTS FOR CLASSES
SPECTRAL PLOTS FOR FIELDS
COINCIDENT SPECTRAL PLOT
STATISTICS DECK
HISTOGRAMS
CLUSTER GROUPING TABLE
CLUSTER MAP
SEPARABILITY INFORMATION LISTING
CLUSTERING STATISTICS SUMMARY
INPUT FIELDS LISTING
ID RECORD LISTING
SUMMARY LISTING
MULTISPECTRAL IMAGE STORAGE TAPE
SPECTRAL MAGNITUDE GRAPH (LINE)
HISTOGRAM SUMMARY
STATISTICS FILE
MERGESTATISTICS
STATISTICS SUMMARY
TRAINING FIELDS LISTING
BI-SPECTRAL PLOTS
SUMMARY LISTINGS
SAMPLECLASSIFY
SECHO
CLASSIFYPOINTS
SEPARABILITY
BIPLOT
RATIO
TYPEWRITER INPUT/OUTPUT
CLASSIFICATION PERFORMANCE SUMMARY
CLASSIFICATION RESULTS (AS INPUT)
CLASSIFICATION RESULTS (ORDERED)
SAVED TRAINING FIELDS LISTING
CLASSES AND CHANNELS TABLE
CLASSIFICATION MAP
SINGULAR CELL MAP
PROCESSING PARAMETERS LIST
INTERMEDIATE RESULTS FILE
CLASSIFICATION RUN IDENTIFICATION TABLE
SAVED TRAINING FIELD LISTING
SEPARABILITY RESULTS LISTING
PLOTS
FILE INFORMATION LISTING
MEANS VARIANCES AND RATIOS LISTING
CLASSIFICATION RESULTS FILE
LISTRESULTS
PUNCHSTATISTICS
PRINTRESULTS
COPYRESULTS
COMPARERESULTS
SMOOTHRESULTS
RESULTS FILE
CLASSIFICATION RESULTS FILE ID LISTING
SAVED TEST FIELDS LISTING
TEST FIELD PERCENTAGES TABLE
TEST FIELD PERFORMANCE TABLE
TEST CLASS PERFORMANCE TABLE
TRAINING FIELD PERFORMANCE TABLE
TRAINING CLASS PERFORMANCE TABLE



LARSYS
MULTI-IMAGE DATA ANALYSIS SYSTEM

LEGEND

- LARSYS PROCESSING FUNCTION
- × OPTIONAL INPUT OR OUTPUT
- PUNCHED CARD
- PRINTED LISTING
- MAGNETIC TAPE
- MAGNETIC DISK STORAGE
- TYPEWRITER LISTING

Eleven of the functions use a Multispectral Image Storage Tape as direct input and the other twelve functions use derivatives of it, i.e., data that is produced as output from one of the other eleven. These derivative data files are the Statistics File (produced by the Statistics function or Cluster function), the Classification Results File (produced by the Classifypoints function), and the Histogram File (produced by the Pictureprint, Imagedisplay, and Histogram functions).

The Multispectral Image Storage Tape contains the multispectral measurements that have been recorded by an airborne or satellite-borne measurement system, converted to a computer-compatible form, and formatted on the tape in the particular way that the LARSFRIS programs require. The basic unit of data on the tape is the "run". A run represents all of the multispectral data from a single large rectangular area on the surface of the earth. The data is recorded on the tape in scan lines, columns (samples within a scan line), and channels (spectral bands). There is a single recorded spectral response value for each channel of each column of each line. For more detailed information of the Multispectral Image Storage Tape and its format, refer to Appendix IV.

These tapes are normally accessed through a "Runtable", a catalog of Multispectral Image storage Tape runs which supplies the tape number and file number of each run. The user specifies only the run number he requires and the LARSFRIS system uses the Runtable to identify the tape number of the tape it is written on. The system then mounts the tape and positions it at the correct file. Two types of Runtables exist in LARSFRIS; a large System Runtable that is maintained by LARS and is automatically available to all users, and the individual user-defined Runtables that exist only for the duration of the execution of a given input deck. Refer to the description of the RUNTABLE System Initialization Function in Section 5 for more details on the use of Runtables.

The narrative that follows summarizes the purposes of each function and its major inputs and outputs. Since all of the functions require control card input, control cards are not specifically mentioned in this subsection - and they do not appear as an input on Figure 1. The general description of the use of control cards appears in Subsection 2.3 and the control cards that apply to each function are described in detail in the functional descriptions in Section 6.

The Idprint function is the first of the "utility" functions. It is useful for reviewing the contents of Multispectral Image Storage Tapes. It prints a formatted listing of the ID record

of these tapes. The listing includes identifying information about the run (run number, flight line number, date recorded, etc.) as well as a table of the spectral bands and calibration values for all channels recorded on the tape.

The Channeltransform function copies an entire run from a Multispectral Image Storage Tape to another tape, and will make algebraic transformations to any subset of channels as specified by the user. The Channeltransform function also copies data values from a Multispectral Image Storage Tape, but for use in programs other than those in the LARSFRIS system. It reads the values from the input tape and converts them into an easily read Fortran format. The data is not acceptable in this format as input to any of the present LARSFRIS functions. The user may request the data values in the form of a card deck, a tape, and/or a listing.

The Linegraph and Columngraph functions assist the user in his initial evaluation of the data on a Multispectral Image Storage Tape. Both functions graph data values from the input tape as a function of spatial position. The Linegraph function graphs the values for each line that is requested and the Columngraph function graphs the values for each column or each calibration function that is requested.

Two functions, the Histogram and Graphhistogram functions, are provided to calculate histograms of the data on the Multispectral Image Storage Tape and to print graphs of the resulting histograms. The Histogram function calculates a histogram of the spectral values for each channel that is specified to it. The resulting Histogram File is written on disk and may also be punched into cards. The Graphhistogram function uses the file on disk to print graphs of the histograms.

The Histogram File may be created by the Pictureprint function as well as by the Histogram function. In any case, it contains information identifying the area that was histogrammed, and the mean, standard deviation and the individual elements of the histogram for each channel. The primary use of the file is in the Pictureprint function where the histograms are used to assign digital display gray levels and pictorial map symbols, respectively, to specific data ranges. These functions can use the file in either card or disk form.

The Pictureprint function assists the user in checking Multispectral Image Storage Tape data quality and in selecting subsets of the data (rectangular areas) that are to be used as training fields or test fields in other functions (usually the Sampleclassify, Statistics, or Printresults functions).

The Pictureprint function produces alphanumeric pictorial printouts of the data for each channel that is specified, with different ranges of data values represented by different printed symbols. It normally uses histograms of the data for these channels (calculated by itself or by another function) to assign the symbols to specific data ranges for the channel. The user may alternatively specify the assignment of data ranges himself, and thus bypass the use of histograms. The pictorial printout is used to manually identify the line and column boundaries of the training or test fields. The user then punches this information into Field Description Cards for input to the other functions.

The Cluster function is a non-supervised classifier that groups a set of measurement vectors drawn from the Multispectral Image Storage Tape into the number of classes specified by the user. The grouping is based on the classification of each point within the area that the user has defined. The function is normally used to assist the researcher in defining appropriate classes within his data and in obtaining an initial measure of the degree of separability between these classes. The principal outputs from the function are a Separability Information Listing, which shows the separability of the clustered classes; a Cluster Map, which uses alphanumeric symbols to pictorially depict the classified areas; a cluster grouping table which gives suggested groupings of the original cluster classes; and a Statistics File which is put on the user's temporary disk and may also be punched on cards.

The Statistics function is one of the key processing functions in LARSFRIS. It calculates statistics for subsets of data values from the Multispectral Image Storage Tape. These subsets (defined by the user on Field Description Cards) are in the form of training fields, which are generally grouped to form training classes. The mean and standard deviation, a covariance matrix, and a correlation matrix of the data values for the channels specified by the user are calculated for each of the training fields and training classes. These statistics are then stored in the Statistics File, which is a primary input to the Separability, Classifypoints, and Sampleclassify functions (the Statistics File can also be generated by the Cluster function). The file

is written on disk by the Statistics function and may also be punched on cards if the user wishes. The three functions will accept it as input in either form.

In addition to the Statistics File, the user may request a variety of optional printed outputs that describe his training fields and training classes. He may request a Statistics Summary which contains the mean and standard deviation vectors and correlation matrices of the channels for each field or class, Histograms of the data values for requested channels, and spectral plots which show the normalized range of the values for all of the channels.

The Separability function assists the user in selecting the features (channels) that will produce the most accurate classification by the Classifypoints function. It uses the class statistics in the Statistics File to calculate measurements of how well the individual classes may be separated from each other for each combination of channels. The product of these calculations is printed in the Separability Results Listing, the function's principal output. This listing shows "best" channel combinations ranked by greatest divergence between class pairs. The divergence values that are used for the ranking may be either the average divergence or the minimum divergence between class pairs. The listing also shows the divergence between each of the class pairs.

The Classifypoints function is the main classification function in LARSFRIS. It implements a maximum likelihood classification rule which classifies the data points from the Multispectral Image Storage Tape on a point-by-point basis. The function uses the class means and covariance matrices from the Statistics File, the data from each individual point to be classified, and class weights (usually a priori probabilities) which may be assigned to each class by the user to calculate the probability that the point belongs to each of the training classes. It then assigns the point to the most probable class.

The results of the classification are written on the Classification Results File. The file is normally written on disk, but may also be written on tape. It contains a record of the class to which each point was assigned, as well as the probability that the point belongs to the class. The file is normally input (in either disk or tape format) to the Printresults function to produce printed outputs that describe in detail the results of the classification. Three other functions, the Listresults, Punchstatistics and Copyresults functions, also are provided to perform various "utility" type operations with the Classification Results File.

The Printresults function provides the user a flexible capability to display the results of the Classifypoints classification in

printed form. The function produces two principle outputs - a pictorial map image of the classified area, and a variety of performance tables. The map image represents each of the data points in the classified area with an alphanumeric symbol for the class to which the point was assigned. The user may assign whatever symbols he wishes to the classes and may control whether or not specific classes are printed or not, may outline test and training fields, and may inhibit the printing of points that have a low probability of correct classification. Performance tables may be printed for training fields and training classes and for test fields and test classes. The tables show how the points belonging to these fields and classes were actually classified. They are a final evaluation of the validity of the training fields and classes that were used and of the accuracy of the classification in the selected test fields and classes.

The Sampleclassify function classifies Multispectral Image Storage Tape data based on group (or area) statistics. It implements a statistical distance measure for classifying test fields; areas that are defined to it by the user of Field Description Cards. The function uses data from the input tape to calculate the mean vectors and covariance matrices for the test fields. It uses these and the similar statistics for the training classes (from the Statistics File) to calculate the

distance between the probability density function of each test field and the probability density function of each training class. It then assigns the field to the closest training class. The principle outputs from the function are two Classification Results Listings, showing the results of the classification for each of the test fields. One of these listings is ordered by data tape order, i.e., by increasing line number on the Multispectral Image Storage Tape, and the other in the order in which the test fields were input by the user.

The last three functions provide special operations on the Classification Results File. The Copyresults function copies the file to a user-specified tape. It will accept the input file on either tape or on disk. On the other hand, both the Punchstatistics and the Listresults functions only accept the input file on tape. The Punchstatistics function punches into cards the Statistics File that was used in the classification and the Listresults function prints a listing of the identification record on the Classification Results File. This listing shows identifying information (tape and file numbers, date classified, etc.) as well as the channels used, class names, class weights if any were assigned, area classified, calibration values, and the number of lines classified. The Copyresults and Punchstatistics functions may, at the user's option, also produce this listing as a byproduct of their normal function.

2.3 CONTROL OF PROCESSING

The principal means of controlling the LARSFRIS Processing Function is an input deck. The deck may consist of three types of cards -- Initialization Cards, which activate special "initializing" actions prior to the execution of the Processing Functions; control cards, which identify and control the Processing Functions; and, data cards, which are processed directly by the functions. The deck will always contain control cards and may or may not contain Initialization Cards or data cards. Initialization Cards are always optional. Many of the Processing Functions have a provision for data cards, but their inclusion may be either required or optional depending upon the individual function and the processing that is desired by the user.

The simplest form of the input deck is a single group of control cards (with or without data cards) that activates and controls a single Processing Function. The deck may be expanded in two ways. First, the user may choose to execute two or more Processing Functions in sequence by combining the cards that relate to each of the functions into a single input deck. The groups of cards are combined by simply placing one group behind the other and submitting them as a single file. The functions will be executed by LARSFRIS in the sequence in which they appear in

the combined file. Secondly, the user may also choose to activate special Initialization Functions that alter the processing environment. The Initialization Functions are activated by placing Initialization Cards in the input deck in front of the control cards for the Processing Functions that he wishes to affect. The actions that the user activates in this way will apply to all Processing Functions subsequently activated in the input file, until he uses other overriding or modifying Initialization Cards.

Initialization Functions

There are nine System Initialization Functions which are activated by System Initialization Cards. The format of the cards consists of a hyphen (-) in column one followed by the appropriate keyword from the list below. The keyword is in some cases followed by one or more parameters. The group of Initialization Functions are:

HD1 - Replaces the first standard header line on printed output.

HD2 - Replaces the second standard header line on printed output.

Comment - Prints a user-defined comment line beneath the headers on all printed output.

DATE - Prints a user-specified date on the header of all printed output and replaces that provided by the system.

TYPE - Specifies that subsequent control card input will be entered from the typewriter keyboard.

CARD - Specifies that control card input will be switched back to the card reader from the typewriter keyboard.

RESET - Causes all Initialization Functions to assume their normal condition.

RUNTABLE - Permits the user to specify input Multispectral Image Storage Tapes other than those catalogued in the system Runtable.

CHECKOUT - Performs a syntax checkout of all control cards without executing any Processing Functions.

More information on the Initialization Functions is contained in Section 5.

Control Cards

The group of control cards for each Processing Function includes the following:

- A Function Selector Card - This is a special control card which identifies the Processing Function to be executed. It is always the first card in the group. It contains an asterisk (*) in column one, followed by the name of the function (e.g., *CLUSTER).

- The Function Control Cards - Following the Function Selector Cards are a number of Functional Control Cards as required by the function or desired by the user. These cards may appear in any sequence. The cards define the specific execution of the Processing Function that is to be performed. The control cards that are supported by each of the Processing Functions are shown in Figure 2-2. As is evident in the figure, some of the cards are quite specialized and apply to only one or two Processing Functions, while others (such as the CHANNELS and the PRINT cards) are used in several of the functions. The reader should consult the individual Processing Function descriptions in Section 6 and the Control Card Dictionary in Appendix I for the details on how these Control Cards are used in each function and the actions that they invoke. If data cards are included in the input deck, they must follow the control cards described above.

Figure 2-2 LARSFRIS Processing Functions

LARSFRIS Control Cards

Control Cards	BIPLOT	CHANNELTRANSFORM	CLASSIFYPOINTS	CLUSTER	COLUMNGRAPH	COMPARERESULTS	COPYRESULTS	GRAPHHISTOGRAM	HISTOGRAM	IDPRINT	LINEGRAPH	LISTRESULTS	MERGESTATISTICS	PICTUREPRINT	PRINTRESULTS	PUNCHSTATISTICS	RATIOMEANS	SAMPLECLASSIFY	SECHO	SEPARABILITY	SMOOTHRESULTS	STATISTICS	TRANSFERDATA
ANNEXATION																			X				
AUTO			X																				
BASERESULTS						X																	
BLOCK						X			X					X	X						X		
BOUNDARY														X									
CARDS	X		X															X	X	X			
CELL																			X				
CELLSIZE																					X		
CHANNELS			X	X	X	X		X	X		X		X	X				X	X	X		X	X
CLASSES			X										X					X	X	X			
COMBINATIONS																				X			
COMPARERESULTS						X																	
DATA	X	X	X	X									X	X	X		X	X	X	X		X	X
DISK													X										
DISPLAY														X									
END	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FROM		X					X					X				X	X						
*Function Sel.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
GROUP															X			X			X		
HISTOGRAM														X									
IDNAME				X																			
INRESULTS																					X		
INTERMEDIATE																			X				
MIXCLASS																					X		
NEWCHANNELS		X																					
NEWRESULTS						X																	
NORATIO																	X						

* Function Select Cd.

Figure 2-2 (con't) LARSFRIS Processing Functions

LARSFRIS Control Cards

	BIPLOT	CHANNELTRANSFORM	CLASSIFYPOINTS	CLUSTER	COLUMNGRAPH	COMPARERESULTS	COPYRESULTS	GRAPHHISTOGRAM	HISTOGRAM	IDPRINT	LINEGRAPH	LISTRESULTS	MERGESTATISTICS	PICTUREPRINT	PRINTRESULTS	PUNCHSTATISTICS	RATIOMEANS	SAMPLECLASSIFY	SECHO	SEPARABILITY	SMOOTHRESULTS	STATISTICS	TRANSFERDATA
OPTIONS	X			X					X								X			X		X	X
OUTRESULTS																					X		
PLOT	X																						
POOL													X										
PRINT			X	X	X		X			X	X		X	X	X	X	X	X	X	X			X
PRIORITY																					X		
PROBABILITY															X								
PROCEDURES			X																				
PSYMBOLS															X								
PUNCH			X						X				X	X								X	X
RESTART			X																				
RESULTS			X												X				X				
SCALE	X				X						X		X									X	
SYMBOLS	X			X										X	X		X		X	X			
TAPE																							X
THRESHOLD															X								
TO		X					X																
WEIGHTS			X																	X	X		
Data in the Input Deck																							
Algebraic Expr.		X																					
Class Names						X																	
Field Desc. Dc			X	X										X	X			X	X			X	X
Histogram Deck														X									
Levels Cards														X									
Statistics Deck	X		X										X				X	X	X	X			

- An END Card - The entire group of cards that relate to a single Processing Function is always terminated with a special control card that contains only the keyword "END".

Data Cards

Figure 2-2 shows the nine Processing Functions that use data cards and the specific types of data cards that they use. The data cards for a Processing Function always follow the functional control cards, and precede the END card, i.e., they are the last cards in the group for that execution of the function. Each individual group of data cards is preceded by a special control card that contains the keyword "DATA". Pictureprint may have up to three groups of data cards in the deck, and the others may have one or two. Inevery case where there may be more than one group of input data cards, the different groups must be placed in the input deck in a specific sequence. Refer to the description of the DATA card in the function's Control Card Dictionary in Appendix II for the required sequence.

There are four types of data cards -- Statistics and Histogram decks, Levels Cards and Field Description Cards. The Statistics and Histogram decks were described in the previous subsection, and Levels cards are described in the functional description of the Pictureprint function in Section 6. A description of Field Description Cards Follows.

Field Description Cards are used in eight of the Processing Functions, and serve the same general purpose in each case. They identify a specific block of data (an area on the ground) by providing a run number, a beginning and ending scan line number, a beginning and ending column number, and the intervals that are used in selecting lines and columns from the data tape. There are two forms of the card and either or both may be used wherever Field Description Cards are required. The first of these is called the "free form" version. Its format is:

RUN(nnnnnnnn),LINE(x,y,z),COL(x,y,z)

RUN is the keyword that identifies this card. It is always required and is followed immediately by the eight-digit run number, which is enclosed in parentheses.

LINE identifies the scan lines that are to be used. The x and y parameters specify the first and the last lines to be selected, and the z parameter gives the line interval that is to be used in selecting lines. For instance, a value of 4 for z would result in every fourth line being used. If z is omitted, LARSFRIS assumes a value of 2 for it. If LINE and/or its associated parameters are omitted, LARSFRIS assumes that all lines in the run are to be used.

COL identifies the columns that are to be used. The x and y parameters specify the first and last columns, and the z parameter, the column interval. If the z parameter is omitted, a value of 2 is also assumed for the column interval, and if COL and its associated parameters are omitted, all columns in the selected lines are used.

The second form of the Field Description Card is of relatively fixed form. Each value (parameter) must be placed in particular card columns, but may be either right or left justified. The format is:

Card Columns	Required	
1 to 8	YES	Eight-digit run number
11 to 18	NO	Field Designation (8 Alphanumeric Characters)
21 to 25	YES	Beginning line number
26 to 30	YES	Ending line number
31 to 35	YES	Line interval
36 to 40	YES	Beginning column number
41 to 45	YES	Ending column number
46 to 50	YES	Column interval
51 to 58	NO	Field Type (Alphanumeric)
59 to 72	NO	Additional information (Alphanumeric)

Card Formats

The basic format of both control cards and Initialization Cards consists of a single keyword, followed (in some cases) by one or more control parameters. The keyword defines the action to be taken and the control parameters expand or qualify the action. The overall format rules that apply to these cards are outlined below:

- All keywords for Initialization Functions include a hyphen (-) as part of the keyword. All keywords for Function Selector Cards include an asterisk (*) as part of the keyword. (Function Control Cards are interpreted as part of a sequence behind a Function Selector Card.)

- A keyword starts at column 1 on a card. It is separated by at least one blank space from the control parameter (or parameters) punched on the remainder of the card through column 72 (columns 73-80 are ignored).

- A control parameter may be a word, a variable, or a combination of the two. A variable may be a numeric value or a literal designation. In a combination, the variable following the word must be enclosed in parentheses. The following rules also apply:

  - A set of variables in parentheses must be separated by commas.
  - A subset of variables in parentheses must be enclosed by slashes (/).

- Multiple values may be entered in the form 2*3, 4*1.75 or 2*A.
- Blank spaces may be inserted between a word or value and a punctuation symbol, except when it is part of that word or value.

Organization of the Input Deck

The placement of cards within the LARSFRIS input deck has been discussed in the preceding pages. This final paragraph recapitulates that material and provides an illustration of a typical input deck.

The typical input deck might be organized as follows:

```
-System Initialization Cards
    *Function Selector Cards
        Function Control Cards
            DATA card
                data cards
            DATA card
                data cards
            END card
```

Processing Function #1

```
-System Initialization Cards
    *Function Selector Card
        Function Control Cards      } Processing Function #2
            END card

    *Function Selector Card
        Function Control Cards
            DATA card               } Processing Function #3
                data cards
            END card
```

The group of cards which define the execution of Processing Function #1 are preceded by System Initialization Cards. These initialization actions will remain in force for processing functions #2 and #3, unless changed by subsequent Initialization Cards.

The cards for Processing Function #1 contain two groups of data cards, each of which is preceded by its own DATA control card, and the entire group of cards is terminated by an END card.

The group of cards for Processing Function #2 is also preceded by Initialization Cards, which may change the earlier initialization actions or invoke entirely new actions. No data cards are required for the execution of the function, so the Function Control Cards are immediately followed by the END card.

The group of cards for Processing Function #3 is not preceded by Initialization Cards. It does, however, have a single group of data cards, which are preceded by a DATA card and followed by the END card.

2.4 CONTROL OF SYSTEM OPERATION

The twenty-three LARSFRIS Processing Functions are supported by nine Initilization Functions and nineteen Control Commands. These major system elements are organized into the three levels of control shown in Figure 2-3: the executive level, the monitor level and the processing level.

The executive level represents the basic interface with the user. It provides the facilities that enable the user to set up and initiate the processing of an input deck. Control will return to the user at this level when all processing for an input file is complete. He may then initiate the processing for a new file or terminate the processing session. All communication with the system at this level is through LARSFRIS Control Commands which are communicated to LARSFRIS through the typewriter terminal.

The second level of control, the monitor level, serves to process Initialization Functions and to select and pass control to the desired Processing Functions. Initialization Cards contained in the input file control the processing that takes place at this step.

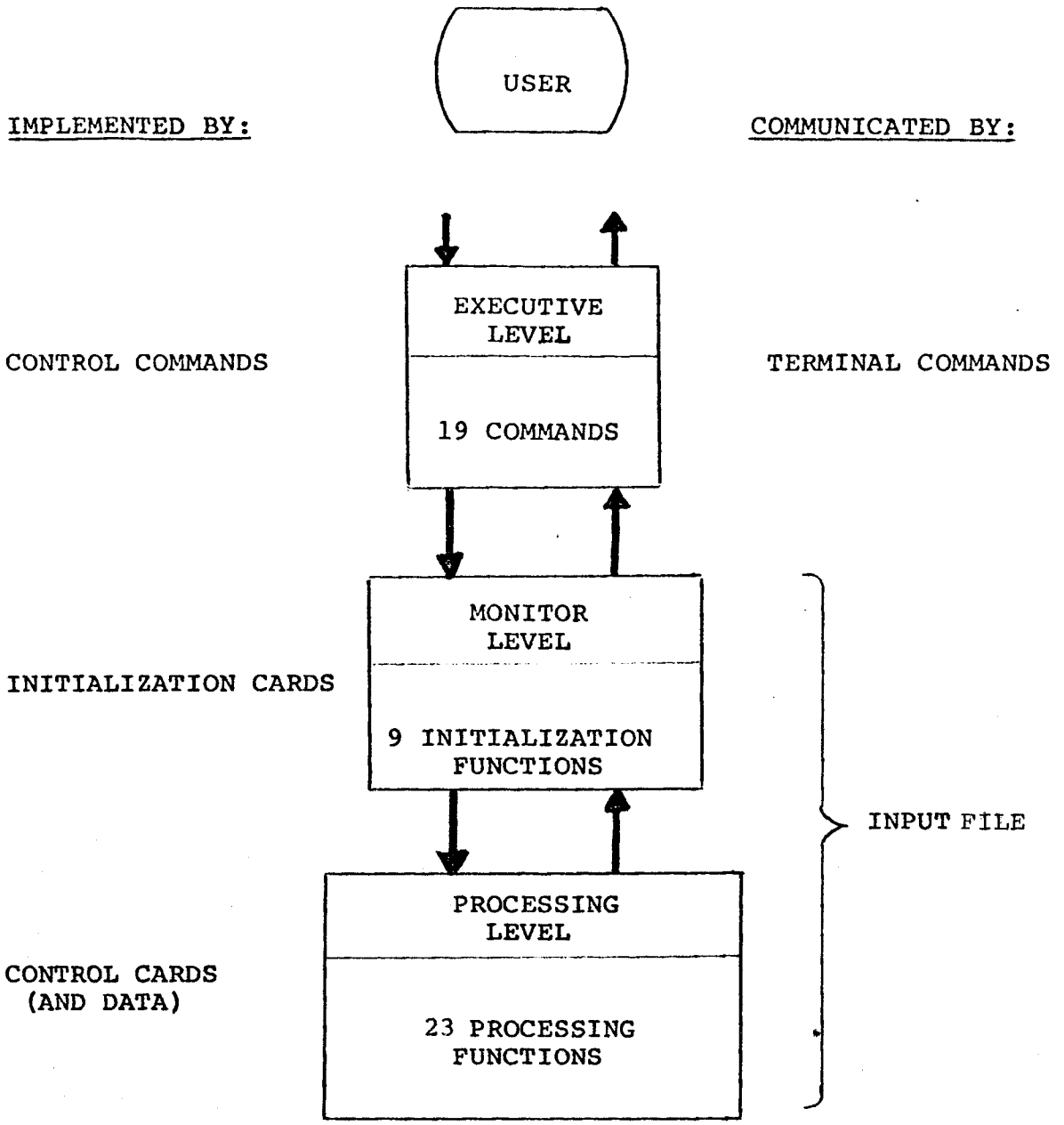


Figure 2-3 The LARSFRIS Organization.

Once a Processing Function has been selected, control is passed to the third level, the processing level. It is here that the function control cards and data cards in the input deck are read by the function, and all functional processing is performed. When processing of a function is completed, control passes upward to the monitor level, and when the input deck is exhausted, control returns to the executive level, i.e., directly to the user.

System Control

The flow of control in LARSFRIS depends on the seven LARSFRIS Control Commands that are underlined in the narrative that follows, the Function Selector Cards, and the END card. This flow is illustrated in Figure 2-4, and the narrative that follows is keyed to the numbers on the figure.

(1) The user initiates LARSFRIS and enters the executive level of control by readying his typewriter terminal and typing two Control Commands:

login [userid]

This command initiates a terminal session. The 'login' keyword is followed by a control parameter that uniquely identifies a "virtual machine" assigned

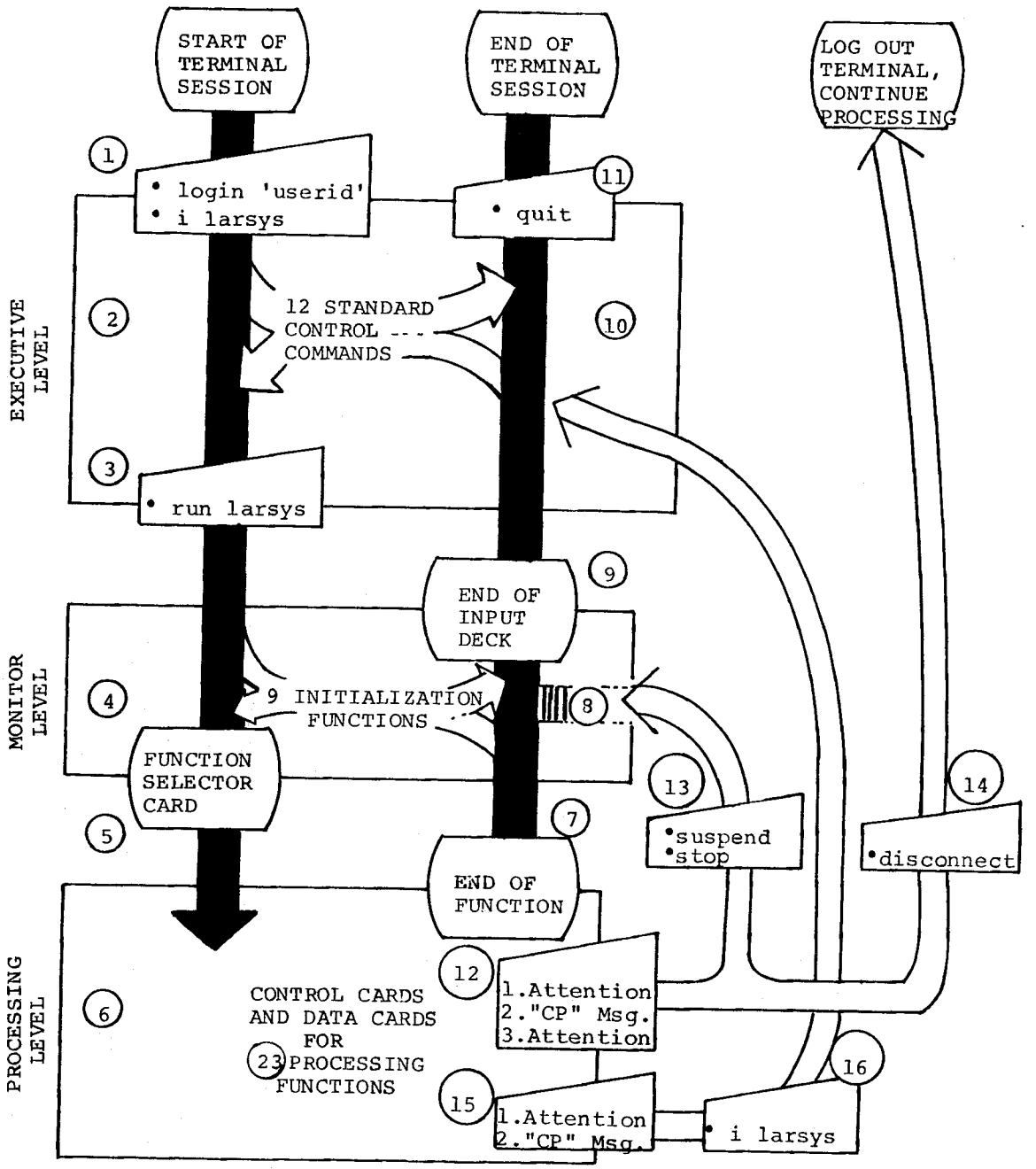


Figure 2-4. Flow of Control in LARSFRIS

to the user (virtual machines will be explained in the next subsection).

i larsys

LARSFRIS is initiated for the user with this command, which also establishes the executive level of control. Any of the Control Commands may now be issued.

(2) The user may issue any of the 12 standard Control Commands that do not cause transition to another control level. These commands are described under a separate heading below.

(3) The user types the following command to transfer control to the monitor level.

run larsys

This command causes a user's input deck to be processed. Therefore, the input deck should have been read into the system prior to issuing 'run larsys'.

(4) The monitor level assumes control and reads the first card of the input deck. If it is an Initialization Card, that function is executed, and the next card is read.

(5) When a function selector card is read, control is passed to the processing level.

⑥ When one of the twenty-three functions is selected, it retains control until its processing is completed. The function will read and interpret the control cards and data cards and will execute the actions that are specified on them. (Note that possible error conditions are not included in this discussion since they introduce a special interactive capability that is covered explicitly in Section 3).

⑦ When functional processing is completed, control passes back to the monitor level.

⑧ If more Initialization Cards or Function Selector Cards are present, the actions beginning from step ④ will be repeated.

⑨ If there are no more cards to be read, control passes back to the executive level.

⑩ Controls in effect at the executive level will begin producing any output from the Processing Function(s) that were executed, and a message will be typed at the terminal indicating the run is completed. At this point, the typewriter keyboard will be unlocked so another command may be entered. If another input deck has been read into the system and the user issues the 'run larsys' command (step ③), the action will resume from step ④ .

(11) If the user is finished with the system at this time, he issues the following command:

quit

The session is terminated, and the user is logged off the system.

The system will type a message that gives computer utilization data for the session and the logout time.

(12) If the user wishes to issue one of the two commands that terminate execution of the current Processing Function (but allow subsequent functions in the input deck to execute) or if he wishes to change the mode to Disconnect, he uses the following sequence:

- Press the 'Attention' key on the typewriter.
- The system will type "CP"
- Press the 'Attention' key again.

(13) If the user wishes to terminate execution of the Processing Function, he will type one of the following commands:

stop

This command will cause an orderly halt to functional processing. The function will be terminated, and control will be returned to the monitor level.

suspend

This command does not apply to all functions. See the current Control Command listing for the functions that have it implemented. It is essentially the same as the 'stop' command, except that the function will be terminated in such a way that processing may be resumed later from the point at which it was interrupted. Control also transfers to the monitor level.

After the system has responded to the command issued, action will resume from step (8) to give control to the next Processing Function or to return control to the executive level.

(14) If the user no longer wishes to attend the terminal while his processing run is completed, he may issue the following command:

disconnect

Processing will continue, but the typewriter terminal will be disconnected from the session and will be available for another user. Outputs will be produced when processing of the input deck is completed. Note that the user may later login his terminal and "reconnect" to the processing in his virtual machine

through this sequence:

- Use the 'login' command as explained in paragraph (1)
- When the "CP" message is typed, issue the 'begin' command rather than the 'i larsys' command.

From this point on, the virtual machine is in interactive mode again.

(15) If the user wishes to terminate the execution of the entire input deck, he starts with only the first two steps of the sequence in paragraph (12) :

- Press the 'Attention' key on the typewriter.
- Wait for the system to type "CP".

(16) The user issues the following command to terminate processing and return to the executive level of control:

i larsys

The command causes the input deck to be terminated. The user is placed in the executive level of control and his status is the same as if he had just issued a normal 'i larsys' command after initially logging in to the system.

Additional Control Commands

The user has at his disposal 12 additional Control Commands that provide system information, permit communication between

terminal users, designate input/output sites, manipulate files, and transfer jobs to batch status.

LARSFRIS provides three commands that permit a user to request information that is stored in the system. Parameters entered with the keywords are used to obtain specific information. Refer to the descriptions of these commands in Section 4 for details on the available parameters.

news

The user may request recent "news", system updates or information about the current operating schedule.

reference

Three parameters enable the user to request a list of the formats and keywords for the Control Commands, Initialization Functions, or control card inputs. Other parameters give current Runtable information.

list

This command provides a reference index to information that is available through the 'news' and 'reference' commands.

Two commands provide the LARSFRIS "message" facility. One permits communication between terminal users (and the computer room operator), and the other permits a user to test his terminal.

msg [userid] [text]'

The message text is typed at the terminal of the user designated. If the user is not at his terminal or is not available, the system notifies the originator.

termtest

Text entered by the user will be typed back at the terminal by the system to help determine if there are problems in the computer link.

Printed or punched output may be produced at a site other than that of the typewriter terminal through use of two commands:

print [site id]

The output will be printed at the site designated. Other parameters with this command permit the user to delay his output until he releases it, and he may direct output to his typewriter.

Punch [site id]

Punched output will be directed to the site designated. The output also can be delayed as with the 'print' command.

Two commands enable the user to manipulate the LARSFRIS Statistics File and Histogram File. The control parameters are the same for each command.

statdeck [---]

The parameters will save the Statistics File on the user's private disk, request its use for processing, or provide messages concerning the status of the saved deck.

histdeck [---]

This command and its parameters are the same as for 'statdeck' and applies to the Histogram File.

One command provides a means to delete specified files from the system.

clear [---]

The 'clear' command will erase a 'statdeck' or 'histdeck' being saved on the user's private disk. A third parameter will erase the input deck(s) that have been read into the system prior to processing.

Another command permits a user to specify that a deck that has been stored on his disk is to be used as an input deck. The deck must be placed on the disk through the use of CMS facilities, since no capability exists in LARSFRIS to provide this service.

ccinput [filename filetype]

The parameters designate the "filename" and "filetype" of an input deck that is on user's disk file (A-disk). The

system will locate the deck and use it for input. Another parameter, 'cards', redesignates input to be accepted from the card reader.

The last command specifies that an input deck is to be submitted for execution under control of the LARSFRIS "batch facility".

batch

By entering this command, the user transfers control of an input deck and processing to the computer room to be part of the "batch" job processing operations. The deck will be executed when system resources are available, and the user's output will be provided at his printer (or punch) device when the run is completed (unless another site has previously been specified).

Modes of Operation

LARSFRIS provides three modes of operation to permit users to make the best utilization of their time and of the system's resources. These three modes have all been introduced earlier in this section in the descriptions of Control Commands. Section 3 of this manual provides practical examples of how the system is operated in each mode. The material that follows provides additional information.

- Interactive Mode

  When the user issues the 'run larsys' command, the system enters the Interactive Mode, and processing of the input deck will begin. If errors are detected, the system will issue appropriate messages to request the user to enter corrections directly from the typewriter terminal. After functional processing begins, the system will issue information messages at certain intervals to inform the user of progress. Upon completion of processing of the input deck, a message will be issued, and the keyboard will be unlocked to await the next command.

- Disconnect Mode

  After interactive processing has begun, the user may enter the 'disconnect' command to free himself of further attention to the requested processing. Functional processing will continue, but the terminal will be "disconnected" for this particular session and will be available to another user.

- Batch Mode

  The user may submit an input deck to be executed in a special batch virtual machine as time and resources are available. After reading in the input deck, the 'batch' command is issued, and the deck is transferred out of the

user's virtual machine for batch processing. An alternative procedure allows the user to submit card decks (preceded by special BATCH control cards) directly through a card reader. The disposition of output is the same as for the other two modes.

The mode of operation selected has no effect on the manner in which Processing Functions are executed, but the capabilities available to the user are restricted to some extent.

For example, some errors encountered in the Interactive Mode may be corrected at the terminal, but these same errors terminate processing in the Batch Mode. This may sometimes be avoided by proper use of the Disconnect Mode. The system issues a message that processing has begun after the input deck has been accepted. At this point, the user can enter the Disconnect Mode and be reasonably certain his requested processing will be successfully completed.

Messages

LARSFRIS issues two types of messages, information messages and error messages. Information messages apprise the user of system actions, inform him of the progress of his processing, etc. Error messages describe abnormal conditions that will terminate the processing unless action can be taken to avoid it.

In many cases, error messages are issued as the processing is being abnormally terminated to inform the user of the reason for the termination.

The form of the two types of messages is similar. Each type has an identification number, followed by a variable-length message text, followed by the name of the program module that issued the message. This latter piece of information is not normally of much value to the user, but it can be quite useful to the programming staff when they are investigating the reasons for abnormal terminations.

The information message format is illustrated by a typical message below:

```
I0092 PICTUREPRINT FUNCTION WAS REQUESTED...        (PICSUP)
```

The identification number at the left starts with an "I" indicating that this is an information message. The four-digit number that follows the "I" is the message number. It may be used to refer to the message list in Appendix III to obtain more detailed explanation of the message. This is not necessary in this case since the text that follows merely states that the Pictureprint function has been requested. This is the type of message that will be issued each time a function begins execution. To the right of the message text is the name of the

program module that issued the message. In this case it is PICSUP, the supervisor for the Pictureprint function.

A typical error message is shown below:

E446 SYNTAX ERROR IN GROUP CARD - TYPE CORRECT CARD (PRIRDR)

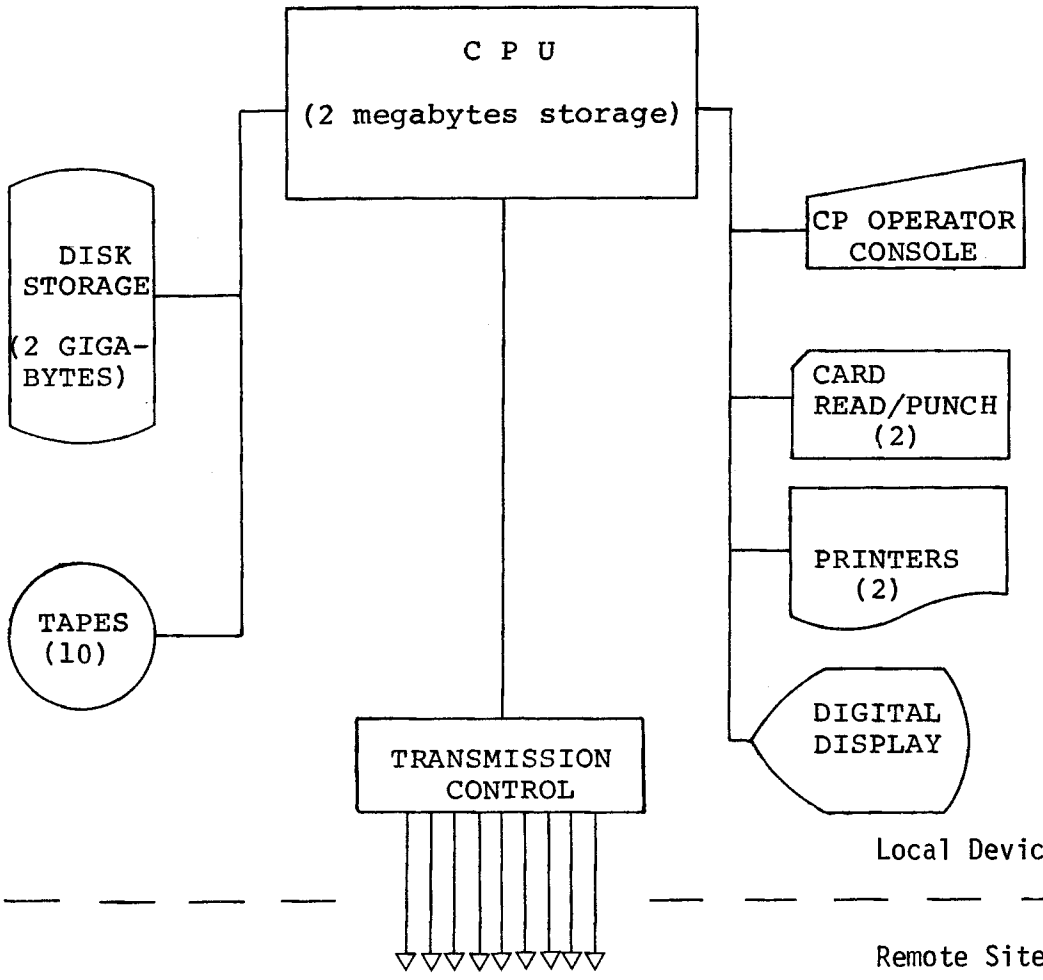
The form of this message is similar to the information message, but a letter "E" prefix indicates that this is an error message, and the message number is a three-digit number. The text in this case explains that the GROUP control card has a syntax error, and instructs the user to type in a correct card. The typewriter keyboard would unlock at this point, and the user would enter the corrected GROUP card in card image format. As in the case of the information message, the name of the program module that issued the message (PRIRDR) is given to the right of the text.

2.5 THE COMPUTER ENVIRONMENT

LARSFRIS is designed to be implemented on a terminal-oriented data processing system. Presently (September, 1980), the computer equipment chosen for LARSFRIS installation consists of an IBM 3031 running under VM/CMS370 and a number of subordinate devices that are used to read and store input data and to output the results of processing. This system of computer equipment is controlled by two special control programs: VM release 6 and the Conversational Monitor System (CMS). The control programs combine with the computer equipment to create the computing system environment. In this section, general characteristics of the environment will be discussed without regard to whether they are implemented by the equipment, the control programs, or both. More detailed information is provided in the LARSFRIS System Manual.

The machine configuration is shown in Figure 2-5. It consists of three main parts:

- Central Processing Unit (CPU)
- Local Devices
- Remote Devices



DEDICATED →
1. Flex 1, LARS
2. Flex 2, LARS
3. Johnson Space Center, Houston, Texas
4. Environmental Research Institute of Michigan Ann Arbor, Michigan
5. ISURSL, Terre Haute, Indiana
6. ACARS, Huntsville, Alabama

DIAL-UP →
7. Ball State University, Muncie, Indiana
8. University of California at Riverside, Riverside, California
9. University of Northern Iowa, Cedar Falls, Iowa

Figure 2.5 Machine Configuration

Central Processing Unit

The Central Processing Unit (CPU) and control programs are the heart of the data processing system. They perform all functional processing and establish the operating environment for the LARSFRIS system. This environment is characterized by:

On-Line Operation

The LARSFRIS user terminals are connected directly to the system (CPU) while a job is being executed. Through his terminals, a user can initiate a job interactively, control the processing (and correct input errors), and receive the results of processing, even though the terminals are a considerable distance from the computer.

Time Sharing

In LARSFRIS, several users may have access to the system at the same time. The system interleaves the operations among the users, so that each receives a fixed "slice" of the CPU time available. When control is transferred to a user's job, the CPU is totally dedicated to that job for an allotted time (or until he no longer needs it). The frequency of time slices is such that the user is not normally aware of the presence of other users, and it will often appear to him that he is the only user of the system. This capability

makes it economically possible for the individual user at a remote terminal to have the power of a large computer system at his disposal.

Virtual Machines

A primary characteristic of VM/CMS370 is the existence of "virtual machines". This feature, in conjunction with the related "virtual storage" feature, enables each user to run his own version of LARSFRIS in what appears to be his own machine configuration. The main advantages to the user are that he is isolated from the processing errors of other users, and that the external operation of LARSFRIS is greatly simplified for him. The benefits are better utilization of the system through dynamic allocation of its resources, and simplification of the task of designing and programming the processing functions for a multiple-user, time-sharing system such as LARSFRIS. More is said about virtual machines later in this section.

Besides these major capabilities, the CPU also performs or controls all of the standard machine operations required in a computer. This includes such activities as activating devices, reading inputs, transferring data, error checking, storage allocation, writing outputs, and accounting for utilization.

The CPU has certain performance characteristics that are of interest. Its main storage capacity is 2 Megabytes of information (alphabetic character, numbers and symbols). Internally, a byte consists of eight binary digits (bits). Bytes are grouped in "halfwords" of two bytes and "fullwords" of four bytes, either of which can be used to store integers and perform integer arithmetic. The range of integer values that can be processed by the CPU is $\pm$32,767 for halfwards and $\pm$2,147,483,647 for fullwords.

Computations that require a wider range of numbers or employ fractions, use another CPU facility called the "floating point instruction set", which represents numbers internally as fractions and exponents. The possible range of values is approximately 10^{-78} through 10^{75}, with precision depending on whether one or two fullwords are used. For one fullword, precision is approximately 16 decimal digits.

Attached to the CPU are local and remote devices. The local devices provide the central facility for data input and output and support the system's processing. The remote devices provide the user with access to the system and output from it.

Local Devices

The local devices, shown in Figure 2-5 consist of three types of functional units:

Magnetic Storage Devices:

tapes, disks, and a drum

"Hard Copy" Devices:

card reader/punches, printers, and the console typewriter.

Digital Display Device:

Unique capability in the computer room to support the LARSYS Imagedisplay function

The magnetic tape units are a basic input device for LARSFRIS since many of the 23 processing functions require a Multispectral Image Storage Tape as input. The magnetic disk storage device is used extensively by LARSFRIS but in a manner that generally is transparent to the user. The user's private, permanent, storage space (his A-disk) resides on one of these magnetic disks. The magnetic drum unit is used exclusively by the system to support the operations required for the time-sharing and virtual machine capabilities.

The hard copy devices provide punched card input and output and printed output.

The digital display in the computer room is the only device of its type in the system. This unit is required to execute the Imagedisplay function available only in LARSYS.

All of the local devices are the responsibility of the system operator in the computer room and he uses one of these, the console typewriter, to control and communicate with the system. The message facility in LARSFRIS provides a means of communication between the user's typewriter terminals and the operator's console typewriter.

Remote Devices

The remote devices consist of typewriter terminals, printers/plotters, and combination card reader/punches. At present (September, 1980) remote terminal devices are installed at nine sites. Dedicated remote terminal sites are Purdue/LARS Flex 1; and Flex 2; Johnson Space Center, Houston, Texas; Environmental Research Institute of Michigan, Ann Arbor, Michigan; Indiana State University Remote Sensing Lab, Terre Haute, Indiana; And Alabama Center for Application of Remote Sensing, Alabama A & M University, Huntsville, Alabama. Currently there are three remote sites with dial-up capabilities; Ball State University, Muncie, Indiana; University of California at Riverside, California; and University of Northern Iowa, Cedar Falls, Iowa.

Virtual Machines

The virtual machine concept implements techniques for managing the total resources of a single computer system in such a way that multiple systems - one for each user - appear to exist. This results in much better utilization of the computer equipment and greatly simplifies the implementation of a multiple-user software system such as LARFRIS.

To the LARSFRIS user, employment of the virtual machine approach means that he runs his own copy of LARSFRIS on his own configuration of a virutal machine. As far as he is concerned, he is the only user of a complete computer system that consists of:

- A system console
- A card reader, card punch, and printer
- Three tape drives
- Three disk drives.

The total LARSFRIS virtual machine configuration is shown in Figure 2-6. The machines in a virutal system do not necessarily exist as real devices. They must be translated (or "mapped") into the real machines. The way that this is done with each unit in the LARSFRIS cofiguration is summarized below.

The Virtual Console

The system console for the LARSFRIS user is his typewriter terminal. It is used to initiate and control his LARSFRIS system and to receive informational and error messages.

The Virtual Card Reader, Card Punch and Printer

During the course of a LARSFRIS terminal session, these devices are represented by files on the disk storage devices at the computer room. If the user has cards to read, he submits them from one of the real card readers. The cards are read by the system and stored on a disk file. The LARSFRIS processing function will then use them from the disk file when it needs them, although it will appear to be reading them from a card reader. This technique provides much better utilization of the actual equipment and improves the speed of LARSFRIS execution.

Cards to be punched or lines to be printed are treated the same way. During the terminal session, they are accumulated (in card or printer line form) on a disk file. When the

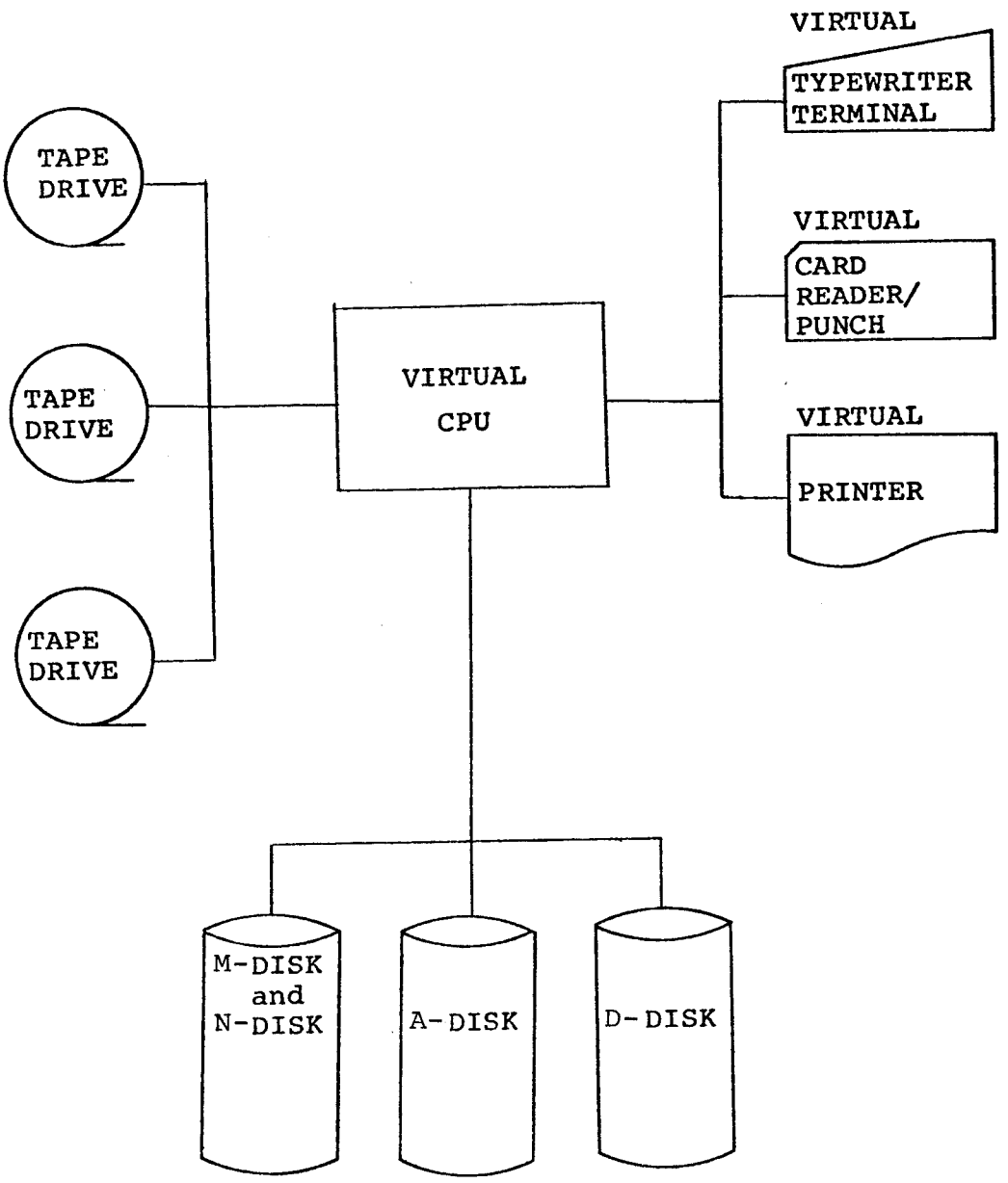


Figure 2-6. LARSFRIS Virtual Machine Configuration

user ends his terminal session, the control program copies the outputs from the disk file onto the appropriate actual device - the card punch and printer at the remote site or in the computer room.

Virtual Tape Drives

Virtual tape drives must correspond one-for-one with actual tape drives in the computer room, i.e., there must be one actual tape drive reserved for every virtual tape drive being used during LARSYS processing. The LARSFRIS virtual machine configuration includes three tape drives; however, none of the present LARSFRIS processors require more than two drives, and most of them no more than one. Tape drives are attached to the virtual machine only when actually required for processing.

Virtual Disk Drives

There are three virtual disk drives in the standard LARSFRIS configuration. Each is translated by the control program into a portion of an actual disk drive. The use of these disk drives is summarized below.

- M-disk & N-disk - All LARSFRIS users share access to a combination that contains the LARSFRIS

processing functions, and necessary system programs. The user's access is limited to reading only, since this information is shared by all users.

- A-disk - This disk provides the user with his own permanent storage. It is normally used to save Statistics or Histogram Files.

- D-disk - This disk provides space to store intermediate results during a terminal session. It is a "scratch pad" area that expands to meet the user's requirements during processing of LARSFRIS functions. The D-disk is always erased after a terminal session. The user will have about five millon bytes of storage available to him on this disk.

SECTION 3

OPERATING LARSFRIS

SECTION 3

OPERATING LARSFRIS

This section provides the step-by-step instructions for controlling and executing the LARSFRIS functions. It is assumed that the reader has a good understanding of the concepts presented in the previous section.

Emphasis is placed on the sequence of actions and controls required to operate the typewriter terminal, and to successfully execute Processing Functions, System Initialization Functions and System Control Commands. An example input deck that executes two LARSFRIS Processing Functions is used throughout the section to illustrate the various operating procedures. This particular input deck was chosen for illustration, and this section is not intended to describe the use of the two functions.

The seven subsections that follow address the following topics:

- 3-1 A description of the input deck that will be used to illustrate the operating procedures.
- 3-2 The First Procedure describes how to activate the typewriter terminal, initiate the LARSFRIS system, and use the system to check the input deck for control card errors.

3-3 Describes how to execute the input deck in the Interactive Mode.

3-4 Describes a slightly more complex illustration of the Interactive Mode. System Support Commands and System Initialization Functions are used, and interactive error correction is illustrated.

3-5 Describes how to execute the input deck in the Disconnect Mode.

3-6 The input deck is submitted to the system for execution in the Batch Mode. The normal procedure, which uses the typewriter terminal, is described here.

3-7 The last subsection describes how to use only the card reader to submit the input deck for batch mode execution.

Although the reader can become acquainted with the operation of LARSFRIS by studying this section, it is recommended that the operations actually be performed at the terminal. This will give the reader a better "feel" for the system.

The runs in the section should be duplicated and performed in the same sequence as they are illustrated, so that the illustrations can be used as a guide. Certain steps are intentionally repeated in each procedure to provide experience in the basic actions and enable the user to more quickly concentrate on LARSFRIS as a tool for data analysis.

3.1 THE INPUT DECK

Figure 1 illustrates the input deck used in this section to illustrate each of the operating procedures. The Control cards for the Classifypoints and Printresults processing functions will be entered in a single input deck. This will cause the execution of PRINTRESULTS to follow that of CLASSIFYPOINTS without user intervention. The processing that is specified by these control cards is briefly described below. Samples of the outputs produced by the execution of this input deck are in Appendix V and a reference list of the outputs is given at the end of this subsection.

The first card in the input deck is the user identification card. It contains the letters "ID" in the first two columns of the card, and the user's identification starting in column ten. This card is always required and it must always be the first card in the deck. It will cause the entire deck of cards that follow it to be placed in the virtual reader of the user's virtual machine. In the example input deck (Figure 1) the user identification is "DEMO". This is the name of the virtual machine on which examples for this section were run.

The portion of the input deck that relates to the Classifypoints function contains three function control cards, two DATA control cards and their associated "data", and an END card to mark the

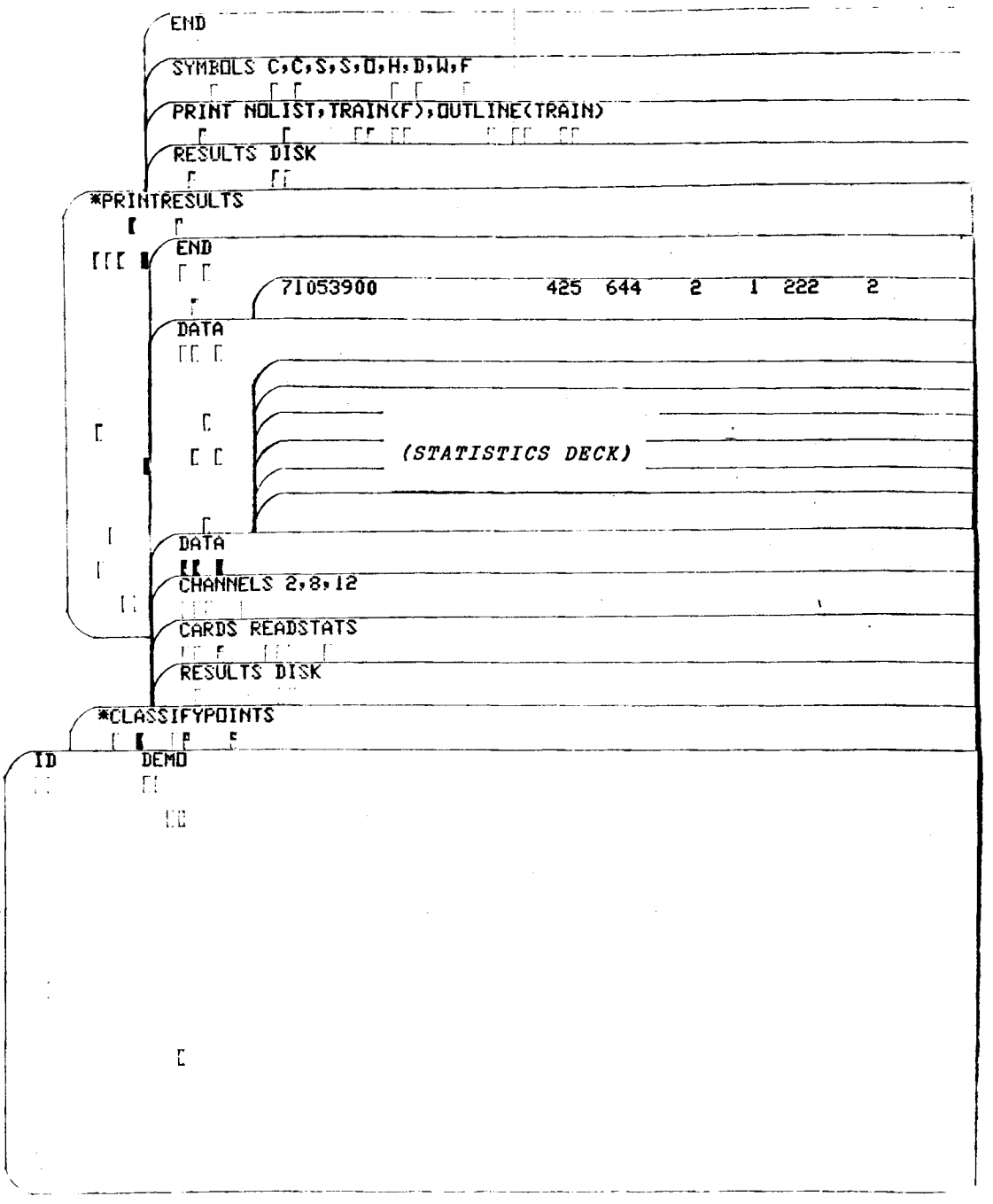


Figure 3-1. The Input Deck for the Examples in Section 3.

end of input to the function. The first three control cards specify that the output Classification Results File is to be placed on disk, that the Statistics File is included in punched card form in the input deck, and that the function is to use data from channels 2, 8 and 12. These cards are followed by the statistics data cards (this is a copy of the Statistics File generated by the second example in the STATISTICS description in Section 6). Next a single Field Description Card that defines the area to be classified is included. In this case every other column from column 1 to column 222 in every other line from line 425 to line 644 will be classified.

The portion of the input deck that relates to the Printresults function consists of four control cards, the last of these being the END card that is always required at the end of the cards for each function. The other three control cards specify that the input Classification Results File is located on disk, the selection of three print options, and the specific symbols that are to be used on the Classification Map to represent each of the nine classes on the Classification Results File. The three print options specify that a listing of saved training fields is not to be printed, that Training Field Performance Tables are to be printed, and that training fields are to be outlined on the Classification Map.

Appendix V contains eight sample outputs that were obtained from the execution of this input deck. They are:

From CLASSIFYPOINTS:

From PRINTRESULTS:

Other:

3.2 INPUT DECK CHECKOUT

The Checkout Initialization function of LARSFRIS is provided to detect errors in a user's input deck before it is used to request processing. The deck is read and analyzed, but the Processing Functions are not executed.

CHECKOUT is always performed in the Interactive Mode. Therefore this subsection will first present the basic procedures for operating LARSFRIS and then illustrate the Checkout function. The following sequence of actions will be covered:

- Prepare the input deck and read it into the system.
- Start an interactive session at the typewriter terminal.
- Analyze the messages received at the terminal and correct errors encountered by the Checkout function.
- Re-run the corrected input deck.
- End the interactive session.

The procedure employed to accomplish these actions consists of individual steps which are numbered. Related steps are grouped under headings to identify their general purpose. Explanations are given as necessary to assist the user in understanding what he is doing and what the system does as a result.

Prepare the Input Deck

1. Punch the input deck as shown in Figure 3-2.

   Note that the Checkout card immediately follows the ID card and that the sample deck has been altered to include two control card errors. The 'CRDS READSTATS' control card for CLASSIFYPOINTS has the keyword misspelled, and the 'RESULTS' control card for PRINTRESULTS is an incomplete entry. (Compare these two cards with the correct form shown in Figure 3-1.)

2. Check the deck for accuracy and proper sequence.

Read the Input Deck into the System

It is assumed that the user knows the basic operation of the card reader at his location. Documentation or assistance should be available locally. The operation of the various types of card reader units is beyond the scope of this manual.

3. Place the deck in the hopper, and press the appropriate control buttons to activate the unit and read the cards.

The cards have been read into the system, and the user is now ready to use the typewriter terminal. It is assumed that the terminal has power on, is attached to the system, and that paper is in the typewriter.

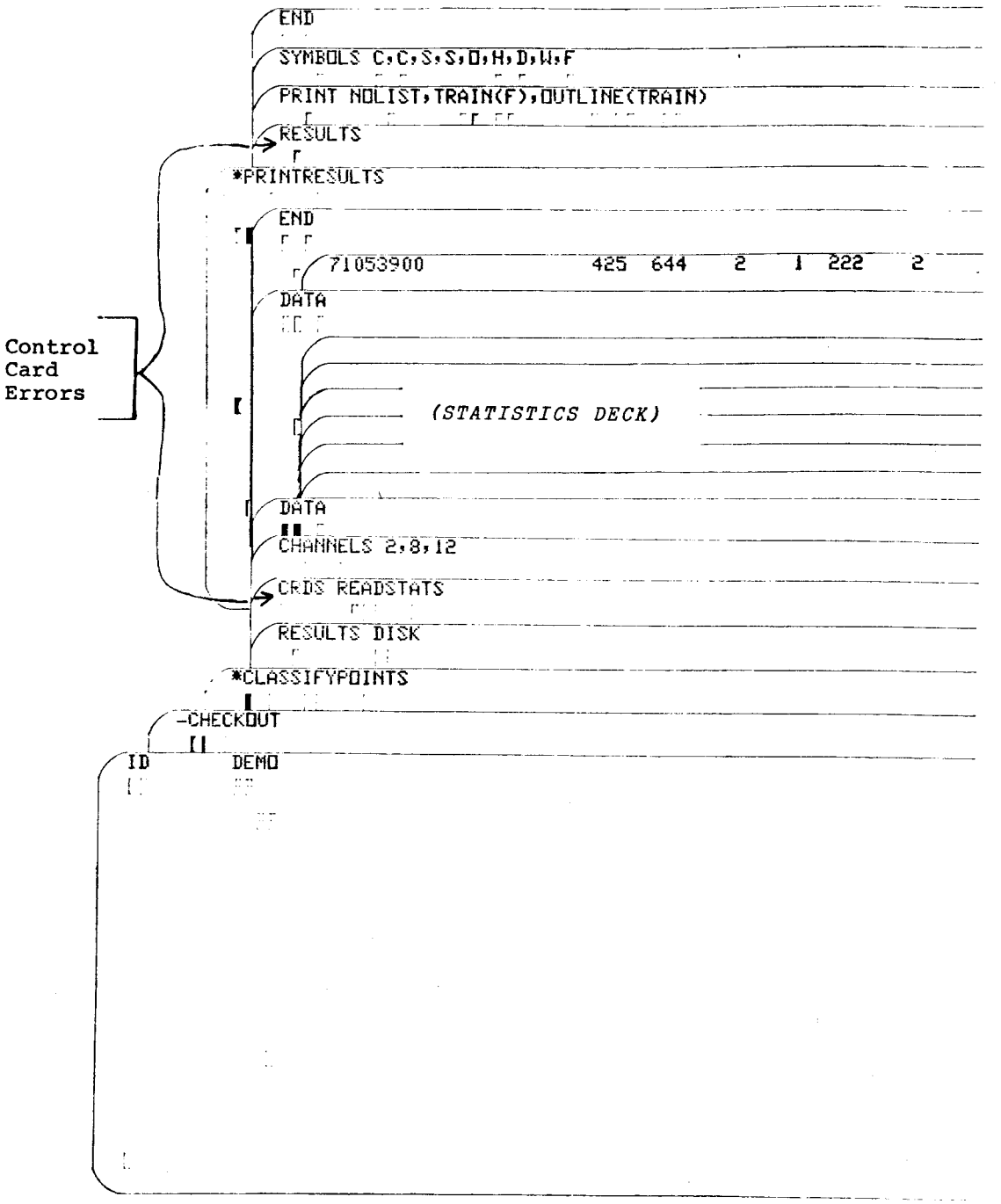


Figure 3-2. The Input Deck for the Control Card Checkout Example

Log In to the System

4. Press the Attention key on the typewriter terminal keyboard once.

   This action unlocks the keyboard, and readies it for use.

The full typewriter terminal sheet for this checkout run is shown in Figure 3-3 on the following page. Each line from the sheet will be repeated in the narrative as it is described.

5. Type the login command, a space, and the appropriate user identification (userid) in lower-case characters. Then press Carriage Return (a "[CR]" indicates a carriage return in this manual).

   login demo [CR]

   The system will respond with a request for the user's password. (Note that the system types in capital letters.)

   ENTER PASSWORD
   ****

```
login demo
ENTER PASSWORD:
********
ENTER NAME:phillips
YOUR OPERATORS ARE ROGER MYERS AND PERRY THAYER.
NEXT SCHEDULED SHUTDOWN 1700 SATURDAY
FILES:- 01 RDR, NO PRT, NO PUN
READY AT 09.37.56 ON 03/02/73
CP
i larsys
LARSYS (Ver 3) READY;

T=0.42/0.83 09.38.20
run larsys
EXECUTION BEGINS...

 I0196  RUNNING CONTROL CARD CHECKOUT     (LARSMN)
 I0112  CLASSIFYPOINTS FUNCTION REQUESTED     (CLASUP)
     CRDS READSTATS
  E102  INVALID KEYWORD - TYPE CORRECT CARD     (CTLWRD)
cards readstats
 I0032  REDUCED STATISTICS COMPUTED.     (REDSAV)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ     (CLAINT)
 I0040  CLASSIFYPOINTS FUNCTION COMPLETED     (CLASUP)

 I0196  RUNNING CONTROL CARD CHECKOUT     (LARSMN)
 I0113  PRINTRESULTS FUNCTION REQUESTED     (PRISUP)

  E456  INCOMPLETE RESULTS INFORMATION GIVEN - TYPE ADDITIONAL RESULTS CARD
results disk
 I0071  PRINTRESULTS FUNCTION COMPLETED     (PRISUP)
 I0004  END OF INPUT DECK - RUN COMPLETED     (LARSMN)
T=3.36/4.96 09.40.03
```

Figure 3-3. Typewriter Terminal Sheet for the Input Deck Checkout Example

The second line is an eight-character mask formed by backspacing and re-typing, using different characters. The user will then type his password over the mask, and it will not be legible to unauthorized users. The typing element is backspaced and positioned at the first character of the mask when it is ready to receive the password.

6. Type the password and press Carriage Return.

   The system will respond with a request to enter the user's name.

   ENTER NAME:

7. Type last name on same line and press Carriage Return (do not Carriage Return to attempt to type on a separate line.)

   ENTER NAME:phillips [CR]

   (Note that the name may be up to 8 characters long.)

The system will respond with a series of messages:

- An operators' log message which contains any information that the system operators wish to convey to users.
- A "FILES" message if the user has files in his virtual reader, printer or punch when he logs in.

- A "READY" message giving the present time and date.
- A "CP" message notifying the user that the keyboard is unlocked and he may proceed.

In the sample run made to prepare this example, the following message was received:

```
YOUR OPERATORS ARE ROGER MYERS AND PERRY THAYER.
NEXT SCHEDULED SHUTDOWN 1700 SATURDAY
FILES:- 01 RDR, NO PRT, NO PUN
READY AT 09.37.56 ON 03/02/73
CP
```

The first three lines identify the operators on duty in the computer room and inform the user that the system will shutdown next on Saturday at 5:00 p.m.

The "FILES" message that follows informs the user that a single deck of cards (the input deck) has been read into the user's virtual reader, and that neither the virtual printer nor the virtual punch have an output file waiting in them.

The fourth line states that the virtual machine is ready and gives the time and date the virtual machine was logged in.

While these lines are being typed, the keyboard is locked. After 'CP' is typed, the typing element is positioned at the margin of the next line, and the keyboard is unlocked and ready for the next command.

Initiate LARSFRIS

8. Type the following Control Command:

i larsys [CR]

This command initiates the LARSFRIS system in the user's virtual machine.

The system responds with a ready message and a line of timing information (a T-message):

DEVELOPMENTAL LARSYS IS READY

T=0.42/0.83 09.38.20

The -message gives the amount of virtual and total CPU time that was used since logging in or since the last R-message was typed. The '0.42' is the virtual CPU time, and the '0.83' is the total CPU time, in seconds. The last item on the line is the time of day. This information is useful in determining how much CPU time is used to run the various functions.

Start Interactive Run

9. Enter the following command:

run larsys [CR]

This command initiates the interactive run.

At this time, the system will type 'EXECUTION BEGINS' to inform the user that it has begun to read the input deck from the

virtual reader. The '-CHECKOUT' card is read, and LARSYS recognizes that the deck that follows is to be processed by the Checkout function and not by the Processing Functions named on the Function Selector Cards. It acknowledges this to the user by typing the message:

I0196 RUNNING CONTROL CARD CHECKOUT (LARSMN)

This is followed by the normal information message to identify the selected Processing Function:

I0112 CLASSIFYPOINTS FUNCTION REQUESTED (CLASUP)

Correct First Card Error

When the card with the misspelled keyword is read, the system will type out the entire card and then issue its standard error message for this type of error. These lines appear as follows:

CRDS READSTATS

E102 INVALID KEYWORD - TYPE CORRECT CARD (CTLWRD)

The user responds by typing in the correct card.

10. Type card keywords as follows:

cards readstats [CR]

Note that the whole card must be typed; otherwise, the system will issue another error message.

Although 'CRDS' is obviously a misspelling to the user, the system can only interpret it as a keyword that has not been defined and, thus, is an invalid keyword.

No response is given by the system if the user's entry is correct; the operation merely resumes. Information messages are issued that normally would come in the course of reading cards and setting up CLASSIFYPOINTS for a run. When the CLASSIFYPOINTS END card is read, the normal "function completed" message (I0040 in Figure 3-3) is typed just as if it were a real run.

Correct Second Card Error

When checkout begins for PRINTRESULTS, message I0196 announcing that Control Card Checkout is being run is issued; followed by information message I0113, which identifies the processing function. The erroneous card is then detected, and the following error message is typed:

```
E456  INCOMPLETE RESULTS INFORMATION GIVEN - TYPE
      ADDITIONAL RESULTS CARD
```

The error message is not preceded by a copy of the erroneous card in this case, as it was for the error encountered in the Classifypoints function. This is because of the nature of the error. The prior error clearly involved erroneous information on the card that required correction, while the present error consists of an omission of data and a request by the function for more information.

11. Type complete RESULTS card as follows:

```
results disk                    [CR]
```

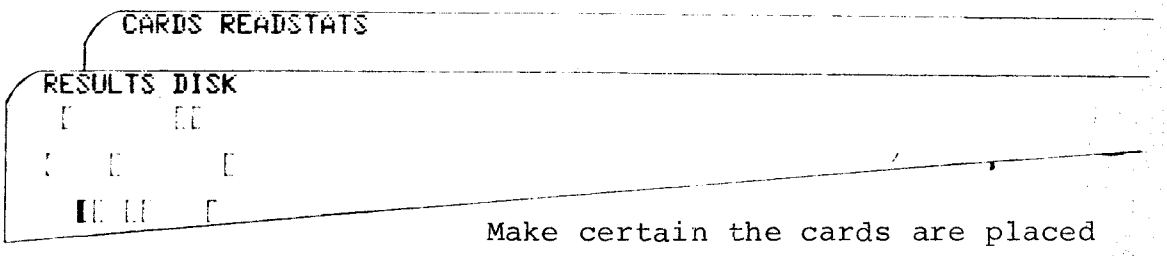
Again, no response is given if the entry is correct.

Checkout resumes with this entry, and information messages are issued as shown in the figure. Message I0004 is issued when the last END card in the deck is read, thus indicating that the run is completed. A T-message is then printed as was explained in step 8. This line also indicates that the user may begin another function and that the system is ready to accept more input and commands.

Correct Input Deck

The errors that were found must next be corrected in the input deck.

12. Punch correction cards and replace erroneous cards.



Make certain the cards are placed in the deck as in Figure 3-1 and that the cards with errors are removed.

Checkout Corrected Input Deck

The corrected deck is run again here to illustrate that the user need not log out of the system to do more processing. Also, he can observe a "clean" checkout. The terminal sheet is shown in Figure 3-4 on the following page.

```
run larsys
** CARDS  XFERED BY FLEXLAB1**
EXECUTION BEGINS...

 I0196  RUNNING CONTROL CARD CHECKOUT     (LARSMN)
 I0112  CLASSIFYPOINTS FUNCTION REQUESTED     (CLASUP)
 I0032  REDUCED STATISTICS COMPUTED.    (REDSAV)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ     (CLAINT)
 I0040  CLASSIFYPOINTS FUNCTION COMPLETED     (CLASUP)

 I0196  RUNNING CONTROL CARD CHECKOUT     (LARSMN)
 I0113  PRINTRESULTS FUNCTION REQUESTED     (PRISUP)
 I0071  PRINTRESULTS FUNCTION COMPLETED     (PRISUP)
 I0004  END OF INPUT DECK - RUN COMPLETED     (LARSMN)
T=2.76/4.40 09.42.20
quit
CONNECT= 00:04:39  VIRTCPU= 000:06.96  TOTCPU= 000:10.76
LOGOUT AT 09.42.30 ON 03/02/73
```

Figure 3.4. Typewriter Terminal Sheet for an Error-free Control Card Checkout Example

13. Read corrected input deck into system.

    This is the same as step 3.

14. Enter command to perform checkout.

    run larsys [CR]

    This is the same command as was used in step 9.

    The 'run larsys' command initiates another interactive run. However, in this case, the user is already logged into the system, so instead of the virtual devices message (see step 7), the following message is issued:

    CARDS TRANSFERRED BY FLEXLAB1

    This acknowledges the action of step 13. FLEXLAB1 is the name of the card read/punch/printer in Flexlab 1 at LARS where the cards were read and transferred to the user's virtual reader.

When the T-message is printed, the last command may be entered.

End Session

15. Log off the system by the following entry:

    quit [CR]

    The system responds to the 'quit' command with two lines as shown at the bottom of Figure 3-4. 'CONNECT' indicates the time in hours, minutes and seconds that the virtual

machine was in operation (attached to the real machine). 'VIRTCPU' is the utilization time of the virtual CPU in minutes and seconds (to hundredths of seconds). 'TOTCPU' is the utilization time of the real CPU. The last line is the logout time and date.

At this point, the user should understand how to do the following actions in operating LARSFRIS:

a. Punch and correctly organize an input deck.

b. Read an input deck into the system.

c. Log in to the system.

d. Initiate LARSFRIS for his virtual machine.

e. Start a LARSFRIS processing run.

f. Enter commands and correct errors at a typewriter terminal.

g. Start a second run in the same session.

h. Log out of the system.

This is the basic knowledge that is required to operate LARSFRIS in the Interactive Mode. In the next sample run, the checkout option is removed, and an actual run of CLASSIFYPOINTS and PRINTRESULTS is performed.

3.3 SIMPLE INTERACTIVE SESSION

The user actions are the same for a simple interactive session as they were for the input deck checkout in the previous subsection. The difference here is that processing will be performed and, as a result, additional messages will be typed at the terminal. The user will remove the '-CHECKOUT' card from the deck, then follow the same procedure.

Since the actions are the same, the first few steps will be combined under the term "Standard Interactive Sequence" for purposes of this section and will include:

	From Section 3.2
Read the input deck.	(Steps 1 to 3)
Login at the terminal.	(Steps 4 to 7)
Initiate LARSYS.	(Step 8)

This sequence will be employed in this and the next three examples.

Figure 3-5 on the following page shows the typewriter terminal sheet for this interactive session. The explanation below will refer to lines and items in the figure.

Check Input Deck

1. Make certain this is the correct input deck and that the '-CHECKOUT' card has been removed.

   It is always good practice to check through a deck before using it.

```
login demo
ENTER PASSWORD:
********
ENTER NAME:phillips
YOUR OPERATORS ARE ROGER MYERS AND PERRY THAYER.
NEXT SCHEDULED SHUTDOWN 1700 SATURDAY
FILES:- 01 RDR, NO PRT, NO PUN
READY AT 09.44.27 ON 03/02/73
CP
i larsys
LARSYS (Ver 3) READY;

T=0.41/0.80 09.44.54
run larsys
EXECUTION BEGINS...

 I0112  CLASSIFYPOINTS FUNCTION REQUESTED     (CLASUP)
 I0032  REDUCED STATISTICS COMPUTED.     (REDSAV)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ     (CLAINT)
 I0002  TAPE     1005 HAS BEEN REQUESTED ON UNIT 0181   (MOUNT)
DEV  181 ATTACHED
 I0003  TAPE READY...EXECUTION CONTINUING     (MOUNT)
 I0035  SEARCHING FOR RUN 71053900     (GADRUN)
 I0036  DESIRED RUN FOUND ... 71053900     (GADRUN)
 I0049    100 OUT OF     110 LINES ARE CLASSIFIED     (CLSFY2)
 I0040  CLASSIFYPOINTS FUNCTION COMPLETED     (CLASUP)

DEV  181 DETACHED
 I0113  PRINTRESULTS FUNCTION REQUESTED     (PRISUP)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ     (PRIINT)
 I0079    100 LINES DISPLAYED.     (DISPLY)
 I0071  PRINTRESULTS FUNCTION COMPLETED     (PRISUP)
 I0004  END OF INPUT DECK - RUN COMPLETED     (LARSMN)
T=68.88/74.02 09.51.30
quit
CONNECT= 00:07:42  VIRTCPU= 001:09.63  TOTCPU= 001:15.30
LOGOUT AT 09.52.01 ON 03/02/73
```

Figure 3-5. Typewriter Terminal Sheet for a Simple Interactive Execution of the Input Deck

Standard Interactive Sequence

2. Do steps 1 through 8 and wait for the first T-message. The system is ready for the first LARSFRIS Control Command.

Invoke Interactive Processing

3. Type:

run larsys [CR]

This is the last user action required for this run before logging out.

Information messages, as illustrated in Figure 3-5, will begin to be typed. After 'EXECUTION BEGINS...' is typed, the next three messages are the same as those issued during Input Deck Checkout.

The first new message is I0002. It indicates that the system operator has received a message on his console terminal to mount Tape 1005 on Tape Unit 181 in the computer room. The system determined from the System Runtable that Run 71053900 (which the user specified in the input deck) is on Tape 1005, and the request was issued automatically.

The next line is a system response message to inform the user that the operator has taken the necessary actions to attach this tape unit to the user's virtual machine. Next, an information message (I0003) is typed by the system to indicate that the

operator found the tape, mounted it, and initiated operation of the unit. CLASSIFYPOINTS then resumes processing. When the function locates the requested run, the user is notified by a message (I0036). Next to appear on the sheet is a progress message (I0049) informing the user that 100 lines have been classified. This message will be repeated each 100 lines until the classification is complete.

Following the completion of CLASSIFYPOINTS (message I0040), the system checks to determine whether or not the next function in the user's input deck requires tape unit 181. When it finds that the unit is not needed, it automatically detaches it from his virtual machine and issues a message to the user informing him of this action.

The next series of messages apply to PRINTRESULTS. The function selection message (I0113) is followed by a message informing the user that all control and data cards have been read (I0034). Actual processing begins at this point and a Printresults progress message (I0079) is issued after the first 100 lines have been displayed. The last Printresults message is the completion message (I0071).

At this point the printer will begin producing the output listings from both functions. Samples of this output is shown in Appendix V, Figures V-1 through V-7. The last two lines are the run completion message and the T-message. The

keyboard is now unlocked.

End Session

4. Type:

quit [CR]

The user is logged out, and the standard message lines are typed. Note that the printer will continue to print output even though the user has logged out. This permits another terminal session to be started if large volumes of print-out are being produced from a previous run.

3.4 INTERACTIVE SESSION WITH OPTIONAL ACTIONS

This subsection describes a slightly more complicated interactive session by including the use of Initialization Functions and LARSFRIS Control Commands. The Initialization Functions will be used to add a "comments" line below the two standard header lines on all printed output and to identify a private Multispectral Image Storage Tape that is not cataloged in the system.

Two Control Commands will be used prior to execution of the processing functions. The first of these will request a copy of the control card listing for the Initialization Functions. The second will direct the printed output to a different site. A third command will be used after execution of the processing functions is ended. It will request that the Statistics File used for the run be saved on the user's private disk.

Figures 3-6 and 3-7, on the following pages, are, respectively, the input deck to be used and the typewriter terminal sheet that results from the run.

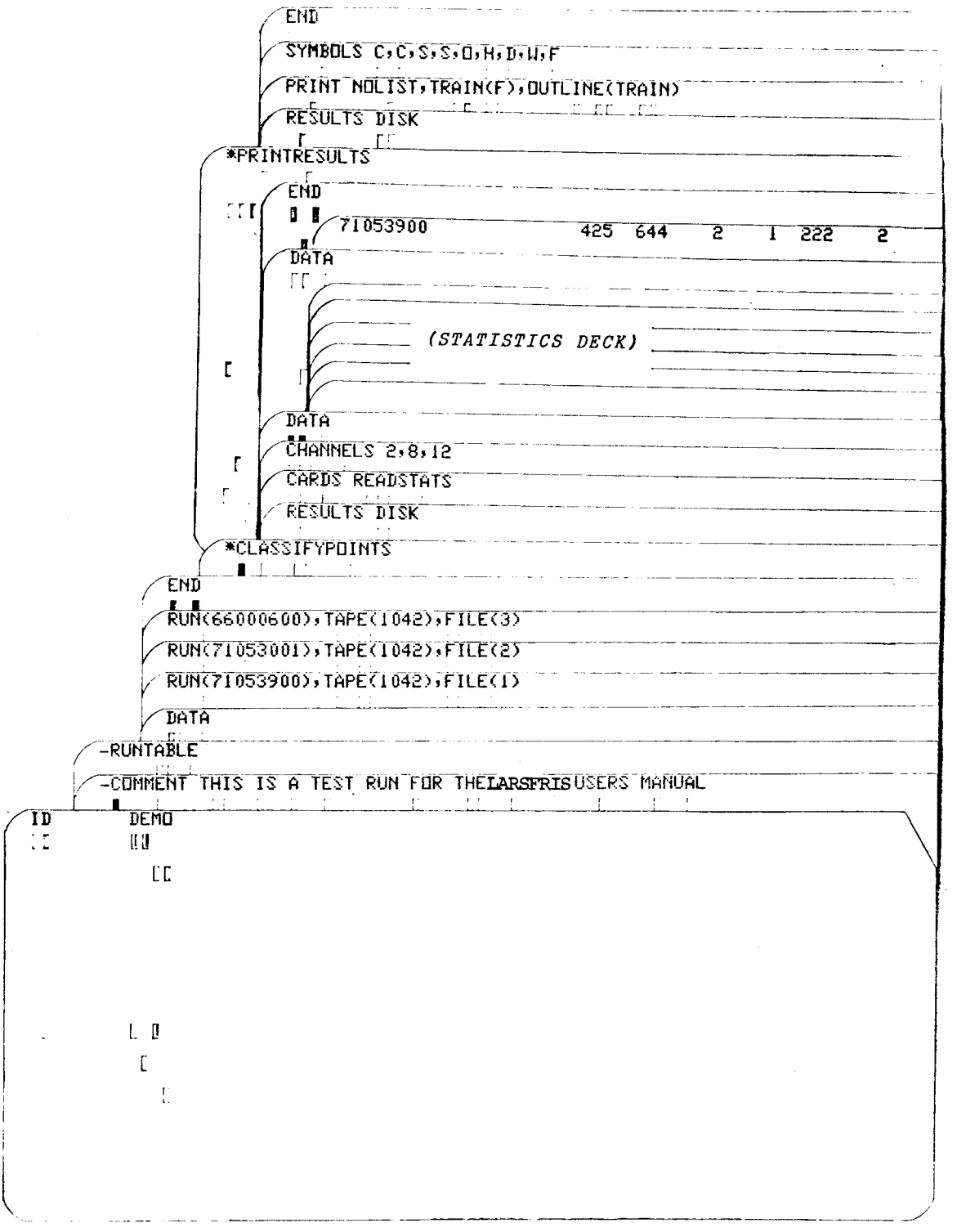


Figure 3-6. The Input Deck with System Initialization Cards Included

```
login demo
ENTER PASSWORD:
********
ENTER NAME:phillips
YOUR OPERATORS ARE ROGER MYERS AND PERRY THAYER.
NEXT SCHEDULED SHUTDOWN 1700 SATURDAY
FILES:- 01 RDR, NO PRT, NO PUN
READY AT 10.15.41 ON 03/02/73
CP
i larsys
LARSYS (Ver 3) READY;

T=0.41/0.86 10.16.15
reference initialization
T=0.87/1.30 10.16.40
print flexlab2
T=0.69/0.93 10.16.59
run larsys
EXECUTION BEGINS...
      -RUTNABLE
  E102  INVALID KEYWORD - TYPE CORRECT CARD     (CTLWRD)
-runtable

 I0112  CLASSIFYPOINTS FUNCTION REQUESTED     (CLASUP)
 I0032  REDUCED STATISTICS COMPUTED.     (REDSAV)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ     (CLAINT)
 I0002  TAPE     1042 HAS BEEN REQUESTED ON UNIT 0181   (MOUNT)
DEV  181 ATTACHED
 I0003  TAPE READY...EXECUTION CONTINUING     (MOUNT)
 I0036  DESIRED RUN FOUND ... 71053900     (GADRUN)
 I0049    100 OUT OF    110 LINES ARE CLASSIFIED     (CLSFY2)
 I0040  CLASSIFYPOINTS FUNCTION COMPLETED     (CLASUP)

DEV  181 DETACHED
 I0113  PRINTRESULTS FUNCTION REQUESTED     (PRISUP)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ     (PRIINT)
 I0079    100 LINES DISPLAYED.     (DISPLY)
 I0071  PRINTRESULTS FUNCTION COMPLETED     (PRISUP)
 I0004  END OF INPUT DECK - RUN COMPLETED     (LARSMN)
T=69.43/75.12 10.23.04
statdeck save
T=0.85/1.16 10.23.45 4
quit
CONNECT= 00:08:17  VIRTCPU= 001:12.60  TOTCPU= 001:18.95
LOGOUT AT 10.23.53 ON 03/02/73
```

Figure 3-7. An interactive Execution of the Input Deck with the Use of System Support Commands and System

Punch Initialization Cards

1. Punch the following card (begin in column 1):

```
-COMMENT THIS IS A TEST RUN FOR THE LARSFRIS USERS MANUAL
```

A comment line may be up to 64 character spaces long.

2. Punch the following six cards:

```
END
RUN(66000600),TAPE(1042),FILE(3)
RUN(71053001),TAPE(1042),FILE(2)
RUN(71053900),TAPE(1042),FILE(1)
DATA
-RUNTABLE
```

The first card (-RUNTABLE) will be misspelled as "-RUTNABLE" in our example in order to illustrate interactive correction of Control and System Initialization Cards.

The -RUNTABLE card (when it has been corrected) will invoke the Runtable Initialization function which enables the user to identify private Multispectral Image Storage Tapes for LARSFRIS.

This will give the system the information it needs to request that the appropriate tape be mounted when it is needed. The second card in the group, the DATA card, is required to inform LARSFRIS that data cards, and not control cards, are to follow. The three data cards that follow are Run Identification Cards that specify the run number, tape number and file number for three private tapes. The tapes are not permanently defined by this action. They are construed as temporary tapes to be used only while this input deck is being executed. The last card in the group is the END card that is required at the end of the data cards. Figure V-8 in Appendix V shows the printed output the system produces when it processes the Runtable cards.

3. Place the seven Initialization cards behind the ID card in the input deck, as shown in Figure 3-6.

Standard Interactive Sequence

4. Do steps 1 through 8 (see Section 3.2) and wait for the first T-message.

Request Initialization Card List

5. Type the following Control Command:

   reference initialization [CR]

   The printer will begin printing the reference listing of the Initialization function cards, the R-message will be typed, and the keyboard will unlock. See the Initialization Functions control card listing in Appendix II for an example of the printer output.

Request Printer Output at an Alternate Site

6. Type the following Control Command:

```
print flexlab2                    [CR]
```

The system responds with a R-message to indicate the request is accepted. This particular command is useful if the user wants the output to be printed at another site.

Invoke Interactive Processing

7. Type the 'run' command:

```
run larsys                        [CR]
```

The system messages begin (see Figure 3-7).

Correct Error Interactively

After the 'EXECUTION BEGINS...' message is typed, LARSFRIS will begin to read the cards from the virtual card reader. The system will detect the error in the second card in the deck and will type the erroneous card and the appropriate error message:

```
-RUTNABLE
E102  INVALID KEYWORD - TYPE CORRECT CARD      (CTLWRD)
  [typing element returns to margin at next line]
```

The keyboard will unlock and the system will wait for the user to enter the correction.

8. Type the complete card with the proper spelling:

```
-runtable                         [CR]
```

The hyphen must precede the word to

identify the entry as an Initialization Function keyword.

The only indication of acceptance is that the keyboard locks and the error message is not re-issued.

The same information messages that were typed in the previous examples can be seen in Figure 3-7. When the run is completed and the T-message is typed, the system will accept any LARSFRIS Control Command. For this session, the user will request that the Statistics deck used for this run (submitted in the input deck) be saved on his private disk (A-disk).

Store Statistics Deck

9. Type the following Control Command:

```
statdeck save                    [CR]
```

This command will transfer the Statistics File for this run from the user's D-disk to his A-disk. For a later run, this Statistics File can be used by entering the 'statdeck use' command to transfer it back to the D-disk. These commands are described in detail in Section 4.

When the "save" action is completed, the system will issue the T-message and unlock the keyboard.

End Session

10. Type:

quit [CR]

The standard lines are typed and the user is logged out. His printed output will be forwarded to him from the LARS Flex lab 2. (This assumes a remote site for this run. The 'print flexlab2' command will have no effect if entered from terminals at Flex lab 2.)

3.5 SAMPLE SESSION IN THE DISCONNECT MODE

The Disconnect Mode is implemented in LARSFRIS for users who do not wish to attend the terminal after their run has started execution. The Disconnect Mode permits users to keep their run going, but log off the terminal so that others may use the system.

To perform a run in the Disconnect Mode, a normal interactive session is started, and then the Disconnect Mode is entered by a special keyboard action. The user is cautioned that he should not "disconnect" until all control cards have been read. Control card errors that occur after the user has entered Disconnect Mode will cause the run to be terminated.

The steps below are described in previous sections, so the actions are abbreviated. The typewriter terminal sheet for this session is shown in Figure 3-8, on the next page.

Check Input Deck

1. Remove the Initialization Function cards from the deck that was used in the previous run.

Standard Interactive Sequence

2. Do steps 1 through 8 (see Section 3.2) and wait for the first T-message.

```
login demo
ENTER PASSWORD:
********
ENTER NAME:phillips
YOUR OPERATORS ARE ROGER MYERS AND PERRY THAYER.
NEXT SCHEDULED SHUTDOWN 1700 SATURDAY
FILES:- 01 RDR, NO PRT, NO PUN
READY AT 10.36.58 ON 03/02/73
CP
i larsys
LARSYS (Ver 3) READY;

T=1.71/2.50 10.37.30
run larsys
EXECUTION BEGINS...

 I0112  CLASSIFYPOINTS FUNCTION REQUESTED    (CLASUP)
 I0032  REDUCED STATISTICS COMPUTED.    (REDSAV)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ    (CLAINT)
cp

disconnect
DISCONNECT AT 10.38.28 ON 03/02/73
```

Figure 3-8. An Execution of the Input Deck in the Disconnect Mode

Invoke Interactive Processing

3. Type the "run" command:

```
run larsys                    [CR]
```

The system messages will begin as shown in the figure.

When message I0034 is typed, the user knows that his control cards have been accepted, and his run should execute successfully.

Enter Disconnect Mode

4. Press the Attention key.

This action will interrupt the system for one of the special System Control Commands (see Section 2). The system will acknowledge the action by typing 'CP' and returning the typing element to the left margin.

5. Press the attention key again.

This action will cause the typewriter terminal to space one line. The keyboard will now be unlocked for entry.

6. Type the following command:

```
disconnect                    [CR]
```

The system acknowledges the command with a "disconnect message". In the sample run the message was:

```
DISCONNECT AT 10.38.28 ON 03/02/73
```

At this point the typewriter terminal is no longer associated with the user's virtual machine. The virtual machine resumes

execution, but the terminal is available for another user.

When execution in the virtual machine is completed, printed output will be produced, and the virtual machine will be logged out of the system.

3.6 SUBMITTING A BATCH RUN FROM THE TERMINAL

Runs in the Batch Mode are always executed in a special batch virtual machine and never in the user's virtual machine. The batch virtual machine is initiated by the operators in the computer room, but the output of a run is produced at the site specified (directly or indirectly) by the user. General characteristics of this mode of operation are described in Section 2.

The user may submit a batch run by reading the input deck into his virtual machine and issuing the Batch LARSFRIS Control Command from his typewriter terminal; or he may submit it directly by inserting special header cards in front of the deck and simply reading it in through the card reader. This subsection describes the procedure for using the terminal to submit a run. Figure 3-9, on the following page, shows the typewriter terminal sheet. The next subsection describes a run submitted using only the card reader.

Standard Interactive Sequence

1. Do steps 1 through 8 (see Section 3.2) and wait for the T-message.

   The input deck submitted for the Disconnect run in Section 3.5 may be used.

```
login demo
ENTER PASSWORD:
********
ENTER NAME:phillips
YOUR OPERATORS ARE ROGER MYERS AND PERRY THAYER.
NEXT SCHEDULED SHUTDOWN 1700 SATURDAY
FILES:- 01 RDR, NO PRT, NO PUN
READY AT 10.45.46 ON 03/02/73
CP
i larsys
LARSYS (Ver 3) READY;

T=2.36/3.37 10.46.24
print flexlab2
T=0.70/0.93 10.46.57
batch
** CARDS  XFERED TO BTLARSYS**
T=1.28/2.34 10.47.22
reference cluster
T=0.86/1.28 10.47.58
quit
CONNECT= 00:02:28  VIRTCPU= 000:05.63  TOTCPU= 000:08.48
LOGOUT AT 10.48.09 ON 03/02/73
```

Figure 3-9. Submitting the Input Deck for Batch Mode Execution

Request Alternate Site for Output

The printed or punched card output from the run may be produced at a location other than the user's site by issuing an appropriate Control Command. This sample run will be made with the assumption that it is submitted from one of the remote terminals but that the output is to be produced in the computer room.

2. Type the following Control Command:

   print computer [CR]

   The system responds with a T-message, and the keyboard unlocks for the next command.

3. Type the following Control Command:

   batch [CR]

   The system responds with the following lines:

   CARDS XFERED TO BTLARSYS

   and another T-message.

   These lines indicate that the input deck has been transferred to the batch virtual reader and erased from the user's virtual reader. The run will be executed in the batch virtual machine when resources are available. Before transferring the deck, the system created two special batch header cards at the front of the deck to identify the user and to specify the output destination. (In the next subsection, the user will provide these cards.)

When the T-message is received, the user's virtual machine is still in the interactive mode, and is ready to receive another command.

Request Reference Listing

4. Type the following Control Command:

reference cluster [CR]

The control card reference listing will be printed, and the system will issue a T-message. Note that since the user had previously issued the 'print' command, the 'computer' destination is still in effect, and his reference listing will be printed there. Output destinations specified by a 'print' or 'punch' command remain in effect until they are changed by another command or the user logs out from the system (issues the 'quit' command).

End Session

5. Type the following Control Command:

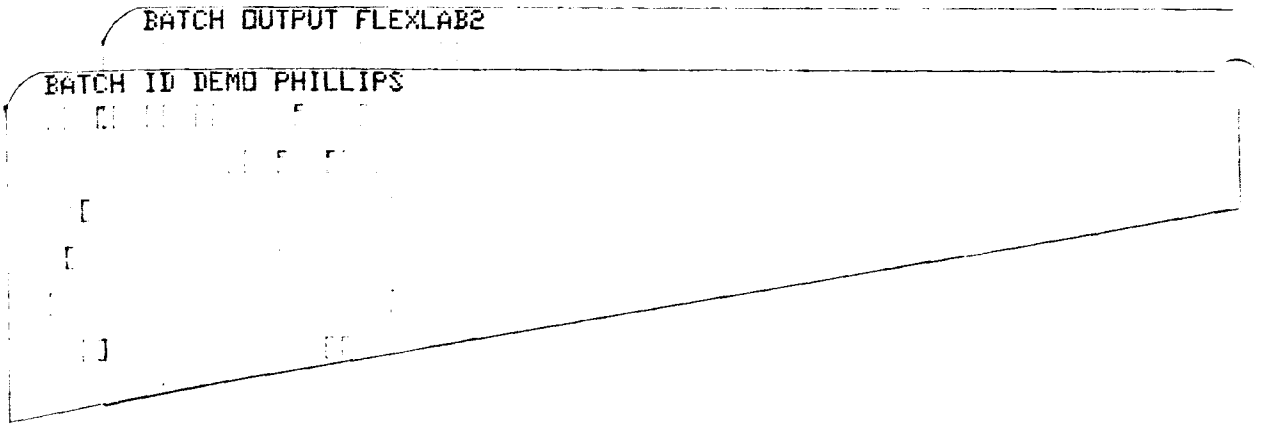
quit [CR]

The logout messages are typed, and the terminal is ready for another session.

3.7 SUBMITTING A BATCH RUN FROM THE CARD READER ONLY

A batch run may be submitted from the card reader without using the typewriter terminal. This requires only that the ID card that precedes the input deck be followed by two batch header cards. When the deck is read in, the system will interpret the header cards as a request to submit the input deck to the batch virtual machine. The cards identify the user to the system and specify the destination for output.

For the sample run, two new header cards will be punched as follows:



The first card identifies the deck as a batch input deck and provides the userid and user's name. The second card specifies the site for output and is always required. The output card above specifies that any printer or punched card output be directed to Flexible Laboratory 2. If the user wished to direct the two types of output to different sites, he may enter a second site ID (preceded by a space). The first site will apply to printer output and the second to punched card output.

The submission sequence is simple: put the header cards behind an ID card for the batch machine at the front of the deck, and submit the deck through the card reader. Note that this ID card is not the normal user's ID card. Figure 3-10 illustrates the card deck used for the sample run.

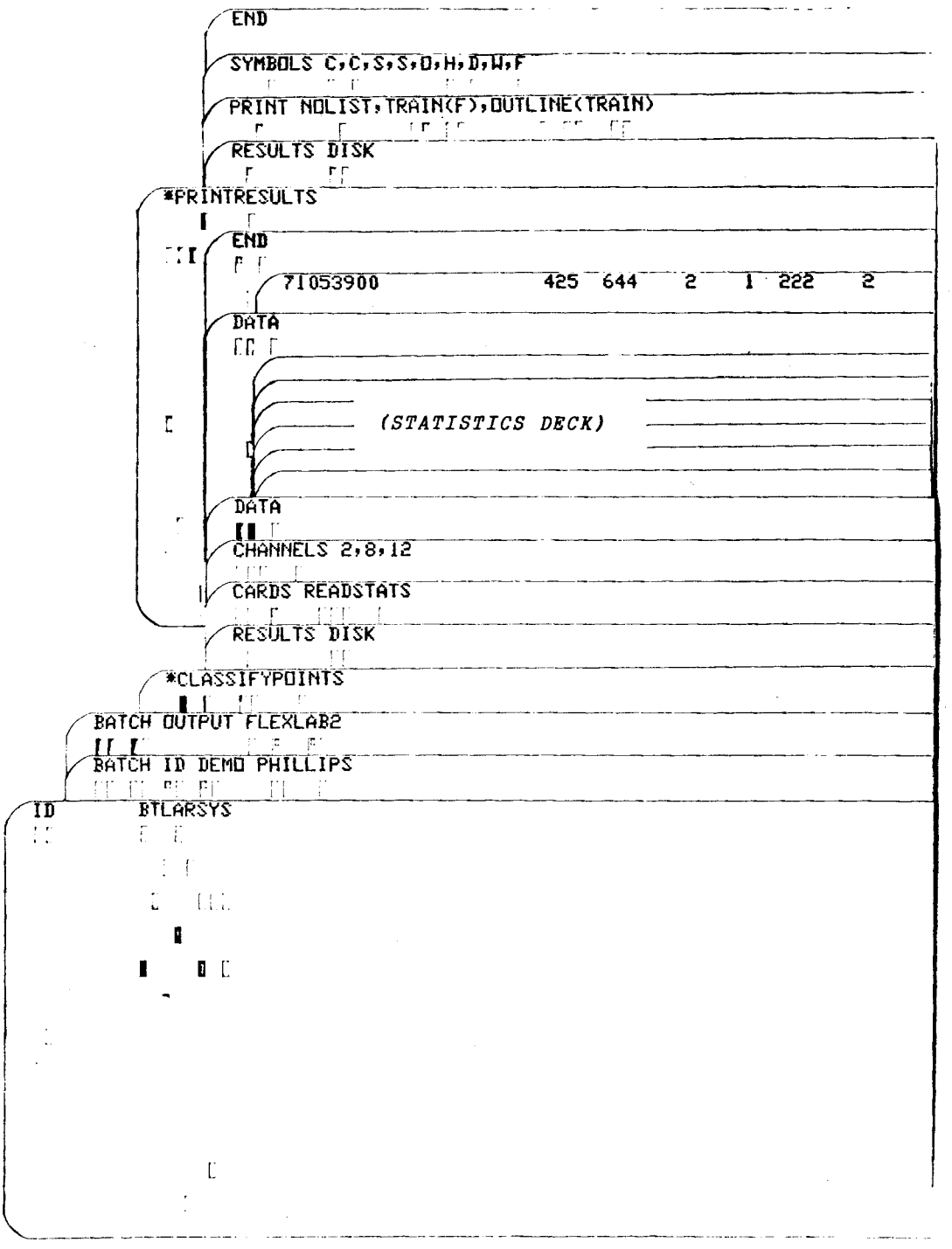


Figure 3-10. Batch Mode Input Deck for Submission from the Card Reader Only

SECTION 4

LARSFRIS CONTROL COMMANDS

SECTION 4

LARSFRIS CONTROL COMMANDS

This section of the User's Manual contains the detailed description of the Control Commands which are used to communicate with LARSFRIS at the executive level of control. The purpose, format, parameters and directions for use are included for each command. The material assumes an understanding of the general concepts of LARSFRIS as presented in Sections 2 and 3.

LARSFRIS Control Commands are communicated to the system through the typewriter terminal. The 'login' command is used to begin a terminal session. The 'i larsys' command is used to begin a LARSFRIS session. After the response to an 'i larsys' command is received, the system will be at the executive level of control and ready to receive all other commands except the 'disconnect', 'suspend' and 'stop' commands. These three commands are issued from the processing level of control. The executive level of control ends when the 'run larsys' command is issued. The terminal session is terminated when the user logs off the terminal by issuing the 'quit' command or by other non-LARSFRIS methods. The LARSFRIS session ends when the user removes himself from LARSFRIS levels of control. Other LARSFRIS sessions can be initiated with the 'i larsys' command during a single terminal session.

The following rules apply to entering all LARSFRIS Control Commands:

- All LARSFRIS Control Commands are entered via the typewriter terminal.
- All command keywords and parameters may be typed in either lower case or upper case letters.
- A keyword and parameter are typed on the same line and are separated by one or more blank spaces.
- A carriage return is required after typing a command to enter it into the system.
- If parameters are part of the command, one and only one parameter must be included, unless explicitly stated otherwise in the command description.
- Mistakes may be corrected before entering into the system by typing the "@" (at sign) to delete the preceding character and the "¢" (cent sign) to delete an entire line.

Experienced users will recognize some of the LARSFRIS commands are CP commands, and others as having the same format as CP commands. It is the intention of this document to explain all commands as LARSFRIS commands so that the inexperienced user can communicate and use the LARSFRIS system without the complication of learning and interfacing with the CP system, the

CMS system, and other special systems that may be devised by experienced programmers. Programmers who want a more versatile access and interface with the LARSFRIS system should become familiar with VM/CMS Users' Guide, IBM Publication GC20-1819-2. Careful study of this manual will lead to a more thorough knowledge of the LARSFRIS commands.

This section is organized in alphabetical sequence for use in easy referencing of the command descriptions. The LARSFRIS Control Commands include:

BATCH	LIST	REFERENCE
BEGIN	LOGIN	RUN
CCINPUT	MSG	STATDECK
CLEAR	NEWS	STOP
DISCONNECT	PRINT	SUSPEND
HISTDECK	PUNCH	TERMTEST
I LARSYS	QUIT	

BATCH

The 'batch' command submits the user's input deck to the system to be processed in the Batch mode, on a special batch virtual machine. The command is related to two other commands that control the mode of processing. The 'run' command is used to initiate processing of an input deck in the interactive mode, and the 'disconnect' command to switch the mode from interactive to disconnect.

Format

batch

Usage

The 'batch' command has no parameters. It is issued from the executive level of control after initiating LARSFRIS. It must be issued separately for each input deck, but the deck may be in the virtual reader with other decks to be run in either batch or interactive mode. When a 'batch' command is entered, it applies only to the next deck in the virtual reader. After the 'batch' command is entered, the system will type an information message denoting the transfer of the deck from the user's machine, and will print a listing of the transferred deck on the line printer. The keyboard will then be unlocked for entry of the next command.

Before transferring the deck, LARSFRIS will add two "header cards" to the front of the deck. One card has the userid and user's name to identify the originator of the deck for output and accounting purposes. The other card carries the site-id's for printed and punched output, and these designations will be the same as specified earlier by the 'print' and 'punch' commands. (Thus, alternate site-id's must be designated before entering the 'batch' command.)

The input deck will be transferred to, and executed in, a batch virtual machine over which the user has no direct control. Because of this Control Commands that initialize or manipulate a virtual machine are not applicable to a batch run. These commands include 'ccinput', 'clear', 'histdeck', and 'statdeck'.

An input deck that has been transferred for batch processing will be run in the batch virtual machine on a first-in, first-out basis.

BEGIN

This command enables the user to resume processing in the Interactive Mode after logging in to his virtual machine while it is in the Disconnect Mode.

Format

begin

Usage

The user first follows the normal login sequence. He enters the 'login (userid)' command, then his password, and then his name. The log-on message he receives will be "RECONNECTED AT...", followed by the "CP" message, rather than "READY AT..". The "reconnect" message indicates that his session is still in effect.

The "CP" message indicates that the functional processing has been interrupted. To resume processing, the user issues the 'begin' command. From this point, the virtual machine is in normal Interactive Mode once again. The user does not issue the 'i larsys' command which would cause termination of the processing function with no recovery or output.

A common error will be for a user to fail to notice the difference between the "reconnect at..." and the "ready at..." messages. The "reconnected" message will only be typed if the processing

which started in another terminal session is continuing. If the "ready" message is printed when the user attempts to reconnect, then the job which was started earlier has been completed and the user was previously automatically logged out. An attempt to issue the "begin" command under these conditions will result in a message "CP ENTERED, REQUEST PLEASE".

CCINPUT

The 'ccinput' command permits the user to submit his input deck from a private disk file rather than from the card reader. This is the most useful command for submitting a job.

Format

```
                 ┌                              ┐
                 │ 'file name'   'file type'    │
ccinput          │                              │
                 │  cards                       │
                 └                              ┘
```

Usage

Users may save their input decks on private disk files for repeated use. The 'ccinput' command facilitates retrieval of these saved decks by specifying the file name and file type. Once the command is given for a particular file name and file type, the file will be the input deck for every 'run' command in the LARSFRIS session.

To revert to the other method of input, the 'cards' parameter is used, and decks in the virtual reader will be used for input. The 'cards' parameter does not affect those decks saved on disk.

CLEAR

This command enables the user to erase the entire contents of his virtual reader or any Statistics File or Histogram File saved on his private disk.

Format

```
clear [ reader    ]
      [ statdeck  ]
      [ histdeck  ]
```

Usage

The 'clear' command must be issued with one of the three parameters. With the 'reader' parameter, any input deck(s) that are in the virtual reader will be erased. The other parameters will cause either the Statistics File or Histogram File to be erased from the private disk. (Also see the 'histdeck' and 'statdeck' command descriptions for other ways to manipulate these decks on the disk).

DISCONNECT

The 'disconnect' command releases the typewriter terminal from a user's virtual machine. It is issued after a processing run has begun. Processing will continue, but the typewriter is no longer associated with it and is made available for other users.

Format

disconnect

Usage

This command provides a user the freedom to start a long-running processing function interactively and then to disconnect his typewriter so that he need not remain at the terminal while the function completes execution. Since the typewriter is removed from his virtual configuration, it becomes available for another user. Note that the user cannot begin another new session, because identical userid's cannot be run concurrently in the system.

The 'disconnect' command is issued through a special sequence of actions:

1. The user should wait for a message stating that the function has begun execution, which indicates that the control cards have been read and have no syntactical errors. This is

important since most errors encountered in the Disconnect Mode will cause termination of the run.

2. He then presses the Attention key and waits for LARSFRIS to type the "CP" message.
3. He presses the Attention key again and then types the 'disconnect' command.
4. A message will be typed indicating the terminal has been disconnected, with the date and time.

When the run is finished, the outputs will be printed or punched at his site or at sites previously specified by 'print' or 'punch' commands.

The user may return to Interactive Mode from Disconnect Mode without affecting the processing. He goes through the normal login sequence as if he were starting a new session. However, the message giving the log-on time will be "RECONNECTED AT...." instead of "READY AT....", which indicates that his virtual machine is still in operation and that the typewriter terminal is again in the configuration. When the user logs in to a "disconnected" virtual machine, processing is interrupted (the "CP" message is typed after the "reconnect" message). To cause processing to resume, the user enters the 'begin' command, and control is returned to the function. The conditions from that point are the same as in any interactive run.

HISTDECK

The Histogram File, created by the Histogram, Imagedisplay, or Pictureprint functions, is written on a temporary disk for use during the LARSFRIS session and is erased at the end of the LARSFRIS session.

The 'histdeck' command provides three actions for extending the availability of a Histogram File. The user can employ the command to save the file (move it to his private disk), to use the saved file for subsequent processing, and to make an inquiry about the existence and status of the saved file.

Format

histdeck [save | use | status]

Usage

The 'histdeck save' command causes a copy of the Histogram File on the temporary disk to be put on the user's private disk. If a file already resides on his disk, the new one will replace it. If a file on the temporary disk is to be saved, the command must be issued prior to ending the LARSFRIS session in which it was created.

The 'histdeck use' command will cause the saved file to be moved back to the temporary disk for use by a Processing Function. The command must be issued before the first 'run larsys' command that invokes a function that will use the file. The file will then reside on the temporary disk until replaced or erased at the end of the LARSFRIS session.

A saved Histogram File will remain on the private disk until it is erased by the 'clear histdeck' command or replaced by a new file being saved.

The 'histdeck status' command will cause one of two messages to be typed. The first message identifies a saved file by providing the number of records comprising the file as well as the date and time it was saved. The second message will be issued when no Histogram File is on the private disk and simply states this fact.

I LARSYS

This command causes the LARSFRIS programs to be initiated in the user's virtual machine. It is used to begin a LARSFRIS session.

Format

```
i larsys
```

Usage

The command 'i' is a standard input which the user may find helpful to think of as an abbreviation for initiate. The 'larsys' parameter is required to identify the system that is to be initiated for the virtual machine and to differentiate it from other systems supported on the LARS computer facility. The 'i larsys' command is usually issued after the 'login' command in the sequence that prepared the virtual machine for operation. It can also be issued anytime during a terminal session after pressing the Attention Key and receiving the message or "CP". The latter operation can be used to cancel a LARSFRIS session. In both uses of the 'i larsys' command, a new LARSFRIS session is initiated.

The response to issuing an 'i larsys' command will be a "Ready" message line and a T-message as explained in Section 3 with examples of these responses. After these messages, the user is in the executive level of LARSFRIS and able to begin his work at the terminal.

LIST

The 'list' command produces list of the information items that are available through the 'news' and 'reference' commands. If no parameter is used with the command a list of all the information items that are available is produced on the printer. Information relating to specific items are requested by using a parameter, in which case the output is provided at the typewriter instead of the printer.

Format

```
        [ (no parameter entered)      ]
        [ 'Processing Function name'  ]
        [ commands                    ]
        [ initialization              ]
list    [ larsys                      ]
        [ runtable                    ]
        [ schedule                    ]
        [ system                      ]
```

Usage

This command produces a list of the titles of information items that may be requested by the 'news' and 'reference' commands. The list also provides the number of lines of output of each item and the date of its last revision.

Shown below are examples of list requests for 'commands' and 'cluster' (a Processing Finction name) provided at the typewriter terminal.

```
list commands

        ITEM      LINES     REVISED
        --------  -----     --------
        COMMANDS    158     11/01/72

T=0.59/0.83 12.02.07

list cluster

        ITEM      LINES     REVISED
        --------  -----     --------
        CLUSTER      61     11/01/72

T=0.53/0.84 12.02.25
```

The following is an example of the printer output provided when 'list' is entered with no parameter.

INDEX TO LARSFRIS SYSTEM DOCUMENTATION

AVAILABLE USING 'NEWS ' COMMAND	ITEM	LINES	REVISED
	LARSYS	4	11/30/72
	SCHEDULE	13	11/01/72
	SYSTEM	2	11/30/72

AVAILABLE USING 'REFERENC' COMMAND	ITEM	LINES	REVISED
	CLASSIFY	84	8/27/72
	CLUSTER	61	11/01/72
	COLUMNGR	40	8/16/72
	COMMANDS	158	11/01/72
	COPYRESU	31	11/08/72
	DUPLICAT	22	8/16/72
	GRAPHMIS	21	9/27/72
	HISTOGRA	44	11/01/72
	IDPRINT	26	8/16/72
	IMAGEDIS	125	11/01/72
	INITIALI	66	8/30/72
	LINEGRAP	36	8/16/72
	LISTRESU	19	8/16/72
	PICTUREP	123	11/01/72
	PRINTRES	106	11/01/72
	PUNCHSTA	24	8/16/72
	RUNTABLE	16	10/26/72
	SAMPLECL	69	8/27/72
	SEPARABI	159	8/27/72
	STATISTI	77	8/16/72
	TRANSFER	66	11/08/72

MSG(Message)

This command permits a user to send messages to the Computer Center operator or to anyone currently logged in the system.

Format

```
msg [ cp       ] 'message text'
    [ 'userid' ]
```

Usage

The 'msg' command will cause the system to type the sender's userid, and the text he entered, at the computer room console or at the terminal of the user specified.

If the virtual machine specified in the 'userid' parameter is not logged in, the system will provide a message to this effect. Another system message will notify the user if the recipient is not receiving messages because he is in Disconnect mode. Messages are not saved for later transmission.

NEWS

This is one of three commands ('list', 'reference', and 'news') that enables a user to request information about the system. The information will either be printed on his printer or at the typewriter. The 'news' command provides information about system updates, operations schedules, and other general news about system use.

Format

news [(no parameter entered) | larsys | schedule | system]

Usage

Printer output is provided in response to the three parameters. If the 'larsys' parameter is used, the system will print the current information about LARSFRIS system updates or functional changes. The 'schedule' parameter will provide the current operations schedule with all the projected down times for maintenance. The 'system' parameter will provide current news of general interest.

If no parameter is entered, the command will be interpreted as the 'system' parameter, except that the information will be typed at the terminal rather than be produced on the printer.

A sample of the outputs obtained from the 'news schedule' command is shown below.

```
FILE. . .      SCHEDULE NEWS      S2
 REVISED 11/01/72

      THE LARS COMPUTER WILL BE AVAILABLE FOR USE 24 HOURS A DAY AND
      7 DAYS A WEEK, EXCEPT FOR THE HOURS BETWEEN 5 PM SATURDAY AFTERNOON
      AND 3 PM SUNDAY AFTERNOON.

      THE COMPUTER SYSTEM IS SCHEDULED TO BE SHUT DOWN FOR PREVENTIVE
      MAINTENANCE EACH TUESDAY MORNING BETWEEN 8 AM AND 10 AM  AND
      EACH FRIDAY AFTERNOON BETWEEN 1 PM AND 3 PM.

      THE SYSTEM MAY OCCASIONALLY BE PRE-EMPTED BETWEEN 8 AND 8.30 AM
      ON MONDAY OR THURSDAY MORNINGS FOR SYSTEM PROGRAMMING OR UPDATES
      THAT CANNOT BE CARRIED OUT DURING HOURS OF NORMAL OPERATION.
```

PRINT

The 'print' command enables a user to designate an alternate site for producing printed output from his run. He may also control the time when it will be printed. It is similar to the 'punch' command.

Format

print ['site-id' | typewriter | hold | release]

Usage

LARSFRIS normally prints all outputs at the user's terminal location at the end of processing for each input deck. This can be changed with the 'print' command. The 'site-id' parameter is used to designate an alternate location for the printer output.

The 'typewriter' parameter causes all printed output to be directed to the user's typewriter terminal. This version of the command obviously should be used only when very small volumes of output are expected.

The above versions of the 'print' command remain in effect throughout the terminal session, unless the user alters them with a new command between input decks.

The last two parameters enable the user to delay his printed output until he requests it. The 'print hold' command delays output until he enters 'print release' or until he logs out of the system. The 'hold' and 'release' parameters may be used in conjunction with the site designation and typewriter versions of the command, but only one parameter can be entered at a time.

The 'print' command must be issued before any printer output is generated by the program. In LARSFRIS, all printed output generated by a program is stored on a disk until the input deck is processed or the user logs out. The 'print' command must be issued before this disk output is generated, because the location where the output will be printed is the first information put on the disk. Thus if the user wants to run a particular input deck and have his output printed at an alternate site, he must issue the appropriate 'print' command before issuing the 'run' command.

PUNCH

The 'punch' command enables a user to designate an alternate site for producing punched card output from his run. He also may control the time when output will be punched. It is similar to the 'print' command.

Format

```
        ['site-id']
punch   [hold     ]
        [release  ]
```

Usage

LARSFRIS normally punches all output at the user's terminal location at the end of processing for each input deck. This can be changed with the 'punch' command. The 'site-id' parameter is used to designate an alternate location for the punched output.

The 'hold' parameter will enable the user to delay his punched output until he issues the 'punch release' command or until he logs out of the system.

QUIT

The 'quit' command is used to terminate an interactive terminal session. It notifies the system to log out the user.

Format

quit

Usage

The command may be issued any time the system returns to the executive level. It should be noted that the 'quit' command is necessary to end a session even after issuing the 'stop' or 'suspend' commands.

LARSFRIS will respond to the 'quit' command with two message lines giving the length of time the terminal was connected, the virtual and real CPU times, and then the time and date of logout. Although the virtual machine is logged out, any output that was previously held and not released will be produced at this time.

REFERENCE

This is one of three commands ('list', 'reference' and 'news') that enable a user to request information from the system. The 'reference' command produces listings of summary information about Control Commands, control cards, and the system runtable.

Format

reference [Processing Function name | commands | initialization | all | runtable | runtable (an eight digit run number)]

Usage

If the user types one of the Processing Function names for the parameter (e.g., 'reference cluster'), LARSFRIS prints a listing of the control cards.for that function. The 'commands' parameter produces a listing of Control Commands. The command keywords, parameters, purposes or function, and any default actions are shown. For the 'initialization' parameter, a listing of the Initialization Function cards is provided in the same format as that for the Control Commands. All three types of these listings are included in Appendix I, but the system reference listings will reflect updates. The date of the last update can be obtained through the use of the 'list' command.

The 'reference all' command produces listings of the Processing Functions, the Control Commands and Initialization Functions.

The user may request a listing of the contents of the system Runtable through the 'reference runtable' command.

A specific run number may be requested with the 'runtable nnnnnnnn' parameter, where nnnnnnnn is an eight digit run number. The information will be typed at the user's terminal in a single-line information message.

An example of the listing produced by the 'reference runtable' command is shown on the following pages.

REVISED 10/26/72

LABORATORY FOR APPLICATIONS OF REMOTE SENSING

PURDUE UNIVERSITY

---- LISTING OF RUNTABLE FILE ----

RUN NUMBER	TAPE	FILE	LINES	CHAN	SAMP	FLIGHTLINE ID	DATA TAKEN DATE	DATA TAKEN TIME	AIRCRAFT ALT	AIRCRAFT HDG	DATE RUN GENERATED
66000600	494	1	950	12	228	PURDUE FLT LN C1	6/28/66	1229	2600	180	JAN 27,1971
69008403	494	5	2265	1	2000	FILM3696A SALTON	3/ 8/69	2001	640000	90	MAR 7,1972
71053001	494	4	1705	12	226	GRN BLT LU FL225	8/12/71	1103	5000	180	APR 5,1972
71054401	495	1	3033	12	452	COLOR TIPP PANEL	7/21/71	1305	1000	180	MAR 9,1972
71054700	494	3	85	12	104	COLOR TIPP PANEL	7/16/71	1407	1000	180	MAR 31,1972
72000100	494	2	100	12	226	NASA MSC OPB FS5	3/ 1/72	1200	0	0	MAR 01,1972

Listing produced by the 'reference runtable' command

RUN

This command requests that processing of the user's input deck (by the system named in the parameter) be started. Processing is performed in the user's virtual machine and begins in the interactive mode. The command is related to two other commands that control the mode of processing. The 'disconnect' command allows the user to change from the interactive mode to the disconnect mode after processing has been started by the 'run' command. The 'batch' command submits an input deck to the system to be processed in the batch mode. Batch mode processing is always performed in a batch virtual machine, never in the user's virtual machine.

Format

```
run larsys
```

Usage

The 'run larsys' command causes control to be passed from the executive level to the monitor level, where processing of the input deck begins. The sequence of control actions that take place after the 'run' command is issued are discussed in Secion 2.2, and illustrated in Section 3. The 'run' keyword represents a request for execution of one input deck, and the 'larsys' parameter identifies the particular LARS system that is being used.

Care should be taken to ensure that an input deck is available for processing before issuing the 'run' command. This is done either by reading the input deck in to the user's virtual reader, or by issuing the 'ccinput' command. If the run is not available, the following output will appear on the typewriter:

```
run larsys
EXECUTION BEGINS...
  E253  NO CARDS IN CARD READER - RUN TERMINATED    (CTLWRD)
IHC2181 FIOCS - I/O ERROR  BSAM INPUT  ERROR 02 ON FILE: "FT05F001"
T=1.08/2.01 15.20.23
```

In addition to the above error message, output similar to that shown on the following page will appear on the printer.

The user can recover from this error by reading his input deck into the virtual reader, (or issuing the 'ccinput' command) and then re-issuing the 'run' command.

```
CP67USERID  DEMO        02/21/73    15.20.01    PHILLIPS

        DEMO                          LABORATORY FOR APPLICATIONS OF REMOTE SENSING          FEB  21,1973
        PHILLIPS                            PURDUE UNIVERSITY                            3 20 01 PM
                                                                                         LARSYS VERSION 3

 IHC218I FIOCS - I/O ERROR  BSAM INPUT  ERROR 02 ON FILE0  FT05F001
  E4Q
 TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14    REG. 15    REG.  0   REG.  1
            IhCUM                      00015604   000179F8   00000000  00012248
            CTLwRD          0045       9201291E   00014D60   00000001  00012248
            LARSMN                     40016044   00012000   0007A1D0  00018C90
 ENTRY POINT=  00012000

 STANDARD FIXUP TAKEN , EXECUTION CONTINUING
  E253  NO CARDS IN CARD READER - RUN TERMINATED     (CTLWRD)
```

Sample of printer output when no input deck available

STATDECK

A major output of the Statistics function and the Cluster function is the Statistics File, which is a temporary file stored on disk for use during the same LARSFRIS session by the Separability, Classifypoints, and Sampleclassify functions. At the end of the LARSFRIS session, the Statistics File is erased.

The 'statdeck' command provides three actions for extending the availability of a Statistics File. The user can employ the command to save the file (move it to his private disk), to use the saved file for subsequent processing, and to make an inquiry about the existence and status of saved files.

Format

statdeck [save | use | status]

Usage

The 'statdeck save' command causes a copy of the Statistics File on the temporary disk to be put on the user's private disk. If a file already resides on his disk, the new one will replace it. If a file on the temporary disk is to be saved, the command must be issued prior to ending the LARSFRIS session in which it was created.

The 'statdeck use' command will cause the saved file to be moved back to the temporary disk for use by a Processing Function. The command must be issued before the first 'run larsys' command that invokes a function that will use the file. The file will then reside on the temporary disk until replaced or erased at the end of the LARSFRIS session.

A saved Statistics File will remain on the private disk until it is erased by the 'clear statdeck' command or replaced (written over) by a new file being saved.

The 'statdeck status' command will cause one of two messages to be typed. The first message identifies a saved file by providing the number of cards that make up a punched Statistics File as well as the date and time it was saved. The second message will be issued when no Statistics File is on the private disk and simply states this fact.

STOP

This command enables the user to terminate the execution of a Processing Function before it has completed. Any output that can be produced will be provided, and any subsequent function specified in the input deck will begin execution automatically. It should be noted that the 'stop' command is implemented in tight programming "loops" and will respond only when large amounts of processing are expected (for example, during classification in Classifypoints).

Format

stop

Usage

A special sequence of actions is required to issue this command:

1. The user presses the Attention key and waits for the system to type the "CP" message.
2. He then presses the Attention key again and types the 'stop' command.
3. The function that is executing is brought to an orderly termination, and an information message is typed.

Upon completion of the 'stop' command, control passes to the monitor level. Any functions remaining in the input deck are read and executed in the normal fashion without further user action. If the user wishes to cancel the entire input deck, he may issue an 'i larsys' command after step one above.

SUSPEND

This command enables the user to prematurely terminate, and later restart, a function that is executing.

Note that this command is currently implemented only for the Classifypoints function. Consult a current Control Commands reference listing or a specific Processing Function reference listing to determine current support of the command. The function will indicate a RESTART control card as one of the options. If the command is issued for an unsupported function, the actions will be the same as for the 'stop' command.

Format

suspend

Usage

A special sequence of actions is required to issue this command:

1. The user presses the Attention key and waits for the system to type the "CP" message.
2. He then presses the Attention key again and types the 'suspend' command.
3. The function executing is brought to an orderly termination in such a manner that it may be re-started later from the point at which it halted. An information message is typed.

Upon execution of the command, control will pass to the monitor level. Any remaining functions in the input deck will be read and executed in the normal fashion without further user action. The function may be restarted in another input deck through use of the RESTART control card (review the reference listing for additional input requirements).

TERMTEST

This command permits the user to test the operation of his typewriter terminal by entering a text line that is "echoed" back to the typewriter by the system.

Format

```
termtest 'nn'
```

Usage

The 'termtest' command may be issued with or without the parameter 'nn'. The parameter is a number, ranging from 01 to 99, that specifies the number of times that the message is to be repeated at the typewriter terminal. If the parameter is omitted, the message will be repeated 10 times.

When the command is entered, the system responds with a message instructing the user to enter an input line. The input line may consist of any combination of characters on the keyboard, and may be up to one full line of typewriter input in length. Input is terminated by the user pressing the carriage return. The system then proceeds to type the line at the terminal the requested number of times.

This command is used to isolate suspected problems of operation. Generally, an incorrect response from the test will indicate trouble in some equipment or in the lines linking the terminal to the computer room. The user can then notify the appropriate maintenance personnel to remedy the problem.

SECTION 5

LARSFRIS INITIALIZATION FUNCTIONS

SECTION 5

LARSFRIS INITIALIZATION FUNCTIONS

This section of the User's Manual contains detailed descriptions of the LARSFRIS Initialization Functions. These are HD1, HD2, COMMENT, DATE, TYPE, CARD, CHECKOUT, RUNTABLE and RESET. Included in the section are the format and directions for use of each function. The material assumes an understanding of the general concepts of LARSFRIS as presented in Sections 2 and 3.

The following considerations apply to all Initialization Functions:

- Initialization Functions are activated by Initialization Cards in the user's input deck. The keyword for the Initialization Card always starts with a hyphen (-) in column one, followed by the name of the function.
- Initialization Cards are placed immediately before the Function Selection Card for the first Processing Function to which they apply.
- An Initialization Card applies to all Processing Functions that follow it in the input deck, unless its action is overridden or reset by a succeeding Initialization Card.
- When all processing for an input deck has been completed, the status of all Initialization Functions are reset to their system default values.

Four of the functions are used to control the content of header information that is printed on all LARSFRIS printed output. Figures 5-1 and 5-2 illustrate standard headers when no Initialization Functions are used and the modification of the headers by the four functions, respectively. These figures also are referenced in the appropriate functions.

HD1 and HD2

These two functions permit the user to change the two standard header lines that appear on all printed output:

Header 1: LABORATORY FOR APPLICATIONS OF REMOTE SENSING

Header 2: PURDUE UNIVERSITY

The Initialization Cards which request the functions specify up to 64 characters of information that will replace the applicable header lines. The new headers are centered on the page as are the standard headers.

Format

-HD1 [up to 64 characters of text]

-HD2 [up to 64 characters of text]

Usage

Either or both Initialization Cards may be used in an input deck. The keyword, a blank, and the text that is to replace the applicable header line is entered on the card. If less than 64 characters are entered, the line will be centered based on the actual number of characters entered. Figures 5-1 and 5-2 show sample LARSFRIS outputs with the standard headers and user-supplied headers respectively.

DEMO
PHILLIPS

LABORATORY FOR APPLICATIONS OF REMOTE SENSING
PURDUE UNIVERSITY

FEB 1,1973
9 52 03 AM
LARSYS VERSION 3

TAPE NUMBER..... 1004
CONTINUATION CODE..... 0
FLIGHT LINE.. CRN BLT LO FL225
PLATFORM ALTITUDE. 5000 FEET

FILE NUMBER..... 1
NUMBER OF DATA CHANNELS.... 12
DATE DATA TAKEN..... 8/12/71
GROUND HEADING.... 180 DEGREES
NUMBER OF LINES..... 1705

RUN NUMBER..... 71053001
NUMBER OF DATA SAMPLES... 228
TIME DATA TAKEN.... 1103 HOURS
REFORMATTING DATE.APR 5,1972

	SPECTRAL BAND		CALIBRATION PULSE VALUES		
CHANNEL	LOWER	UPPER	CC	C1	C2
1	0.46	0.49	0.0	186.35	192.65
2	0.48	0.51	0.0	205.90	211.20
3	0.50	0.54	0.0	206.00	224.40
4	0.52	0.57	0.0	174.75	195.40
5	0.54	0.60	0.0	187.85	194.10
6	0.58	0.65	0.0	232.40	222.75
7	0.61	0.70	0.0	208.65	224.95
8	0.72	0.92	0.0	124.60	67.65
9	1.00	1.40	0.0	44.60	80.65
10	1.50	1.80	0.0	77.65	126.30
11	2.00	2.60	0.0	93.25	117.70
12	9.30	11.70	25.45	85.25	0.0

5-1

Figure 5-1. Standard LARSFRIS Headers

DEMO
PHILLIPS

THIS IS A SAMPLE FOR THE HD1 INITIALIZATION FUNCTION
SAMPLE FOR THE HD2 INIT FUNCTION

NEW DATE=JULY 4 1984
9 52 16 AM
LARSYS VERSION 3

THE COMMENT LINE IS ADJUSTED TO THE LEFT MARGIN

TAPE NUMBER..... 1004
CONTINUATION CODE..... 0
FLIGHT LINE.. CRN BLT LO FL225
PLATFORM ALTITUDE.. 5000 FEET

FILE NUMBER..... 1
NUMBER OF DATA CHANNELS.... 12
DATE DATA TAKEN..... 8/12/71
GROUND HEADING.... 180 DEGREES
NUMBER OF LINES..... 1705

RUN NUMBER..... 71053C01
NUMBER OF DATA SAMPLES... 228
TIME DATA TAKEN.... 1103 HOURS
REFORMATTING DATE.APR 5,1972

	SPECTRAL BAND		CALIBRATION PULSE VALUES		
CHANNEL	LOWER	UPPER	C0	C1	C2
1	0.46	0.49	0.0	186.35	192.65
2	0.48	0.51	0.0	205.90	211.20
3	0.50	0.54	0.0	206.00	224.40
4	0.52	0.57	0.0	174.75	195.40
5	0.54	0.60	0.0	187.85	196.10
6	0.58	0.65	0.0	232.40	222.75
7	0.61	0.70	0.0	208.65	224.95
8	0.72	0.92	0.0	124.60	67.65
9	1.00	1.40	0.0	44.60	80.65
10	1.50	1.80	0.0	77.65	126.30
11	2.00	2.60	0.0	93.25	117.70
12	9.30	11.70	25.45	85.25	0.0

Figure 5-2. User-Supplied Headers

COMMENT

The Comment function permits the user to add a third line to be printed below the two header lines on all printed output.

Format

-COMMENT [up to 64 characters of text]

Usage

The keyword on the Initialization Card is followed by one blank and then by 1 to 64 characters of text. The text that is entered is placed on the fourth line of all printed output starting at the left margin. Figure 5-2 shows a sample LARSFRIS output containing a comment line.

DATE

This function permits the user to specify the date that is to appear on all printed output.

Format

-DATE [up to 20 characters of information]

Usage

The keyword on the Initialization Card is followed by a blank and then by 1 to 20 characters of information. If less than 20 characters are entered, the function will complete the 20-character space with blanks. The function assumes that the user is entering a date and will replace the standard date with whatever the user has entered on his card. The new date appears on the first line at the right margin of every page. Figures 5-1 and 5-2 show sample LARSFRIS outputs with the standard date and a user-supplied date, respectively.

TYPE

This function switches the source of Initialization and control cards from the virtual card reader to the typewriter terminal.

Format

-TYPE

Usage

When the Initialization Card for this function is detected in the input deck, card reading from the virtual card reader stops, the typewriter keyboard is unlocked, and the user is instructed to enter cards from the keyboard. Initialization Cards and Control Cards, but not data cards, may then be entered from the keyboard instead of the virtual card reader. Data cards are always read from the virtual card reader.

Once the '-TYPE' Initialization Card has been detected in the input deck, LARSFRIS will continue to expect either Initialization Cards or Control Cards from the keyboard until one of the following actions occurs:

1. The user types either the '-CARD' or the '-RESET' keyword, activating the respective initialization function. Either of these will cause the processing function to switch back to the virtual card reader for its source of input "cards". The reader should note, however, that the RESET function also resets

all other Initialization functions to their standard (default) value.

2. The user enters a 'DATA' control card. This specifies to the processing function that data cards are to follow. Since LARSFRIS will accept data cards only from the virtual card reader, it also causes the function to switch to the reader to begin reading the cards. The data cards must, of course, have been placed in the card reader previously. A 'DATA' control card is not placed in front of the first such data deck. If more than one data deck is present, however, the second and third decks are preceded by the 'DATA' card. The data cards for the function are always followed by the normal 'END' control card.

3. The user types an 'END' control card. This causes the processing function to stop accepting control cards, and to begin executing the deck that has been entered.

If the processing function encountered an 'END' control card while the 'TYPE' Initialization function was in effect, it will return to the keyboard for the next card after the processing function is complete. This is true regardless of whether the END card was encountered from the virtual card reader or was entered from the typewriter. If the user has no more functions

to execute, he may indicate the end of the input deck by simply entering a carriage return. He may also type the '-CARD' or '-RESET' Initialization Cards to direct the function to read the next portion of the input deck from the virtual card reader, or may continue to type the control cards at the typewriter.

Examples

Following are some simple examples of the use of this function:

1. No data cards, all input from the keyboard

	Card Reader	Typewriter Keyboard
a.	-TYPE	
b.		control cards . . . END
c.		[CR]

(The processing function reads the '-TYPE' card and switches to the keyboard where it obtains all of the control cards for the function. Upon detecting the END card it executes the processing function and returns to the keyboard. The carriage return indicates the end of the input deck and terminates all processing.)

2. Data cards are required by the function

Card Reader	Typewriter Keyboard
a. -TYPE	
	b. control cards
	.
	.
	.
	DATA
c. data cards	
.	
.	
.	
END	
	d. [CR]

(The sequence is similar to the preceding one, except that the user types a 'DATA' control card. This causes the function to switch to the card reader for the data cards. At the end of processing the carriage return from the typewriter terminal terminates the input deck and all processing.)

3. Multiple Data Decks

Card Reader	Typewriter Keyboard
a. -TYPE	
	b. control cards
	.
	.
	.
	DATA

c. data cards
.
.
.
DATA
data cards
.
.
.
DATA
.
.
.
END

d. [CR]

(Same as the preceding example except that 'DATA' control cards precede the second and third data decks.)

4. Using the '-CARD' Initialization Function

Card Reader	Typewriter Keyboard
a. -TYPE	
	b. control cards . . . -CARD
c. control cards . . . DATA data cards . . . . END	

(In this sequence the user entered some of the control cards from the keyboard and then switched back to the virtual card reader by typing the '-CARD' keyword. He had previously placed other control cards, followed by data cards, in the reader. Since the END card was detected while the CARD function was in effect, control does not pass back to the keyboard at the end of processing.)

CARD

This function switches the source of the input deck from the typewriter keyboard back to the virtual reader.

Format

-CARD

Usage

This Initialization Function is always entered from the typewriter keyboard. It switches the source of the input deck back to the virtual card reader after the Type function had caused it to be switched to the typewriter. If a -CARD Initialization Card is detected when reading the input deck from the virtual reader, it will have no effect.

Refer to the description of the TYPE Initialization function for further details on how these two functions are used.

CHECKOUT

This function permits the user to check his input deck for errors before executing it. It is particularly useful for checking an input deck that executes more than one Processing Function, since an error in the control cards for one of the later functions could cause abnormal termination of the entire sequence after considerable processing had been performed.

When the Initialization Function Card that activates this function is detected in the input deck, all control and data cards for the Processing Functions that follow it are read and checked for syntax, invalid or missing values, and invalid sequences. No processing of data is performed for the requested functions; however, standard error messages are typed, and the user must correct the error at the typewriter keyboard in order for CHECKOUT to continue. A correction entered at the typewriter does not correct the input deck. Any erroneous cards will have to be repunched before using them for actual execution. An example of the use of the Checkout function is included in Section 3.

Usage

When the CHECKOUT card is detected in the input deck, it causes the execution mode for the Processing Function control cards that follow it to be set to "checkout", rather than "execution".

Any Initialization Cards that follow the CHECKOUT card in the input deck are, however, executed just as they would be in the normal execution mode. When the first Function Selector Card is read, the normal card-reading and checking routines are used to read and check the input deck, but all functional processing is inhibited.

Data cards that are part of the input deck will be completely checked for correct syntax, and the standard error messages will be typed if errors are detected. However, since no attempt is made to actually process the data, or to locate data that is referenced in the input deck, the level of data card and data file checking that can be performed varies. Data cards and data files are subject to the following two general considerations:

- No data that is generated by a previous function is required to properly execute the Checkout function.
- Tapes that are specified in the input deck will not be mounted, and any errors related to properly mounting the tapes, accessing the data, or errors in the data itself will not be detected.

The four types of data cards that may be present in the input deck are handled as follows:

- Field Description Cards and Levels Cards are completely checked, but (as mentioned above) incorrect references to input data will not be detected. For instance, if a Field Description Card specifies a line or column number (or a Levels Card, a column number), that does not exist on the specified run, the error cannot be detected until processing is actually performed; i.e., until the Multispectral Image Tape is actually mounted and an attempt is made to locate the data.

- If the Statistics File is included in the input deck, it will be read and recreated on the disk as in normal processing. All related Statistics File data and control card checking will be performed. The new Statistics File that is created on the disk from the input deck will, of course, replace any Statistics File that had previously been placed there.

- If the control cards indicate that the Statistics File is to be input from disk (i.e., there is no 'CARDS READSTATS' control card), the Checkout function will attempt to read it from the disk and perform Statistics File checking. If the Statistics File is not actually

on the disk, it will ignore the file and bypass the related checking.

- If the Histogram File is included in the input deck, it will be read, and all related checking will be performed. It will not write the Histogram File to disk, and any previous Histogram File that was placed there will remain unchanged. If histograms stored on the disk file are to be used in execution, they will be ignored and related checking omitted.

RUNTABLE

This function permits the user to create a private Runtable that identifies Multispectral Image Storage Tapes that are not cataloged in the system Runtable, or that are copies of cataloged runs created by the CHANNELTRANSFORM Function

Format

```
Card 1:              -RUNTABLE
Card 2:              DATA
Card 3,4,5,etc:      RUN(nnnnnnnn),TAPE(ttt),FILE(ff)
  .                    .
  .                    .
  .                    .
Last Card:           END
```

where: "nnnnnnnn" is the run number of a single Multispectral Image Storage Tape run,

"ttt" is the tape number on which the run is located,

"ff" is the file number on the tape.

Usage

The Initialization Card for the Runtable function is followed by a DATA control card and then by up to ten run identification cards. Each of these cards identifies a Multispectral Image Storage Tape run that the user wishes to use as input to an execution of the LARSFRIS functions. This user-supplied Runtable will be used for locating a run before the system Runtable is used. The last run identification card is followed by an END control card. Only up to ten entries may be made in the user

Runtable. If more than ten are entered, the excess run cards after the tenth one are ignored. Note that multiple executions of RUNTABLE in a single LARSFRIS run add cumulatively to the user Runtable.

RESET

This function causes all Initialization functions to be reset to their default status.

Format

-RESET

Usage

When the Initialization Card for this function is detected, all Initialization functions are reset to their normal (default) status. The reset function is invoked in an input deck to reset parameters that were set by other Initialization functions earlier in the input deck. It has no use between the execution of input decks, since LARSFRIS automatically resets all Initialization functions to their default status when any input deck is completed.

The default status of the Initialization Functions is:

function	Status	Result
CARD	in effect	Input decks are read entirely from the virtual card reader.
TYPE	not in effect	Input decks are read entirely from the virtual card reader.
CHECKOUT	not in effect	Input decks are completely executed, instead of just being checked for accuracy.
COMMENT	not in effect	The fourth line of all printouts is blank.

The default status of the Initialization Functions (con't):

function	Status	Result
DATE	not in effect	The actual date is printed on all printouts.
HD1	not in effect	The standard first header line is printed on all printouts.
HD2	not in effect	The standard second header line is printed on all printouts.
RUNTABLE	not in effect	No runs are cataloged in the user Runtable.