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Final Technical Report
October 1977

CARTOGRAPHIC COMPILATION STUDY
Design Specifications - Advanced Revision and Compilation System (ARCS)

PRC Information Sciences Company

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

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This report contains the hardware capability specification and complete functional flow, batch and interactive processing, for the advanced digital compilation/revision system.

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I. SYSTEM OVERVIEW

This section presents an overview of major concepts and attributes concerning the Advanced Revision and Compilation System.

A. Environment

The production environment, which the Advanced Revision and Compilation System (ARCS) is conceived to operate within, is expected to evolve with time because of required technology development and implementation timeframes. The envisioned overall production environment, as defined by the Advanced Cartographic System (ACS) concept, basically conforms to current production phases, with automated systems and techniques being implanted where and when process effectiveness can be validated. The ACS concept consists of four major production phases:

- o Source Data Acquisition and Processing
- o Data Storage, Maintenance and Retrieval
- o Source Exploitation and Product Compilation
- o Product Finishing and Reproduction

Figure I-1 illustrates the logical associations of the major production phases and identifies the major activities which are planned to occur in each phase. Identified below each phase is a list of automated systems which are currently operational in the production environment. The system defined in this report is expected to operate within the bounds of the Source Exploitation and Product Compilation Phase.

The Source Exploitation and Product Compilation Phase represents some of the most demanding processes in terms of cartographic expertise, judgement, and man-hour expenditures. Not too surprising is the fact that automated support to product compilation is one of the least developed areas.

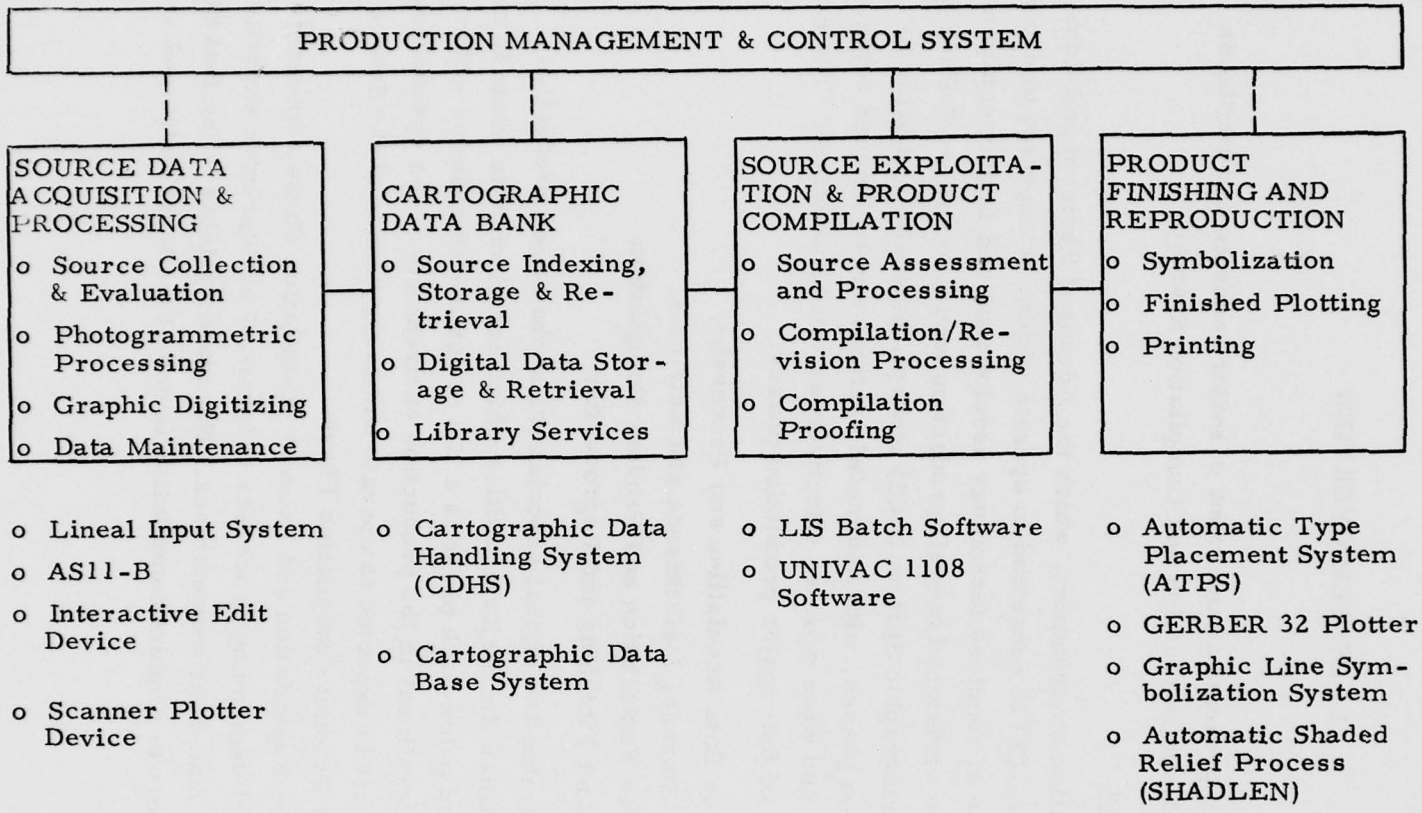

Figure I-1 ACS Concept and Operating Environment

B. Purpose and Goals

The general purpose of the Advanced Revision and Compilation System is to provide cartographers with advanced computer techniques for effective compilation and revision of cartographic products. Within the ACS environment ARCS provides the major link between data bank information (e.g., digital and graphic) and final product finishing. Basic premises on which the system concepts are based include: significant levels of digital feature information exists or can be efficiently derived over the product area; the data requires some level of selection, graphic manipulation and proofing; and digital compilation capabilities will complement and improve effectiveness of other automated systems such as data banking and automated finishing systems. The types and sequence of advanced compilation techniques to be applied to specific jobs will vary depending upon the characteristics and extent of digital and graphic sources and requirements of the desired product. Inherent in the basic concept is the requirement that feature data is encoded such that it may be retrieved and manipulated based on physical description and location.

Specific goals of the advanced system include the following:

- Provide effective and flexible processes for exploiting graphic and digital cartographic data towards generation of cartographic products.
- Provide specialized automated processes and/or computer aids for displaying and manipulating cartographic data.
- Replace many of the repetitive, time-consuming, and predictive manual compilation/revision processes with cartographer directed digital processes.
- Allow for interfaces with current manual and automated systems which are anticipated to be integral to the advanced compilation environment.
- The advanced system should be capable of supporting compilation of standard and special products which can be derived from combinations of digital and graphic sources.

C. Interfaces

Based on the role of the Advanced Revision and Compilation System and its various components, several interfaces with other manual and automated systems are required as illustrated in Figure I-2. Three general types of interfaces are currently defined:

- o Pre and Post-Compilation Interfaces
  - Data Bank Interface - consists of input of digital and graphic source information and associated source identification information and recommended usage.
  - Product Finishing Interface - consists of output of digital feature files and associated proof plots.
- o In-Process Interfaces - those interfaces which occur during the compilation phase and involve supplementary manual techniques or automated systems, such as:
  - production management and control
  - aeronautical compilation services
  - names placement services
  - shaded relief compilation
- o Internal Compilation System Interfaces - those interfaces between subsystems of the advanced compilation system which are addressed in the following sections.

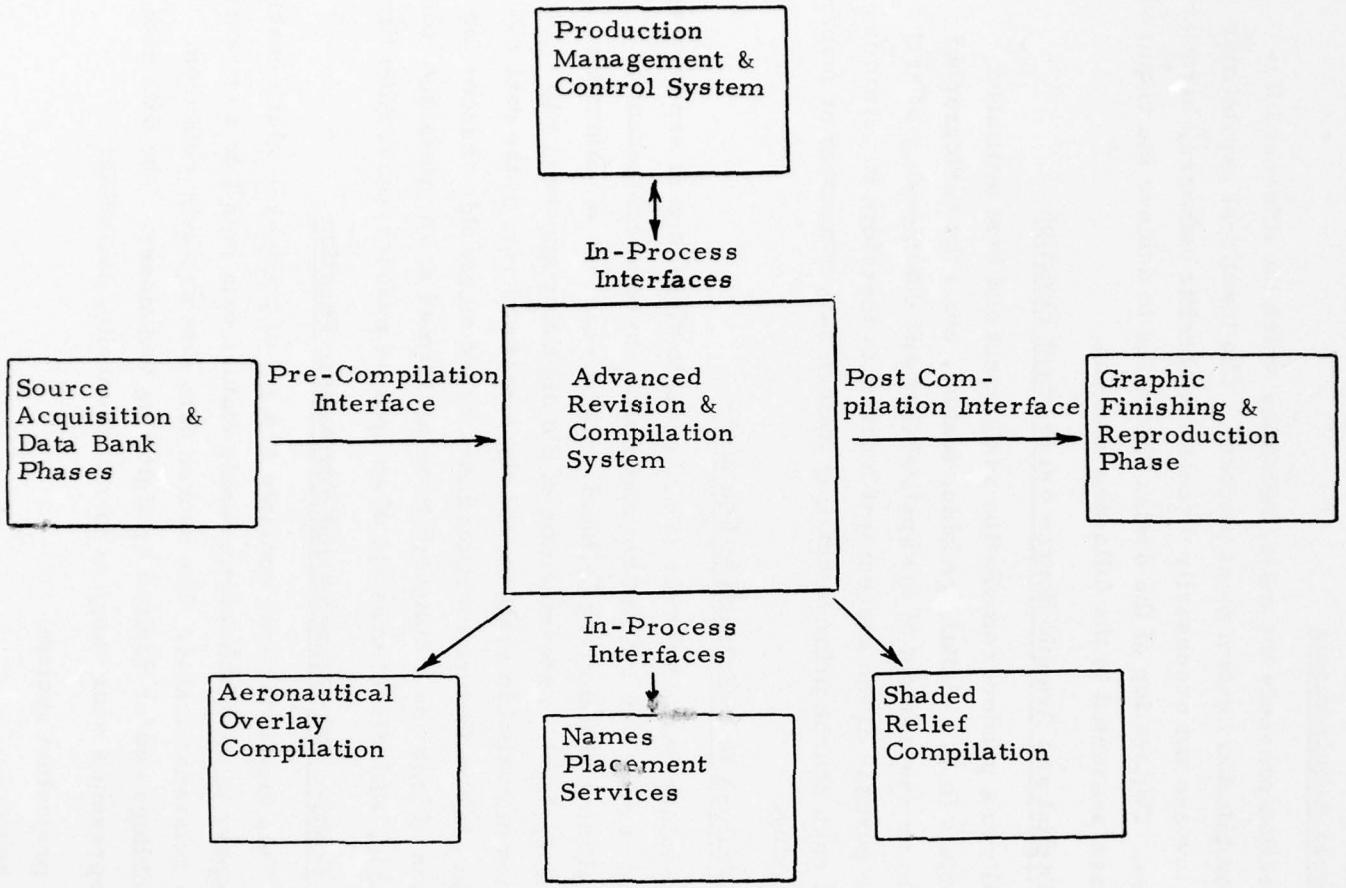

Figure I-2 System Interfaces

D. Functional Requirements

This section presents the major functions which the Advanced Revision and Compilation System must perform. The functional capabilities presented below are not necessarily directed at specific software, hardware, or procedures. Delineation of the design strategies to achieve the required capabilities are presented in the following sections.

1. Digital and Graphic Source Assessment Function

Given a product compilation assignment and best available source materials (e.g., digital, graphic, textual, etc.) the cartographer must perform an assessment of the applicability and commonality of each source. The purpose of the assessment function is therefore to determine the utility of each source prior to detailed feature data extraction or manipulation processing.

2. Feature Data Extraction Function

Feature data extraction (i.e., graphic digitizing) is expected to be performed at either an interactive compilation system component or a dedicated digitizing system (e.g., lineal, raster scanner, or automatic line following system). Determination of the digitizing approach will depend on efficiencies of available systems and the extent and type of the data extraction task. Minor feature modifications, based on graphic sources for revision types of jobs are anticipated to be performed at an interactive compilation station, with direct creation of an updated product compilation file.

3. Feature Data Merging and Formatting Function

This functional area consists of a set of processes which enable the cartographer to assemble cartographic feature data sets into a common compilation reference frame. The source data sets are extracted from data bank holdings and/or derived by digitizing techniques. The data sets normally represent a wide range of format diversity, including:

- projection system
- scale

- o coordinate type (geographic, table rectangular)
- o area of coverage
- o data point resolution
- o feature information content

Given the feature data sets and each of their attributes the cartographer can direct the application of proper types and sequence of software processes. The minimum set of software processes includes the following:

- o Projection Transformations
- o Registration and Scaling
- o Line Generalization
- o Sectioning
- o Paneling
- o Feature Extraction/Suppression
- o Feature Symbolization
- o Digital Rectification

4. Graphic Data Display and Interactive Function

The purpose of this function will be to display selective feature information such that the cartographer can evaluate feature content and positioning and execute necessary compilation/revision actions. Due to the volume of information and extensive compilation actions to be performed the man/machine rappore and associated design is critical to development of an effective capability. To allow for product revision or update, this function will also include provisions for data entry from supplementary graphic information.

5. Plotting, Proofing and Reporting Function

Inherent to the overall compilation phase are provisions for the cartographer or review personnel to perform various levels of verification and proofing of compilation processes. Performance of the proofing function is expected to occur at various steps in the compilation phase. Plotting will consist of quality review/edit plots and quick proof plots for content verification.

A major human factors attribute of the system will be comprehensive reporting of processes and file contents. The cartographer will receive or can request various process reports at critical steps during the compilation.

E. Operational Concept and Processes

The Advanced Revision and Compilation System (ARCS) will provide a set of hardware/software/procedure tools to be exploited and directed by cartographic personnel. The system components rely on the user for direction of function assignment and processing parameters. Once directed, the system will perform automatic processes where feasible, and provide the necessary dialogue with the user to assure accuracy and completion of processes.

The types of jobs which ARCS can support are anticipated to vary significantly in terms of size, complexity, and priority. Therefore, the user's approach to performing each job will vary, and likewise exploitation of the advanced system will differ in sequence and duration of processes. Presented below (Figure I-3) is an operational flow which depicts major process steps, sequences, decision points, inputs and outputs which are anticipated for most conventional compilation/revision jobs. The major process steps include:

- o Job Planning
- o Data Bank Accessing
- o Source Assessment
- o Data Extraction
- o Compilation Batch Processing
- o Interactive Graphic Revision and Compilation
- o Product Proofing and Review

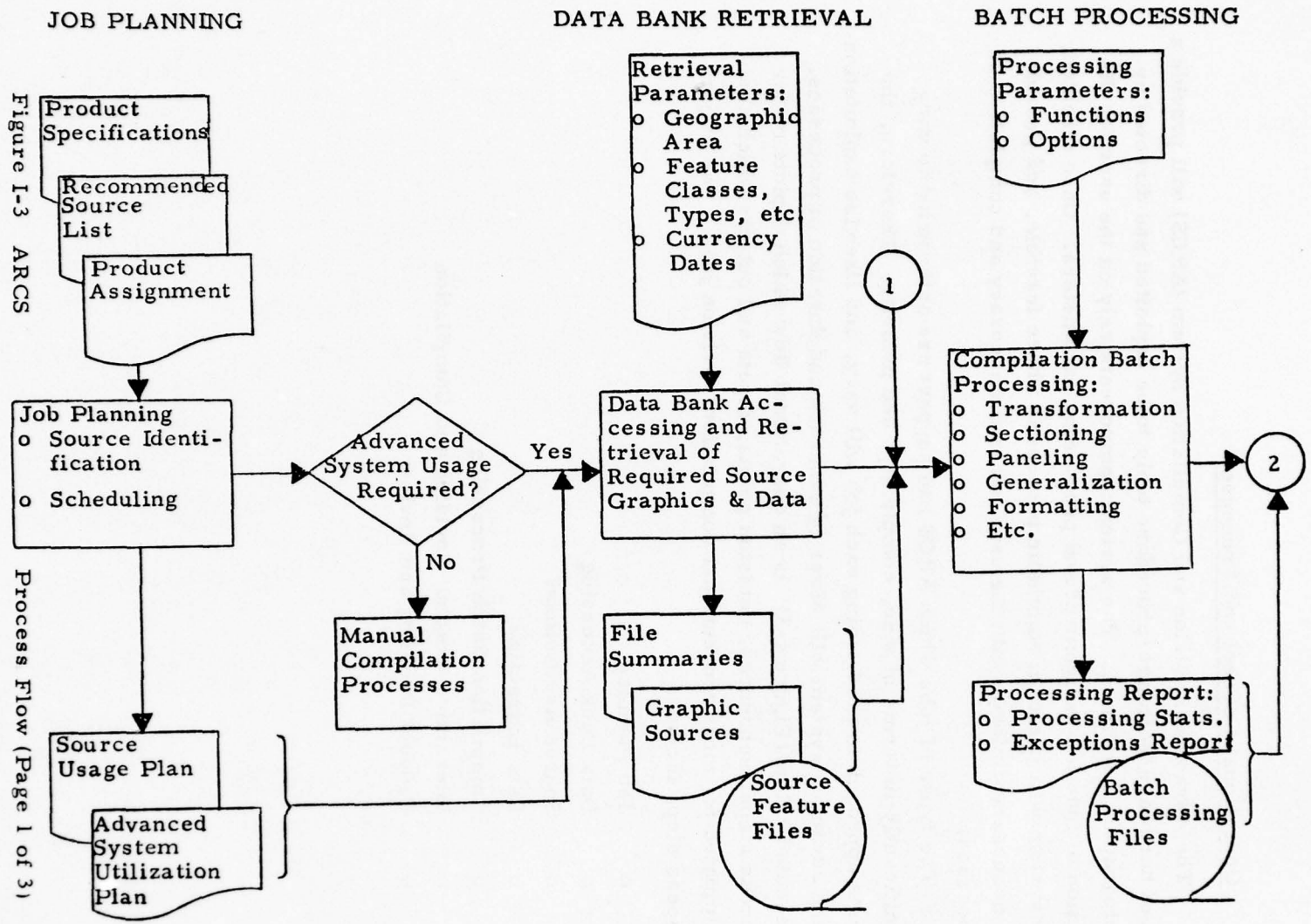

Figure I-3 ARCS Process Flow (Page 1 of 3)

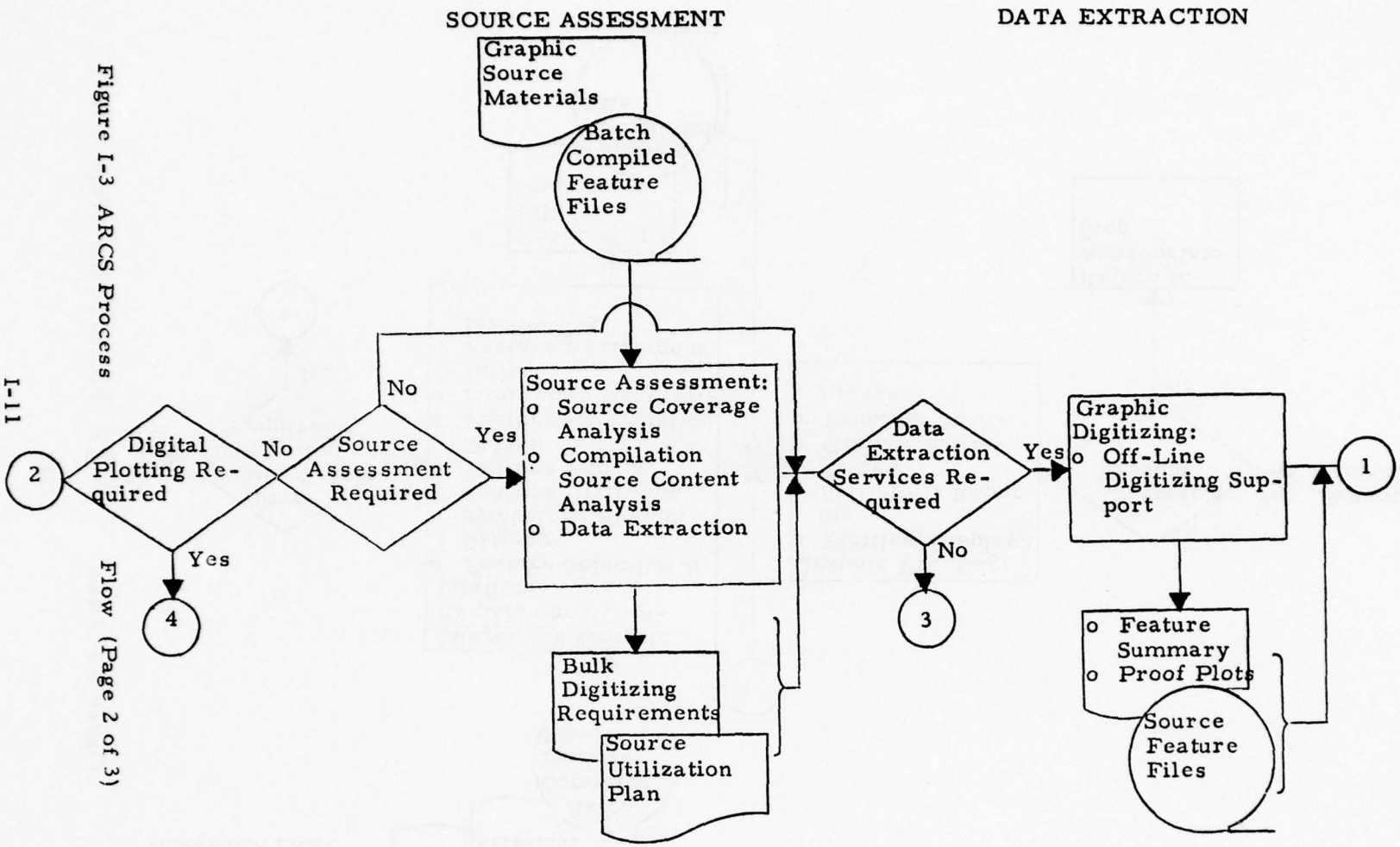

Figure I-3 ARCS Process Flow (Page 2 of 3)

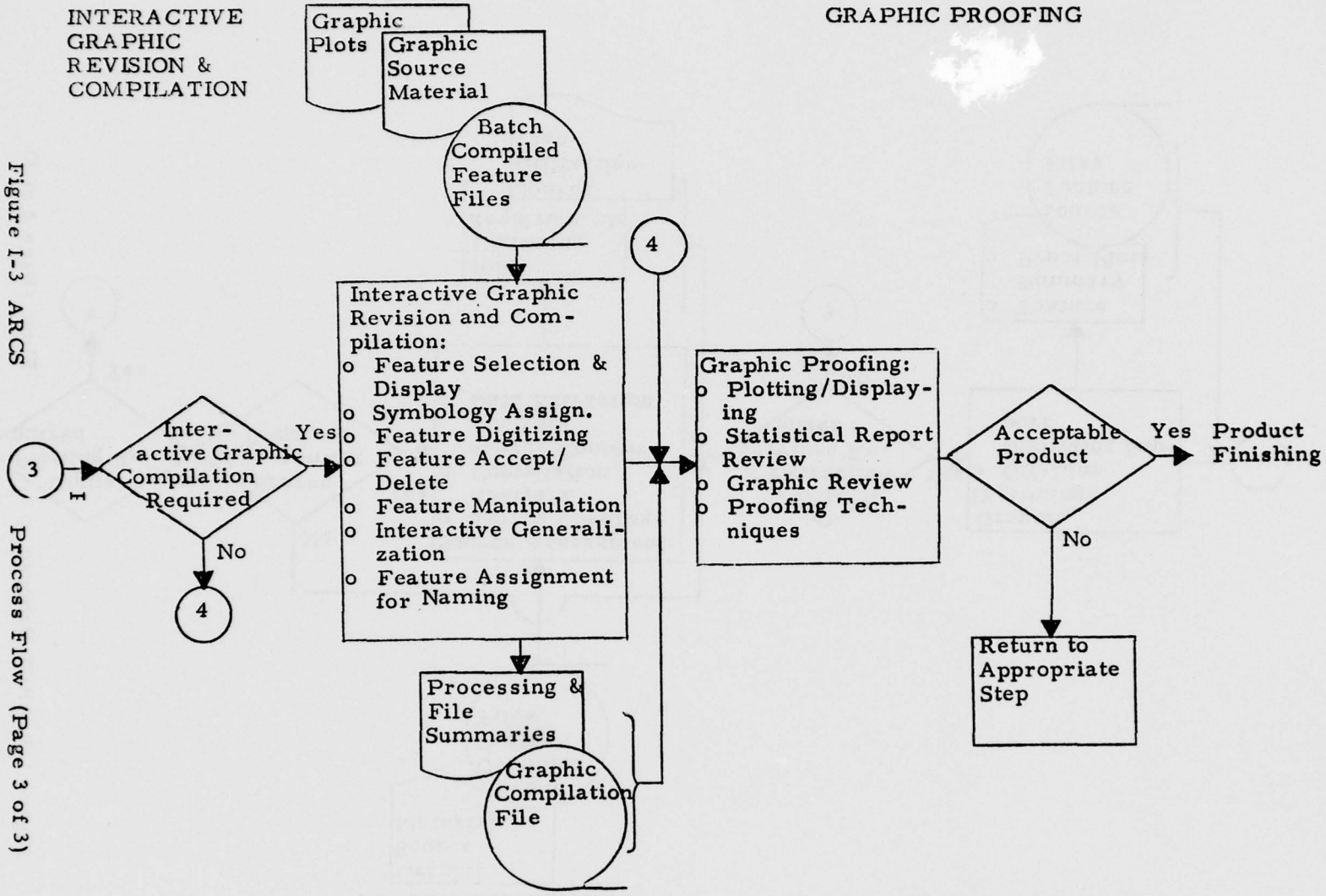

Figure I-3 ARCS Process Flow (Page 3 of 3)

F. Definition of Processing Subsystems

The operational concept and functional requirements of ARCS have been segmented into logical processing units. The segmentation is based on logical division of processing functions, and allows for flexibility in hardware configuration while maintaining complete commonality of interfacing processes. While integration of all functions of ARCS is feasible, more effective utilization of hardware resources could be realized by separation of certain functional areas.

Two major processing subsystems have been defined for the initial development model:

- o Graphic Compilation Batch Subsystem
- o Graphic Compilation and Interactive Subsystem

1. Graphic Compilation Batch Subsystem

The batch subsystem will provide the requisite set of cartographic data processing functions for reducing, transforming, commonizing, and formatting feature data for input to the interactive subsystem. The minimum set of functional processes required to support ARCS includes:

- o Sectioning
- o Geographic Transformation
- o Registration and Scaling
- o Paneling
- o Line Generalization and Data Reduction
- o Feature Extraction
- o Feature Symbolization
- o Digital Rectification

Typically one or more digital source file(s) will contain information of significant value for a product compilation. The cartographer will use the batch subsystem for extracting and compiling pertinent data from the source files and formatting the compiled data for subsequent plotting, displaying, and manipulation.

2. Graphic Compilation and Interactive Subsystem

The interactive subsystem will provide the cartographer with display and interactive hardware and software tools for reviewing and manipulating cartographic data. The subsystem will provide a wide range of processing capabilities to comply with various types of compilation/revision jobs and feature manipulation tasks. General functional areas to be provided by the interactive subsystem includes:

- o General Support - file input and output processing and related functions.
- o Graphic Support - graphic display functions.
- o Source Assessment - provides for assessment of geographic coverage and source contents.
- o Data Extraction - feature description and digitizing.
- o Feature Manipulation - basic feature edit functions.
- o Interactive Generalization - set of functions directed at major compilation problem areas.
- o Alphanumeric Text Assignment - functions to support assignment of features to be named and text positioning.
- o Graphic Proofing - services to support the validation of product quality.

G. Configuration Strategies

The design concept for ARCS defines a set of hardware/software tools which can be effectively expanded and/or reconfigured to conform to a wide range of DMA production requirements and management strategies for resource utilization. Future options in the configuration strategy vary from total integration of all subsystems to separation of all major subsystems.

- o Total Integration - all subsystems could be physically attached to a master processor and could be serviced by common tape, disc, printer, and teletype units. The primary attribute of this configuration is inclusion of batch functions on the master processor. Failure of any single unit (e.g., tape or disc unit controller, master processor) could disable all system capabilities.
- o Separation of Batch and Interactive Processes - all batch related processing functions could be installed on a standalone batch processing system. Batch processing requirements can be achieved independent of interactive processes and could easily be developed as a standalone subsystem without any significant degradation of the overall system throughput.
- o Configuration Options to Service Interactive Functions - the interactive functions generally include: interactive compilation and revision processes, graphic proofing, and source assessment. These functions require interactions with the source assessment, digitizer, refresh CRT, and large screen display devices. Usage of the three major devices is anticipated to be independent for certain sessions. Therefore the interactive subsystem can include three individual work station types. Each work station can service a separate job or function when not required by a user at one of the other stations. Based on these premises the hardware/software configurations for interactive functions could be designed to allow for various combinations of devices. Eventual configurations could therefore be based

on experience gained from test and evaluation and management plans for system usage in a production environment. A primary reason for considering various configurations is the goal of achieving cost-effective utilization of all system components. Making necessary allowances in the original system design is the recommended approach. Optional configurations of the interactive components for a processing environment could include the following:

- Combined Source Assessment/Refresh CRT/Large Screen Configuration - provides full capabilities and could permit simultaneous and independent use of all stations. This configuration represents the proposed development model and is discussed in detail in following sections.

- Standalone Large Screen Display Configuration - provides for independent usage of large screen display devices for: digital data assessment, compilation processes which are not dependent on highly interactive activities (e.g., general viewing, feature deletion/acceptance actions, etc.), and graphic proofing.

- Standalone Refresh CRT/Digitizer Configuration - provides ability to perform all compilation processes concerned with intensive interaction (e.g., feature generalization, realignments, feature adds, etc.). Major constraint is, of course, the limited ability to display and view the full graphic.

- Multi-Refresh Stations and Large Screen Display Configuration - This configuration would consist of two refresh CRT/digitizer stations and one large screen display device. Users at each of the CRT/digitizer stations would share use of the large screen device.

II. GRAPHIC COMPILATION BATCH SUBSYSTEM

A. Purpose

The primary purpose of the batch processing subsystem is to provide the set of batch software functions which are required to effectively commonize digital feature data towards product compilation. The software functions to be applied to a feature file may vary, depending on the particular product requirements and attributes of the digital source files being processed. The batch system is intended to provide those cartographic data processing functions which: can be effectively applied to large volume feature files in a batch or background processing mode; and can be predefined, in terms of processing functions and parameters, by cartographic users.

B. Functional Requirements

The potential set of functions to be included within the batch system consists of two groups: 1) a basic group of well defined processes which are mandatory for data commonizing and product formatting; and 2) an expanded group of application processes directed at detecting and resolving complex compilation problems. The expanded application processes are less established in terms of software techniques and feasibility. Therefore the software design must contain specific provisions for the basic set of required processes and general provisions for expansion and augmentation of higher level functional capabilities.

The basic set of required functions includes the following:

- o Sectioning
- o Geographic Transformation
- o Registration and Scaling
- o Paneling
- o Line Generalization and Data Reduction
- o Feature Extraction
- o Feature Symbolization
- o Digital Rectification

1. Sectioning

a. Purpose

The purpose of sectioning is to physically segment a cartographic feature file into two subfiles based on a defined set of area boundaries. All features which cross the defined boundaries will be divided into two or more segments and associated with either the interior (sectioned) or exterior (rejected) files. Compilation and revision applications of sectioning includes:

- o cleaning/deleting the boundary of a feature file to conform to the boundary of the required product;
- o preparing adjacent or overlapping files for subsequent paneling; and

- o extracting an outdated interior or exterior area of a file for merging/compilation of updated information.

b. Processing Parameters

- o Number and complexity of section polygons
- o Sectioning of both geographic and table rectangular coordinate formats
- o Option to retain either or both interior and exterior sectioned files for subsequent processing

2. Geographic Transformations

a. Purpose

The purpose of the transformation function is to convert feature files to a common compilation reference frame. Compilation reference frames should be table rectangular representations for any standard product projection system. File inputs can consist of geographic or table rectangular coordinate formats.

b. Processing Parameters

- o Input format - table rectangular or geographics
- o Projections - Transverse Mercator, Lambert Conformal, Polyconic, Polar Stereographic
- o Spheroids and Datums - preferred and optionally user defined models
- o Output format - reference frame and scale

3. File Registration and Scaling

a. Purpose

Paneling and, in general, piecing of table rectangular files together for plotting/displaying, requires one or both files to be registered. Given a master reference frame one or more feature files will be fitted to the master control. The transform parameters for translation, rotation and scaling will be based on: "best fitting" of sets of

common control points from each file to the master reference frame; or as specified by the user.

b. Processing Parameters

- o Definition of sets of control points for registration processing can be via user input or extracted from file contents
- o Mathematical fitting algorithm to be applied
- o Precision of fit acceptable
- o Process options - scale, translate/rotate, scale/translate/rotate

4. Paneling of Data Files

a. Purpose

Cartographic paneling implies concatenation of two or more files such that features which are logically continuous across a panel line are physically joined and smoothed at the intersection. Paneling is one of the basic compilation functions and will frequently be required for production jobs. In fact, it will be tasked with combining several source files for many product compilations. One of the reasons for combining continuous feature segments will be to achieve effective interactive processing and generation of continuous symbol patterns. Some applications, such as DRLMS, not only require logical joining of feature segments for terrain matrix creation, but also employ paneling for file merging. Paneling of feature files in either geographic or table coordinate formats is required because certain applications require the results yielded by unique attributes of paneling in either geographic or table formats.

b. Processing Parameters

- o Job setup and processing variables
  - number of panel files
  - definition of panel lines or determination of such lines
  - setting of tolerance for endpoint matching
  - feature segment join/no-join option
  - area of influence to use for feature segment joining

- extent of header match (i.e., class, type, subtype, description, numeric, etc.) required for acceptance

o Process Reporting -- complete reporting of paneling actions is important to subsequent processes. Examples of such data include the number of features paneled or feature segments which intersect with a boundary but could not be paneled because of header difference or excessive distance to a possible partner. Such features could be specially tagged and/or placed into an exception file for interactive processing.

5. Line Generalization and Data Reduction

a. Purpose

The purpose of this processing function will be to perform data reduction and, when required, to approximate the original line with a simplified, less convoluted line. The resultant line should still convey the the general character of the feature, in concert with the product scale. Basically, the compiler will request the function to smooth curvilinear lines which are "too busy" for the product scale.

Data reduction is the process of reducing the data point resolution. The process is primarily performed after scale reduction (e.g., 1:50,000 large-scale graphic reduced to 1:250,000 medium-scale graphic) to eliminate data points which are no longer significant to the delineation. Reduction of data points is highly significant to processing time and digital storage required for subsequent compilation and chart finishing processes.

b. Processing Parameters

o Line cleaning and data reduction options

o Line smoothing options

o Holding of critical point locations

6. Feature Extraction

a. Purpose

The purpose of this function is to automatically extract features, based on classification, which are significant for the product compilation. Cartographic information to be shown on charts is dependent on product purpose, specifications, scale, information available, and special attributes of the geographic areas. Extensive feature selection/suppression can be directed by the compiler and performed automatically since selection criteria are well defined for a specific compilation and features are defined in terms of a detailed classification scheme.

b. Processing Parameters

- o Level of feature definition
- o Feature code masking
- o Feature selection specifications

7. Feature Symbolization

a. Purpose

The purpose of feature symbolization is to generate feature symbols for plotting or displaying of unique feature groups for visual interpretations. The automatic symbolization provides an effective tool for portraying feature groups according to established patterns. Cartographic symbology is composed of various combinations of lines, dashes, spaces, ticks, double lines, and point symbols (e.g., dots, squares, circles, etc.).

b. Processing Parameters

- o Symbol specification files
- o Specification overrides
- o Symbol output format

8. Digital Rectification

a. Purpose

The purpose of this function is to correct distortions of aerial photography due to camera platform orientation, image motion, and terrain elevation differences. Feature lines digitized directly from photography can be digitally corrected for further compilation work.

b. Processing Parameters

- o Imagery type (panoramic or frame)
- o Ephemeris data
- o Control data
- o Elevation data

C. Interfaces

The batch subsystem will interface with a data bank system and the Graphic Compilation Subsystem. The basic interfaces consist of digital feature data and job control and processing information.

Inputs

- Data bank digital feature files
- Graphic processing files
- Process control parameters

Outputs

- Processing summary reports
- Graphic processing files

D. Hardware Requirements

The Batch Subsystem will require standard hardware services under a central computer system:

- Computer system with 32K - 64K words of memory.
- Two, 9-track magnetic tape units.
- Disk space for program files and temporary feature files.
- Card reader.
- High speed line printer.

E. Software Requirements

The batch software must operate within the control mechanism of the operating system of the host computer. Programming language and conventions should conform to FORTRAN V and/or ASCII COBOL. Program organization should be modular and allow for a high degree of functional expansion, program overlaying, and execution of multiple functions. Considerations should be given to restart/recovery if processing times are expected to be extensive (i.e., greater than 30 minutes CPU time). Major program areas will include the following:

- Job setup
- Job control and monitoring
- File input and output processing
- Functional processing
- Process reporting

III. GRAPHIC COMPILATION & INTERACTIVE SUBSYSTEM

This section of the report includes a functional design specification for the Graphic Compilation and Interactive Subsystem.

A. Purpose

The purpose of the Graphic Compilation and Interactive Subsystem is to provide an integrated set of hardware and software which will provide interactive tools for cartographers to compile, review, and manipulate cartographic data towards product compilation. The type of manipulation will vary depending upon the characteristics of the source and requirements of the desired product. A premise is that the digital source has been commonized by previous batch processing. Further, the digital source may be incomplete and additional feature extraction may be warranted from supplementary graphics. Inherent in this basic concept is the requirement that digital features are encoded such that they may be retrieved by description and/or by location.

B. Interfaces

Cartographic feature files which will be input to and output from the Graphic Compilation and Interactive Subsystem will constitute the interfaces between Graphic Compilation Batch Subsystem, Graphic Finishing System, and other related compilation processes.

- o Source Feature Files
  - Contains digital feature data.
  - File is possibly associated with a specific source material.
  - File typically will require batch processing.
- o Batch Processing File
  - File which contains feature data commonized as a result of batch processes.
  - Coordinate location data is formatted to a common projection system, datum, and scale.
  - Features which were associated with any form of error situations are appropriately flagged for special handling by compiler at the compilation station.
- o Graphic Compilation File
  - Final compiled line-center file.
  - Symbol directives could be included in feature header records.
  - This file is the primary interface with the Graphic Finishing System.
- o Names Placement File
  - Special file containing textual names, start location and orientation parameters.
  - File could interface with geographic names specialist and names placement system.
  - File could be integrated with Graphic Compilation File.

C. Functional Requirements

The Graphic Compilation and Interactive Subsystem will permit the compiler to interactively perform functions analogous to those of the manual compilation processes.

Exact sequences and types of processes to be performed or directed by the compiler at the compilation station will vary from one job to another. General compilation actions to be performed include:

- Examination and assessment of the geographic coverage and limits of various source graphics and digital data files.
- Determination of source content adequacy, potential conflicts of feature information and feature revision requirements by visual comparison of composite digital and graphic sources.
- Identification of source selected for extraction of digital feature information and further compilation.
- Suppression of insignificant features due to size, relative importance or over-congestion.
- Resolution of feature conflicts/coalescence.
- Corrections of errors/inconsistencies due to minor data base errors and/or batch processing problems.
- Determination and flagging of features to receive special symbology.
- Review and verification of overall feature content and presentation in view of product requirements; and
- Change of feature portrayal to reflect increased or decreased relative importance (e.g., conversion of city outline to point symbol).

The list of general compilation actions to be performed at the Graphic Compilation and Interactive Subsystem must be translated into a succinct set of hardware/software functional requirements. The functions defined below are required for the compilation of cartographic products in an

interactive computer-based environment. These functional capabilities may be categorized into the eight following areas.

- o General Support
- o Graphic Support
- o Source Assessment
- o Data Extraction
- o Feature Manipulation
- o Interactive Generalization Aids
- o Alphanumeric Text Assignment
- o Graphic Proofing

With the exception of the General Support functions, the functions of the Graphic Compilation and Interactive Subsystem rely on a high degree of interactive dialogue between the cartographic compiler personnel and a combination of computer-controlled display devices, digitizers and keyboards. These physical devices and their specific functions must be logically arranged in order that the man/machine interaction is effective and effortless. A complete breakdown of the major functional categories into discrete autonomous functions is presented below.

1. General Support

The general support functions provide compilation assistance to the operator and are predominately invoked by the compiler internally controlled and executed by the system.

- o File Input: tape to disk.
- o File Structuring: index file for interactive processing.
- o File Output: disk to tape.
- o File Filtration: extract feature subsets.
- o File Merge: combine feature subsets.
- o File Registration: register graphic to digital file.
- o Intermediate Proof Plotting: obtain hardcopy of compilation file.
- o File Processing Summary: statistical report to support proofing for compiler and reviewer.
- o Job and Process Reporting: generate miscellaneous reports pertaining to job planning, component utilization, job statistics, and source coverage analysis.

- o Assignment of Display Symbology Specifications: building and updating of compilation symbology specifications.
- o Feature Transformation/Rectification: computes and applies transform and/or rectification parameters for converting graphic input (i.e., maps and photos)data to compilation reference frames.
- o Print: format reports for printing on the hardcopy printer.

2. Graphic Support

The graphic support functions assist the compiler to obtain a quality view of the digital cartographic data through the available display devices. These functions are implicitly invoked by the compiler at his compilation station and are automatically controlled and executed by the system.

- o Graphic Display: display files or subsets relative to specified center reference point and feature group selection set.
- o Augment/Suppress Current Display: specify subsets to include/exclude from display.
- o Scaling: obtain greater separation of displayed graphic information.
- o Subarea Definition: localize compiler actions to a smaller area with the Graphic Processing file.
- o Feature Group Selection: by area and descriptors.
- o Graphic Registration: interactive definition of registration control parameters.
- o Menu Manipulation: permit man/machine dialogue via A/N CRT.
- o Temporary Symbology: temporary assignment of special symbols for interpretation support.
- o Display Symbolized Features: convert center line display to symbolized display.

- o Display Annotation: display names and/or special numerics associated with displayed features.
- o Hardcopy Plot: generate a "quick" look plot of current display or portion of Graphic Processing file.
- o Suppress Symbology: redisplay center line data.
- o Cursor Control/Display: display cursor symbol relative to position of manual tracking tool.
- o Find Feature: retrieve feature and highlight display to notify compiler.
- o Accept Graphic: accept all revisions and purge previous transactions.
- o Accept Display: temporarily accept all transactions performed to the displayed features.

3. Source Assessment

These functions allow the compiler to assess the geographic coverage and content of source materials. The majority of this functional area will be served by the source assessment hardware device.

- o Source Coverage Analysis: allows for entry of source area limits and composite display of coverage of multiple sources.
- o Graphic Image Parameters: allows for entry of hardware settings (e.g., scale, positioning, etc.) prior to data extraction. This information will be carried with the resulting digital file and will permit re-creation of image orientations.

4. Data Extraction

These functions permit the graphic digitization of features from supplementary source materials. Features will also be described by the entry of relevant classification parameters.

- o Feature Descriptor Entry: enter feature descriptors conforming to a classification scheme.

- o Feature Trace: digitize feature by trace or point mode entry.

5. Feature Manipulation

The feature manipulation functions modify the graphic representation of feature data by direct compiler interaction with the hardware tools and applications software of the system. These functions pertain to specific feature actions. Feature manipulations which exceed a specified tolerance will be appropriately flagged.

- o Feature Shift: eliminate feature coalescence or reduce congestion by "pulling" a feature or feature segment. Definition of a "pull point" and endpoints of the segment to be shifted will result in a graduated shift of the feature segment.
- o Feature Segment Edit: allows for replacement or deletion of any segment of a feature with a new traced segment. This includes end segment modify or delete and mid-segment modify or delete.
- o Auto Revision Edit: ability to automatically merge feature "edit segments" with specified original feature lines. The edit segments: can physically reside on revision update files, compositely displayed with a product compilation file, and selectively merged.
- o Segment Feature: create a new feature from a segment of another; used for symbology changes in continuous features; may enter new header.
- o Delete Feature: flag indicated feature as being deleted.
- o Accept Feature: flag indicated feature as being accepted.
- o Feature Join: either end to end; end to junction; closure.
- o Feature Clip: clip end of feature at junction.
- o Feature Header Modification: display descriptors and modify.

6. Interactive Generalization Aids

Interactive generalization is anticipated to be one of the more powerful interactive compilation functions. All generalization aids will be applied at the discretion of the compiler. The capability to add additional aids to the system is required. This area is expected to be expanded with time.

- o Eliminate Insignificant Features: all features smaller than specified size in given area and of certain feature description.
- o Elimination of all but a Selected Set of Features: retain only features in a given area of a particular feature description group.
- o Line Generalization: smooth a specific feature or subset of displayed feature groups. Select generalization type, and identify hold points (specific feature actions).
- o Conversion of Feature Outline to Center Point: replace with a circle of specified size and connect all previously intersecting features to circle.
- o Conversion of Feature Group to Outline: bound area and delete all features of particular description within and retain outline.
- o Double to Single Line Generalization: eliminate redundancy of parallel features or segments.

7. Alphanumeric Text Assignment

These functions will permit the compiler to assign names to particular features and to specify the positioning of alphanumerics.

- o Names Placement: enter text and its orientation for special names file, or define orientation of names already associated with features.
- o Annotation Placement: enter text and its orientation for areas (non-features).

8. Graphic Proofing

This functional area will permit compiler/reviewer to review the compilation job and validate the integrity of the actions performed and associated digital product. These capabilities will basically rely on other functional services described in the above sections.

- Statistical Record: major compilation actions will be recorded with the job log for subsequent review. Reports describing the processing activities and compilation file summary can be produced.

- Displays and Plots: displays and plots of selective feature information (e.g., including before/after information) can be generated for proofing.

D. Operational Goals and Requirements

1. Accuracy/Precision Requirements

Display of cartographic quality information which complies with compilation tolerances at scale requires the following accuracy/precisions.

Addressable Resolution	.002"
Increment Size	.002" (minimum for closure)

(Normal increment sizes will average .004" to .010" depending on mix of feature types and extent of data compaction applied prior to input to the compilation subsystem.)

2. Data Volumes (Batch Processing Files)

- Small Chart Format Capability (high density)
  10,000 Features
  2,500,000 Data Points (assuming high resolution of 250 points/feature).

- Large Chart Format Capability (high density)
  52,500 Features
  13,200,000 Data Points (assuming high resolutions of 250 points/feature).

For the purpose of establishing practical design criteria for data handling, it is assumed that the size of the largest Batch Processing File will be derived via one-fourth of the large chart format with a 50% overage of source feature information.

- Batch Processing File
  20,000 Features
  5,000,000 Data Points

3. Format Size

Small Graphic Format - 19" x 27"
Large Graphic Format - 38" x 54"

The size of the graphic represented by the Batch Processing File will typically conform to the small graphic format or 1 quadrant of a large graphic format.

4. System Response Times (Man/Machine Communications)

Command/Control - 1 Second

Single Feature/Point Location Finding - 3 to 5 seconds

Graphic Refresh CRT Display: Full Area - 10 to 20 seconds; Local Feature Change Display 3 to 5 seconds.

Large Screen Display: Full Area (medium density chart) 30 seconds to 3 minutes (depending upon feature group selection and symbology).

5. Display Characteristics

To allow the user to quickly interpret feature categorization, graphic displays must provide for at least 6 levels of line differentiation. The 6 levels can be accomplished by any combination of techniques, including: color, line weight, grey shading, or line symbology. Basic line symbology (i.e., dashing, ticking and casing) is required to provide, in addition to interpretation support, near finished symbol presentation. Line weights should be representative of final symbol sizes considering feature type and display scale. Desired line weights which are discernable and representative are 4, 8, and 12 mils at 1X and 8, 12, and 16 mils at 2X.

6. Physical Environment

The environment of the advanced compilation system must be conducive to human control and interaction without undue hardships because of hardware characteristics or unnecessary wires, gadgets, buttons, etc. Functionally associated hardware devices should be integrated where feasible, to allow for effective human control and interaction.

E. Hardware Configuration and Component Requirements

This section presents the proposed hardware configuration, requirements, and design elements constituting a development model of the Graphic Compilation and Interactive Subsystem. Individual components are identified in terms of their performance characteristics relevant to the subsystem requirements.

1. Configuration Overview

The initial development model is an ensemble of multiple compilation stations as illustrated in Figure III-1. As portrayed in Figure III-1 three individually configured compilation work stations (i.e., Source Assessment Station, Interactive Compilation Station, and Proofing Analysis Station) are supported by the initial development model. Collectively, these work stations are called the interactive subsystem which is comprised of the following functionally related components:

- o A/N CRT and Keyboard
- o Refresh Graphic CRT & Processor
- o Special Function Keyboard
- o Large Screen Display and Trackball
- o Graphic Digitizer Table and Cursor
- o Source Assessment/Data Extraction Device

Table III-1 illustrates how particular subsets of these components can be operationally combined to perform the major system applications.

The stringent processing requirements imposed by the feature densities to be displayed at the refresh CRT necessitates a dedicated graphic display processor. A goal of the system design is to display as much of the digital graphic as possible in a flicker-free manner over a comparable area of the CRT screen. In order to accomplish this, the graphic display processor must expend most of its processing power refreshing (writing) the current CRT image. Clearly, the writing speed of the CRT determines the minimum processing requirements and the memory size of the graphic display processor. It is not anticipated that sufficient processing power is available at the graphics display processor to perform any other major graphic processing function.

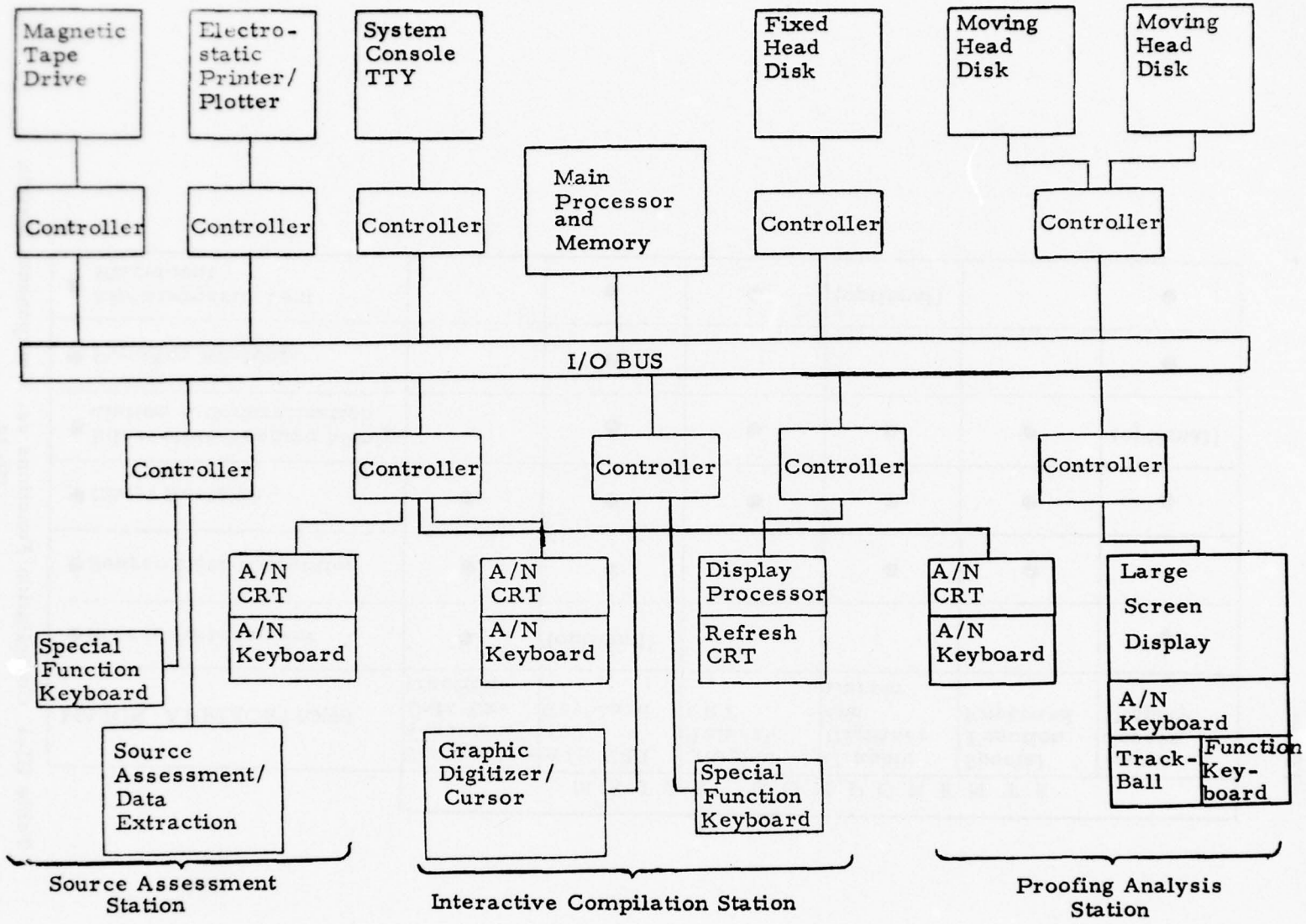

Figure III-1 Graphic Compilation and Interactive Subsystem

MAJOR APPLICATIONS	MAJOR COMPONENTS					
	Source Assessment/ Data Extraction	A/N CRT and Keyboard	Graphic Refresh CRT	Graphic Digitizer and Cursor	Special Function Keyboard	Large Screen Display
● Source Assessment	●	(optional)				●
● Source Data Extraction	●	●		●	●	
● Chart Revision	●	●	●	●	●	●
● Interactive Feature Manipulation & Generalization		●	●	●	●	(optional)
● Proofing Analysis		●				●
● Alphanumeric Text Placement		●	●	(optional)		●

Table III-1 Compilation Functions vs. Components Matrix

The main processor provides the necessary control for the other components of the compilation station including:

- o A/N CRT and Keyboard
- o Special Function Keyboard
- o Large Screen Display and Track Ball
- o Graphic Digitizer Table and Cursor
- o Source Assessment/Data Extraction Device

In addition, the main processor provides general support in controlling the following peripherals:

- o Magnetic Tapes
- o Moving Head Disks
- o Fixed Head Disks
- o Electostatic Printer/Plotter
- o System Console TTY

The main processor should be chosen on the basis of satisfying the overall requirements of the initial development model of the Graphic Compilation and Interactive Subsystem. The processor should also be sufficiently flexible to support a single or any combination of work station types.

The development of operating software for the various processors constituting the initial development model of the Graphic Compilation and Interactive Subsystem requires certain hardware and software that is not required for the operational configuration. Normally, each processor vendor supplies the necessary basic software tools, such as text editors, debug packages, symbolic assemblers, etc., as part of the hardware purchase. These packages, however, often assume or depend upon the presence of certain input/output devices, as well as the availability of supplemental mass storage. The specific hardware devices required for system development support will depend largely on the processor vendors selected.

2. Component Requirements

The establishment of hardware performance characteristics for the Graphic Compilation and Interactive Subsystem is based on the results of analysis of interactive compilation requirements and technology assessments. Practical design criteria have been formulated by reconciling subfunctional requirements with state-of-the-art performance characteristics.

a. Large Screen Display

(1) Purpose

The primary role of this device is to provide high quality displays of the overall compilation product. The display will permit presentation of the entire graphic processing file at the same scale as the compilation reference frame. The large screen display will provide an on-line proofing plot capability which will permit the compiler to rapidly verify the contents of his working data file as the compilation progresses. Although viewed primarily as a display device only, the large screen display will also allow some compilation actions that do not require a high degree of interactivity. Some of the generalization functions which perform bulk deletion of feature groups are potential candidates:

- o Delete Feature
- o Accept Feature
- o Eliminate insignificant features
- o Retain selected set of features and eliminate all others

Additionally, merging of revision feature information with original information (Auto. Feature Edit) is planned for the large screen display device. Another function provided by the Large Screen Display will be to maintain a continual status on features currently being interactively manipulated. This type of use will identify which features have already been manipulated and the type of manipulation that was performed. Since the status of all compiled features will be permanently saved, the ability to subsequently display the status of all compiled features on the large screen display will be of significant use for in-process reviewing.

The compiler would have the optional ability to work directly from the large screen display by selecting areas of interest and pointing to particular features with an accompanying tracking tool such as a track ball. These same functions could also be exercised at a digitizing table with a digitizing cursor ganged to the movement of a cursor symbol on the large screen display. Man/machine dialogue at the large screen display will also be supported by the availability of an alphanumeric and function keyboard. This is one example of the flexibility which must be designed into the subsystem to give the compiler a reasonable degree of freedom during a compilation session.

(2) Performance Characteristics

- Accuracy/Precision

Addressable resolution	$\leq$ .002"
Minimum spot size	$\leq$ .008"
Vector size (minimum)	$\leq$ .002"
Repeatability	$\leq$ .05%
Vector Size Diversity	.002" to .010"

- Image Size

Minimum:	19" x 27"
Optimal:	37" x 53"

- Maximum Display Volume

Minimum screen (19" x 27")	$\geq$ 20,000 inches (5,000,000 short vectors)

- Character/Symbol Generation

Variety:	60 characters (compatible with A/N CRT keyboard set)

- Line Differentiation

Minimum:	6 levels
Recommended: (via hardware or software techniques)	3 Line Weights: 8, 12, 16 mils; 3 Symbol Types: dash, tick, dot

- o Display Speeds

  10,000 short vectors/second (4 to 10-mil vectors)

- o Dynamism

  Refresh graphic/cursor superpositioning
  Write/erase characters/point symbols - 250 minimum

- o Cursor Control

  Track ball and automatic cursor tracking

- o Alphanumeric Keyboard

  Standard alphanumeric

- o Function Keyboard

  Minimum number of keys = 30

- o Hardcopy Output

  Diazo microfilm copy capability

b. Graphic Refresh CRT

(1) Purpose

The purpose of the graphic refresh CRT is for rapid display of cartographic features. The graphic refresh CRT serves primarily as a feedback mechanism for the feature manipulation functions. The compiler may verify his feature manipulation actions which are performed via a manual tracking cursor at the digitization table. The feature modifications are instantly reflected in an updated display of the new cartographic data. By linking with the digitizing cursor, the graphic refresh CRT provides dynamic interactivity between the compiler and the digitally compiled product. The graphic refresh CRT complements the relative lack of dynamicism of the large screen display. While the compiler needs the perspective offered by the overview presentation of the large screen display, the refresh CRT allows him to focus his attention on the immediate geographical vicinity of the features he wishes to manipulate.

(2) Performance Characteristics

Write-only device.

- o Accuracy/Precision
  - Addressable Resolution: $\leq$ .005"
  - Spot Size: $\leq$ .012"
  - Vector Size: $\leq$ .005" (Variable sizes)
  - Relative Positioning Accuracy $\pm$.005"
- o Image Size
  - Minimum: 10" x 10"
- o Display Volume
  - $\geq$25,000 vectors at 30 frames per second (e.g., 250 features at 1 inch/feature and 100 vectors/inch)
- o Brightness
  - $\geq$ 25 foot lamberts
- o Line Differentiation
  - Minimum: 6 levels (via hardware or software techniques)

c. Alphanumeric CRT and Keyboard

(1) Purpose

This device is used for command/control communication between the compiler and the system. As an alphanumeric display the compiler is instructed what to do during some of the more intricate compilation procedures. Features that are retrieved may be more fully identified by a review of displayed feature descriptors. In the data entry mode for entering compiler commands or modifying feature descriptors each keystroke is echoed on the display screen for review.

The keyboard is logically integrated with the alphanumeric CRT but is physically independent. The keyboard may be detached and positioned about the surface of the digitizing table for the convenience of the compiler.

(2) Performance Characteristics

- Keyboard
  Standard alphanumeric
  Detachable
- Display Volume
  Minimum 20 lines @ 60 characters/line
  Character height: .125" - .25"
- Writing Speed
  Full screen $\leq$ 1 second
- Required Features
  - ASCII code
  - cursor control in all directions including home and return
  - display symbols $\geq$ 96
  - addressable cursor
  - cursor blinking
  - line or character insert and delete
  - buffering (line)

d. Graphic Digitizer/Cursor

(1) Purpose

The digitization table will be at the center of the compilation activity. Affixed to the table will be a plot of the graphic processing file or other graphic sources from which the compiler will selectively compile the product file. After registering the plot to its digital representation residing on disk, the compiler may use the digitizing cursor to point to areas of interest for the purpose of defining areas to be displayed or defining point locations for feature manipulation and interactive generalization. The digitizing cursor is the primary tracking tool for entry of graphic coordinate locations for feature transactions and low volume feature digitization. Movement of the digitizing cursor can be "ganged" to either of the graphic display devices with special cursor symbols marking the current relative position of the cursor. The digitizing cursor when placed at a location on the hardcopy graphic will result in the display cursor symbol to appear at the identical relative position on the graphic display.

(2) Performance Characteristics

- Table Characteristics ($\geq$ 42" x 58") usable digitization area (backlighting desirable)
- Resolution: $\leq$ .001"
- Overall Accuracy: $\leq \pm$.005"
- Repeatability: $\leq$ .001"
- Cursor:

  Free-moving for pointing and tracing

  Minimum no. of control buttons = 5 (e.g., FIND, POINT, TRACE EDIT, etc.)

Mechanical Adjustments

- o Tilt
- o Height

Physical Structure

- o Capable of providing a separate gantry above the table for placement of the refresh CRT and A/N CRT.

Interface

- o Interface control unit for integration with main processor.

e. Special Function Keyboard

(1) Purpose

This device is physically small and very mobile. The purpose of the special function keyboard is to quickly and easily initiate applications software responsive to the interactive compilation functions. Depression of appropriate buttons by the compiler will control the sequence of events taking place at the compilation station. Functions that may be controlled by the Special Function Keyboard (SFK) include:

- o Graphics Display
- o Augment/Suppress Current Display
- o Scaling
- o Display/Suppress Symbology
- o Generalization
- o Feature Manipulation

(2) Performance Characteristics

- o Mobility - keyboard must be light and small in order to be easily moved about the graphic digitizing table.
- o Function keys - functionally color-coded and programmable backlighting very desirable. Minimum No. of keys = 42.
- o Interface - provided to interface device with main processor.

f. Refresh CRT Display Processor

(1) Purpose

The display processor executes a list of display commands that define the object to be shown on the CRT face. Ordinarily the display processor does not modify the display list. The actual construction or modification to the display list is left to a more conventional miniprocessor, which, depending on the particular vendor, may or may not be a part of the refresh CRT device. Commands interpreted by the display processor can control scaling, rotation, intensity modulation, "blinking" and display "windowing", in addition to the presentation of the basic graphic picture.

(2) Performance Characteristics

The display processor must have sufficient processing speed and memory capacity to support the required Refresh CRT display volume in a "flicker-free" manner.

g. Main Processor

(1) Purpose

The purpose of this processor is to provide the necessary control, functional support, and interface for the following components of the graphic compilation station:

- o Source Assessment/Data Extraction Device
- o Alphanumeric CRT and Keyboard
- o Special Function Keyboard
- o Graphic Digitization Table/Cursor
- o Large Screen Display
- o Fixed Head Disk Controller/Multiple Disks
- o Moving Head Disk Controller/Multiple Disk Drives
- o Magnetic Tape Controller/Multiple Tape Drives
- o Electrostatic Printer Plotter
- o System Console TTY
- o Refresh CRT

The main processor must provide adequate computational and storage capacity to satisfy the overall requirements of the Graphic Compilation and Interactive Subsystem. One of the goals of the system design is to select a processor and peripheral equipment configuration to support the initial development model and allow for some flexibility in hardware enhancement to support additional functions. For example, the initial development model should permit upward/downward reconfiguration for inclusion/exclusion of the following compilation station components:

- o Alphanumeric CRT and Keyboard
- o Special Function Keyboard
- o Graphic Digitization Table/Cursor
- o Refresh CRT
- o Large Screen Display
- o Source Assessment/Data Extraction Device

The maximum limits of the data transfer capacity, number of peripheral controller slots, number of external interrupts and memory size are important factors to be considered during the selection process.

(2) Performance Characteristics

- o Word Size
  - 16 or 32-bit (8-bit byte addressable)
- o Memory Size
  - 128-192K bytes depending upon exact requirements of operating system and final placement of functional software.
- o Maximum Memory Expansion Size
  - 256K bytes (minimum)
- o Memory Speed
  - $\leq$ 1 microsecond per cycle
- o Microprogramming (optional)
  - Read only memory, user programmable
- o Memory Type
  - Core or semiconductor
- o Storage Protection
- o Number of General Purpose Registers
  - Arithmetic (multiple)
  - Index (multiple)
- o Time to Add Memory to Register
  - $\leq$ 2.0 microseconds
- o Hardware Multiply/Divide
- o Extended Fixed Point Arithmetic
- o Hardware Byte Manipulation
- o Stack Hardware
- o Internal Code - ASCII

- o Floating Point Hardware
- o Real-time Clock
- o I/O Word Size
  - 16 or 32 bits
- o Direct Memory Access
  - Supports up to 8 device controllers
- o Maximum Channel Capacity
  - 2 mhz (minimum)
- o External Interrupts
  - Vectored for 32 devices (minimum)
- o Peripherals/Controllers
  - 1 9T magnetic tape controller
  - 2 9T magnetic tape drives
  - 1 Disk pack controller
  - n Disk pack drive(s); 40 megawords capacity each*
  - 1 Fixed head disk controller
  - n Fixed head disk platter(s) (256K words each)*
  - 1 Electrostatic printer/plotter controller
  - 1 System console TTY
  - 1 High speed communications interface for Graphic Display Processor
  - DMA type synchronous
  - Full duplex
  - 16-bit parallel transfers
  - 1 Controller for A/N CRT and Keyboard
  - 1 Controller for Large Screen display keyboards and trackball

*Variable depending whether batch compilation subsystem is integrated with the interactive subsystem.

h. Electrostatic Printer/Plotter

(1) Purpose

In the Graphic Compilation and Interactive Subsystem both the plotting and printing capabilities of this device may be exploited. Used as a printer, file summary reports and in-process proofing statistics can be quickly obtained. In the graphic mode, hardcopy "quick" plots of the graphic display images and feature files can be generated.

(2) Performance Characteristics

- Graphic/Alphanumeric Modes - simultaneous
- Accuracy/Precision
  Accuracy: $\leq \pm .2\%$ over full width
  Addressable resolution: 200 dots per inch
- Speed - Graphic Mode
  Paper rate: 22" wide x 1" length/second
- Speed - Alphanumeric Mode
  $\geq$ 500 lines per minute
- Character Generation
  - 120 total
  - upper and lower case (alphabetic)
  - 200 characters/line
- Form Widths
  $\geq$ 22"
- Paper Type
  Opaque or translucent

i. Source Assessment/Data Extraction

(1) Purpose

This device is highly effective for performing source coverage analysis, comparison of source material; chart update reviews, and revisions to digital feature files. Although sources requiring extensive feature digitization are expected to be processed by other specialized digitizing systems, this device supports direct data extraction and feature deletion. The compiler can superimpose two graphic sources onto a single viewing plane for visual comparison and assessment. Further, a transparency graphic or plot can be positioned on the table surface for superimposition and comparison with the other two projected images. Data extraction can be accomplished by displaying the sources (i.e., true scale or geometrically transformed), identifying the control information, and digitizing the selected features by means of a manual cursor.

(2) Performance Characteristics

o Table Surface and Viewing Plane Characteristics

- Minimum (20" x 30") usable work area for digitization, viewing of imagery and placement of graphic materials.
- Projected image plane must be coincident with the top side of the table surface to minimize parallax.
- Placement of transparent graphics on the table surface nor user movements above the table should restrict or interfere with the projected image display.
- The medium of the viewing surface should minimize the diffusion of the projected image so that a clear, sharp image is maintained.

- The graphics table must provide coordinate digitizing in a manner compatible with the other graphic digitizer component (i.e., same data format, accuracy, resolution, etc.)

o Graphic Source Formats

- Positive Litho — 20" x 30" Maps/Charts/Plots (10" x 14" should be viewable) option for handling (mounting) large formats would be desirable.

- Positive Film (Frame and Panoramic Format)
  9" x (variable length)
  9" x 18"
  6" x (variable length)

o Graphic Display Characteristics

- Simultaneous display of at least two independently projected images.
- Each source image display area should allow for no less than 10" x 14" and may be manually repositioned anywhere within the usable table surface area.
- Display only segments (windows) from either of the source graphics.
- "Flip" either image on or off.
- Visually distinguish each separate source image (e.g., highlight each image with a different tint, color, or intensity level).
- Permit true color images.
- Permit color filtration for suppressing major colors/tints from the viewed image.
- Independent focusing of each source image.

o Display Accuracy

- Positional Accuracy of the graphic image identical to the true scale hard copy version of the graphic ($\pm$.002").

o Image Transformation/Rectification

- Each graphic display mechanism must provide for independent positioning of its projected image.

- The following image transforms may be applied independently to both source images:

  -- 2 axes scaling (anamorphic transformation along either orthogonal axis). Axes orientation is selectable and independent scaling $\pm$ 10%.

  -- Scaling range for each source image (. 2 to 2X)*

  -- Translation (to allow for overlap of images at any position within the display area)

  -- Rotation (0^{o} to 360^{o})

*While this range of image scaling is highly desired, cost tradeoffs should be considered. Scaling of sources on a separate copy camera is believed to be more cost effective. For example map sources could be scaled on the copy camera. The resulting microform could be loaded on the projector at the assessment device for comparing with roll film imagery. The range of scaling could then be reduced to $\pm$10%.

F. Software Organization and Processing Requirements

1. Overall Organization

The software of the Graphic Compilation and Interactive Subsystem is functionally organized under the following major programs (see Figure III-2:

- o Executive
- o Data Management
- o General Support
- o Source Assessment
- o Data Extraction
- o Interactive Feature Manipulation
- o Refresh Display
- o Interactive Generalization
- o Alphanumeric Text Placement

In the context of the GCIS software requirements, each major program is simply a logical grouping of similar software functional modules. The system functional architecture (i.e., operational functions/processes) is mapped onto the system software architecture (i.e., programs/modules) as presented in the matrix in Figure III-3. A few observations with respect to the logical grouping of the software modules should be noted. First, the programs that are application-oriented are very well matched with the major system interactive operations:

Program	Operation(s)
Source Assessment	Source Assessment
Data Extraction	Data Extraction
Graphic Support	Graphic Display
Interactive Feature Manipulation	Interactive Feature Manipulation
Interactive Generalization	Interactive Generalization
Alphanumeric Text Placement	Alphanumeric Text Placement

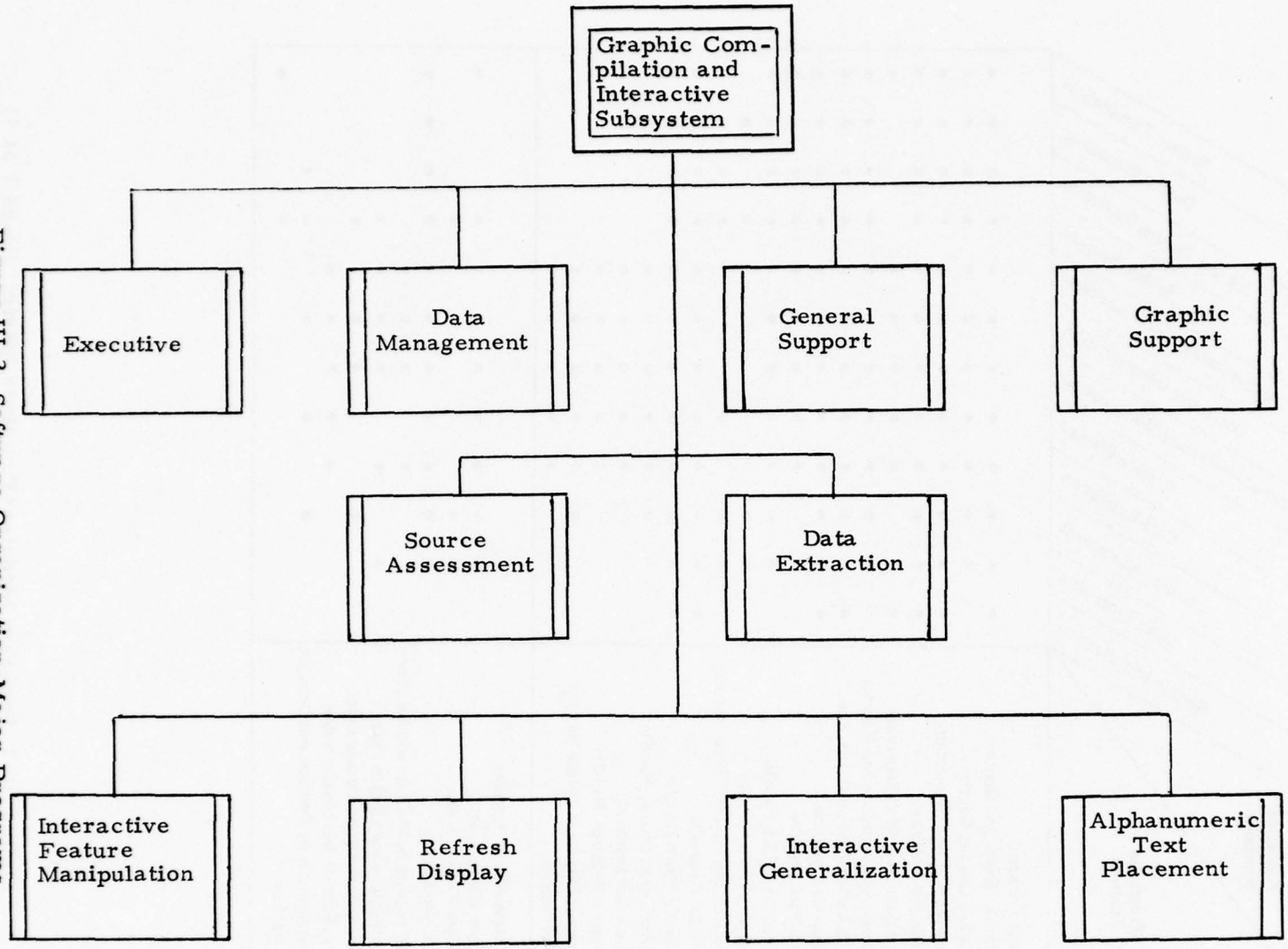

Figure III-2 Software Organization-Major Programs

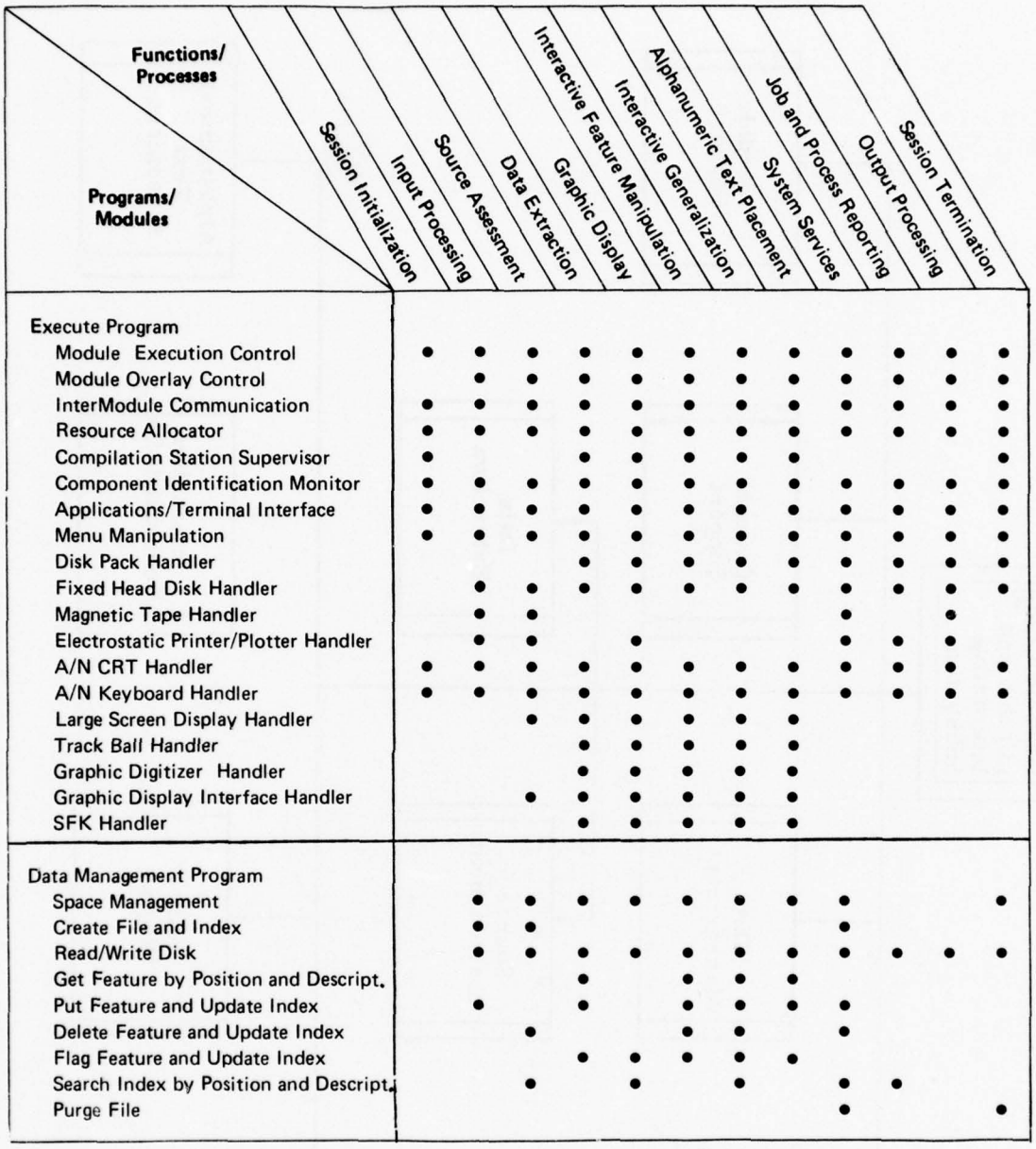

Figure III-3 Program Modules/Functions Matrix (Page 1 of 4)

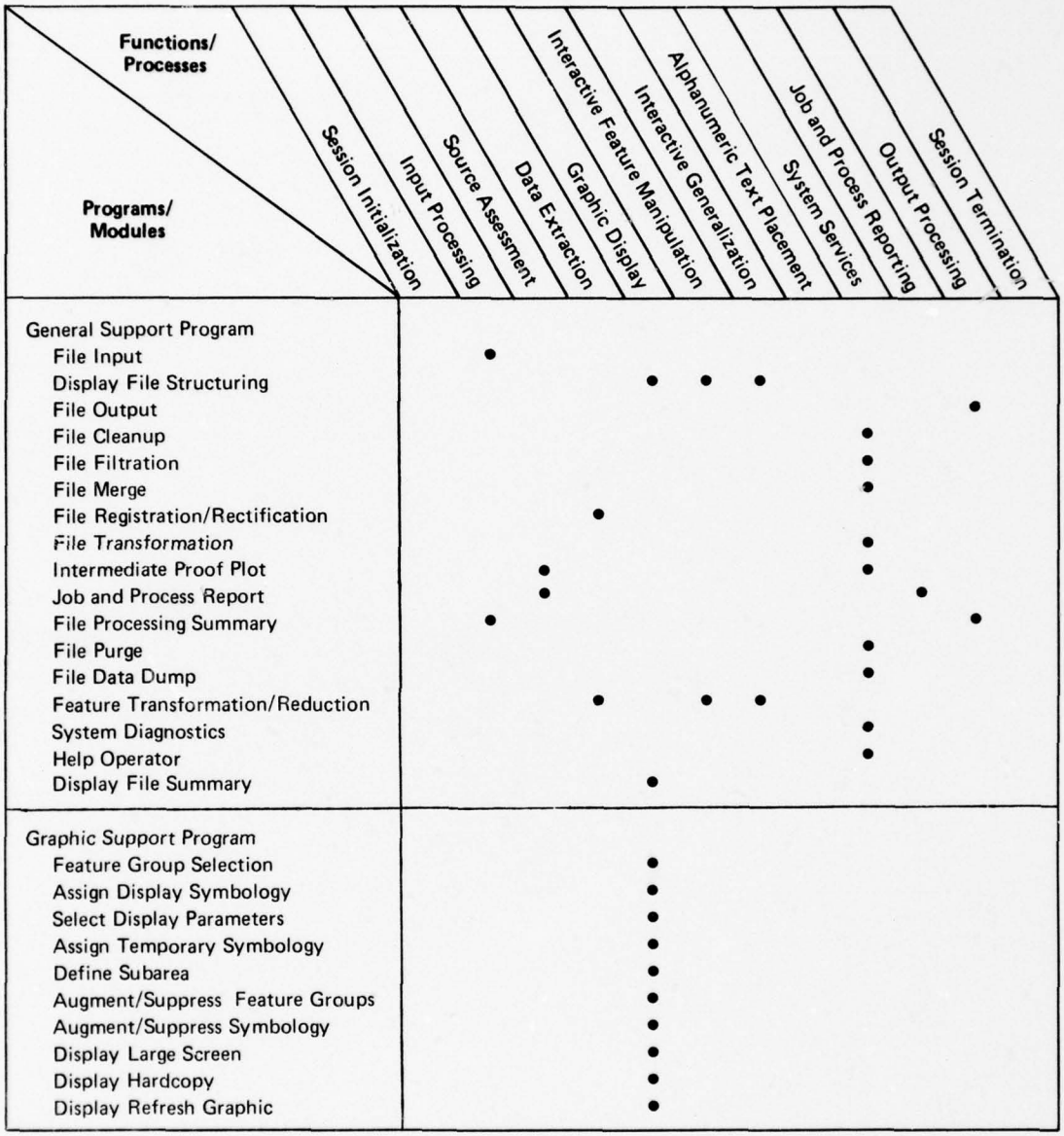

Figure III-3 Program Modules/Functions Matrix (Page 2 of 4)

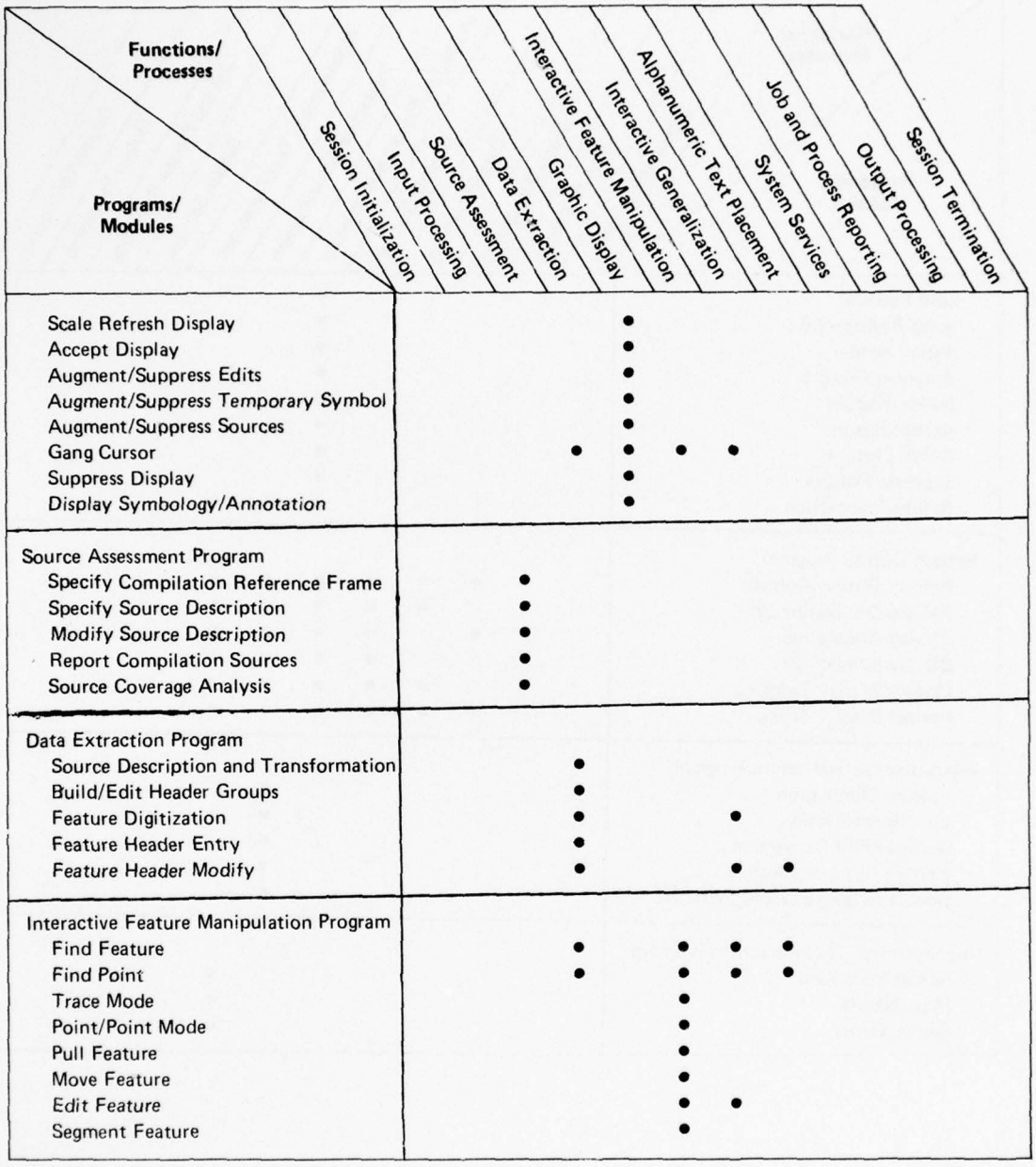

Figure III-3 Program Modules/Functions Matrix (Page 3 of 4)

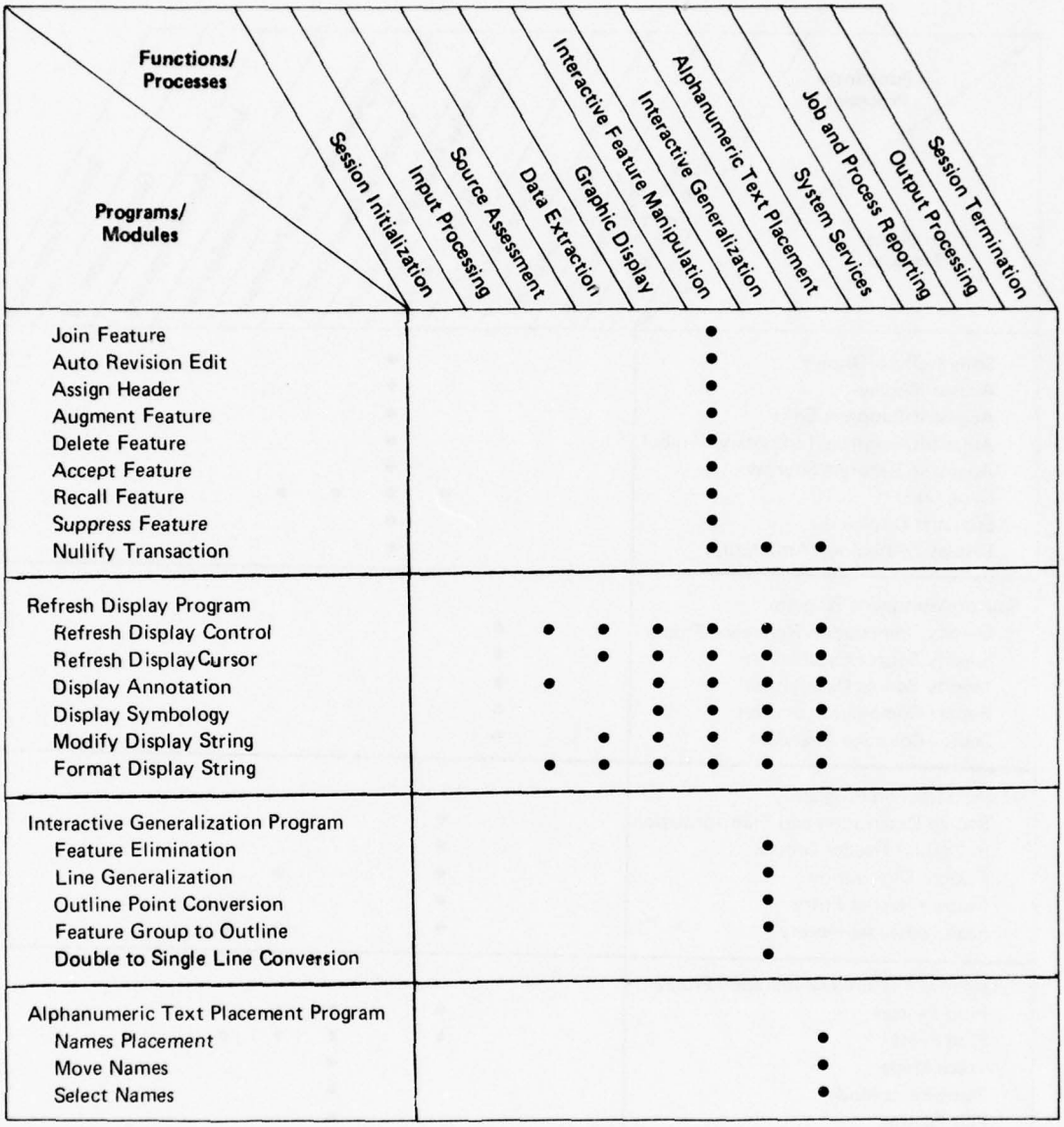

Figure III-3 Program Modules/Functions Matrix (Page 4 of 4)

The modules of these major programs tend to be performed only for their intended and related system operations.

Conversely, the major support programs (*i.e.*, Executive, Data Management and General Support) tend to span across the entire range of system operations. Similarly, the Refresh Display Program supports only the interactive system operations (i.e., Source Assessment, Data Extraction, Graphic Display, Interactive Feature Manipulation, Interactive Generalization and Alphanumeric Text Placement). In short, the grouping of software modules versus system functions appears to be logical, consistent and complete.

2. Processing Requirements

a. Executive Program

The Executive program is that software which controls the various hardware components attached to the Main Processor, as well as controlling the orderly execution of the Main Processor software. The modules within the Executive Program and their responsibilities and capabilities, will be described in general below. The discussions are not aimed at any particular computer processor. However, they cover those capabilities of currently available vendor-supplied operating systems, which are deemed desirable for the Interactive Subsystem requirements. The Executive Program modules are illustrated in Figure III-4.

The discussions are logically grouped into three areas as follows:

- Those modules which pertain to Main Processor software control
- Those modules which control the standard system hardware
- Those modules which control the special purpose compilation hardware

(1) Main Processor Software Control

(a) Module Execution Control

This module will be responsible for the orderly execution of the Main Processor software modules and subroutines throughout the compilation process. This module will be designed in such a way as to allow future expansion to multiple compilation components with little or no modification. This module will contain the following capabilities:

- Multiprogramming Support
- Memory Management Support
- Re-entrant Coding Support (if available)
- Multitasking Support
- Task Execution by Priority

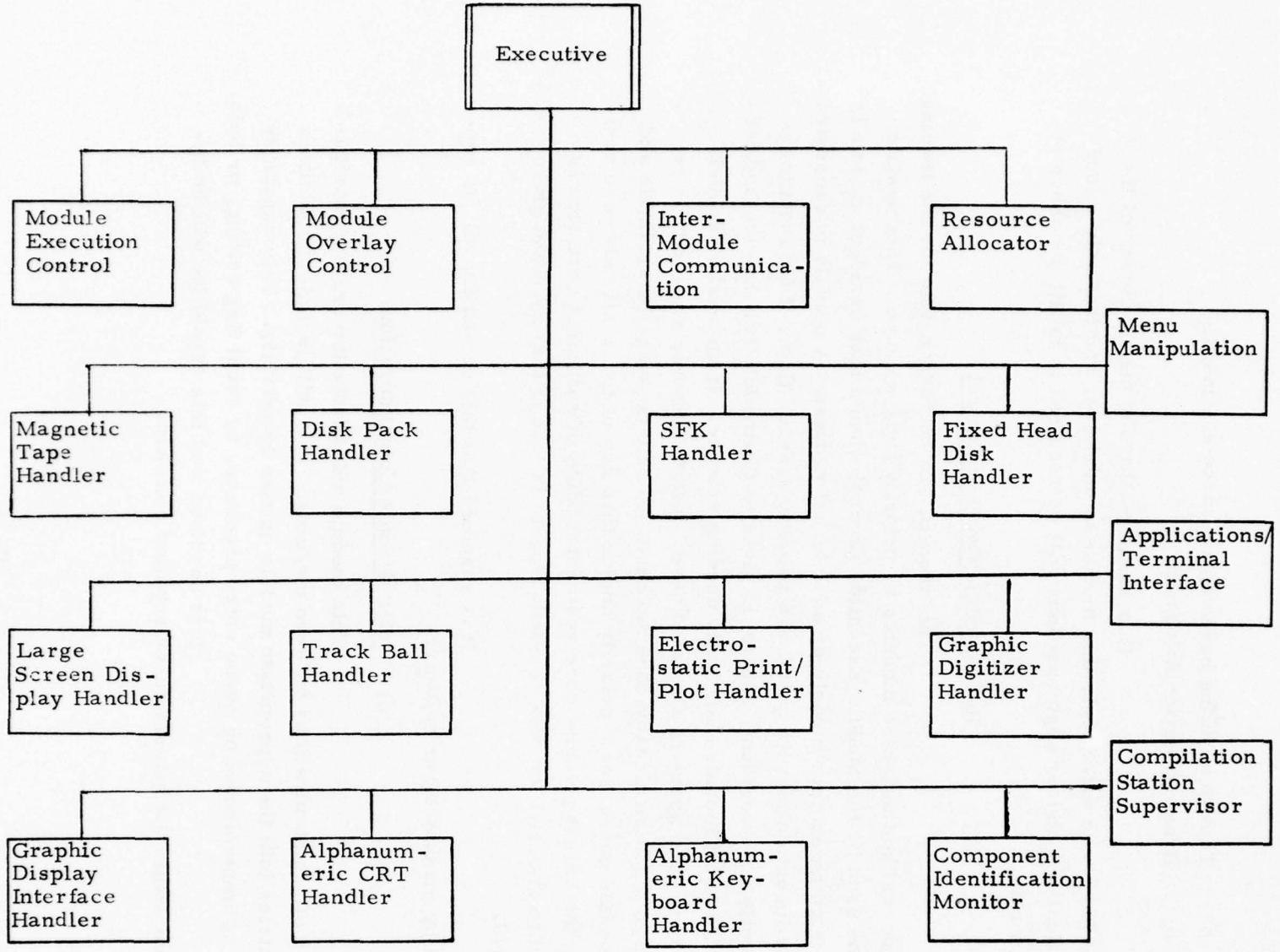

Figure III-4 Executive Program

- o Task Scheduling based on resource availability
- o Dynamic Buffer Allocation

It is assumed that the manufacturer of the target hardware will supply this module or modules, and that only minor modifications and/or augmentations will be required to fulfill the above requirements.

(b) Module Overlay Control

This module will be responsible for the loading of disk resident software modules by priority and/or queue. This module will be used by the Module Execution Control when a disk resident module is requested by another module or an external request. A module is requested by the insertion into its queue of a priority ordered flag. If the module is currently core resident, control is given to the module if it has the highest priority of all modules currently needing service. If the module is disk resident, core space is allocated based upon the module's priority in relation to modules already core resident. Should no space be available and the module possesses a priority higher than any of those already core resident, the lowest priority core resident module of sufficient core size is paged to disk and the disk resident module is loaded into core and given control.

It is assumed that this capability will be supplied by manufacturer software.

(c) Inter-Module Communication

This module will handle the orderly manipulation of communications between modules. This will include the addition of entries into the appropriate module queues by priority. This capability may be implemented by queue entry presence, by event flag setting, or both.

It is assumed that this capability will be included within the manufacturer supplied software.

(d) Resource Allocator

This module will maintain control over the allocation of Main Processor resources such as peripherals, I/O channels, and data file availability. Resources will be allocated to modules based upon the priority system discussed above.

(e) Component Identification Monitor

This module will support the hardware control within a multi-station configuration. The following hardware devices may be logically assigned in various combinations to achieve the desired working environment:

- o Graphic Digitizer and Cursor
- o Source Assessment/Data Extraction Device
- o A/N CRT and Keyboard
- o Special Function Keyboard
- o Graphic Refresh Display Interface
- o Large Screen Display and Trackball

Regardless of the particular arrangement of components, each station utilizes the A/N CRT and keyboard and the Special Function Keyboard as the vehicles for man/machine dialogue and station control.

A control table will be maintained with an entry for each station. Each entry will contain the hardware port identifiers of the above devices pertaining to the corresponding station. Each entry will also contain a station identifier unique to the corresponding station. All handlers for the above devices will call this module identifying the port of entry when data is received, and will receive in return the station identifier. This identifier is then carried along with the received data to be used by other modules to determine which data files and current operations apply to the station in question. No modules, are therefore assigned to a particular station, but are shared by all stations. The handlers for the above devices, when called upon to output data, will call this module identifying the station and device handler type, and will receive the port of exit identifier

in return. It is at the device handler level only that station identification is pertinent.

(f) Compilation Station Supervisor

This module supports the flexible reassignment of compilation components to the various logical work environments available to users of the GCIS. The purpose of this software is to promote the concept of resource sharing among the multiple concurrent users of the GCIS. This module adapts to the current physical configuration of the compilation components by having access to the internal physical device lists of the Executive, which are determined when the software system is generated.

At log-on time, the user must tell the system what function(s) he wishes to perform. This module will either verify that all of the components necessary for the desired function are available and allocate the resources for the intended job or notify the user that the required resources are not available. When the user logs off these resources will become available for the use of others.

In general this module supports the Component Identification Monitor module by specifying in the station control table each physical component that is to be associated with each station. Since the operating environment of each station is determined by the man/machine dialogue controlled at the alphanumeric keyboards and function keys, the Compilation Station Supervisor will present only the subset of compilation option menus compatible with the resources allocated to the stations and enable only the applicable function key pushbuttons.

The Compilation Station Supervisor ensures that each user has a completely protected working environment that is free from interference from other system users. Further each user may invoke only those operations that are logically permitted by the resources available to him. To this extent, each user's working environment is completely under the control of the Compilation Station Supervisor.

(g) Applications/Terminal Interface

This module will handle the highest level of man-machine communications via the A/N CRT and Keyboard associated with each compilation station. This software module will most probably be vendor-supplied and will permit multiple-terminal access to both the GCIS interactive applications and the vendor support software. The primary purpose of this module is to permit the compiler to directly request major compilation operations by entering unsolicited high-level,user-oriented commands from the A/N Keyboard.

(h) Menu Manipulation

This module is used by all interactive application modules requiring menu manipulation (i.e., query/response, parameter selection, etc.) to interact with the compiler. This module permits the compiler to communicate with the system via the A/N Keyboard as prompted by presentation of an application-specific A/N CRT menu. The following are requirements of this module:

- o Retrieve menus from disk
- o Format menus for A/N CRT
- o Manipulate menu data entry
- o Perform error detection on entered key data

(2) Standard System Hardware Handlers

The following modules manipulate the peripherals devices which are standard manufacturer hardware and which would normally be delivered with suitable manufacturer supplied software.

(a) Magnetic Tape Handler

This module will manipulate the Main Processor magnetic tape drive at the hardware addressing level, including hardware and bad tape error detection. This module is used to read and write the graphic processing tape files, the intermediate graphic processing save tape files, the finished compilation tape files and intermediate proofing plot tape files.

(b) Disk Pack Handler

This module will manipulate the moving head disk hardware at the hardware addressing level, including all reads, writes, and hardware error detection. This module is used to read and write the disk resident graphic processing file, the feature index files, and any intermediate temporary data base oriented files.

(c) Fixed Head Disk Handler

This module will manipulate the Main Processor fixed head disk at the hardware addressing level, including hardware error detection. This module is used by the Module Overlay Control to page in and out the disk resident software.

(3) Special Purpose Hardware Handlers

The following modules manipulate the special purpose hardware components which in general do not have manufacturer supplied software.

(a) Large Screen Display Handler

This module will manipulate the Large Screen Display at the hardware addressing level, including hardware error detection. This module is used to view large chart sections, but offers no interactive operations other than subarea definition.

(b) Track Ball Handler

This module will manipulate the Track Ball, attached to the Large Screen Display, at the hardware addressing level, including hardware error detection. This module is used by the compiler to define subarea on the Large Screen Display.

(c) Electrostatic Printer/Plotter Handler

This module will manipulate the Electrostatic Printer/Plotter at the hardware addressing level, including hardware error detection. This module is used to produce a "quick" look at the current status of the Graphic Processing file and also to support the Job and Process Reporting Module.

(d) Graphic Digitizer Interface Handler

This module will manipulate the Graphic Digitizer Interface Control Unit at the hardware addressing level, including hardware error detection. This module is a dual purpose module, servicing both the Source Assessment/Data Extraction and the Graphic Digitizing devices, which both connect to the Main Processor through an electronically similar Interface Control Unit. This module is used to input digitizer cursor pushbutton key codes for system direction, Graphic Digitizing Cursor coordinates for interactive graphics control, and trace or point feature digitization.

(e) Graphic Display Interface Handler

This module will manipulate the Graphic Display Interface at the hardware addressing level, including hardware error detection. This module is used to send data to and receive data from the Refresh Display Processor via a communications channel.

(f) A/N CRT Handler

This module will write data to the A/N CRT at the hardware addressing level, including hardware error detection and handling. This module is used to present instructions and menus to the compiler.

(g) A/N Keyboard Handler

This module will read data from the A/N Keyboard at the hardware addressing level, including hardware error detection and handling. This module is used to accept key data from the compiler in response to menu requests.

(h) Special Function Keyboard Handler

This module directly services all SFK button depressions. The appropriate key code is associated with each button depression by means of an SFK table maintained by this module. Some SFK buttons are used to change context during system operations from one subfunction to another. Others are multi-purpose depending upon the module

currently operating and connected to the device. In the default state, the SFK is functionally connected to the Compilation Station Supervisor. The multipurpose SFK button identification number will be returned to the currently operating module by the Special Function Keyboard module.

b. Data Management Program

The Data Management Program executes within the Main Processor and is responsible for the management of all compilation data residing on the subsystem disks. The program operates under the control of the Executive Program and provides the following services:

- o Disk Space Management
- o Data Storage
- o Data Retrieval
- o Data Maintenance

The data file structure used by the Graphic Compilation and Interactive Subsystem permits accession to data records (features) by unique identification numbers, table coordinate position, feature classification descriptors, compilation status (flags) and logical disk addresses.

The Data Management Program structures the data presented to the Graphic Compilation and Interactive Subsystem in such a manner that the storage, search and retrieval operations are optimized for minimizing response times associated with interactive processing.

The Data Management Program is comprised of a set of independent software modules which operate asynchronously in a multiprogramming fashion to collectively accomplish the overall functions of the program. The Data Management Program is composed of the following modules (see Figure III-5):

- o Space Management
- o Create File and Index
- o Read/Write Disk Block
- o Get Feature by Position and Descriptors
- o Put Feature and Update Index
- o Delete Feature and Update Index
- o Flag Feature and Update Index
- o Search Index by Position and Descriptors
- o Purge File

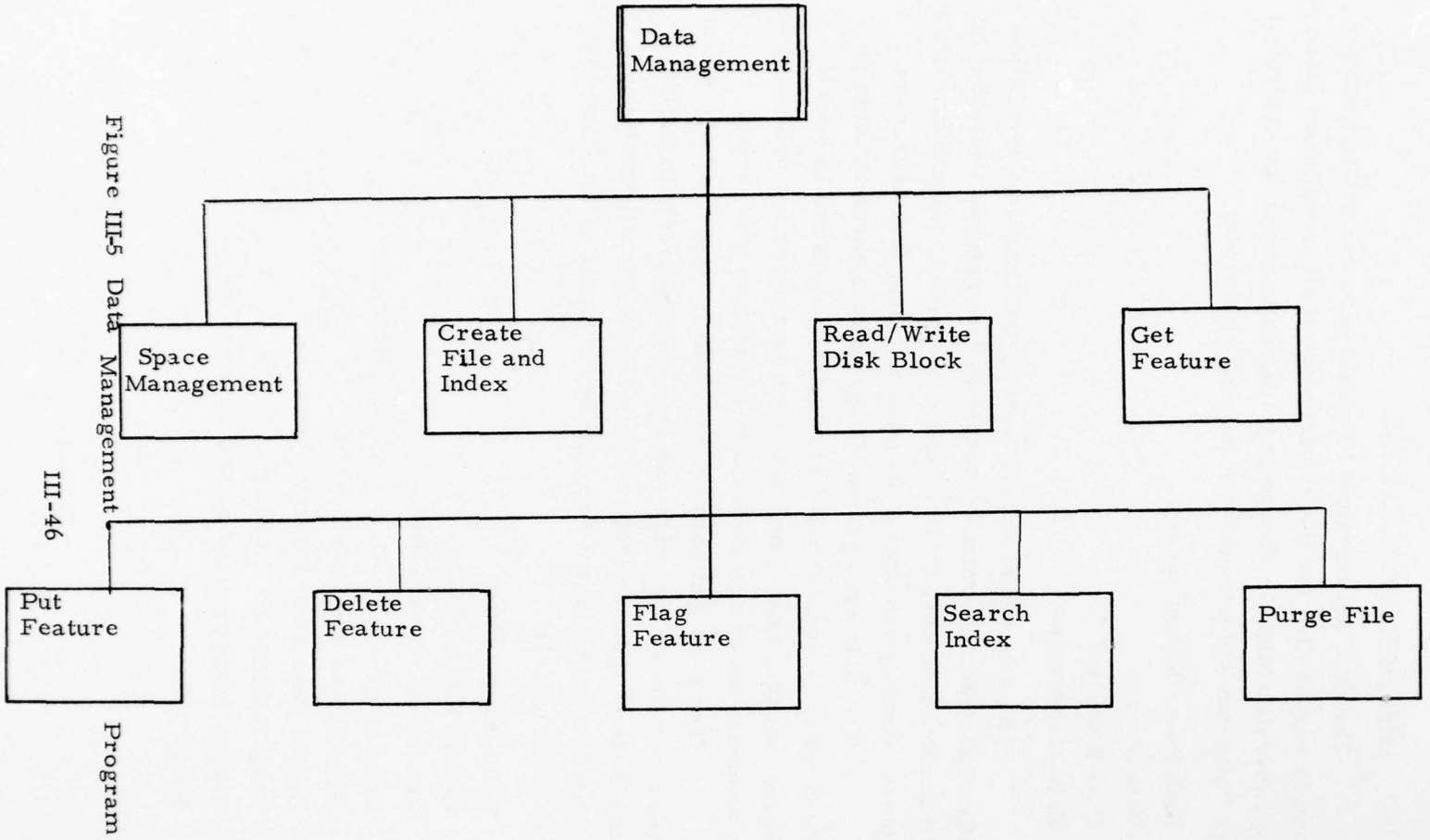

Figure III-5 Data Management

(1) Space Management

This module is responsible for the allocation and deallocation of disk storage.

(2) Create File and Index

This module initializes a file by obtaining sufficient beginning storage space for the data and its associated grid index file.

(3) Read/Write Disk Block

This module provides the interface between the requesting software and the moving head disk handler for reading or writing physical disk sectors by their proper address.

(4) Get Feature by Position and Descriptors

This module selectively retrieves the feature satisfying the specified classification descriptors and that is closest to the indicated X, Y position.

(5) Put Feature and Update Index

This module stores the feature and updates the grid index file with the feature's descriptors information, status and disk address.

(6) Delete Feature and Update Index

This module removes the feature from the feature file and the grid index file.

(7) Flag Feature and Update Index

This module locates a feature and records the specified status condition in the feature file and the grid index file.

(8) Search Index by Position and Descriptors

This module finds all features satisfying the specified classification descriptors within the grid cell indicated by the in- X, Y position.

(9) Purge File

This module removes a file from the disk directory and returns the disk storage for other use.

c. General Support Program

The General Support Program is generally non-interactive in nature and operates in a low priority mode at the main processor. The program is comprised of independent software modules which may be called explicitly through the System Console Teletype or the Alphanumeric CRT and Keyboard, or implicitly as required to support other processes. These modules generally require the use of the main processor peripherals such as tape drives, disks and the Electrostatic Printer/Plotter. The modules constituting the General Support Program are as follows (see Figure III-6):

- o File Input
- o Display File Structuring
- o File Output
- o File Filtration
- o File Merge
- o File Registration/Rectification
- o Intermediate Proof Plot
- o File Processing Summary
- o File Cleanup
- o File Purge
- o File Data Dump
- o Feature Transformation/Reduction
- o System Diagnostics
- o Help Operator
- o File Transformation
- o Job and Process Reporting
- o Display File Summary

(1) File Input

This module inputs a graphic processing tape file which is pre-processed, and formatted by the Graphic Compilation Batch Subsystem. The file is read, indexed, and stored on disk.

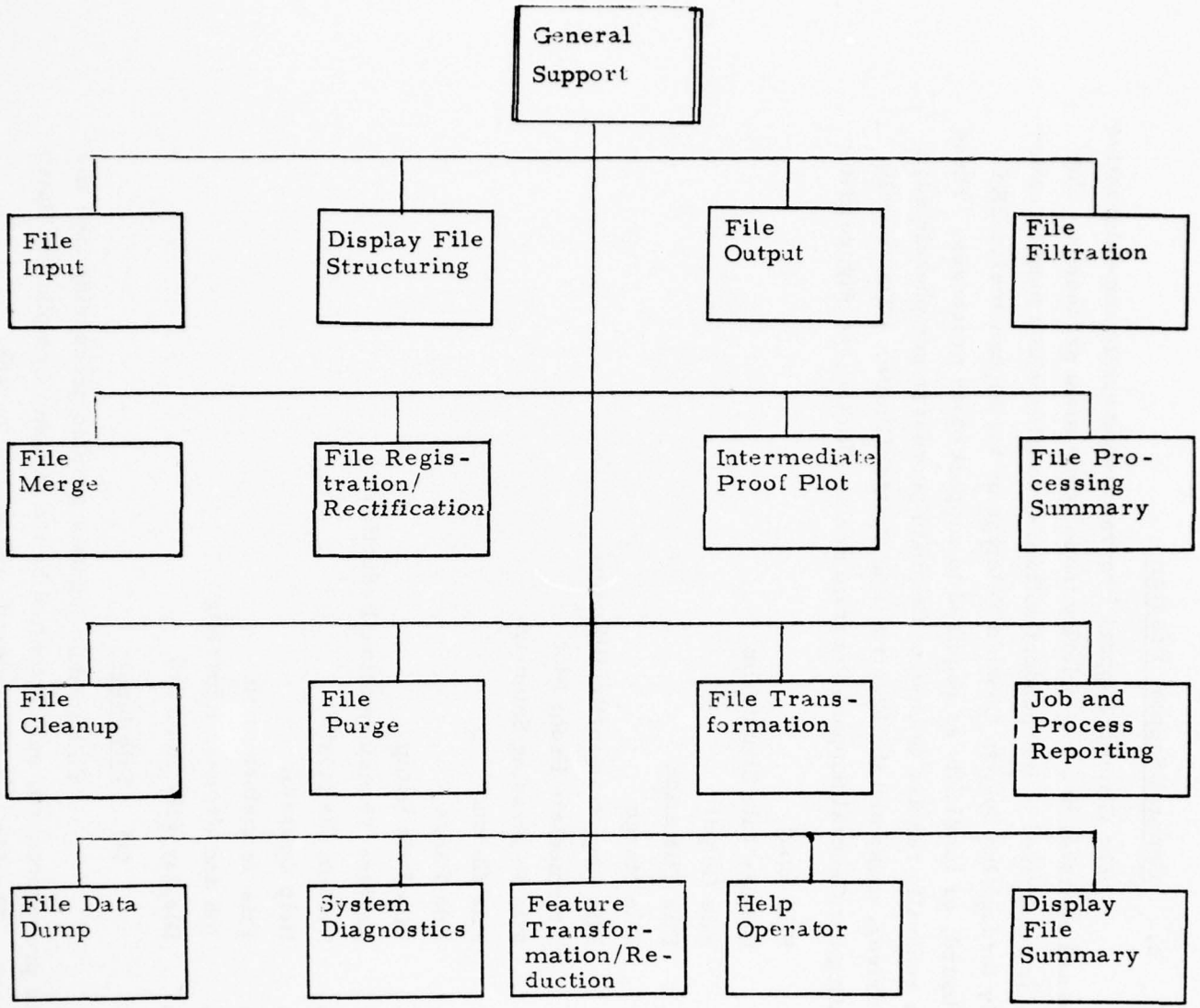

Figure III-6 General Support Program

(2) Display File Structuring

This module reads all or portions of the graphic processing disk file and structures display data for the display or plotting device.

(3) File Output

This module reads the graphic processing disk file and writes the data to magnetic tape for temporary save purposes or for final compilation results.

(4) File Filtration

This module is used to extract features by area and descriptor classification from a graphic processing file. The File Filtration module works in conjunction with the File Output or File Input modules to produce the desired output file.

(5) File Merge

This module is used to merge the contents of secondary source tape file(s) with a graphic processing disk file or to simply perform a disk to disk file copy.

(6) File Registration/Rectification

This module registers a source graphic affixed to the Graphic Digitizer to a graphic processing disk file. Data referenced in the source graphic frame will be transformed to the frame defined in the graphic processing file and vice versa. This module will also compute digital (non-terrain) rectification parameters so that data can subsequently be rectified/transformed to fit the destination reference frame.

(7) Intermediate Proof Plot

This module reformats a graphic processing disk file and produces a tape file for off-line graphic plotting.

(8) File Processing Summary

This module obtains statistics to reveal the contents of a graphic processing file and prepares a report for either the Printer or the Alphanumeric CRT.

(9) File Cleanup

This module sanitizes the graphic processing disk file by eliminating absolute features which have either been deleted or replaced by revised versions.

(10) File Purge

This module may be used to release disk space allocated previously for a disk file that is no longer needed.

(11) File Data Dump

This module permits selective retrieval of disk files for perusal on either the A/N CRT display or the Electrostatic Printer/Plotter.

(12) System Diagnostics

This module supports a limited set of on-line diagnostic tools which provide a means for verifying proper equipment operation prior to active compilation.

(13) Help Operator

This module serves as a training aid for new users to guide them through compilation operations they may be unfamiliar with.

(14) File Transformation

This module works in conjunction with the File Registration/Rectification Module to permit the merging of secondary files of different projections or scales with the graphic processing file which is in the reference frame of the compilation product. This module also performs direct and inverse transforms for data passing between the reference frame of the graphic processing file and the source graphic frame. This permits the graphic processing file to be handled "in-place".

(15) Job and Process Reporting

This module is responsible for the collection of data for the following:

- o job planning
- o component utilization
- o job statistics
- o source coverage analysis

The reports may be produced for either the printer or the Alphanumeric CRT.

(16) Display File Summary

This module supports the Graphic Support program by formatting and displaying a statistical summary of the current display (i.e., Refresh Graphic CRT or Large Screen Display) on the A/N CRT.

(17) Feature Transformation/Reduction

This module supports the interactive application software for associating feature data in the compilation reference frame with the interactive user reference frame at the graphic digitizer. Registration and Rectification parameters are employed to transform input data from the graphic digitizer to the compilation reference frame.

d. Graphics Support Program

The Graphics Support Program consists of modules which provide application-oriented control for both the Large Screen Display and the Refresh Display. These modules are executed within the Main Processor and interact with the compiler via the A/N CRT, A/N Keyboard, Large Screen Display and Track Ball, the Graphic Digitizer, Digitizing Cursor, and Special Function Keyboard. Interaction also occurs between the use of the Digitizing Cursor and the feedback view on the Refresh Display via the communications channel to the Refresh Display Processor.

The Graphics Support Program is comprised of the following modules (see Figure III-7):

- o Feature Group Selection
- o Sub-area Definition
- o Display Refresh Graphic
- o Suppress Display
- o Display Large Screen
- o Refresh Display Scaling
- o Assign Display Symbology
- o Assign Temporary Symbology
- o Gang Cursor
- o Augment/Suppress Sources
- o Display Hardcopy
- o Augment/Suppress Symbology
- o Select Display Parameters
- o Accept Display
- o Augment/Suppress Feature Groups
- o Augment/Suppress Edits
- o Augment/Suppress Temporary Symbology
- o Display Symbology/Annotation

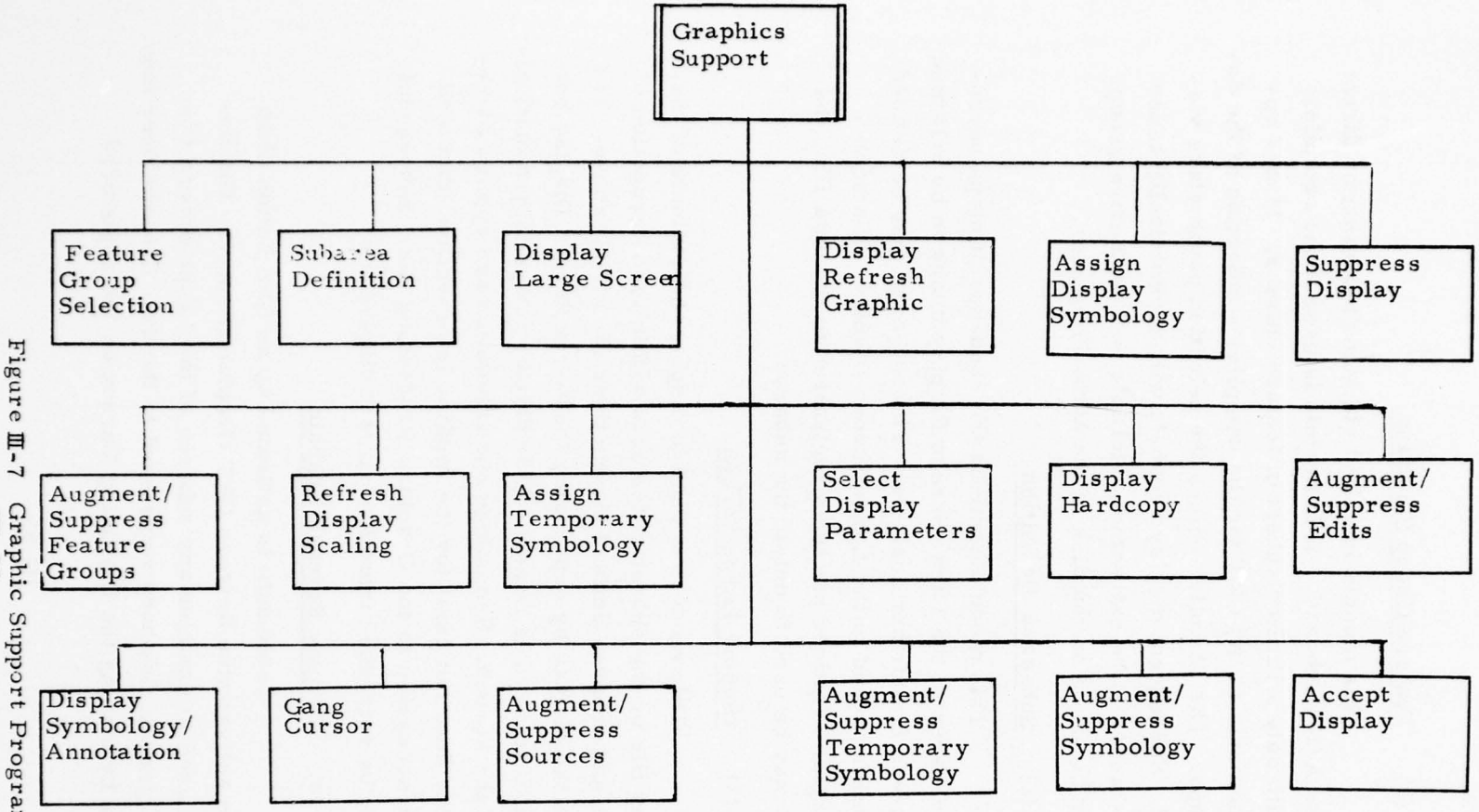

Figure III-7 Graphic Support Program

(1) Feature Group Selection

This module is called via Menu Selection or direct request through the A/N Keyboard. This module is used if the compiler chooses to deal with only a limited subset of feature classes. Menus appear on the alphanumeric (A/N) CRT for the compiler's selection of the desired feature groups. The compiler enters the selection parameters via the A/N Keyboard. Subsequent display requests will automatically cause features of these classes to be extracted. Multiple sets of feature group specifications may be saved on the disk of the Main Processor.

(2) Sub-area Definition

This module controls the sequence of steps necessary to define a sub-area of the Large Screen Display image to be enlarged over the entire screen for further analysis. The sub-area may be defined using the Track Ball attached to the Large Screen Display. If a source graphic on the Graphic Digitizer has been registered to the data file, the Digitizing Cursor may be used to define the subarea.

(3) Display Large Screen

This module is used to display the contents of the graphic processing file or the subset of features within the intersection of the feature groups and subarea defined by functions (1) and (2) above. The compiler requests the display by depressing the Large Screen Display button on the SFK. If a subarea is requested the display image is automatically enlarged to fill the screen. Symbology and annotation are applied as required. If a display does not exist for the implied intersection, this module creates one by accession to the Graphics Processing file. Subsequent requests need only be refreshed from the current display file.

(4) Display Refresh Graphic

This module is activated by an SFK button when the user wishes to activate the Refresh CRT Graphic Display. The Refresh CRT can be used to examine any subarea of the Large Screen Display. If a source graphic has been registered to the data file, the user may define the subarea by placing the Digitizing Cursor on the registered

source document. Otherwise the subarea position will be determined relative to the origin of the digitizer table. This module will then generate a display image containing all feature surrounding the target point entered at the digitizing device and that satisfy the feature group selection criteria previously entered. The resultant display will cover as large an area as possible with a full capacity display. If the requested area is very dense the displayed area will be small. If the requested area is less dense, the displayed area will be larger. This limitation is imposed by the "flicker free" and core limitations of the Refresh Display Processor.

(5) Assign Display Symbology

This module may be activated by menu selection or by direct request through the A/N Keyboard. This module permits the compiler to associate subsets of the available symbology types to the feature groups previously indicated by the Feature Group Selection activity. The resultant symbology assignments are stored on disk in a repository known as the Symbol Assignments file. The association is performed interactively by the operator through the A/N CRT and Keyboard in consort with the Refresh CRT (if available).

(6) Suppress Display

This module may support either the Large Screen Display or the Refresh CRT. At the Proofing Station the module is activated by depression of a Large Screen Keyboard button. It will purge the image on the Large Screen Display or may be called to abort an image currently being written. At the Interactive Station, this module is activated by a SFK button and will erase the image on the Refresh CRT by instructing the Refresh Display Program to terminate the refresh cycle operation. In either case, all features that were displayed will be flagged as suppressed.

(7) Augment/Suppress Feature Groups

This module permits the compiler to quickly add or suppress feature groups from the current display at either the Refresh CRT or the Large Screen Display. It is activated by depression of either a SFK

button or a Large Screen Keyboard button. Prior feature group selections are displayed on the A/N CRT and may be easily modified through either the SFK or Large Screen Keyboard. Symbology and annotation will be applied as required.

(8) Refresh Display Scaling

This module allows the compiler to cause the Refresh Display image to be selectively enlarged by the depression of a set of SFK scale buttons. In addition to the nominal 1X scale, scales of 2X and 4X may be selected for the Refresh CRT. The image is enlarged about the center reference point which was utilized by the Display Refresh Graphic module to create the initial 1X display.

(9) Assign Temporary Symbology

This module is functionally similar to the Assign Display Symbology module. However, in this case, symbology is assigned to compilation status conditions (flags) rather than feature groups. During interactive compilation, the type of transaction performed on each feature is associated with that feature by means of a codified flag character. The types of status flags include all of the interactive functions that may be performed on the GCIS but are not limited to this set. For example, another type of status condition might reflect that a feature was modified in such a manner that tolerance limits were exceeded.

This module may be activated by menu selection or by direct request through the A/N Keyboard. The compiler may then interactively assign subsets of the available symbology types to the various types of status conditions. The results of this association are stored in the Temporary Symbology Assignments file on disk. Symbology selection may be enhanced by displaying the symbol types on the Refresh Graphic CRT when it is available.

(10) Select Display Parameters

This module is invoked by menu selection or direct request through the A/N Keyboard. The current parameters for the display selection are displayed and consist of:

- o Annotation (on/off)
- o Symbology (on/off)
- o Large Screen Utilization (yes/no)
- o Area Outline on Large Screen (yes/no)
- o Base Scale of Display
- o Display Summary (on/off)

The display parameters may be modified by A/N Keyboard editing. This module also permits the user to request a hardcopy plot of the current Large Screen Display image by menu selection from the parameter list. In the event that a display file has not been previously allocated and created, this module will request the DMS to do so.

(11) Display Hardcopy

This module may be invoked by depression of the appropriate SFK button or by menu selection via the A/N Keyboard through the Select Display Parameters module. Activation of this module causes the exact contents of the image of the current display device to be reproduced on the Electrostatic Printer/Plotter. Symbology and annotation will be generated as required. In the event that no display device is currently active, this module will utilize the current display parameters to generate a hardcopy graphic of a display image as it would have appeared.

(12) Augment/Suppress Edits

This module permits the compiler to easily add or suppress subsets of features from the current display at either the Refresh CRT (Interactive Station) or the Large Screen Display (Proofing Station). Each subset consists of features each having undergone a common type of interactive compilation function, which is represented by a codified flag character associated with each feature. This module is activated by depression of either a SFK button or a key on the Large Screen Keyboard. Previous feature status selections are displayed at the A/N CRT. These selections are presented within a menu illustrating all possible types of feature status but are distinguished from the unselected types by a flag symbol. Prior selections may be disabled and new selections easily made

by line number entry through either the SFK or Large Screen Keyboard. Temporary Symbology and annotation will be applied to the modified graphic display image as required.

(13) Gang Cursor

This module is invoked by depression of the applicable SFK button (Interactive Station) or a key on the Large Screen Keyboard (Proofing Station). A tracking cross is displayed on the Refresh CRT or the Large Screen Display and is "ganged" to the movement of either the Digitizing Cursor or Track Ball, respectively. This mode would typically be used in between functions to assist the compiler in directing the tracking tool to "point" to a particular region of the display image. The Gang Cursor mode is automatically terminated by selection of any other interactive function or by a second depression of the "Gang Cursor" button or key.

(14) Augment/Suppress Sources

This module is invoked by depression of the applicable button on the SFK or Large Screen Keyboard. A menu will appear on the A/N CRT displaying all of the individual sources that comprise the Graphic Display File. The sources that are currently enabled for display purposes will be flagged by a special symbol. The operator may then change the current source selections by addition or deletion by entering the appropriate line number corresponding to the source subfile. The SFK will be used for the line number entry at the Interactive Station, while the Large Screen Keyboard will be employed for this purpose at the Proofing Station. The display image is updated to reflect the modified source selections. Symbology and Annotation is applied as required by the most recent selections. A complete image restore may be necessary for the Large Screen Display if a previously displayed source is disabled. If only new sources are added the previous selections, the current display image will be augmented appropriately.

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UNCLASSIFIED RADC-TR-77-340-VOL-2 NL

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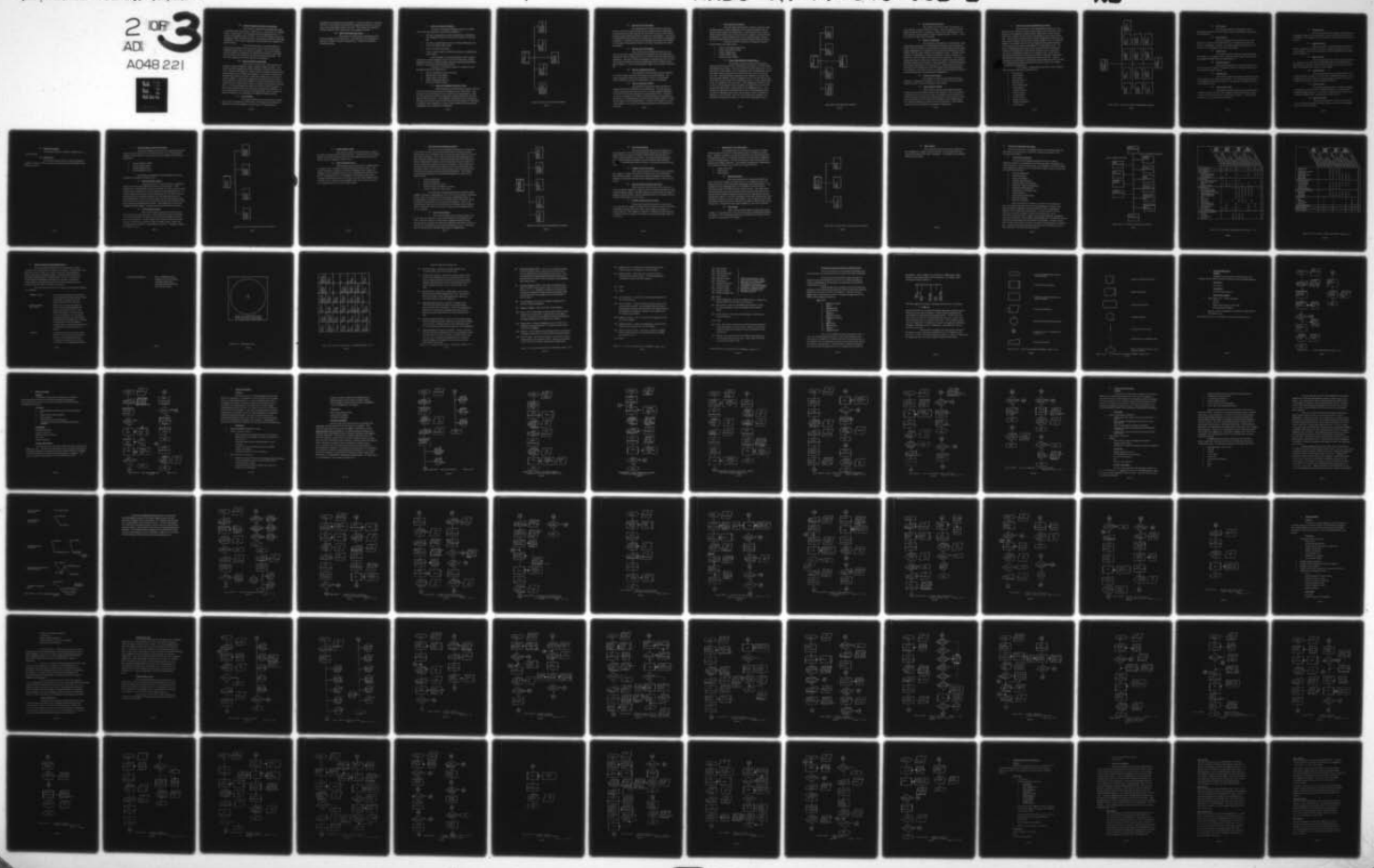


(15) Augment/Suppress Temporary Symbology

This module is invoked by the appropriate button on the SFK or the Large Screen Keyboard (i.e., Interactive or Proofing Station, respectively.) The Temporary Symbol Assignments file is retrieved and displayed on the A/N CRT. The A/N CRT display relates the compilation status conditions and their corresponding temporary symbology assignments. The current compilation status selections are flagged by a special symbol.

The current selections are easily modified by entry of the associated menu line number which causes that particular compilation status flag to be enabled or disabled. The current display image is updated accordingly by the application of temporary symbology to the selection class of features having the indicated status type. The line center image of each revised feature is eliminated.

(16) Augment/Suppress Symbology

This module is invoked in the same fashion as for the other "Augment/Suppress" types of graphic display functions. The current Symbol Assignments and Specifications are displayed in the A/N CRT. The menu will depict the subset of feature classes previously chosen for symbology, the symbology code assigned to each feature class and an optional flag character to denote whether the assignment is currently selected for display. Through the appropriate keyboard (SFK for the Interactive Station or Large Screen Keyboard for the Proofing Station), the line number is entered which either enables or disables the associated selection entry. The new symbology selections will cause the feature groups affected to be redrawn either line-centered or symbolized as specified. At the Proofing Station, the Large Screen Display image will be rewritten to apply symbology (or no symbology) to the applicable feature groups.

(17) Accept Display

This function applies only to the Interactive Station and as such is activated by a SFK button. The compiler may confine his attention to the image displayed on the Refresh CRT during feature

manipulation and interactive generalization. When the compiler is satisfied with the current Refresh CRT image after suppressing features, he may depress the Accept Display button on the SFK. This causes the suppressed features within the CRT viewing area to be flagged as deleted.

(18) Display Symbology/Annotation

This module is invoked when a symbolized and/or annotated display is to be generated. The display file will be updated as indicated by either the Symbol Assignments or Temporary Symbology Assignments files.

e. Source Assessment Program

The Source Assessment Program consists of modules which control the sequence of operations pertaining to:

- o the entry of appropriate control information for definition of the compilation reference frame for the Graphic Processing file.
- o the entry or modification of source coverage information and source description information.
- o source coverage assessment.
- o source content analysis of individual graphics or superimposed two at a time.

These modules are executed within the Main Processor and interact with the compiler via the A/N CRT and Keyboard, Graphic Digitizer and Cursor, Refresh Display, Special Function Keyboard and/or the Source Assessment/Data Extraction Device.

The Source Assessment Program is comprised of the following modules (see Figure III-8):

- o Specify Compilation Reference Frame
- o Specify Source Description
- o Modify Source Description
- o Report Compilation Sources
- o Source Coverage Analysis

(1) Specify Compilation Reference Frame

This module may be invoked either by menu selection or by direct request through the A/N Keyboard of any GCIS station. The operator will be instructed via the A/N CRT to enter parameters through the A/N Keyboard to define the geographic boundary and grid for the compilation reference frame. The geographic coordinates of the boundary and grid intersects will be echoed on the A/N CRT for the operator's verification. Acceptance of the compilation reference frame definition will result in the initialization of the Graphic Processing file.

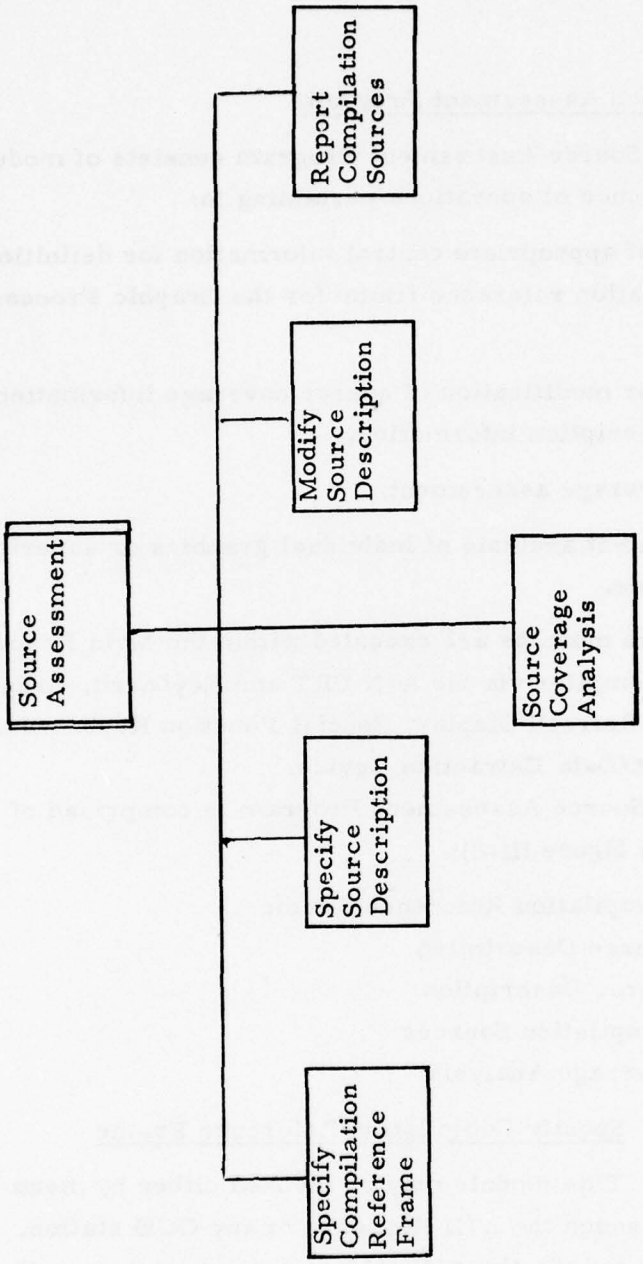


Figure III-8 Source Assessment Program

(2) Specify Source Description

This module may be invoked either by menu selection or by direct request through the A/N Keyboard of any GCIS station. The operator will be instructed via the A/N CRT to enter the source identification and description parameters through the A/N Keyboard. The source coverage limits and control will be echoed on the A/N CRT for the operator's verification. Acceptance of the source definition will result in the Graphic Processing file being updated with the new source description and control information.

(3) Modify Source Description

This module may be invoked by either menu selection or by direct request through the A/N Keyboard of any GCIS station. The operator will be instructed via the A/N CRT to enter the desired source identifiers. The source control information is retrieved onto the A/N CRT. The operator indicates the desired modifications and/or deletions which, upon acceptance, result in the appropriate update of the Graphic Processing file.

(4) Report Compilation Sources

This module is selected either via menu selection or a direct request from the A/N Keyboard at any GCIS station. The source coverage is reported on either the A/N CRT or Electrostatic Printer/Plotter as selected by the operator via the A/N Keyboard.

(5) Source Coverage Analysis

This module is selected via menu selection or a request from the A/N Keyboard at any GCIS station. The user selects various source materials from the source coverage summary displayed at the A/N CRT; he also specifies the desired output device. The source coverage, including source outline, control graticules, and annotation is produced as: a hardcopy plot on the Electrostatic Printer/Plotter, a Large Screen Display at the Proofing Station, a refresh CRT display at an Interactive Station, or an off-line intermediate proof plot of all digital sources specified.

f. Data Extraction Program

The Data Extraction Program consists of modules which provide necessary control allowing the user to perform graphic data extraction and/or feature description entry. These modules are executed within the Main Processor and interact with the compiler via the A/N CRT and Keyboard, Graphic Digitizer and Cursor, Refresh Display, Special Function Keyboard and/or the Source Assessment/Data Extraction Device.

The Data Extraction Program is comprised of the following modules (see Figure III-9):

- Source Description/Registration
- Build/ Edit Header Groups
- Feature Digitization
- Feature Header Entry
- Feature Header Modify

(1) Source Description and Registration

This module is selected via the A/N Keyboard or menu selection from the Source Assessment work station or the Interactive Compilation work station. The user selects the desired graphic source ID's from the A/N CRT display. He is requested to enter the geographic coordinate frame control, projection and scale for all new source ID's via the A/N CRT. This information is appended to the Graphic Processing File. The geographic reference points are displayed on the A/N CRT and the user inputs these control points via the Digitizing Cursor. He then selects either a true or compilation reference scale. When compilation reference scale is chosen, the geographic reference points are displayed on the A/N CRT and the user inputs these control points via the Digitizing Cursor. The Graphic Processing File is updated with the new, mathematically derived transform coefficients based on the control points. Error residuals are displayed on the A/N CRT. The user may accept these residuals, terminating the registration process, or reject them, repeating the above.

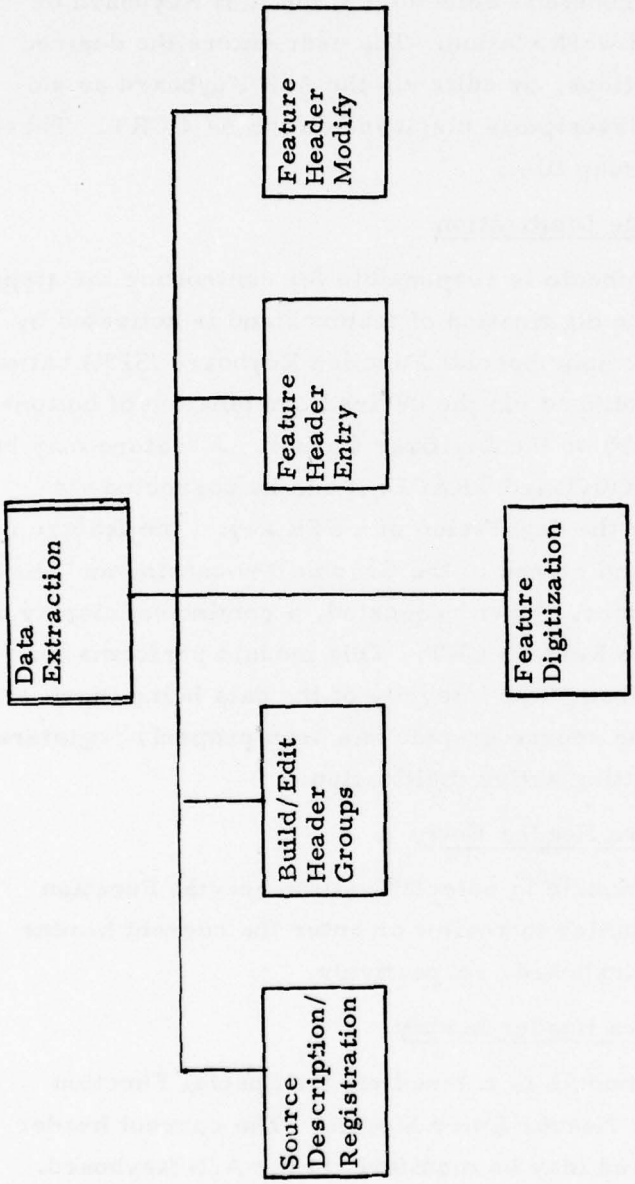


Figure III-9 Data Extraction Program

(2) Build/Edit Header Groups

This module is selected via the A/N Keyboard or menu selection from any GCIS work station. The user enters the desired header group insertions, deletions, or edits via the A/N Keyboard as selected from the header group descriptors displayed on the A/N CRT. These are reflected in the Header Group file.

(3) Feature Digitization

This module is responsible for controlling the steps of operations necessary for the digitization of features and is activated by means of the depression of a unique Special Function Keyboard (SFK) button. Feature digitization is accomplished via the desired combination of buttons (POINT, TRACE, EDIT, STOP) on the Digitizer Cursor. A feature may be created by a combination of POINT and TRACE; it can be corrected via EDIT; it is ended via STOP or the depression of a SFK key. The feature is transformed and/or reduced and stored in the Graphic Processing and Display files with the current header. When requested, a continuous display of trace data is maintained on the Refresh CRT. This module performs the necessary error detection to insure the integrity of the data being input. For example, it will insure the source graphic has been properly registered to the data file prior to permitting active digitization.

(4) Feature Header Entry

This module is selected via the Special Function Keyboard. It permits the compiler to review or enter the current header via the A/N CRT or the A/N Keyboard, respectively.

(5) Feature Header Modify

This module is entered via the Special Function Keyboard or from the Feature Header Entry Module. The current header is displayed at the A/N CRT and may be modified via the A/N Keyboard. A feature header is updated by locating that feature; via find feature at the Interactive Station or via Track Ball coordinates at the Proofing Station. The compiler modifies the header via the A/N Keyboard. This change is reflected in both the Graphic Processing and Display files.

g. Interactive Feature Manipulation Program

The Interactive Feature Manipulation Program is comprised of a set of software modules which together with the hardware components of the compilation station permits a high degree of interactivity between the compiler and the Graphic Compilation and Interactive Subsystem. The services performed by the Feature Manipulation Program are invoked by the compiler's actions at the Graphic Digitizer and are verified by display at the Graphic Refresh CRT and Large Screen Display (optional). The tracking tool for feature manipulation is the Digitizing Cursor. All feature manipulation transactions can be preceeded by the Find Feature function for identifying the small number of features to be manipulated. Any feature manipulation function can be applied to the current feature. Following the find feature step the user invokes a particular manipulation edit function by depressing the applicable button on the SFK. Menu instructions for performing an edit function will be displayed on the A/N CRT. Upon completion the display illustrates the updates made to the Graphic Processing and Display files.

The modules constituting the Interactive Feature Manipulation Program include (see Figure III-10):

- Pull Feature
- Move Feature
- Edit Feature
- Segment Feature
- Join Feature
- Auto Revision Edit
- Assign Header
- Augment Feature
- Delete Feature
- Accept Feature
- Recall Feature
- Suppress Feature
- Nullify Transaction
- Find Feature

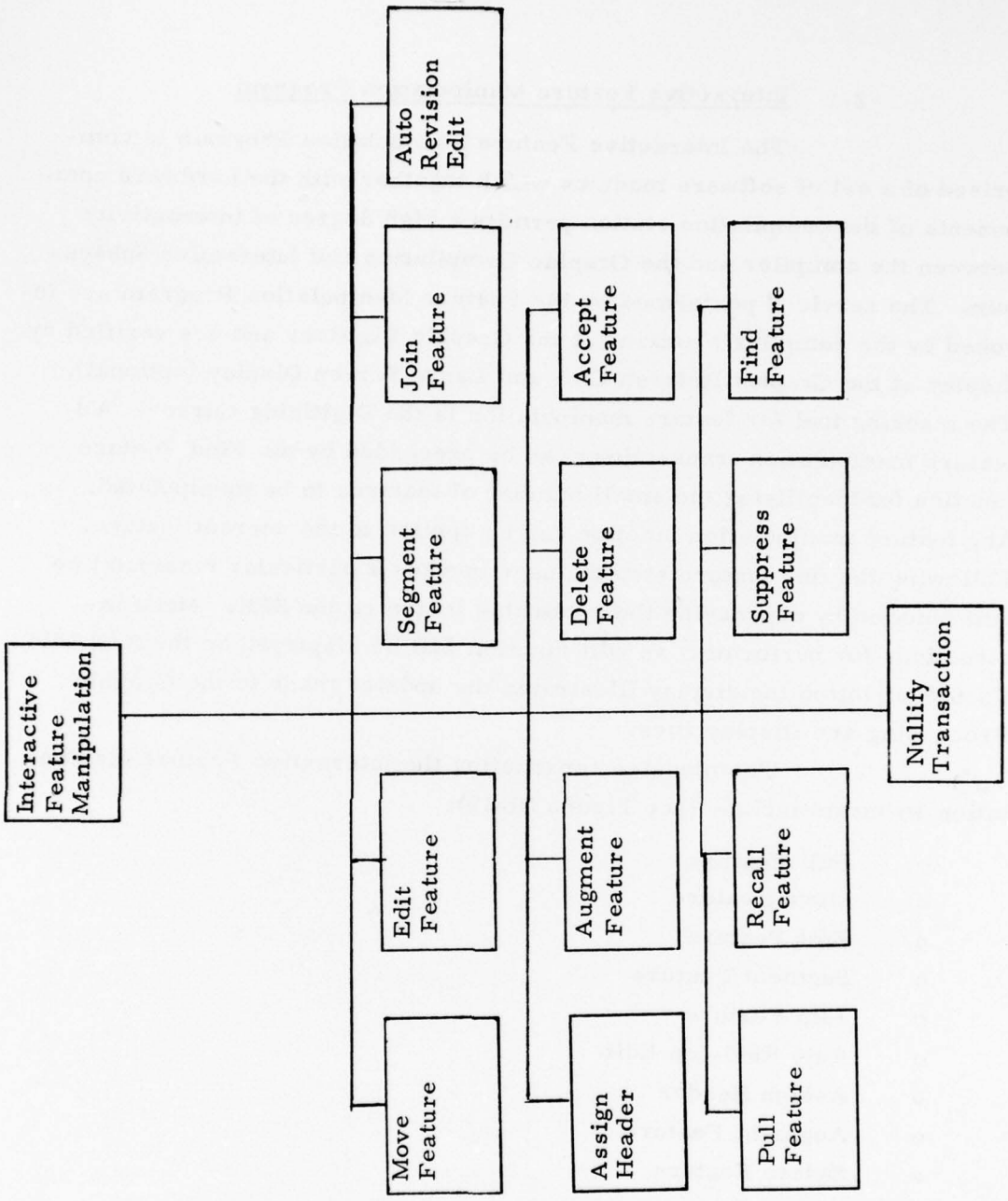


Figure III-10 Interactive Feature Manipulation Program

(1) Pull Feature

This module provides the capability to resolve cartographic conflicts by performing an elastic band segment shift between two given points.

(2) Move Feature

This module affects feature movement via translation from a point on the original feature to a similar point on the new feature. Transaltion, rotation, and scaling are performed when the move is based on two original and two new feature points.

(3) Edit Feature

This module provides software control permitting the compiler to re-digitize feature segments, performing a smooth join of the segment end points with the original feature.

(4) Segment Feature

This module provides the necessary software control to permit the compiler to segment a feature to effectively produce two new features from the original.

(5) Feature Join

This module assists the compiler during end-to-end, end-to-junction, and closure join functions. The end-to-junction join provides clipping of intersection overrun. This function is limited to features with common headers.

(6) Auto Revision Edit

This module provides software control allowing the compiler to update a feature in the Graphic Processing file with a feature segment from the Graphic Processing Revision Subfile. A smooth join is performed at the given segment end points.

(7) Assign Header

This module permits the compiler at the Interactive Compilation Station or Proofing Station to assign a given header to the current feature. By redefining the current feature, this can become an iterative process.

(8) Augment Feature

This module affects implementation of Temporary Symbol Assignments into the Graphic Processing and Display files for the current feature. This feature is displayed with the appropriate symbology and/or annotation.

(9) Delete Feature

This module provides the software control allowing the compiler at the Interactive Compilation Station or Proofing Station to flag features for possible deletion from the Graphic Processing and Display files. Such features are erased from the display.

(10) Accept Feature

This module provides the necessary software control to permit the compiler at the Interactive Compilation Station or Proofing Station to restore a feature previously flagged as deleted or otherwise accept a feature for the finished compilation product.

(11) Recall Feature

This module provides software control permitting the compiler at the Interactive Compilation Station or Proofing Station to redisplay original features. These may be restored into the Graphic Processing and Display files, surpressing the edited feature.

(12) Suppress Feature

This module provides the software control necessary to permit the compiler to remove features from the current display window on the Refresh CRT.

(13) Nullify Transaction

This module allows the compiler to negate the current transaction.

(14) Find Feature

This module provides software control enabling the compiler to locate a feature or point on a feature via the FIND button on the Digitizing Cursor.

h. Refresh Display Processor Program

The Refresh Display Processor is an independent programmable processor connected to the Main Processor over a communication channel. It must therefore contain software to accomplish the following requirements:

- o Refresh Display Control
- o Format Display String
- o Modify Display String
- o Refresh Display Cursor

The modules comprising the Refresh Display Processor Program are illustrated in Figure III-11.

(1) Refresh Display Control

This module acts as a small executive, maintaining control over the Refresh Display Processor and its software. It will manipulate the communication channel to the Main Processor at the hardware address level, including hard error detection and handshaking protocol. It receives spontaneous data and control information from the Main Processor, passing control to appropriate modules and subroutines based upon the control information. This module interrogates the modified display string, upon requests from Main Processor modules, passing requested information back across the communications channel. This module also executes the "Suppress Refresh Display" command received from the Main Processor.

(2) Format Display String

This module is given control when feature data is received from the Main Processor. Some manipulation and/or formatting must be performed upon the data before it becomes the display string for the refresh operation. A feature status table is built by this module which contains an entry for each feature within the display string. Status data, pertaining to each feature, is built within the table (i.e., displayed, suppressed, deleted, etc.).

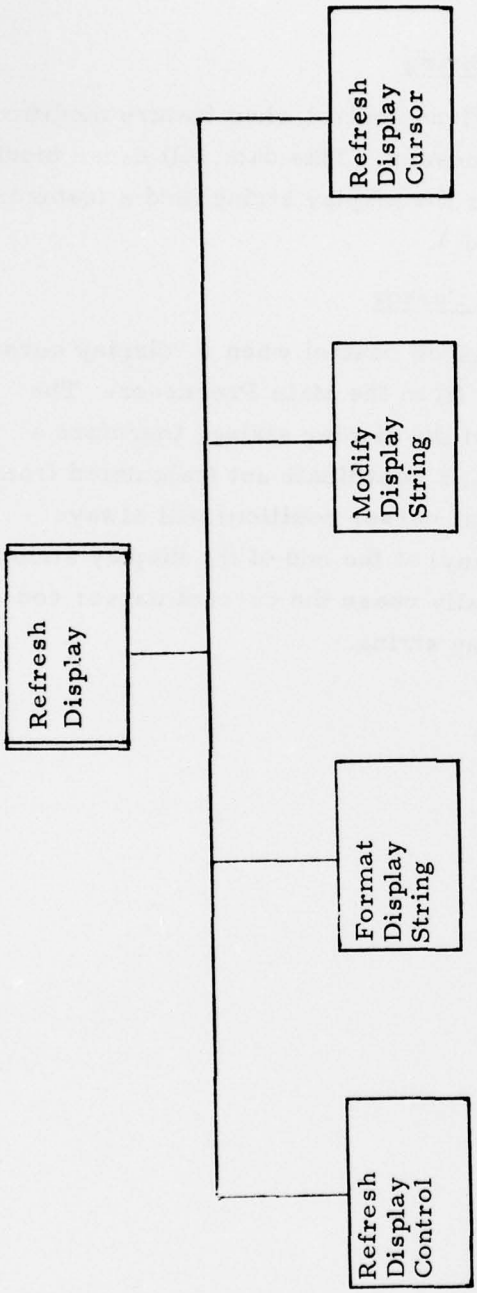


Figure III-11 Refresh Display Processor Program

(3) Modify Display String

This module is given control when feature modification data is received from the Main Processor. This data will cause modifications to the feature status table and/or the display string (add a feature, delete a feature, suppress a feature, etc.).

(4) Refresh Display Cursor

This module is given control when a "display cursor" or "blank cursor" command is received from the Main Processor. The cursor will always be added to the end of the display string, therefore a "display cursor" command with a new X, Y coordinate set (calculated from the X, Y coordinates of the current digital cursor position) will always overwrite the previous cursor code (if any) at the end of the display string. A "blank cursor" command will essentially cuase the current cursor code to be removed from the end of the display string.

i. Interactive Generalization Program

The Interactive Generalization Program is executed within the Main Processor on a medium priority basis to minimize lengthy waiting times for the compilers and at the same time give deference to more time critical programs. The services provided by this applications program generally require longer response times than those of the Interactive Feature Manipulation Program, since the program processes subsets of features rather than single features per transaction. Under control of the Executive Program simultaneous requests for the same Interactive Generalization module will be granted equal priority and each transaction will be processed in parallel through interleaving techniques. The modules comprising the Interactive Generalization Program are as follows (see Figure III-12):

- o Feature Elimination
- o Line Generalization
- o Outline to Point Conversion
- o Feature Groups to Outline Conversion
- o Double to Single Line Conversion

The Interactive Generalization program modules receive compiler commands originating from the A/N CRT and Keyboard, Digitizing Cursor, SFK, and Trackball at the Interactive Compilation Station or Proofing Station. Results of the generalization may be selectively viewed on either the Refresh CRT or the Large Screen Display. Further, the Nullify button on the SFK or the Reject Key on the Large Screen Keyboard may be depressed in order to erase the results of the transaction if they are unacceptable.

(1) Feature Elimination

This module provides the necessary software control to allow the compiler to cause certain features to be flagged as deleted. Features which are smaller than a minimum length threshold specified by the compiler and which also satisfy the intersection of the current Feature Group Selection and Subarea Definition are thus "eliminated" from the display and the Graphic Processing and Display files.

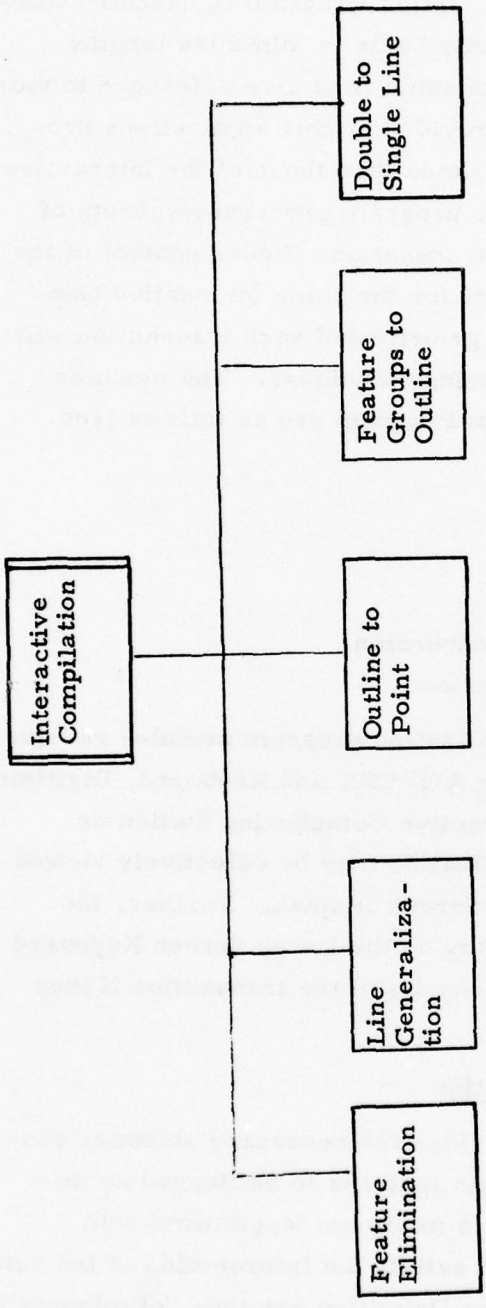


Figure III-12 Interactive Generalization Program

(2) Line Generalization

This module provides the necessary software control to permit one of several generalization algorithms to be applied to a single feature or a subset of features defined by the intersection of a Feature Group Selection and a Subarea. The generalization algorithms provide data cleaning, smoothing, and data reduction of the specified features. The generalized feature(s) may be subsequently reviewed by the compiler.

(3) Outline to Point Conversion

This module provides the software control allowing the compiler to replace the outline of a feature with a circle generated about the center point. Features which joined the original areal feature outline will be selectively joined to the replacement circle, which may vary in size.

(4) Feature Group to Outline Conversion

This module provides the necessary software control to permit the compiler to replace a group of similar point features with a single boundary outline. The point features enclosed within the outline are flagged as deleted and the outline is optionally added to the Graphic Processing and Display files as a new feature.

(5) Double to Single Line Conversion

This module provides the software control necessary to permit the compiler to replace the two features, or feature segments, constituting a double line feature with a single replacement feature or feature segment. The original two features are flagged as deleted and the centerline feature is added to the Graphic Processing and Display files as a new feature.

j. Alphanumeric Text Placement

The Alphanumeric Text Placement Program is executed within the Main Processor on a high priority basis to minimize response time. Compiler commands are entered through the A/N CRT and Keyboard and Digitizing Cursor or Trackball (optional) at the Interactive Compilation Station or Proofing Station. Results are displayed on the Refresh CRT or a Large Screen Display (optional). The modules comprising the Alphanumeric Text Placement Program are as follows (see Figure III-13):

- o Names Placement
- o Move Names
- o Select Names

(1) Names Placement

This module provides the necessary software control to permit the compiler to assign names to, or modify the names of a particular feature, and to specify the positioning of the alphanumerics. The compiler uses the Digitizing Cursor or Trackball to direct the names placement and the A/N CRT Keyboard to enter the text. The names placement information is stored in a special Names Placement file which is correlated with the finished compilation file and may be subsequently used for exploitation purposes. The text orientation is generated automatically based upon feature group and feature representation. The compiler may view this orientation of the names on the Large Screen Display or Refresh CRT during this process. This process may also be applied to "free text" annotation.

(2) Move Names

This module provides software control allowing the compiler to translate and/or rotate the text string by redefining the baseline orientation. The repositioning affected in the Graphic Processing and Display files is illustrated via the display.

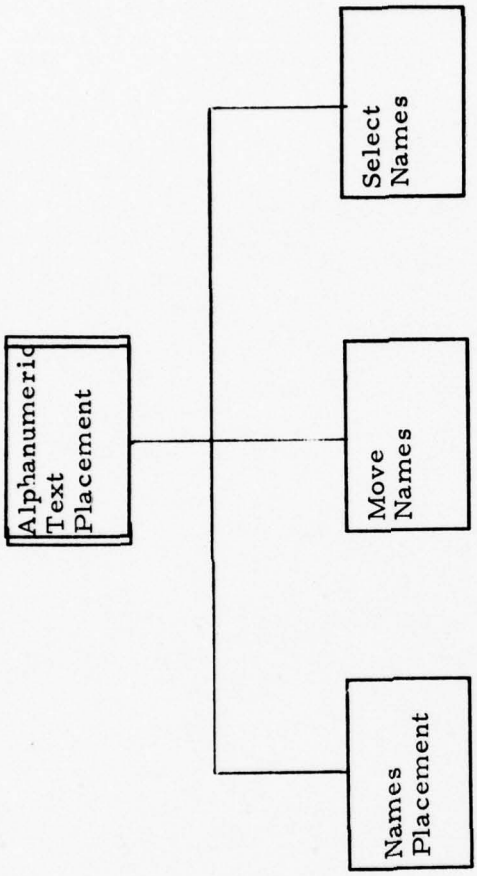


Figure III-13 Alphanumeric Text Placement Program

(3) Select Names

This module provides the necessary software control enabling the compiler to indicate that the current feature has been selected for naming on the final compilation. The Graphic Processing file reflects this selection.

G. Scenario of Interactive Processes

This section presents a description of basic man/machine steps and interactions for performance of all major functional operations at the interactive subsystem.

1. Overview of Functions

The interactive subsystem will provide the user with an extensive repertoire of capabilities for performing digital compilation and related functions. Towards compilation, recompilation, and revision/update of cartographic products the user is expected to exploit various combinations of the following functions:

- o Session Initialization
- o Input Processing
- o Source Assessment
- o Graphic Data Extraction
- o Graphic Display and Plotting
- o Interactive Feature Manipulation
- o Interactive Generalization
- o Alphanumeric Text Placement
- o System Services
- o Job and Process Reporting
- o Output Processing
- o Session Termination

The exact types and sequences of functions to be performed at a work session will vary from job to job depending on: the type of job, extent of digital and graphic sources available, and the cartographers' approach to the specific job peculiarities. In concert with this general operating concept the interactive subsystem will allow the user to selectively exploit any single or logical set of major functional capabilities (see Figure III-14) at a work session. As illustrated the user will start and end with Session Initialization and Termination, respectively. Sequence of all other functions will depend on the user and status of the particular compilation job. A matrix of all major functions/processes and associated major system components is presented in Figure III-15.

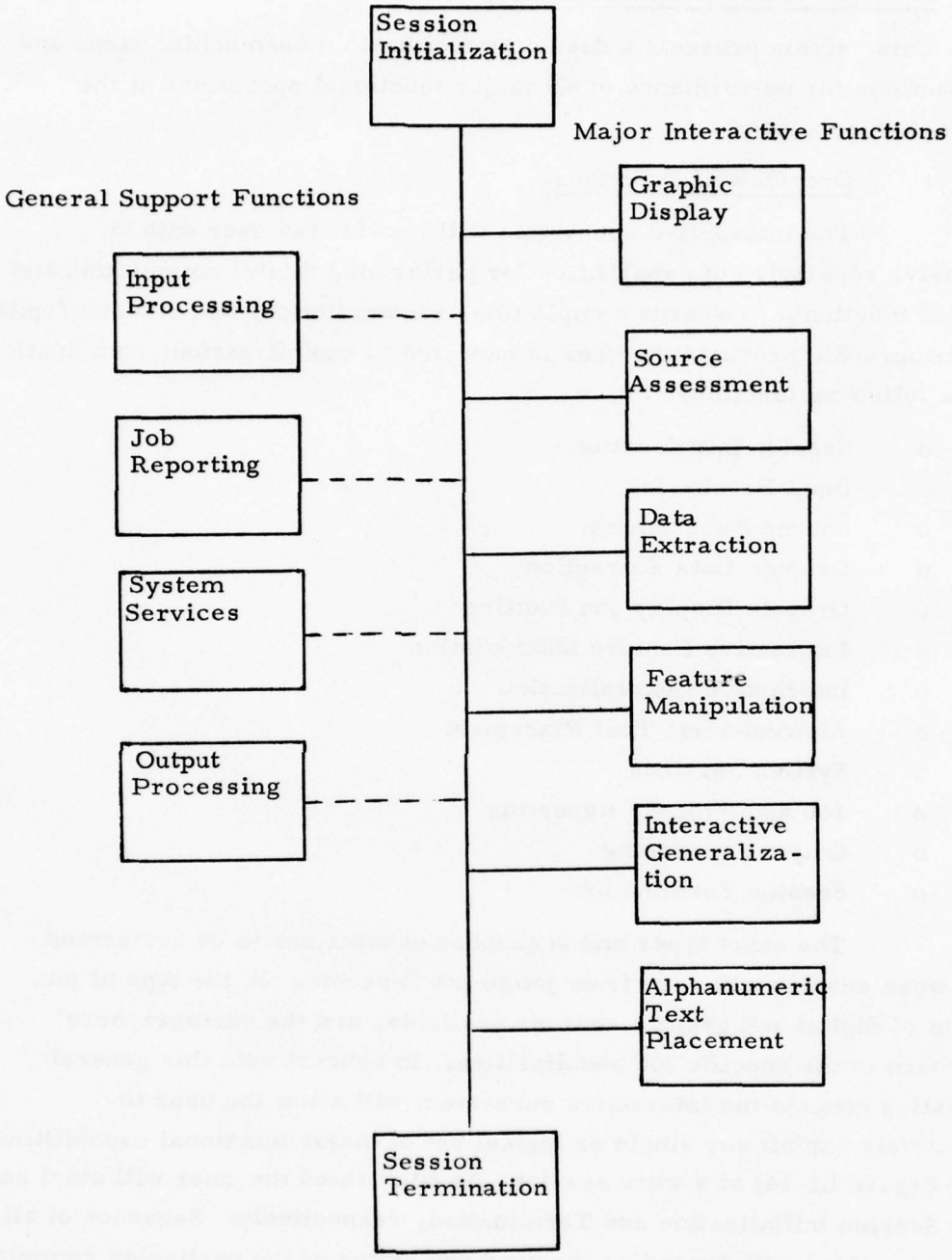


Figure III-14 Interactive Subsystem Functions

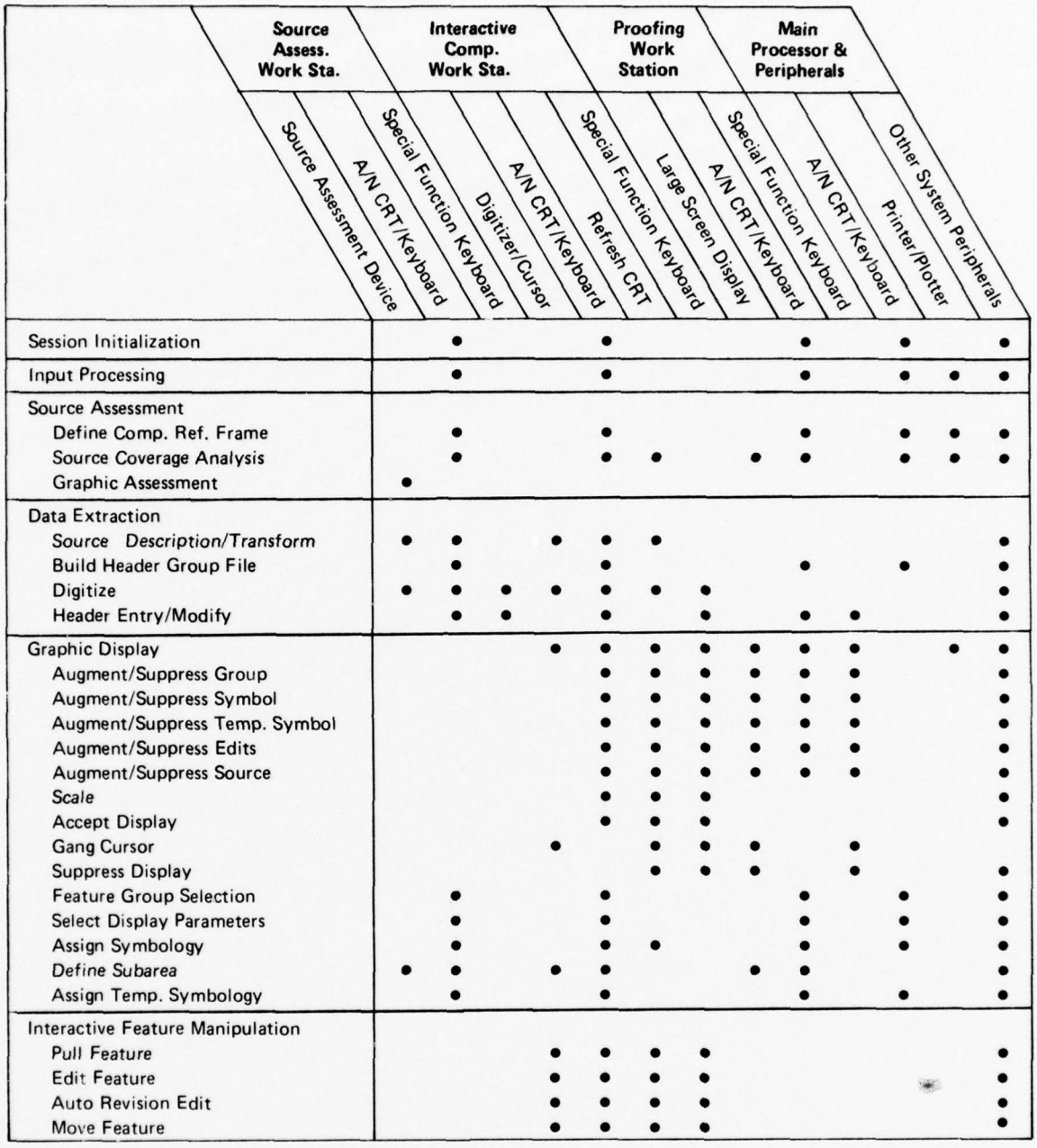


Figure III-15 Processes/Components Matrix (Page 1 of 2)

	Source Assess. Work Sta.		Interactive Comp. Work Sta.			Proofing Work Station			Main Processor & Peripherals				
	Source Assessment Device	A/N CRT/Keyboard	Special Function Keyboard	Digitizer/Cursor	A/N CRT/Keyboard	Refresh CRT	Special Function Keyboard	Large Screen Display	A/N CRT/Keyboard	Special Function Keyboard	A/N CRT/Keyboard	Printer/Plotter	Other System Peripherals
Segment Feature					•	•	•	•					•
Join Feature					•	•	•	•					•
Augment/Suppress Feature					•	•	•	•					•
Recall Feature					•	•	•	•	•	•	•		•
Delete/Accept Feature					•	•	•	•	•	•	•		•
Assign Header					•	•	•	•	•	•	•		•
Modify Header						•		•		•	•		•
Interactive Generalization													
Eliminate Features					•	•	•	•	•	•	•		•
Line Generalization					•	•	•	•	•	•	•		•
Outline to Point					•	•	•	•	•	•	•		•
Group to Outline					•	•	•	•					•
Double to Single Line					•	•	•	•					•
Alphanumeric Text Placement													
Display Name					•	•	•	•	•	•	•		•
Move Names					•	•	•	•	•	•	•		•
Select Names					•	•	•	•	•	•	•		•
System Services													
Help		•				•				•		•	•
Diagnostics												•	•
File Maintenance		•				•				•		•	•
Activity Log												•	•
Job & Process Reporting		•				•				•		•	•
Output Processing		•				•				•		•	•
Session Termination		•				•				•		•	•

Figure III-15 Processes/Components Matrix (Page 2 of 2)

2. Major Tools for Man/Machine Dialogue

The man/machine dialogue will be achieved via a number of devices and communication techniques. Generally, communications with the system will be verified by machine responses, acknowledgment lights, messages, and graphic displays. Most functional control will be achieved/acknowledged in approximately 1 second. Single feature retrieving and manipulation will require 1-5 seconds, and multiple feature displays will typically require 10-30 seconds depending on the display device and volume of graphic information.

The major devices to be used to effect the man/machine dialogue are as follows:

Digitizer Cursor	-	the cursor, illustrated in Figure III-16 will be employed for input of high resolution graphic coordinate data, and digitizing/edit control commands.
Special Function Keys (SFK)	-	will be used to direct the system to invoke various graphic displays and interactive graphic functions. The SFK will provide for some 42 function keys and in addition, each key will be sequentially numbered for combination function/numeric assignments. Activated keys/functions will be backlighted. A sample SFK is illustrated in Figure III-17. A SFK will be provided at each work station.
Trackball	-	provided with the Large Screen Display Device for coordinate input and feature finding. Control commands for the Trackball are planned to be provided by the SFK at the Proofing Work Station.

A/N CRT and Keyboard - these components will be located at each work station and will provide major communications between the user and the system.

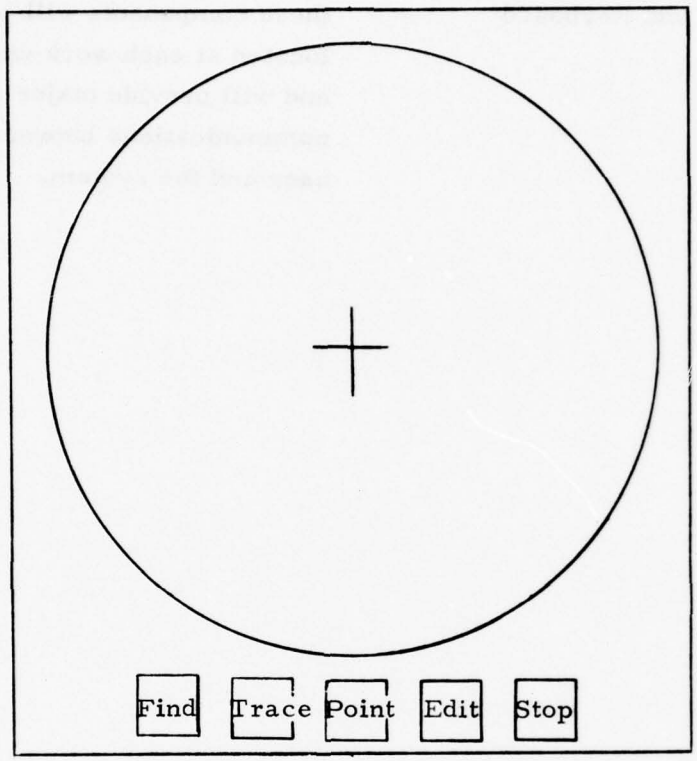


Figure III-16 Digitizing Cursor

0 Refresh Display	1 Large Screen Display	2 Hardcopy Plot	3 Augment/ Suppress Group	4 Augment/ Suppress Symbol	5 Augment/ Suppress Temp. Sym.
6 Augment/ Suppress Edits	7 Augment/ Suppress Source	8 Accept Display	9 Suppress Display	10 Scale	11 Gang Cursor
12 Digitize	13 Enter Header	14 Assign Header	15 Modify Header	16	17
18 Accept Feature	19 Delete Feature	20 Suppress Feature	21 Augment Feature	22 Recall Original Feature	23
24 Pull Feature	25 Edit Feature	26 Auto Revision Edit	27 Move Feature	28 Segment Feature	29 Join Feature
30 Eliminate Features	31 Line Generalize	32 Outline to Point	33 Group to Outline	34 Double to Single Line	35
36 Names Placement	37 Move Names	38 Select Names	39	40 Help	41 Nullify

Figure III-17 Special Function Keys & Definitions (Page 1 of 5)

Context of Special Function Keys

(0) Refresh Display - generates a graphic display of the currently defined file on the Refresh CRT.

(1) Large Screen Display - generates a graphic display on the Large Screen Display of the currently defined file. If the user is employing both the Refresh CRT and Large Screen Display, depression of K1 at the Refresh Station would result in updating the Large Screen with new features or edits.

(2) Hardcopy Plot - generates a graphic plot on the system plotter of the currently defined feature file. The current file can be defined by the display parameter options or represents that file currently displayed.

(3) Augment/Suppress Group - generates a display on the A/N CRT of the feature groups and associated display status (on/off) of the current file. Entry of the appropriate numeric key will switch the display status and result in that feature group being added to or deleted from the display.

(4) Augment/Suppress Symbol - used to convert feature groups from a symbolized format to their line center representation and vice versa. Subsequent entry of the appropriate numeric key identifies which feature group(s) is to be redisplayed.

(5) Augment/Suppress Temporary Symbols - features will have special status flags indicating that certain compilation actions have taken place, such as: deleted, accepted, edited, generalized, etc. This SFK will permit the user to request special symbols to be applied to/removed from features with special status flags.

Figure III-17 Special Function Keys & Definitions (Page 2 of 5)

(6) Augment/Suppress Edits - the user can modify the display to include/exclude features which have been altered by feature manipulation and generalization processes. A list of manipulation and generalization processes will be presented on the A/N CRT for user selection of corresponding SFK numeric keys.

(7) Augment/Suppress Source - the user can modify the display to include/exclude features which were derived from source 1, 2, .., n. Definition of which source group to be modified is performed by depressing the appropriate SFK numeric key which corresponds to the sources listed on the A/N CRT.

(8) Accept Display - the user can assign accept flags to all features currently displayed.

(9) Suppress Display - this erases the current display.

(10) Scale - the current display is scaled by the numeric factor defined by a numeric SFK. Typically the scale change will be 1X, 2X, 3X, 4X for purposes of closely examining and possibly modifying areas of high feature density.

(11) Gang Cursor - causes the digitizer cursor location to be displayed on the Refresh CRT or trackball location on the Large Screen Display.

(12) Digitize - used to initiate the digitizing software, subsequent to graphic registration and other required set-up processes.

(13) Enter Header - used to build a header or select one of a previously defined set of header groups. This key is normally used to select a new header during feature digitization.

Figure III-17 Special Function Keys & Definitions (Page 3 of 5)

(14) Assign Header - results in the header selected via the numeric key to be assigned to a current feature.

(15) Modify Header - allows the user to modify any item contained in the feature header. The text modification is performed at the A/N CRT Keyboard.

(16) Blank

(17) Blank

(18) Accept Feature - results in an accept flag being posted on the current feature.

(19) Delete Feature - results in delete flag being posted on the current feature and the current display will be altered to appropriately symbolize the deleted feature (deleted features are typically not displayed, although can be displayed for verification and proofing.

(20) Suppress Feature - the current feature is suppressed from the current display.

(21) Augment Feature - allows for displaying a current feature which had been suppressed from the display.

(22) Recall Original Feature - generates a display of original feature lines which have been altered due to line editing, generalization, etc.

(23) Blank

Figure III-17 Special Function Keys & Definitions (Page 4 of 5)

(24) Pull Feature
(25) Edit Feature
(26) Auto Revision Edit
(27) Move Feature
(28) Segment Feature
(29) Join Feature
(30) Eliminate Features
(31) Line Generalize
(32) Outline to Point
(33) Group to Outline
(34) Double to Single Line

These keys initiate the hardware/software controls which allow the user to effect the desired type of feature line modifications or generalization processes. Other user actions necessary to complete these processes are discussed in following sections.

(35) Blank

(36) Names Placement - directs the display device to augment the display with the name of the current feature.

(37) Move Names - this key will initiate those actions to allow the user to position a name or annotation on the display device.

(38) Select Names - allows the user to assign a "select flag" to a current feature.

(39) Blank

(40) Help - this service will produce current function and process status information on the A/N CRT. Steps to be followed to complete a process in progress will be also displayed when appropriate.

(41) Nullify - this key will be used to nullify the immediate process being performed by the user. This action will return the status to the prior event.

Figure III-17 Special Function Keys & Definitions (Page 5 of 5)

3. Functional Scenario and Hardware/Software Flow

This section presents an operational description of all major functions and associated processes for the interactive subsystem.

Every user of the interactive system will sign on/sign off at one of the A/N CRT's. The user can exploit any single or various combinations of the functions for achievement of a particular compilation job or step.

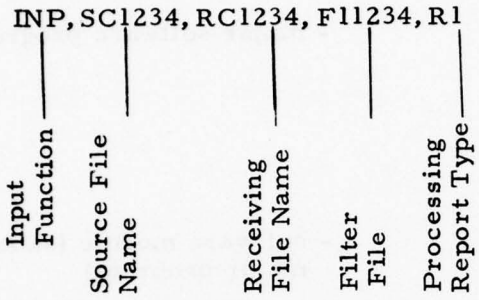
Entry into the major functional level of the interactive subsystem will be performed by text entry of the function name mnemonic (minimum 3 characters) via the A/N keyboard. The user can enter FUNCTION and all functional services currently available to his work station will be displayed as follows:

FUNCTION

1. INITIALIZATION
2. INPUT
3. ASSESSMENT
4. EXTRACTION
5. DISPLAY
6. MANIPULATION
7. GENERALIZATION
8. TEXT
9. SERVICES
10. REPORTING
11. OUTPUT
12. TERMINATION

The user can initiate any major function by entry of either the function sequence number or entry of the mnemonic text, consisting of a minimum of 3 unique characters (underlined above). A streamlined mode for definition of functions and associated processing parameters is also planned. Certain functions require very limited user direction and the experienced user is capable of direct entry of

parameters. Such functions to be included are Initialization, Input, Services, Reporting, Output, and Termination. An example of the streamlined entry technique is:

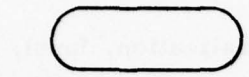


The other approach for input of functional commands is, for example:

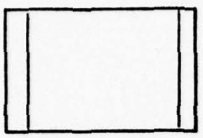
> INP ← CR

which is followed by the system generating appropriate questions and/or directions for the user to respond. Further actions associated with each function are described in following sections. To allow the user a wide range of freedom in selecting interactive processes, major interactive services will be accessable via the SFK. Once a graphic and/or cursor is registered to a digital file, the user can apply any combination of display, digitizing, feature manipulation, generalization, and text placement processes.

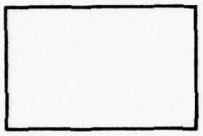
The function descriptions presented below summarize the purpose, major processes, components used, description of each process, and a flow of hardware/software activities. Figure III-18 presents the symbol legend used for the hardware/software thread flows.



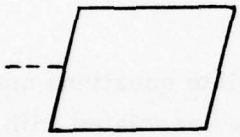
- terminal symbol-either entry or exit of process



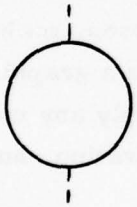
- major software program



- software module (subordinate to major program)

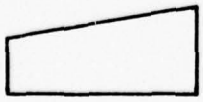


- free text commentary



- thread process (external process)

- connector where: n=sequence no., m=page no.



- manual input action

Figure III-18 Thread Flow Symbols Definition (Page 1 of 2)

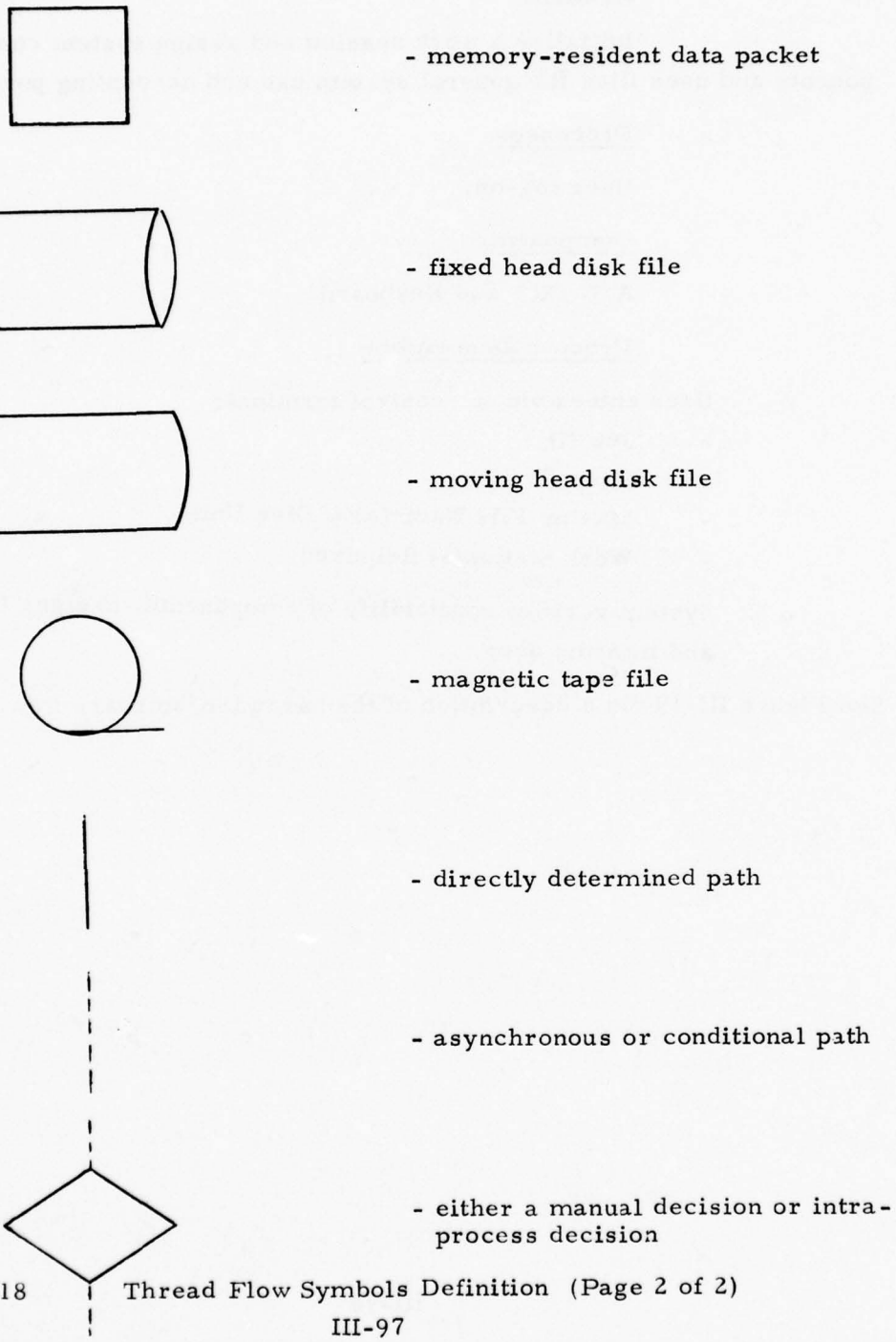


Figure III-18 Thread Flow Symbols Definition (Page 2 of 2)

a. Session Initialization

Purpose

Initialize a work session and assign system components and user files for general system use and accounting purposes.

Processes

User log-on.

Components

A/N CRT and Keyboard

Process Description

- o User enters via a control terminal:
  - Job ID
  - User ID
  - Master File Name(s) & Disc Unit
  - Work Station(s) Required
- o System verifies availability of components, assigns file(s) and informs user

See Figure III-19 for a description of the hardware/software flow.

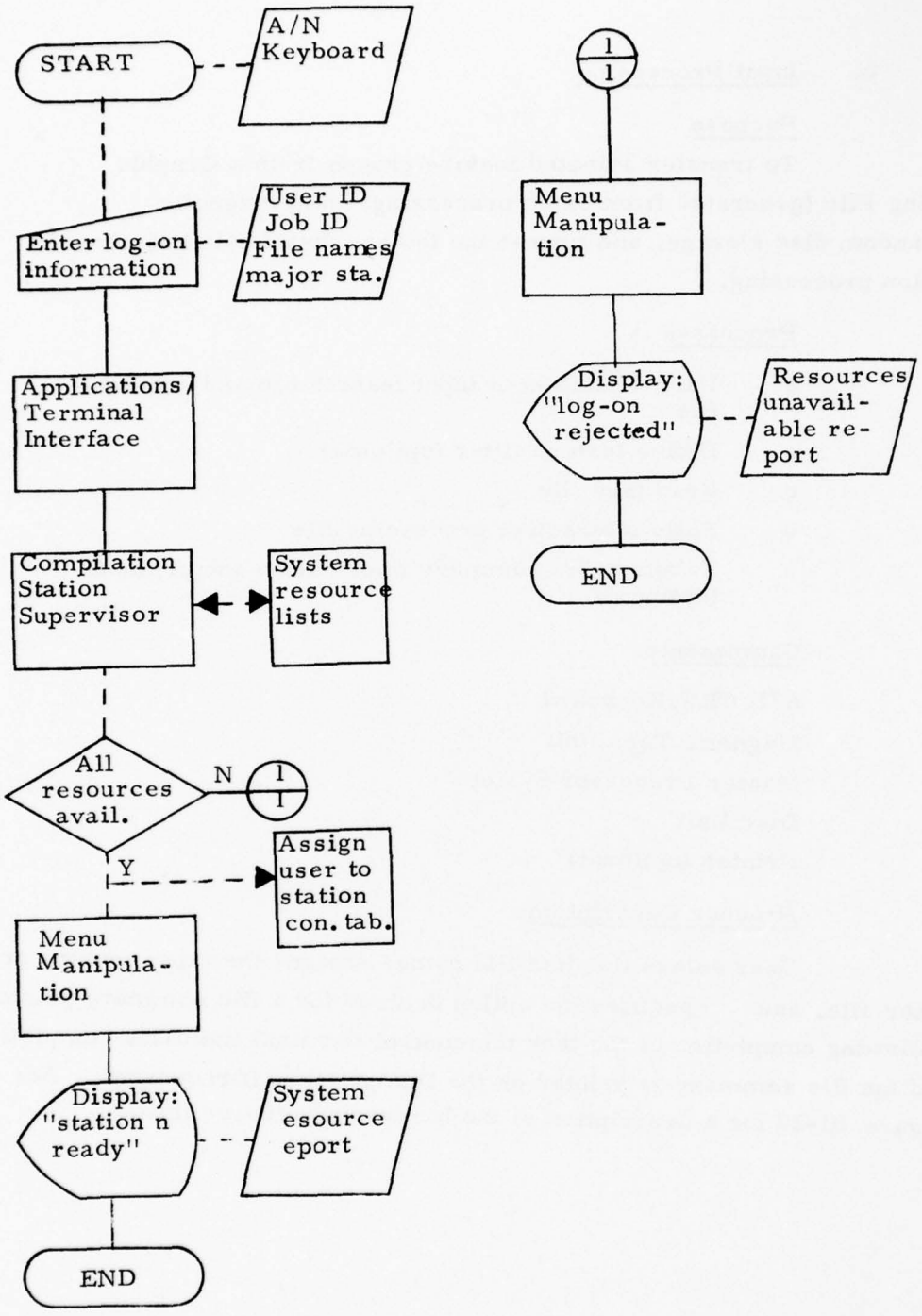


Figure III-19 Session Initialization (Page 1 of 1)

b. Input Processing

Purpose

To transfer selected feature groups from a Graphic Processing File (generated from batch processing) from magnetic tape to random disc storage, and format the feature data for interactive compilation processing.

Processes

- o User definition of input feature file and receiving file
- o Define feature filter (optional)
- o Read tape file
- o Build interactive processing file
- o Tabulate file summary information and printout (optional)

Components

A/N CRT/Keyboard

Magnetic Tape Unit

Master Processor System

Disc Unit

Printer (optional)

Process Description

User enters the disc file name, assigns the tape, feature group filter file, and specifies the option desired for a file summary printout. Following completion of the task the control terminal indicates completion and the file summary is printed on the line printer, if requested. See Figure III-20 for a description of the hardware/software flow.

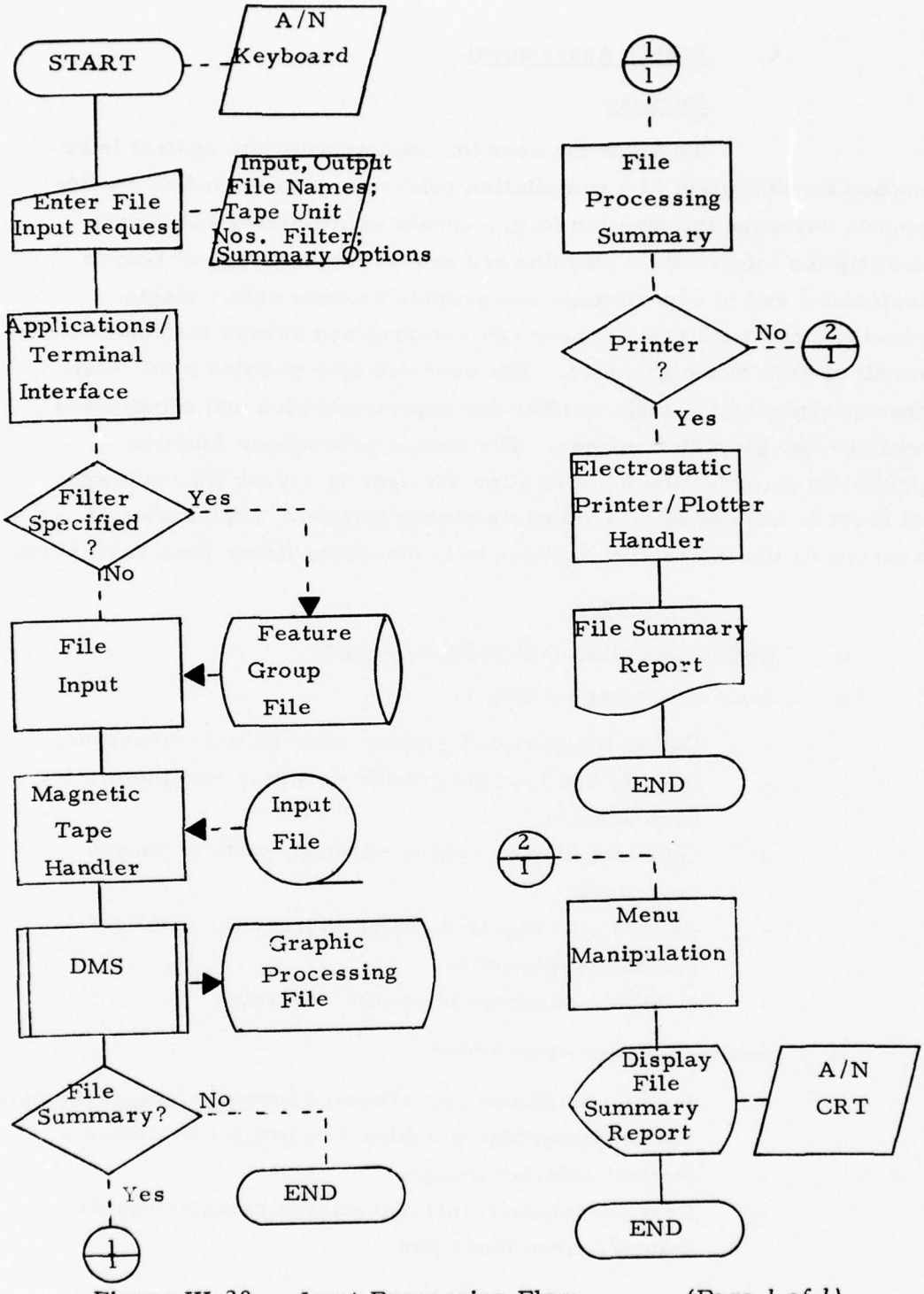


Figure III-20 - Input Processing Flow (Page 1 of 1)

c. Source Assessment

Purpose

To allow the user to: load appropriate control information for definition of a compilation reference frame; load or modify source coverage information (e.g., corner coordinates) and source description information; examine and assess the coverage of source materials; and to superimpose two graphic sources onto a single viewing plane such that the user can compare and assess the relative merit of each of the graphics. The user can also position a full scale transparency on the table surface for superimposition and comparison with the two projected images. The source assessment function primarily provides the tools to allow the user to review the coverage of sources and optically manipulate source images. Exploitation of sources by the interactive subsystem is discussed under Data Extraction.

Processes

- o Define Compilation Reference Frame
- o Source Coverage Analysis
  - Obtain imagery and graphic sources to be assessed.
  - Identify and load geographic coverage parameters for each source.
  - Generate display and/or hardcopy plots of source coverage.
  - Assess coverage and select sources for detailed content assessment.
  - Generate hardcopy of source coverage.
- o Source Content Assessment
  - Position hardcopy plot of source coverage on assessment table.
  - Place appropriate graphics into projection devices.
  - Project selected images.
  - Register/scale/transform images using reference frame/source index plot.

- Prepare overlay of features to be digitized by an off-line system; perform other functions--direct data extraction, and/or perform feature manipulation to current digital file, as required.

Components

Source Assessment Device
Large Screen Display
A/N CRT & Keyboard

Process Description

The user will enter via an A/N CRT and Keyboard the geographic location parameters for the area to be compiled. This reference frame provides the basis for fitting, registering, or transforming digital data and graphics. The source coverage analysis will allow the user to selectively view the coverage of alternate combinations of source materials. Thus the user can define alternate sources and view the resulting coverage until he decides on further actions required. One use of this capability will be to prepare a hardcopy plot of the selected source coverage, composite with the compilation reference frame (i.e., graticules) for subsequent positioning of projected images at the assessment component. Mounting and image projection and positioning actions will be primarily manual/mechanical processes (i.e., no digital processes required), except when the assessment results in direct data extraction, or manipulation of digital feature information. See Figure III-21 for a description of the hardware/software flow.

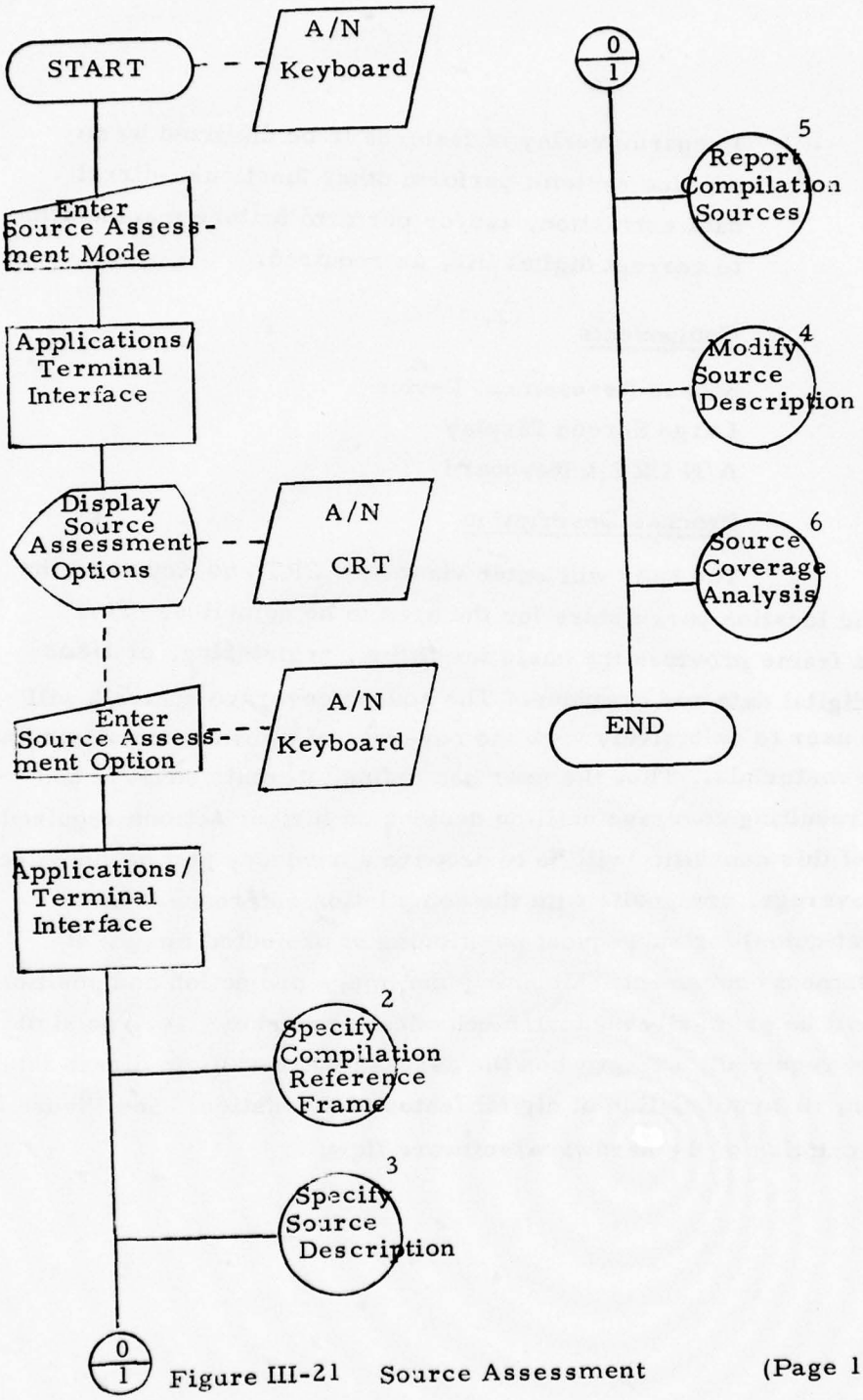


Figure III-21 Source Assessment (Page 1 of 7)

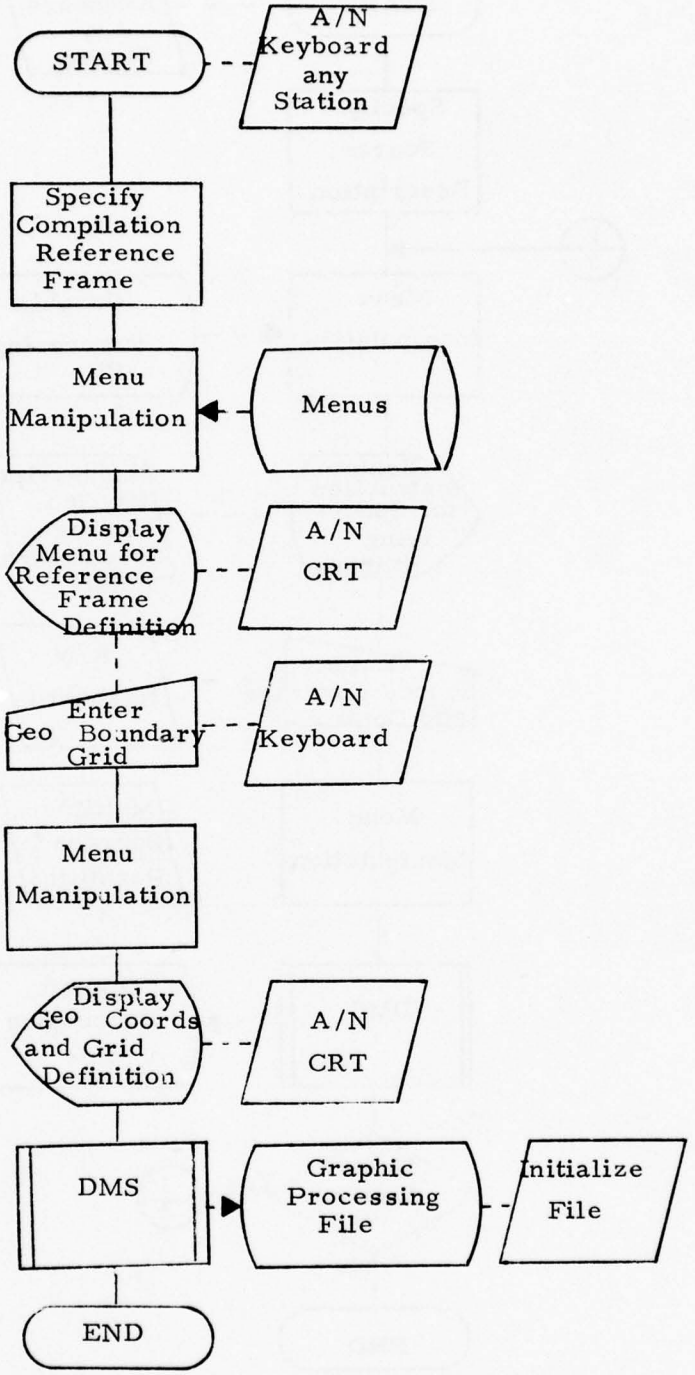


Figure III-21 - Source Assessment - Specify Compilation Reference Frame (Page 2 of 7)

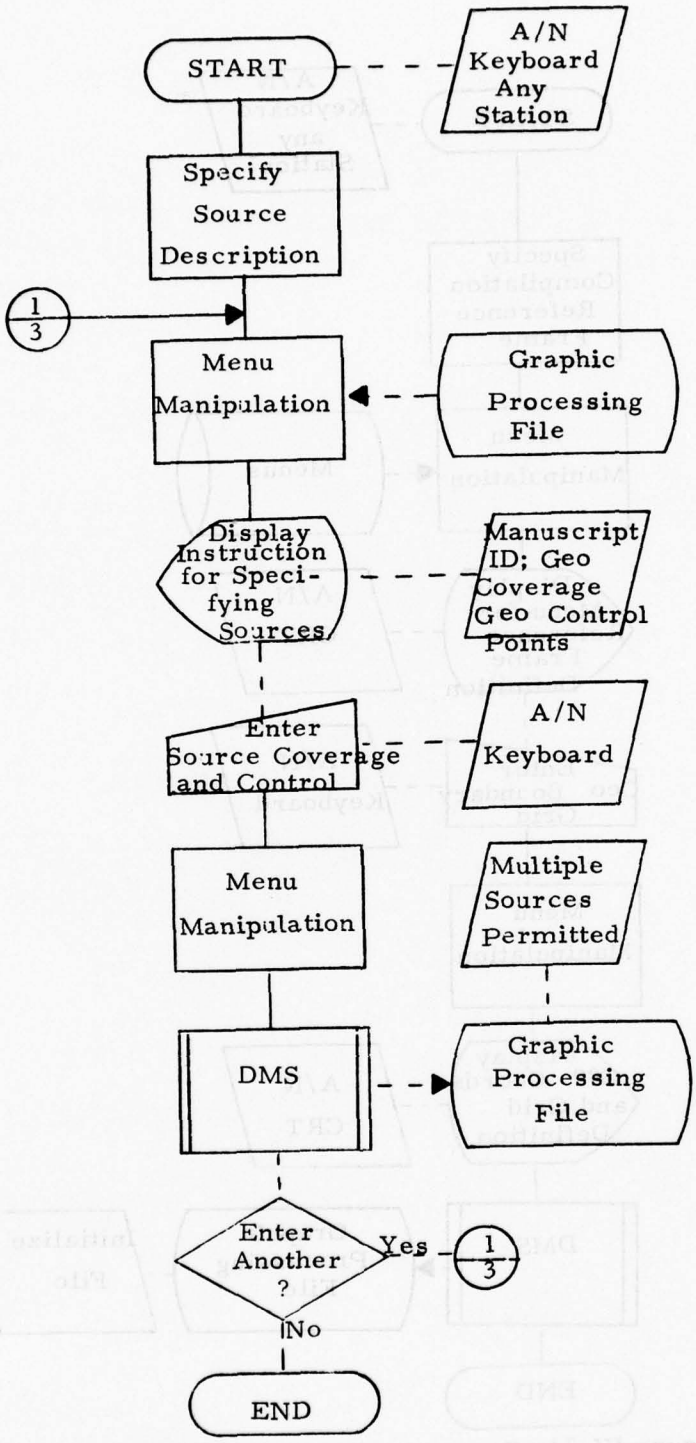


Figure III-21 - Source Assessment - Specify Source Description (Page 3 of 7)

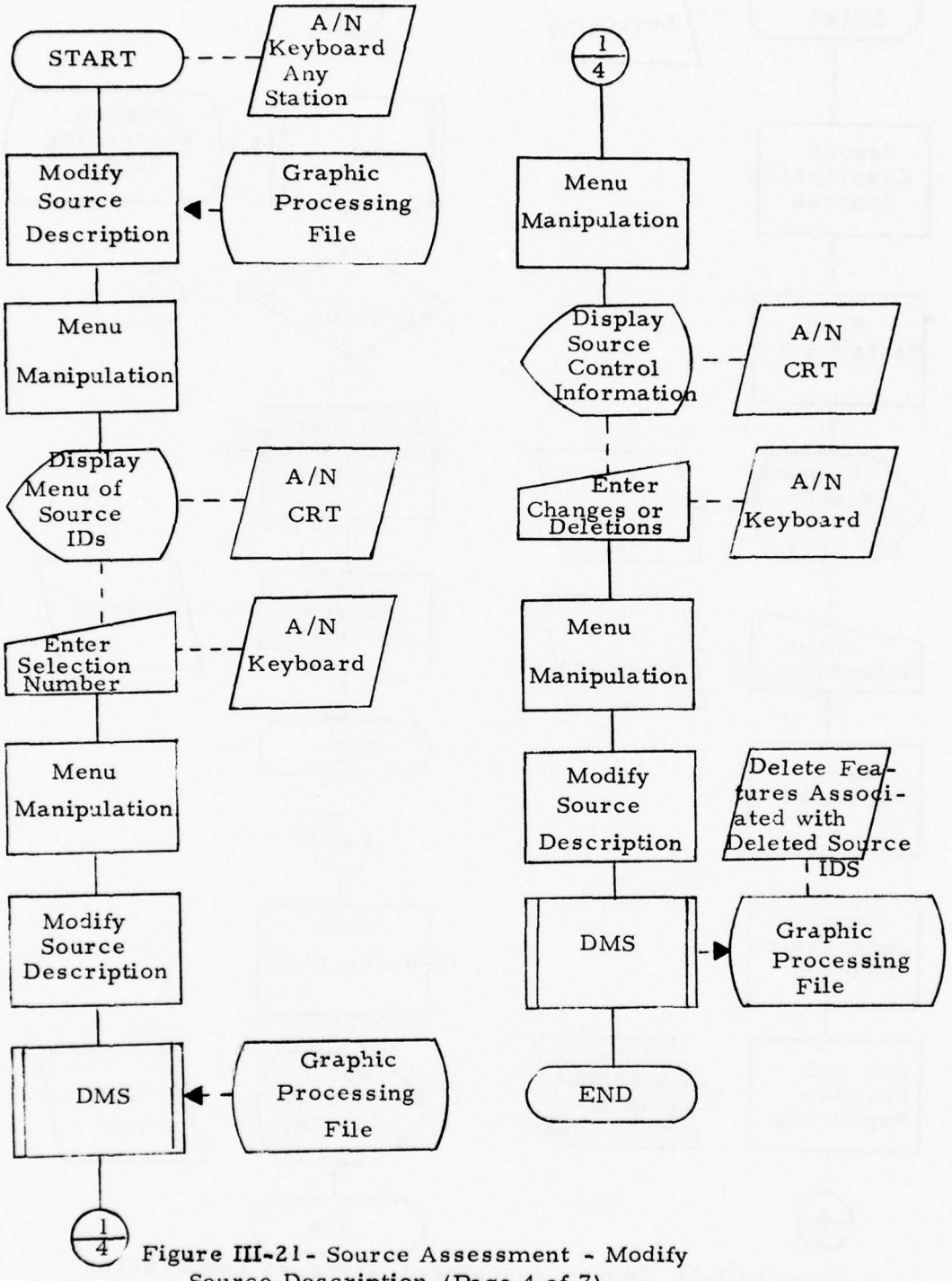


Figure III-21- Source Assessment - Modify Source Description (Page 4 of 7)

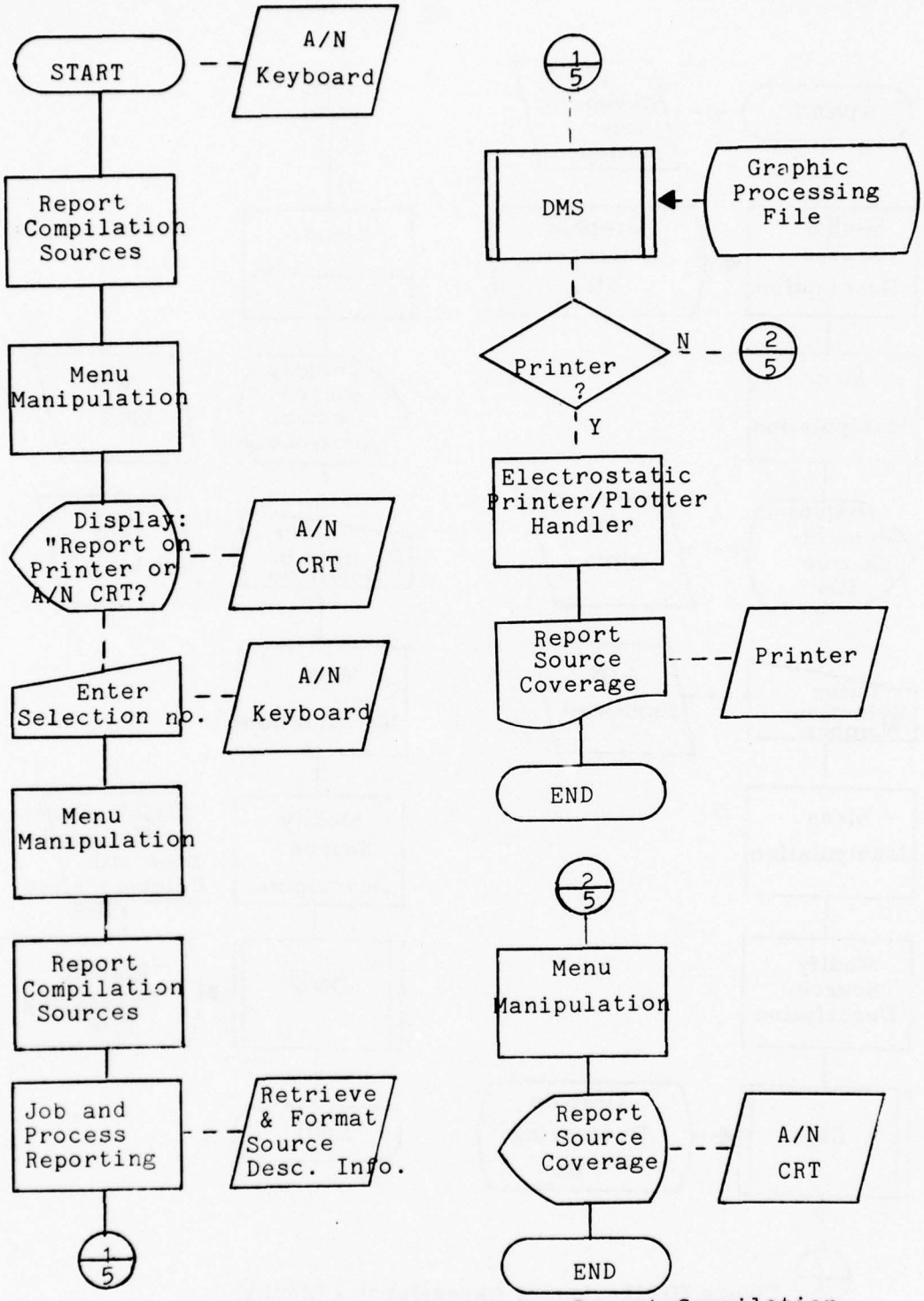


Figure III-21 Source Assessment - Report Compilation Sources (Page 5 of 7)

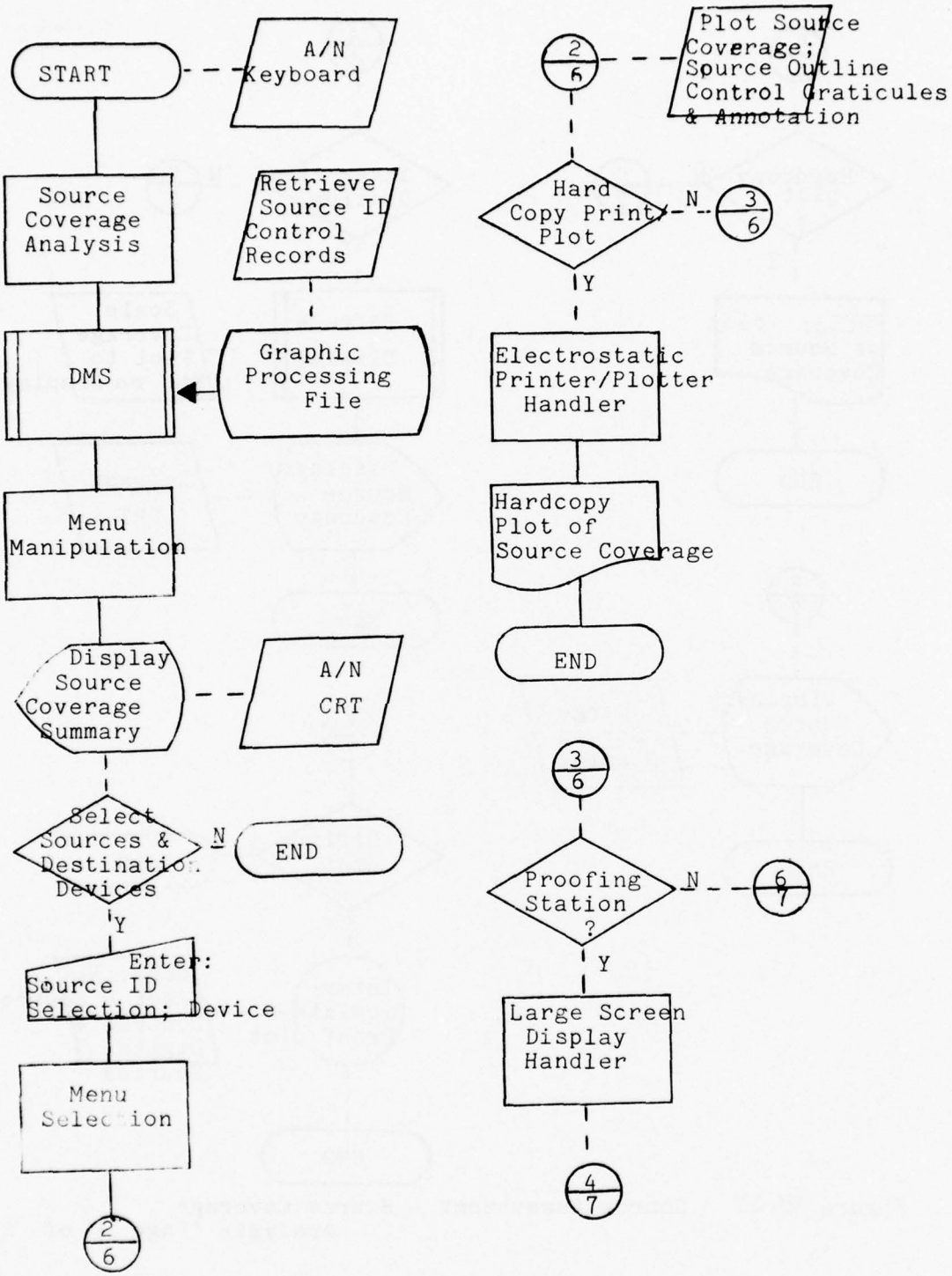


Figure III-21 Source Assessment-Source Coverage Analysis (Page 6 of 7)

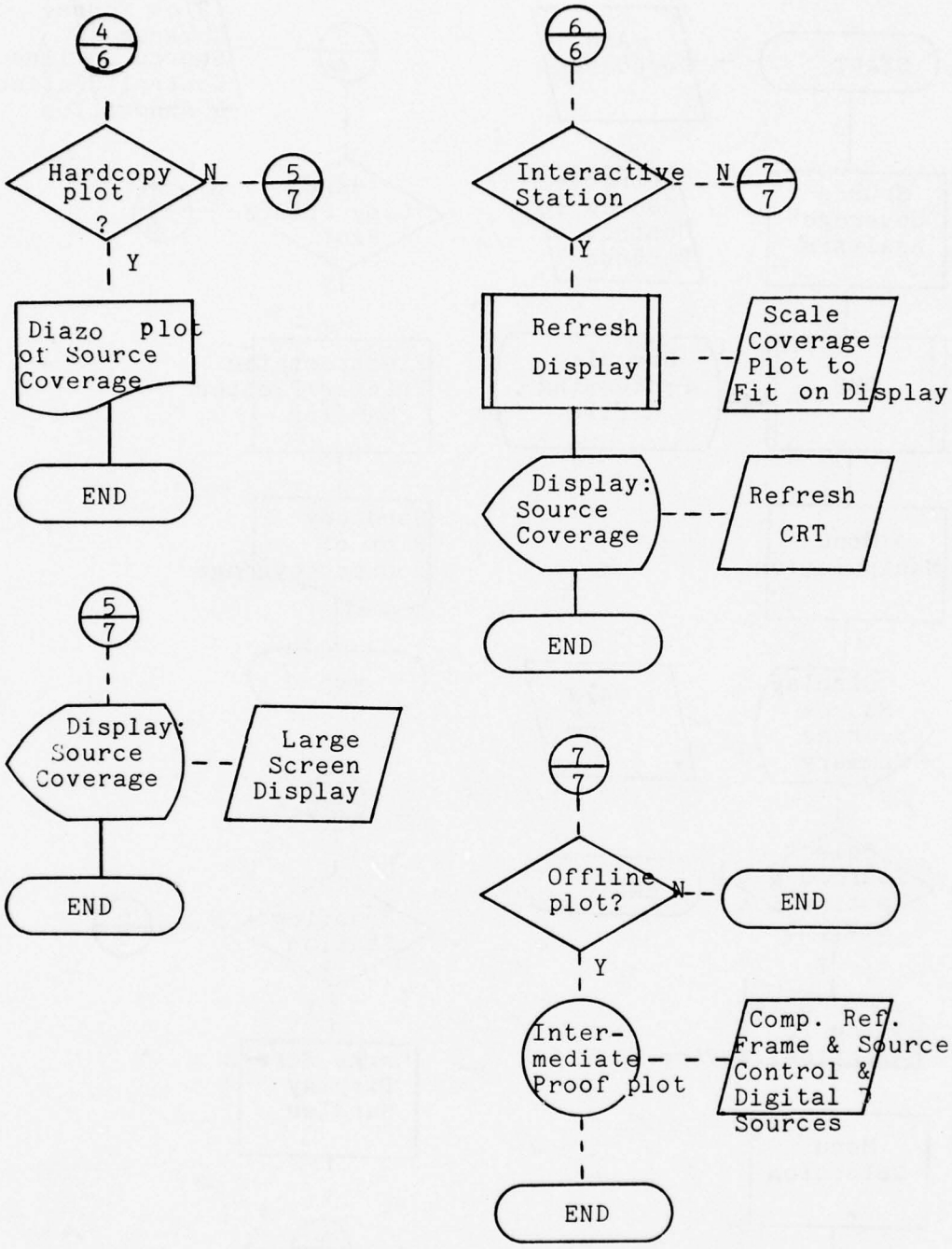


Figure III-21 Source Assessment - Source Coverage Analysis (Page 7 of 7)

d. Graphic Data Extraction

Purpose

To provide for computation of registration, transformation, or rectification parameters for conversion of a graphic to the reference frame of the Graphic Processing File; software/hardware services to allow the user to digitize feature information from graphic sources; and software algorithms to transform/rectify digital source data to the compilation reference frames. The extraction processes can be performed at either the assessment or interactive work stations.

Processes

- o Source Description/Transform
  - Define type of file being created and transforms required
  - Enter graphic identification and reference frame parameters
  - Enter control point coordinates of graphic
  - Compute registration/transformation/rectification coefficients
  - Display and verify conversion parameters and precision of fit
- o Build Header Group File
- o Digitize
  - Select header group and augment as required
  - Digitize feature lines
  - Display trace data representing new features (optional)

Components

Graphic Digitizer/Cursor
SADE Digitizer/Cursor (optional)
A/N CRT and Keyboard
SFK
Refresh CRT (optional)

Process Description

The user will request the data extraction function via the A/N keyboard (i.e., > EXTRACT). The current digitizing processing parameters will be displayed on the A/N CRT. The user will then enter or modify the following:

- o graphic identification and reference frame parameters
- o compilation reference frame
- o receiving disc file name
- o graphic display option
- o header group file or build option
- o source type and transformation type

Options provided to the user to account for various source types will include: registration, transformation (non-lineal), projection transforms, and rectification. The user will be able to direct digital feature information through the necessary transform algorithms for incorporation into the graphic processing file based on the compilation reference frame. The user can optionally capture raw digital data by passing the data directly to a standalone digital file. This standalone type of file can subsequently be transformed to and merged with a graphic processing file. Likewise, the standalone file can be output for general use and data base application. Conversion of digital source data to the compilation side will typically include scale reduction and associated data point reduction.

Depending on the transform options the user will either further define the source parameters for rectification or proceed to control point entry. Rectification parameters to be input will include:

- o photo type (pan, strip, frame)
- o velocity
- o altitude
- o focal length
- o sweep rate
- o average ground distance
- o roll
- o pitch
- o yaw

The user will then enter the control points from the source graphic for verification with previous control or entry of new control points. The control points will be verified against the original set or new transform coefficients will be mathematically derived. The precision of fit will be graphically displayed on the Refresh CRT and the error residuals will be listed on the A/N CRT for user verification and acceptance.

The user can now proceed to extract feature information which includes entering feature descriptor information and line digitization. This process must be as streamlined as possible and also provide for accurate data entry. The fact that features are frequently described identically, the header entry scheme should allow for direct entry of up to 10 to 20 previously defined headers. The user can select any one of the previously defined headers by depressing the "ENTER HEADER" SFK and numeric SFK corresponding to the list of headers displayed on the A/N CRT. Any modification to the header or creation of a new header is performed at the A/N keyboard and reflected on the A/N CRT. Any header entered is automatically carried to the next feature unless altered by the user. This will allow the user to digitize any number of features by using only the digitizer cursor and associated cursor keys.

Feature digitizing will take the form of depressing TRACE or POINT cursor keys as illustrated in Figure III-22. The user can traverse curvilinear features using the TRACE cursor key. Straight line segments or features can be entered via the POINT cursor key. Mixing of the TRACE and POINT cursor modes is also required. Backlighting of the current active cursor key will provide verification to the user of the cursor status. Termination of a feature line can be achieved by depression of the STOP cursor key or is implicitly invoked by depression of certain keys on the SFK. Digitized feature data will optionally be augmented to the display on the Refersh CRT for user review and verification.

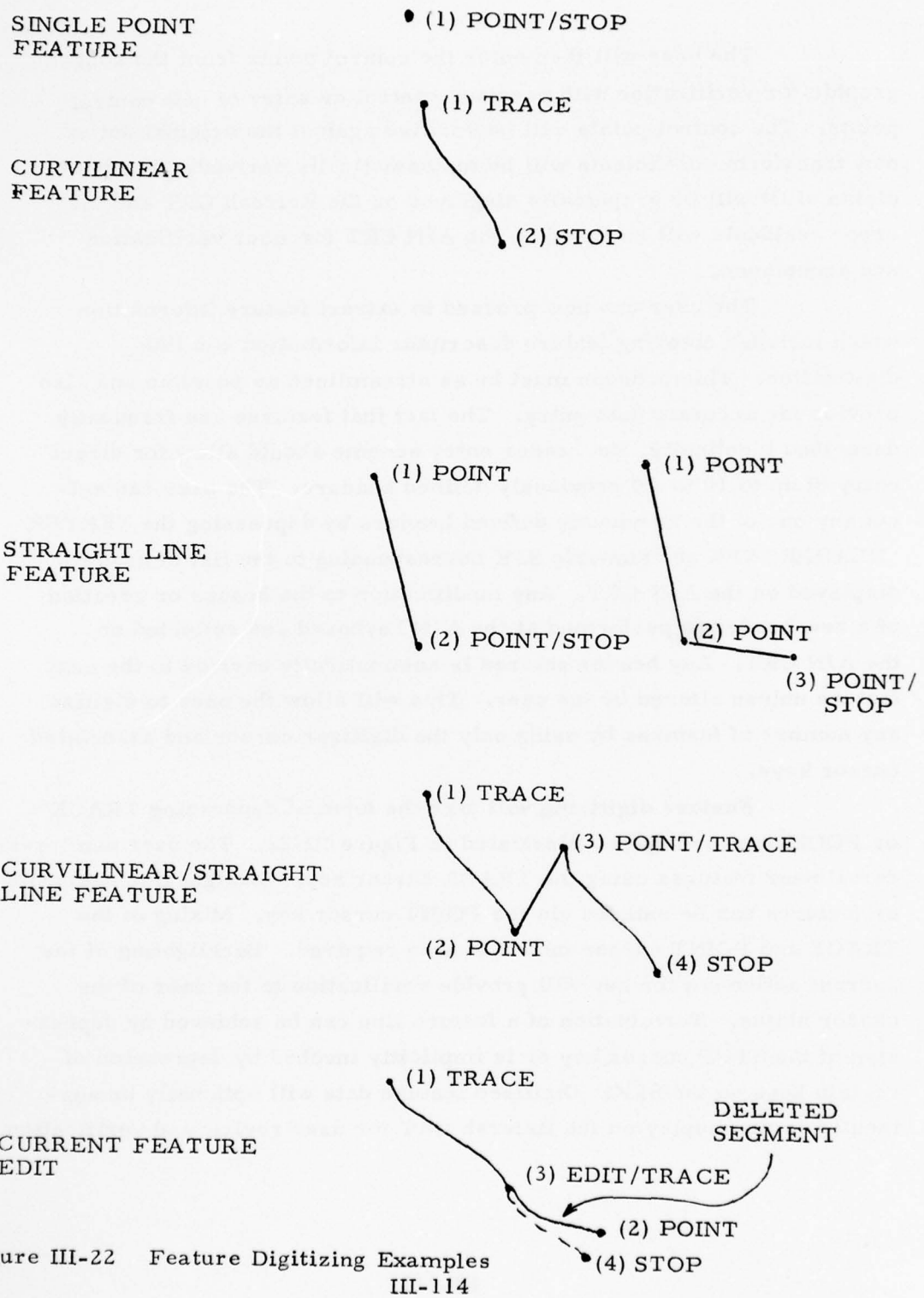


Figure III-22 Feature Digitizing Examples

As part of the digitizing function the user can delete the currently digitized feature or back-up the digitized line to an edit point and re-digitize from the edit point. This capability will allow the user to immediately correct detected errors. The user will depress the POINT key to terminate tracing, move the cursor to a point on the digitized segment, depress EDIT cursor key and continue tracing from that point. The edit point will be displayed on the Refresh CRT along with the current feature for user verification. Figure III-23 presents a hardware/software flow for major data extraction processes.

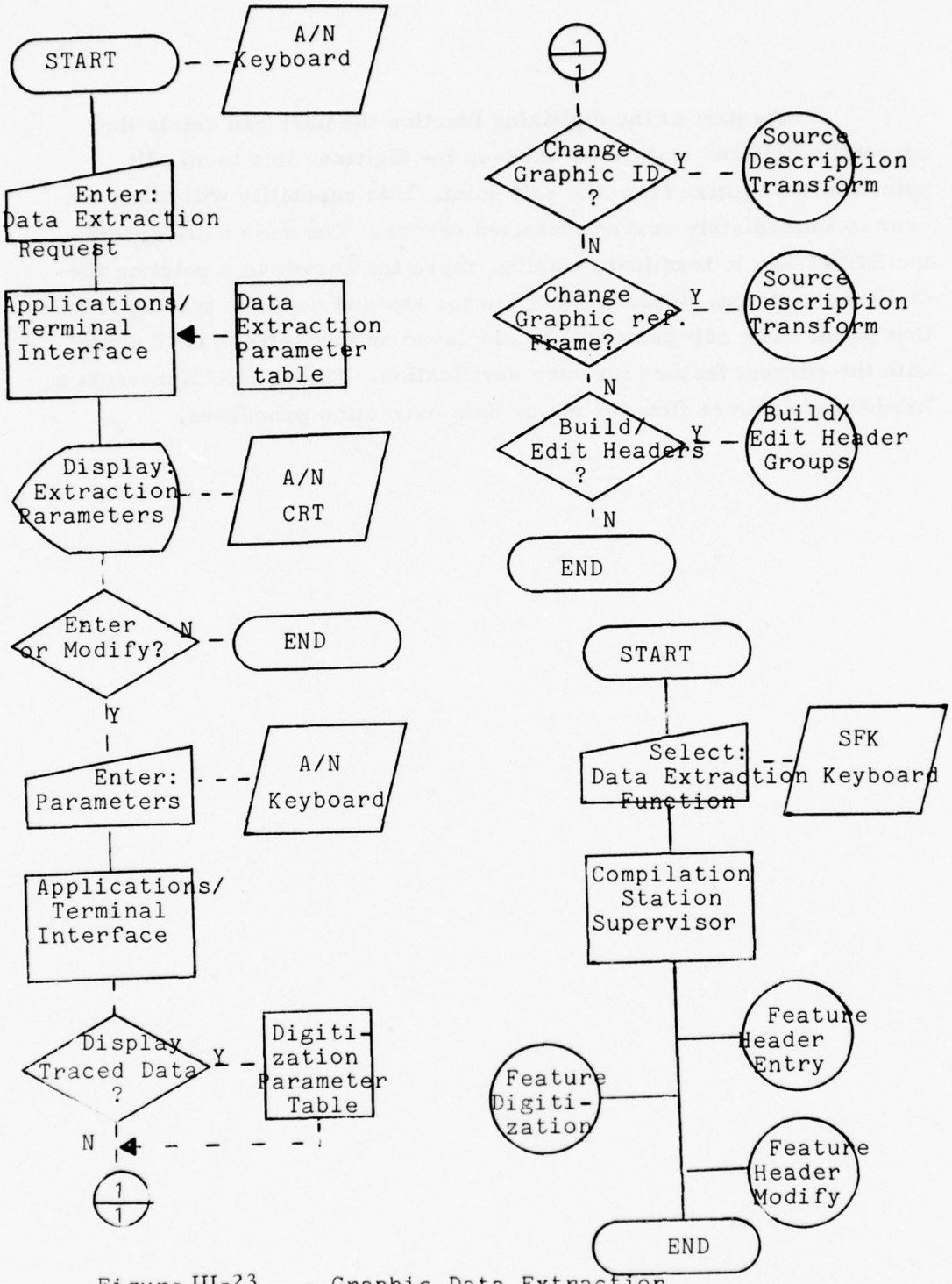


Figure III-23 - Graphic Data Extraction

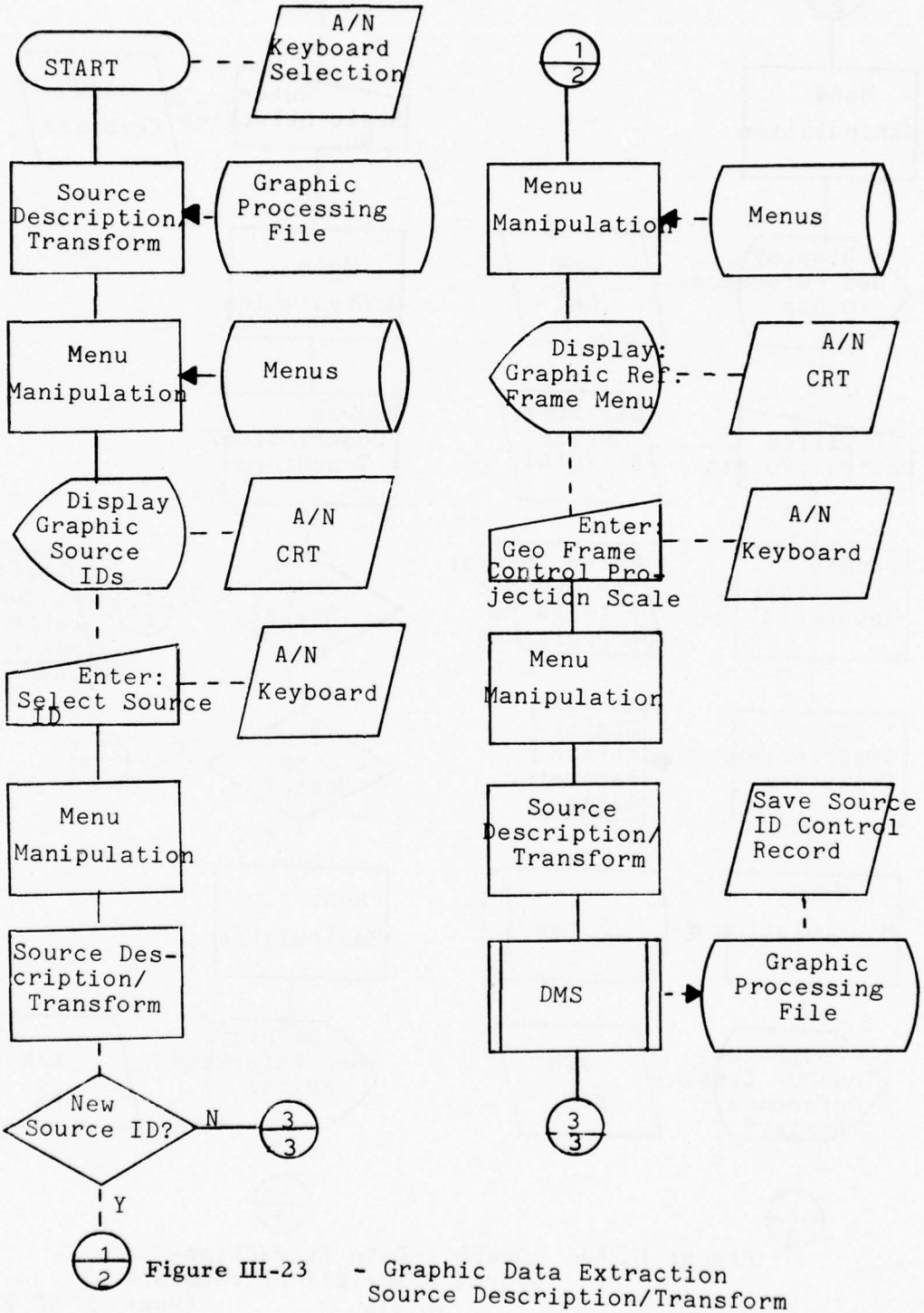


Figure III-23 - Graphic Data Extraction
Source Description/Transform
(Page 2 of 11)

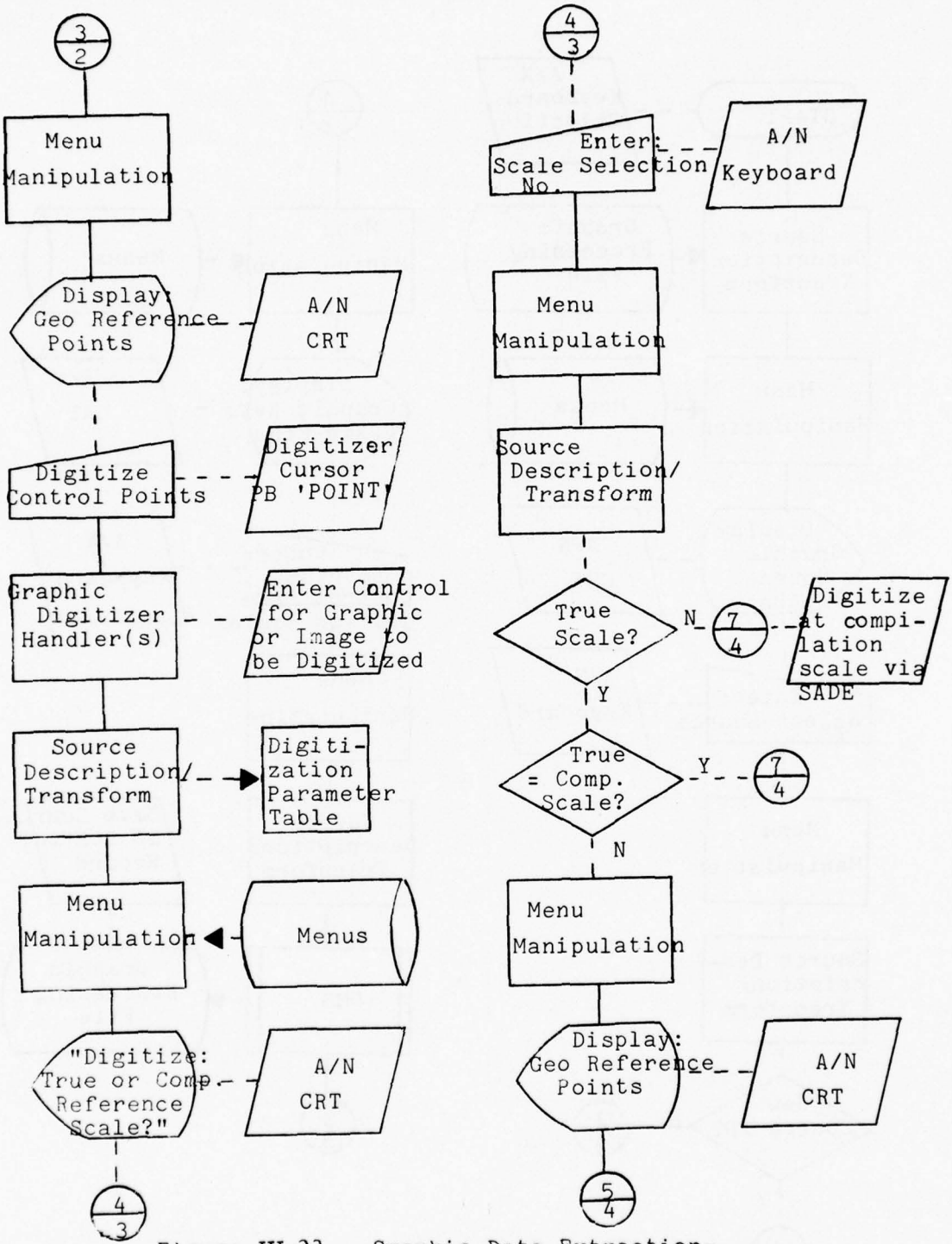


Figure III-23 Graphic Data Extraction-
Source Description/Transform
(Page 3 of 11)

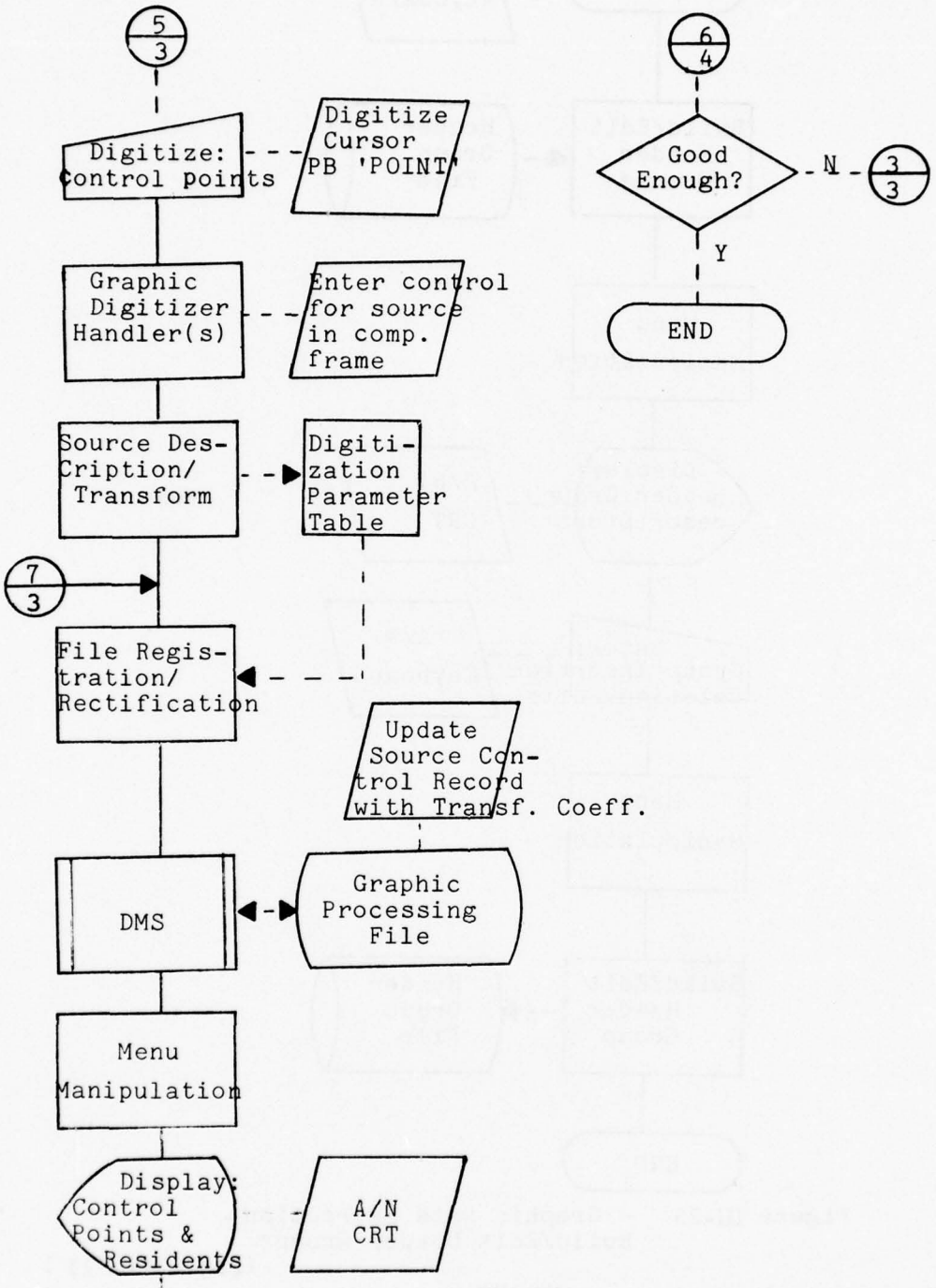


Figure III-23 - Graphic Data Extraction-
Source Description/Transform

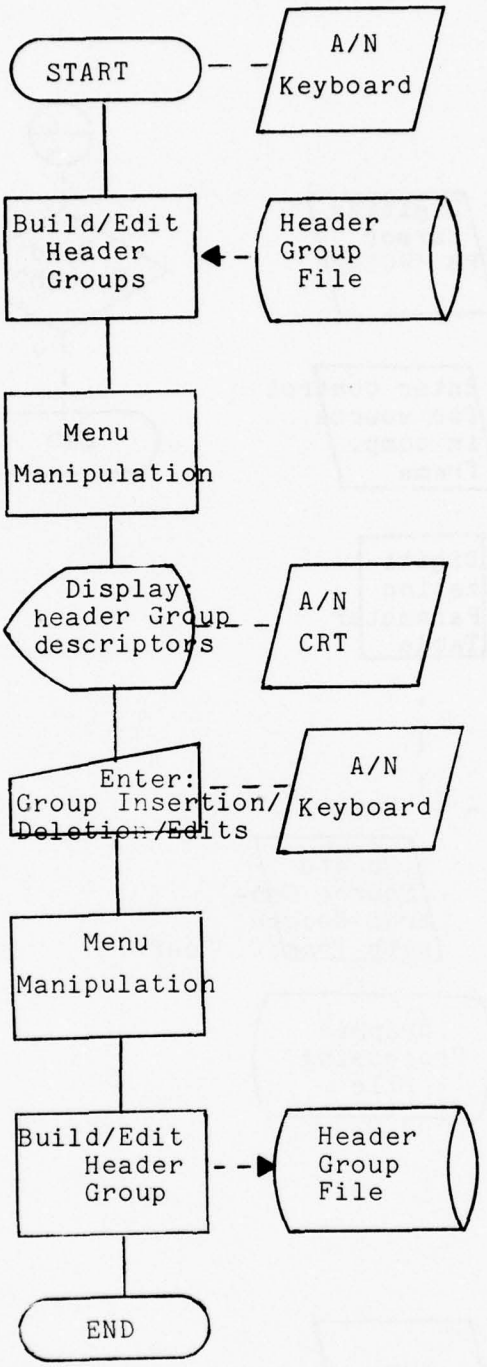


Figure III-23 - Graphic Data Extraction - Build/Edit Header Groups

(Page 5 of 11)

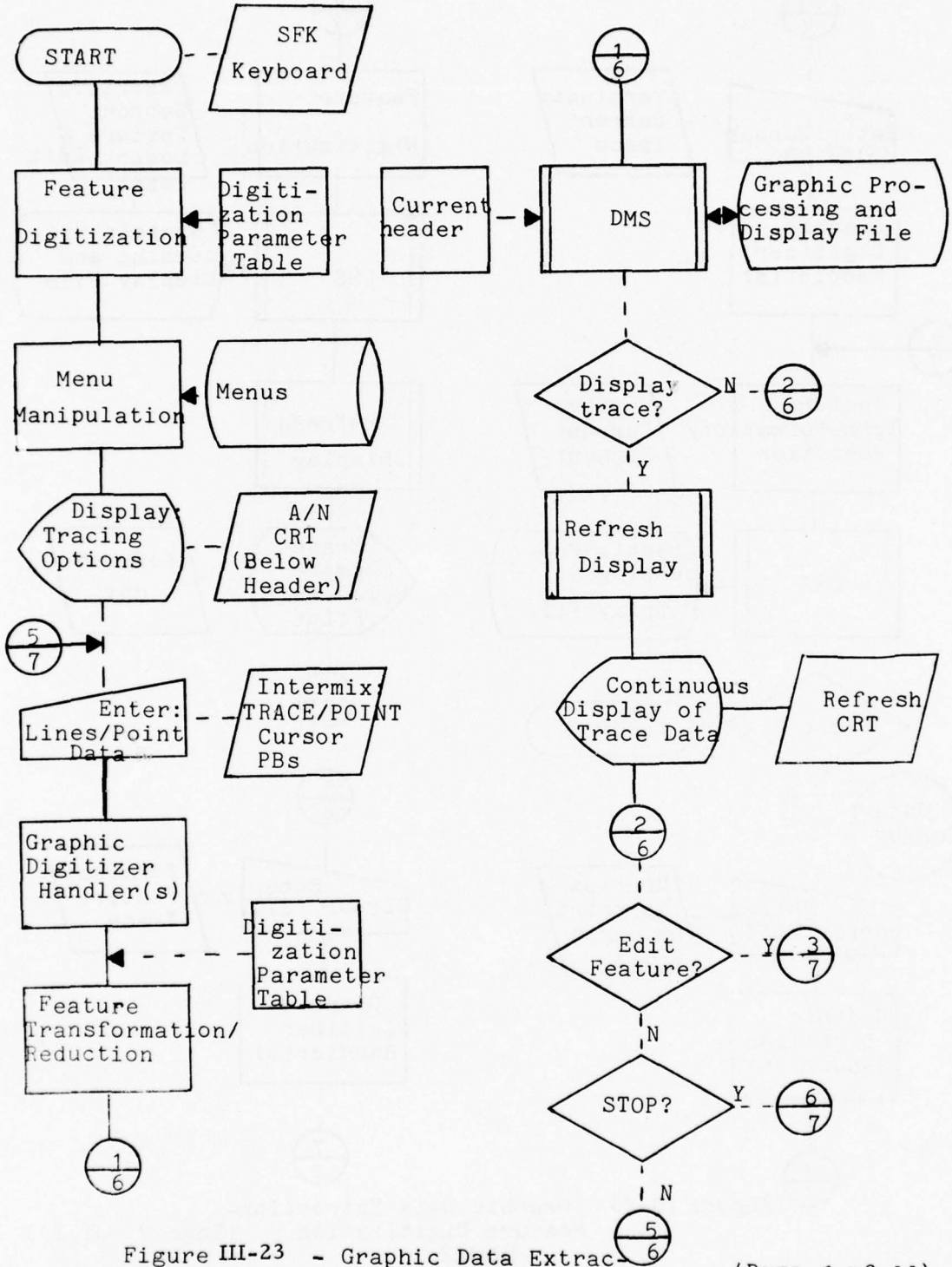


Figure III-23 - Graphic Data Extraction - Feature Digitization (Page 6 of 11)

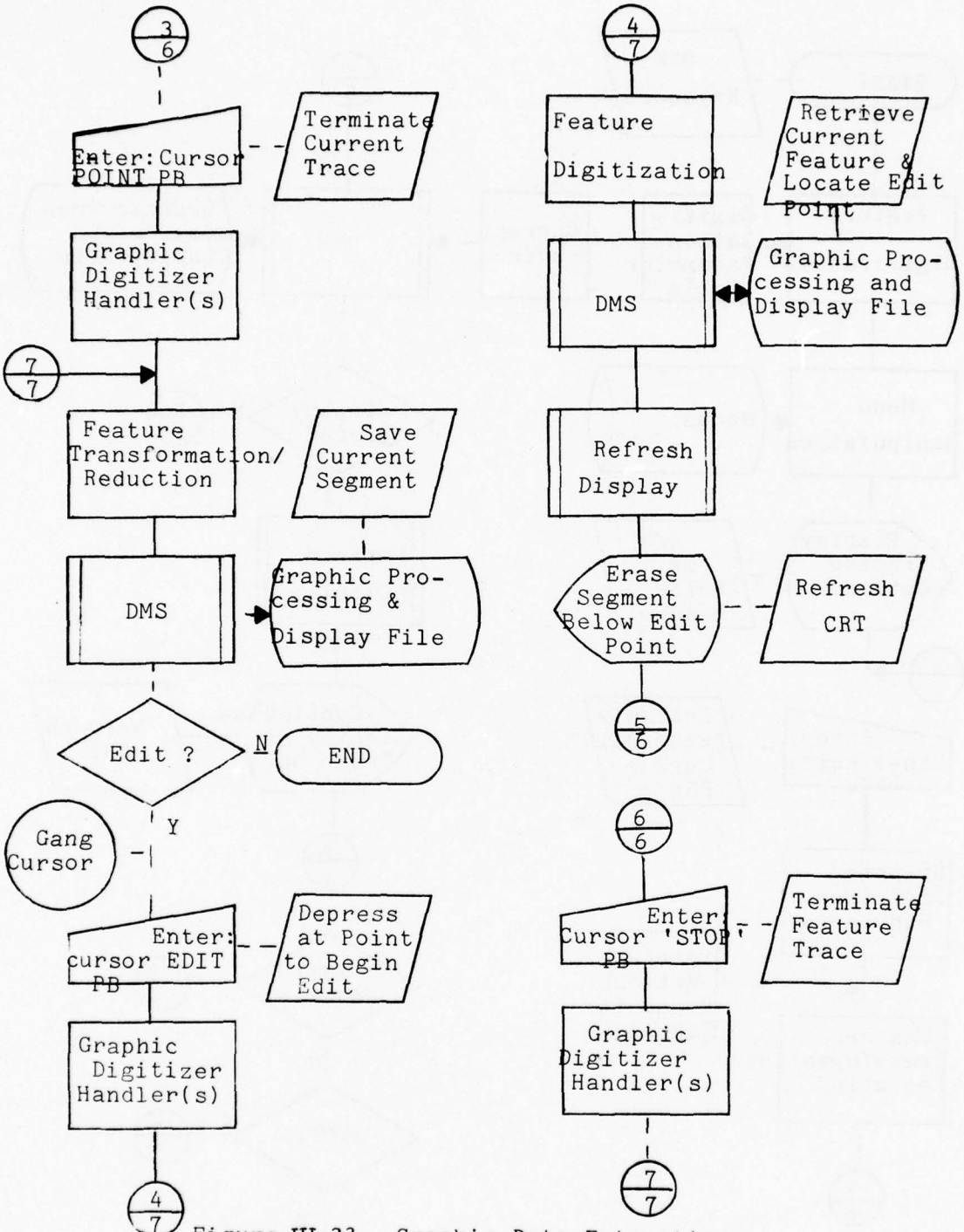


Figure III-23 Graphic Data Extraction-
Feature Digitization (Page 7 of 11)

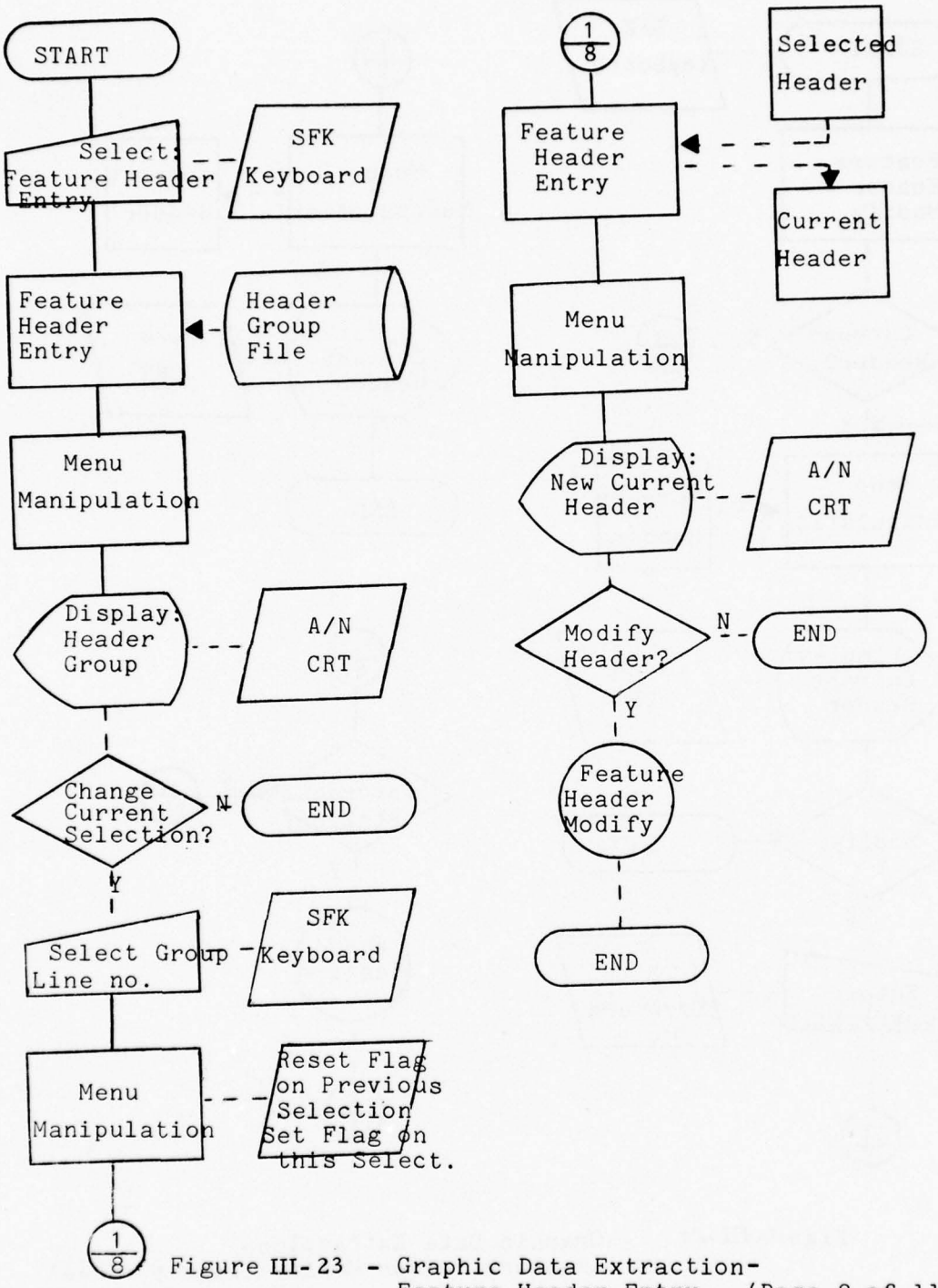


Figure III-23 - Graphic Data Extraction-
Feature Header Entry (Page 8 of 11)

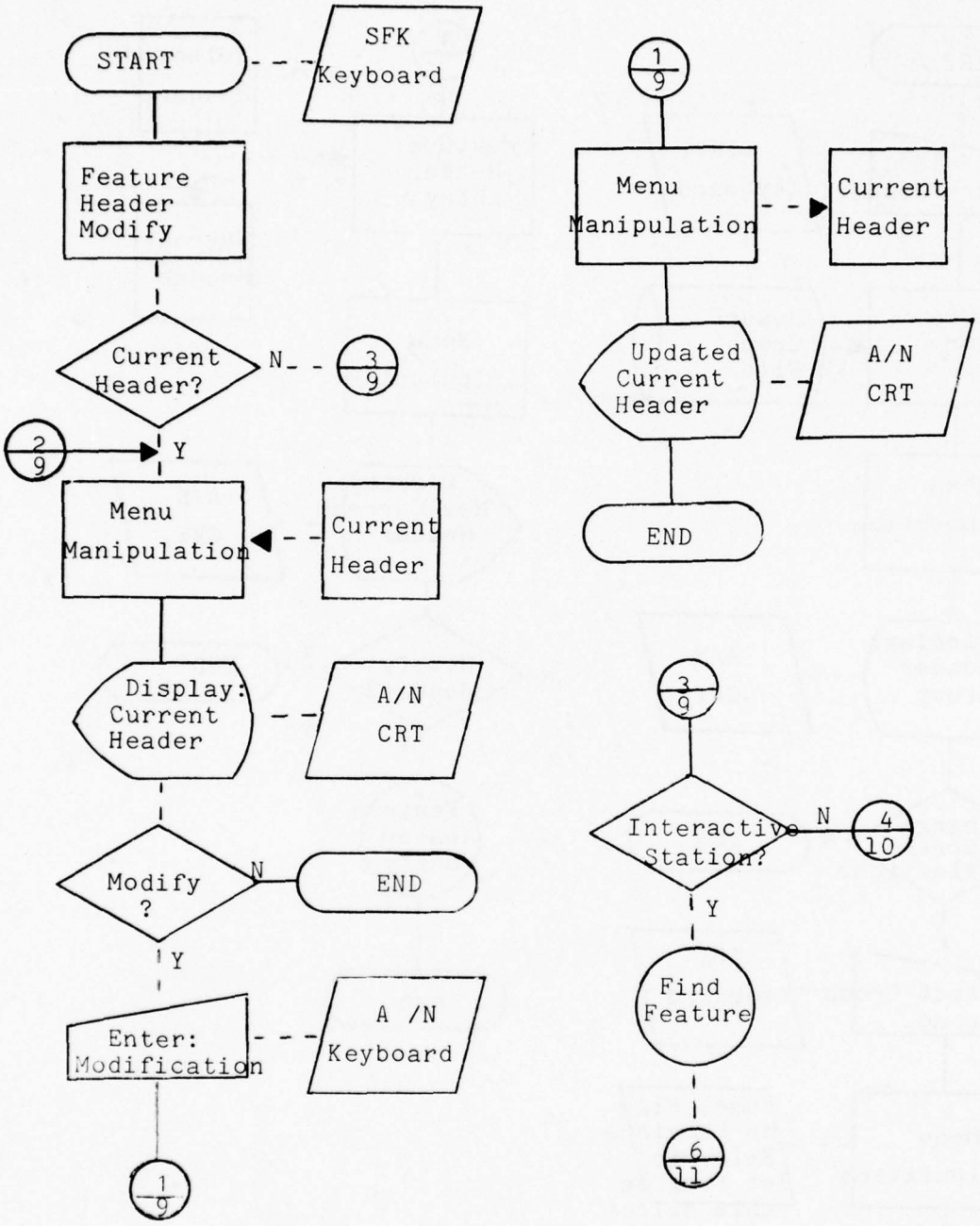


Figure III-23 - Graphic Data Extraction- Feature Header Modify (Page 9 of 11)

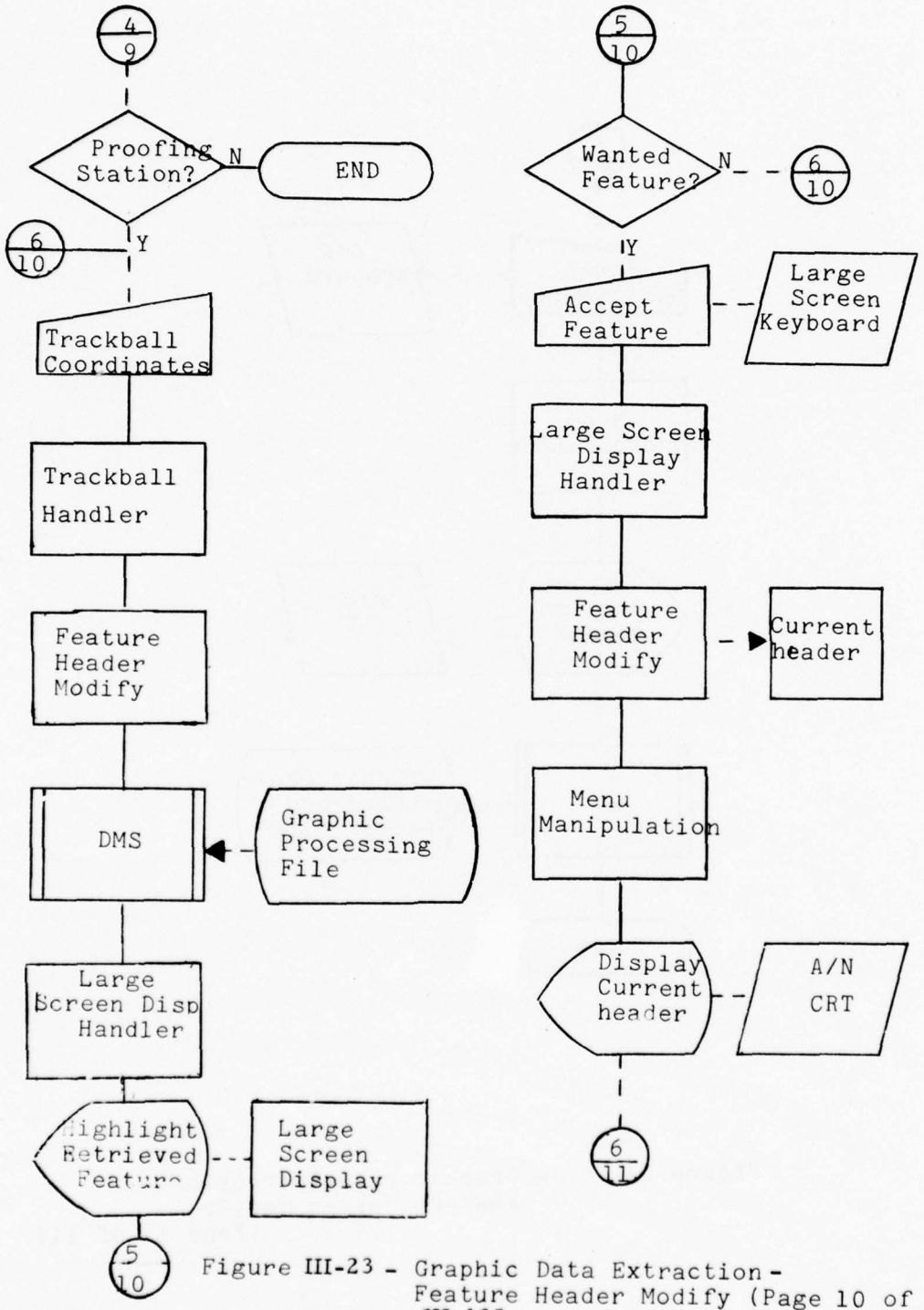


Figure III-23 - Graphic Data Extraction - Feature Header Modify (Page 10 of 11)

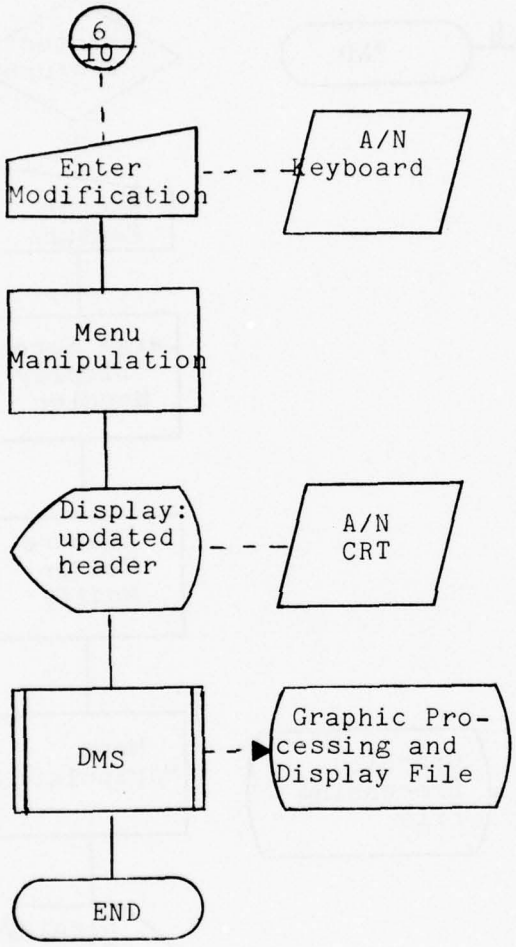


Figure III-23 - Graphic Data Extraction-
Feature Header Modify
(Page 11 of 11)

e. Graphic Display

Purpose

To generate a graphic display of selected feature information which may be portrayed by various symbology techniques. The resultant display can be presented on the large screen display component, refresh graphic CRT, or hard copy printer/plotter component.

Processes

- o Display process parameters:
  - Source files
  - Symbol specification file
  - Feature group selection sets (filter file)
  - Feature status flags
  - Display components
  - Base display scale
  - Display area definition
  - File summary option
- o Modify display parameters
- o Display current display file summary (optional)
- o Display or plot graphic
- o Display area outline (optional on Large Screen Device)
- o Modify current display (via SFK)
  - Scale
  - Augment/suppress feature groups
  - Symbolize feature groups
  - Augment/suppress symbology
  - Augment/suppress edits
  - Augment/suppress source
  - Suppress display

Components

A/N CRT
Graphic Refresh CRT (optional)

Large Screen Display (optional)
A/N Keyboard
Printer/Plotter (optional)
Graphic Digitizer and Cursor (optional)
Special Function Keyboard

See Figure III-24. This particular set of processes represents one of the key ingredients to effective performance of interactive functions. The A/N CRT will be used for presenting the current set of display parameters (e.g., scale, feature group, etc.) and the SFK and A/N keyboard will be used for modification of display parameters.

The user will request the Graphic Display Function (DIS) via the A/N CRT keyboard. A display of current display process parameters will be presented on the A/N CRT. If required the user can modify any of the display parameters by entering the corresponding line numbers. This will invoke further dialogue depending on the specific parameter to be modified. The user will then enter required changes via the keyboard.

The user can proceed to other interactive functions (e.g., Manipulation, Generalization, etc.) and concurrently modify the graphic display by using the display processes provided on the SFK (e.g., Scale, Augment/Suppress Feature Group, etc.). This particular facility will provide a basic and powerful vehicle to support interactive compilation. Major changes to the current display file will be achieved by returning to the A/N CRT and Keyboard for modification of the display parameters.

Large Screen User

Depression of the LARGE SCREEN DISPLAY SFK will result in display generation of the compilation boundary on the large screen device. The user can use the trackball/cursor to define any sub-area to be displayed on the large screen display and the appropriate area will then be generated on the large screen component. A summary of the current display file will be presented on the A/N CRT.

Refresh CRT User

At the Refresh CRT the user will depress the REFRESH DISPLAY SFK and then position the cursor to the desired graphic location and depress the point cursor button. The corresponding feature data surrounding the area of interest will be displayed on the Refresh CRT. A summary of the current display will be presented on the A/N CRT. If the large screen display is active for this work session the boundary will be displayed which corresponds with the Refresh CRT graphic display area. The user at the Refresh CRT can change scale or augment/suppress or change symbology of specific feature groups, by using the SFK. Also the user can "walk" around the total graphic area by depressing the REFRESH DISPLAY SFK and moving the digitizing cursor to different locations over the graphic area. Once the user is satisfied with a current display he can progress to other interactive functions (e.g., feature manipulation, interactive generalization, etc.).

Printer/Plotter User

The hardcopy plot option can be exercised in one of two ways. The user can generate a hardcopy plot from any work station by using the A/N CRT and Keyboard. The plot is generated in the same manner as a display with the exception that the user defines the plotter as the graphics device. Any definition of the subarea requires use of one of the graphic display devices.

A user at one of the graphic display stations can commit a current display to the hardcopy plotter by depressing the HARDCOPY PLOT SFK.

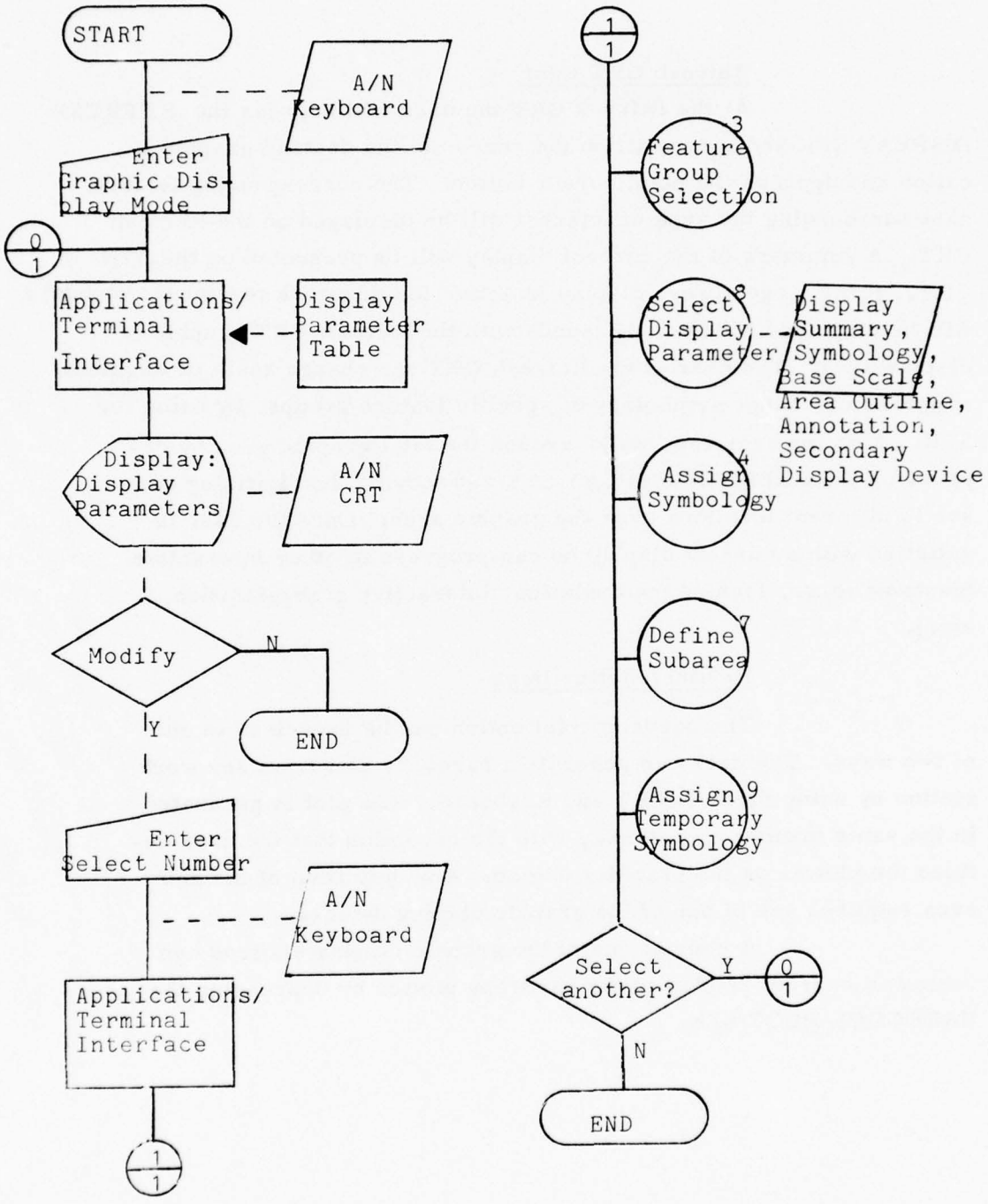


Figure III-24 - Graphic Display

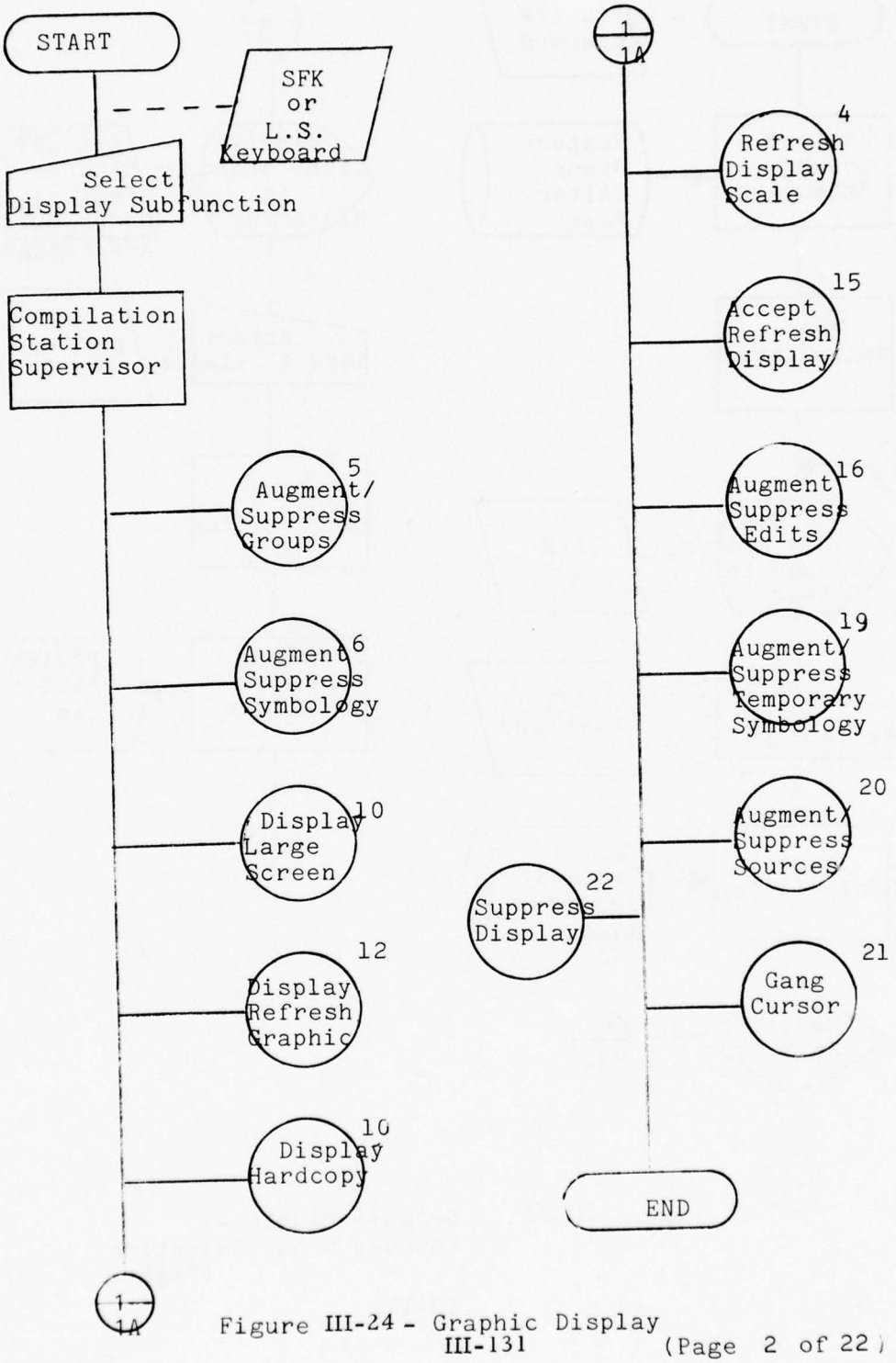


Figure III-24 - Graphic Display (Page 2 of 22)

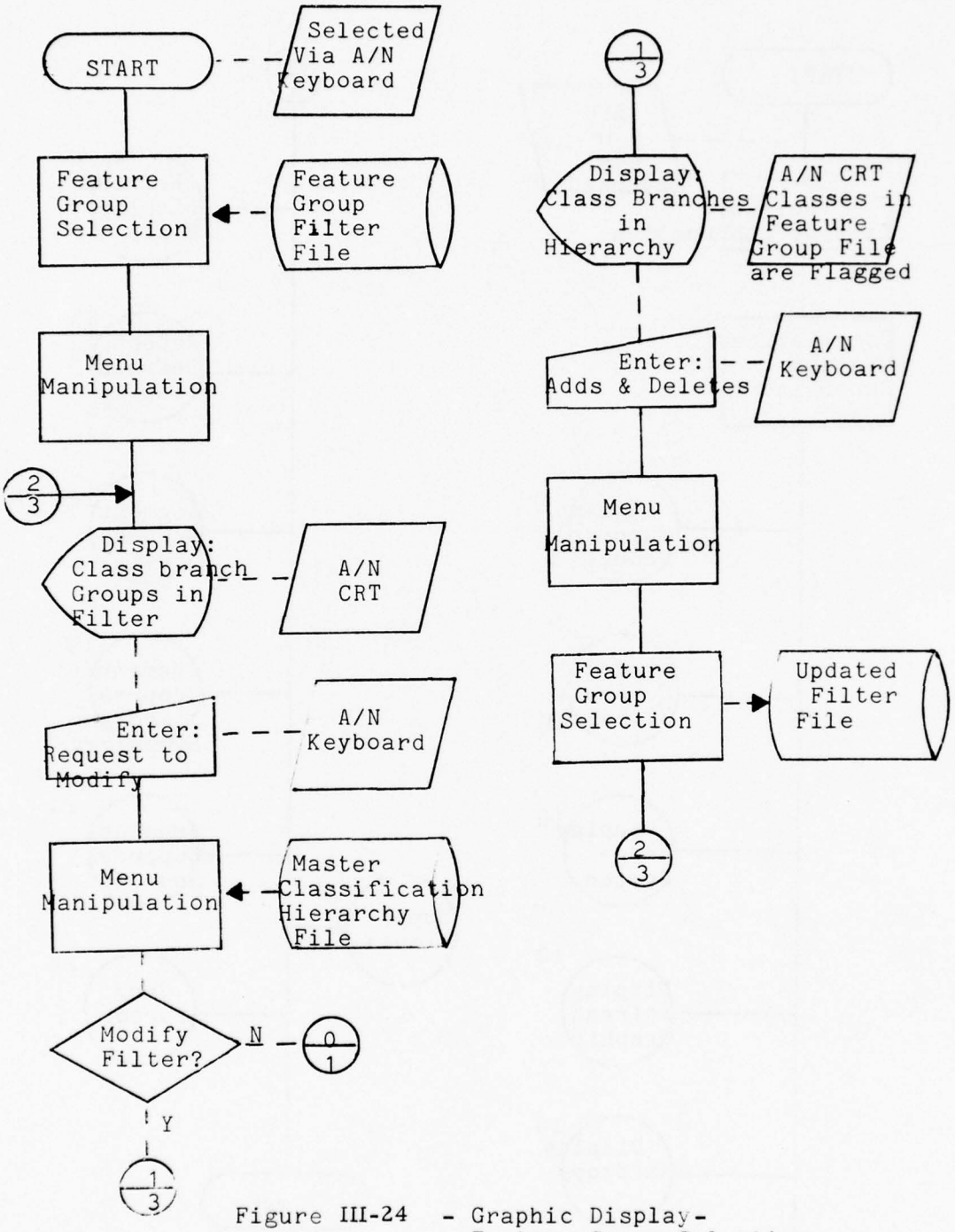


Figure III-24 - Graphic Display-
Feature Group Selection
(Page 3 of 22)

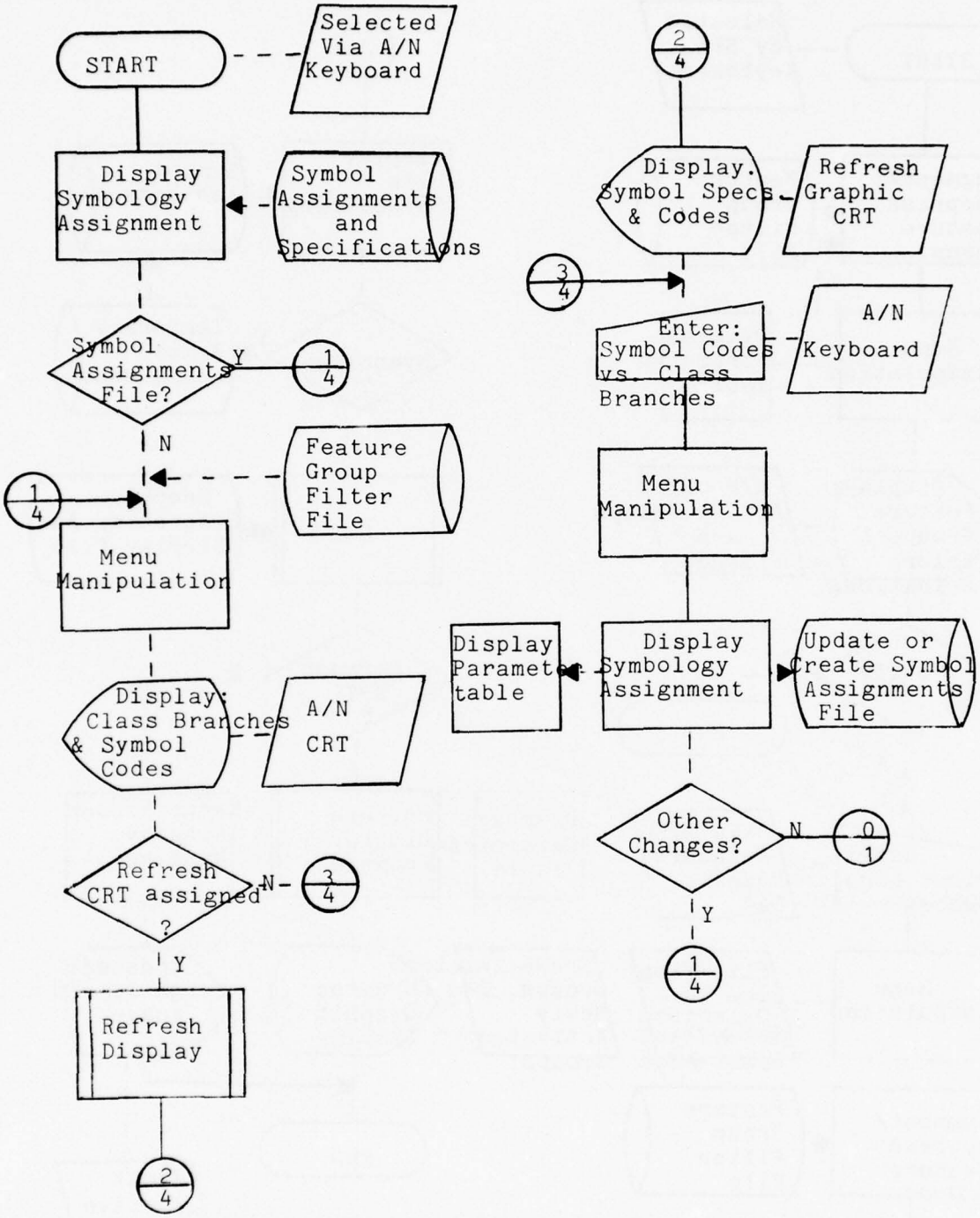


Figure III-24 - Graphic Display-
Assign Symbology
(Page 4 of 22)

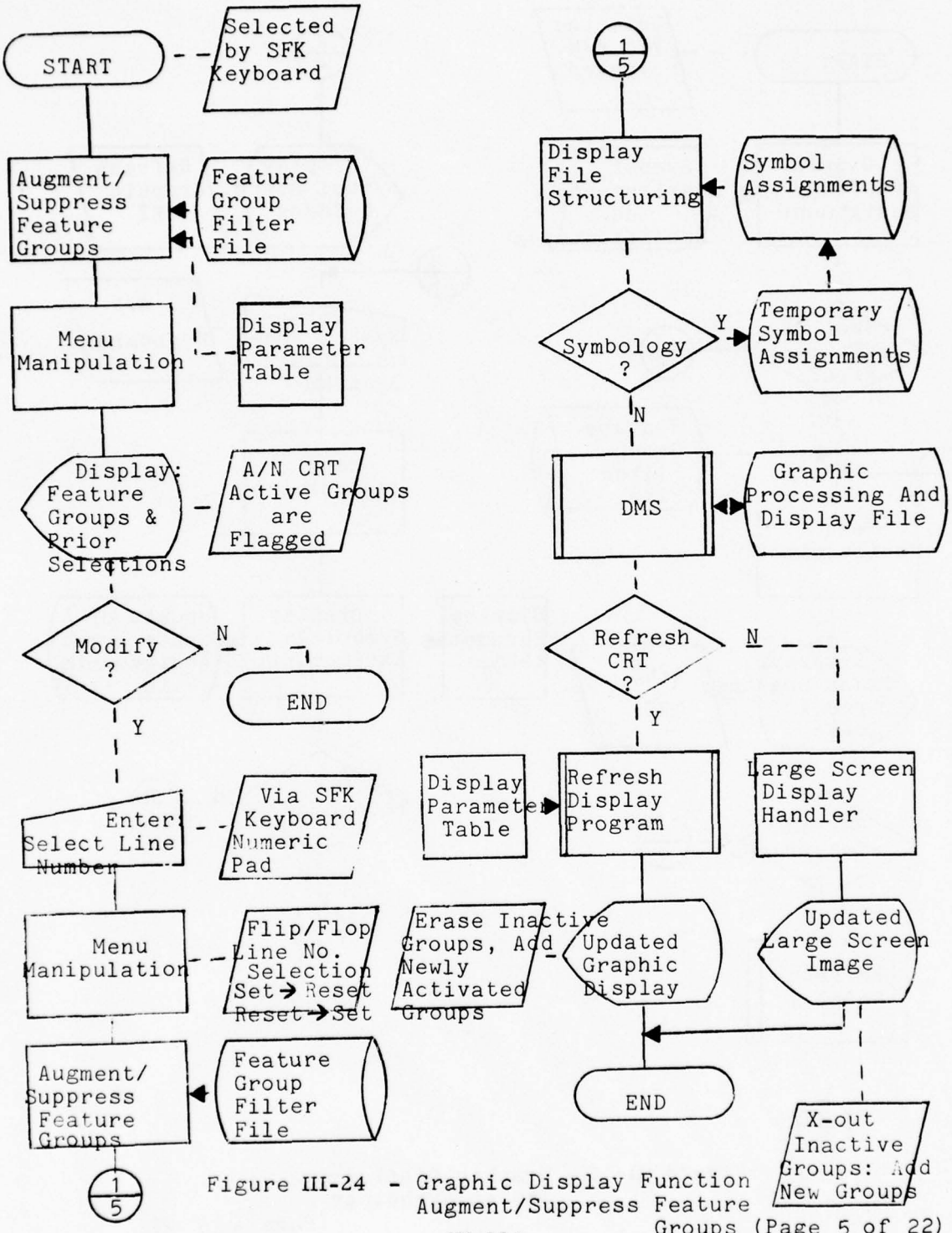


Figure III-24 - Graphic Display Function Augment/Suppress Feature Groups (Page 5 of 22)

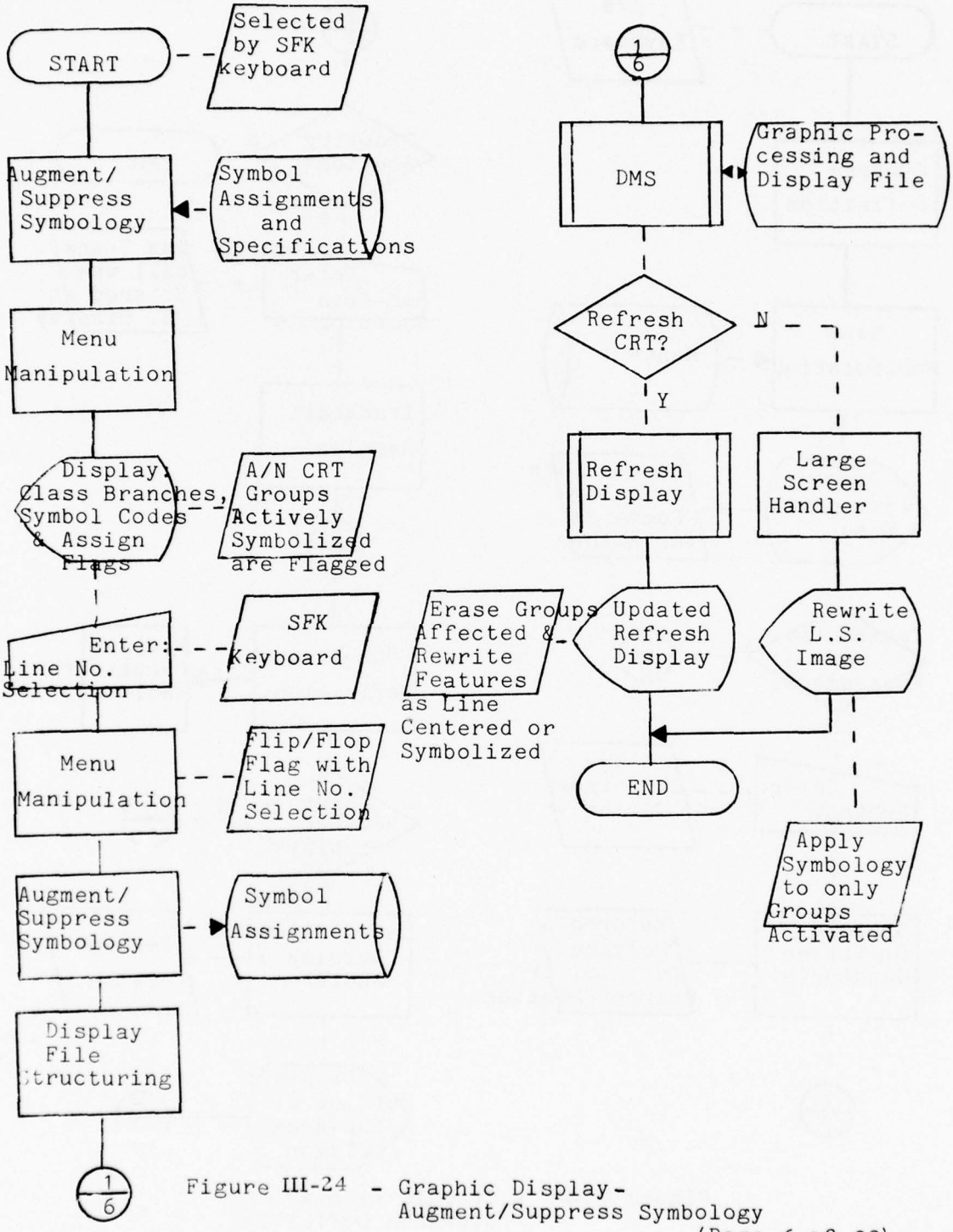


Figure III-24 - Graphic Display - Augment/Suppress Symbology (Page 6 of 22)

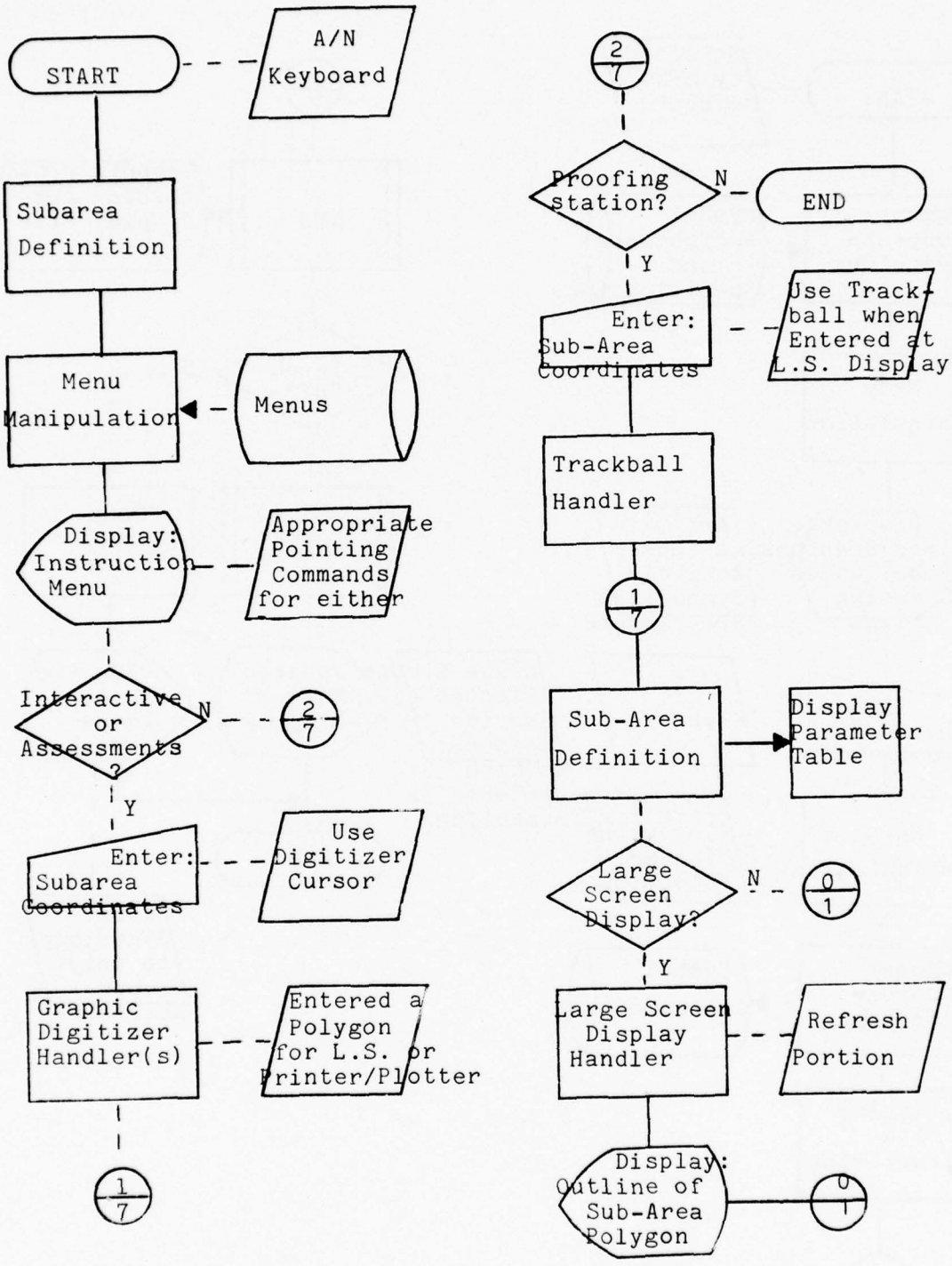


Figure III-24 - Graphic Display - Sub-Area Definition

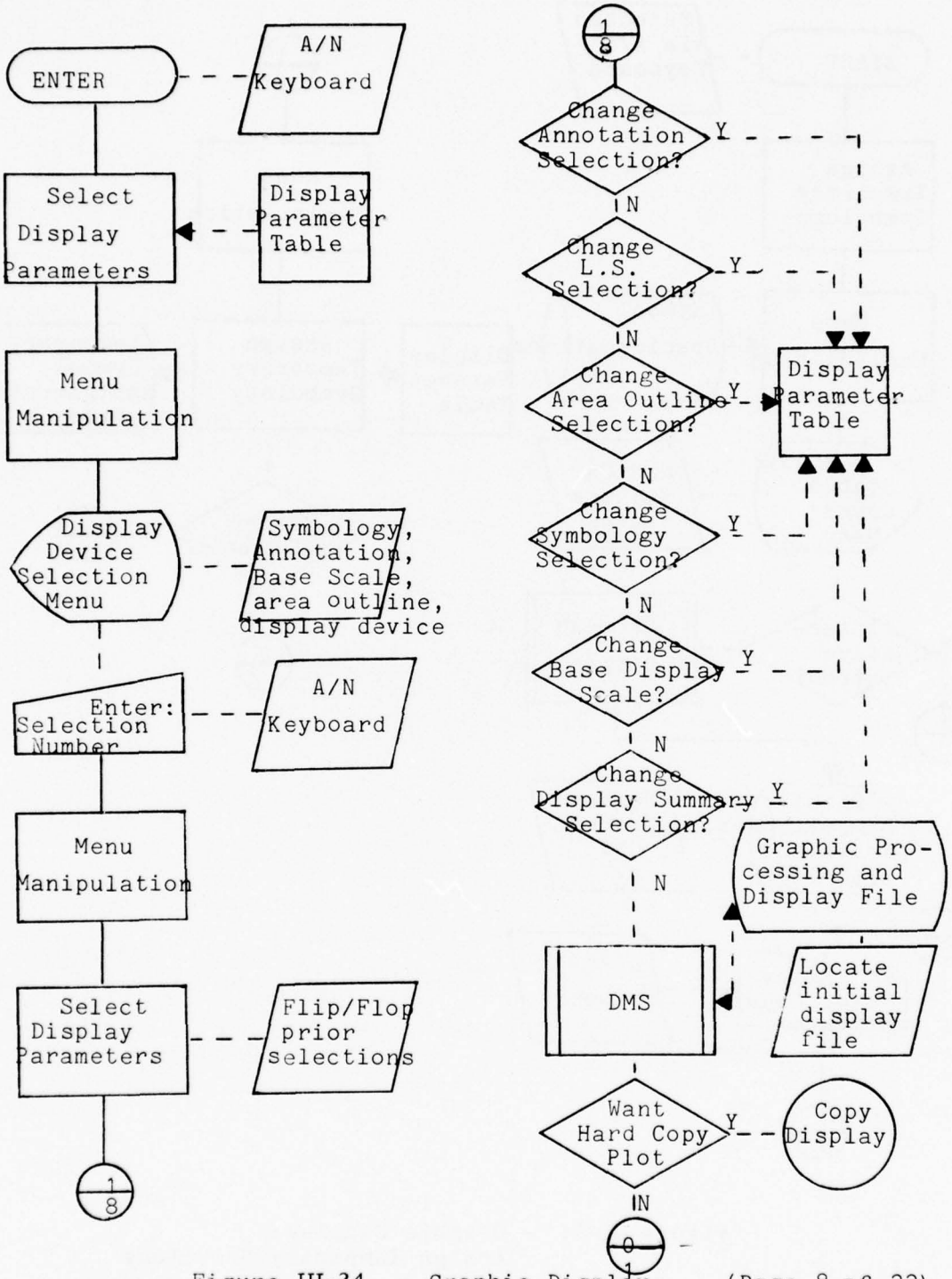


Figure III-24 - Graphic Display- Select Display Parameters (Page 8 of 22)

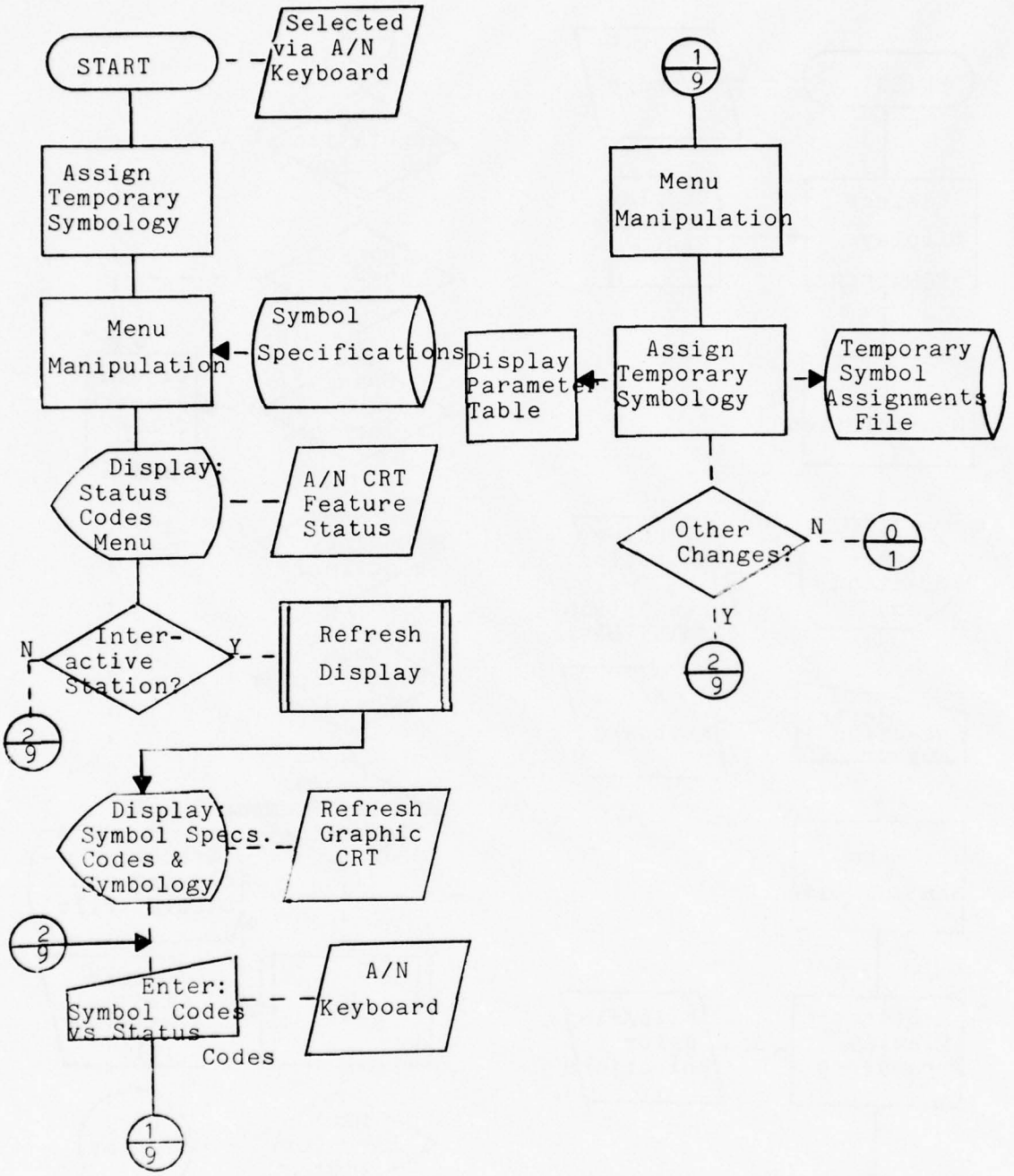
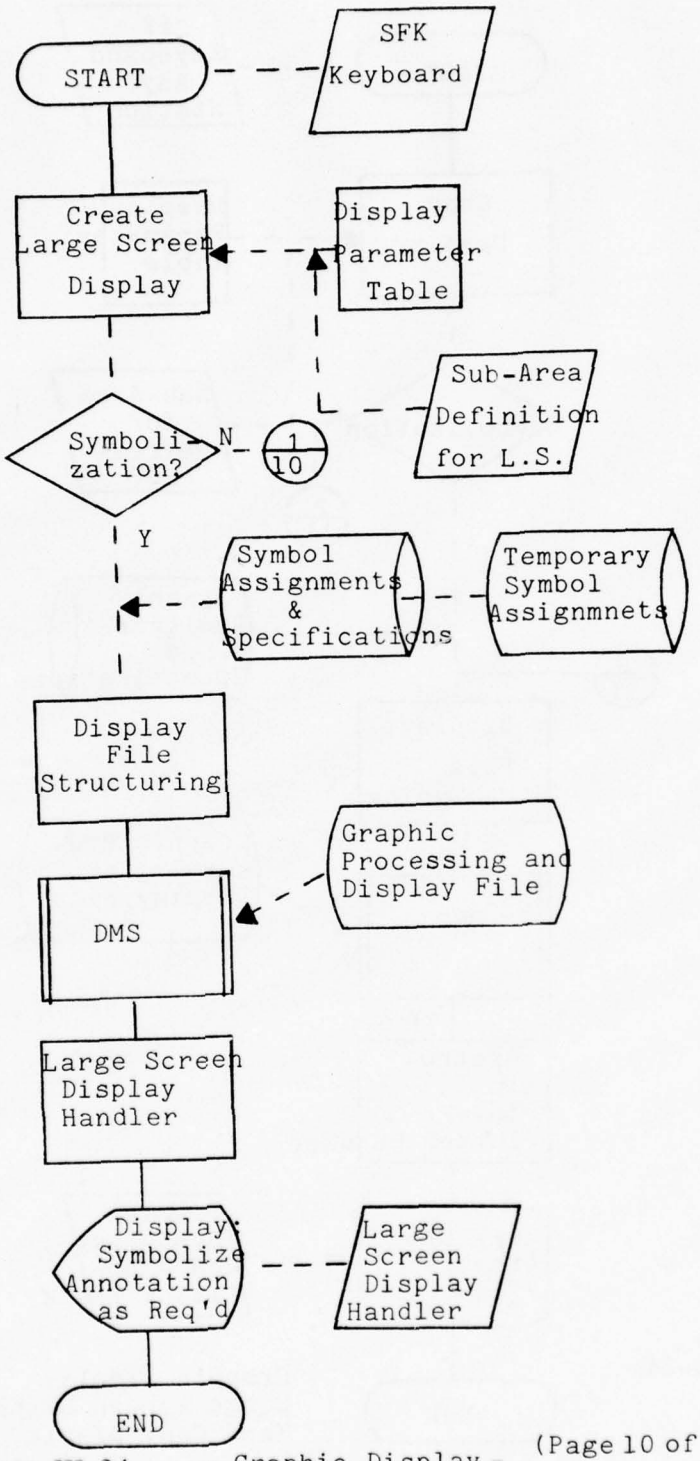


Figure III-24 - Graphic Display-
Assign Temporary Symbology

(Page 9 of 22)



(Page 10 of 22)

Figure III-24 - Graphic Display - Large Screen Display Hard Copy Display

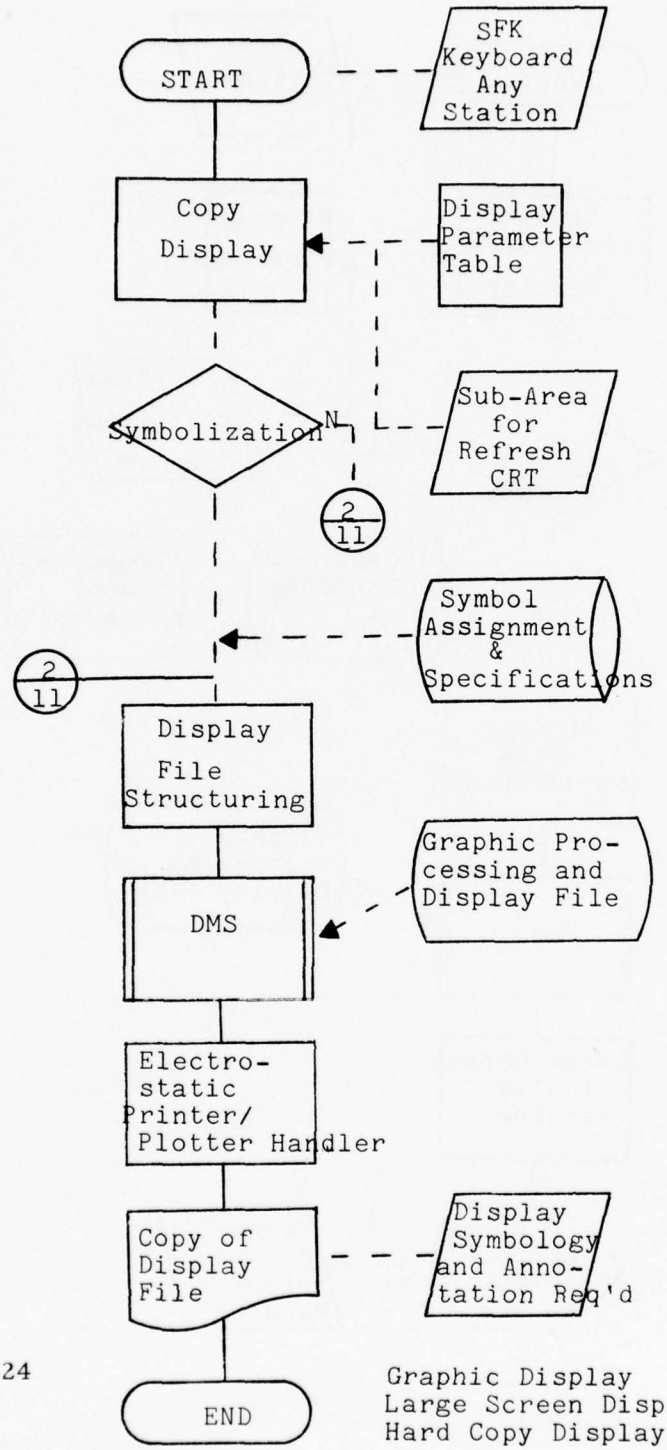


Figure III-24

Graphic Display
Large Screen Display
Hard Copy Display (Page 11 of 22)

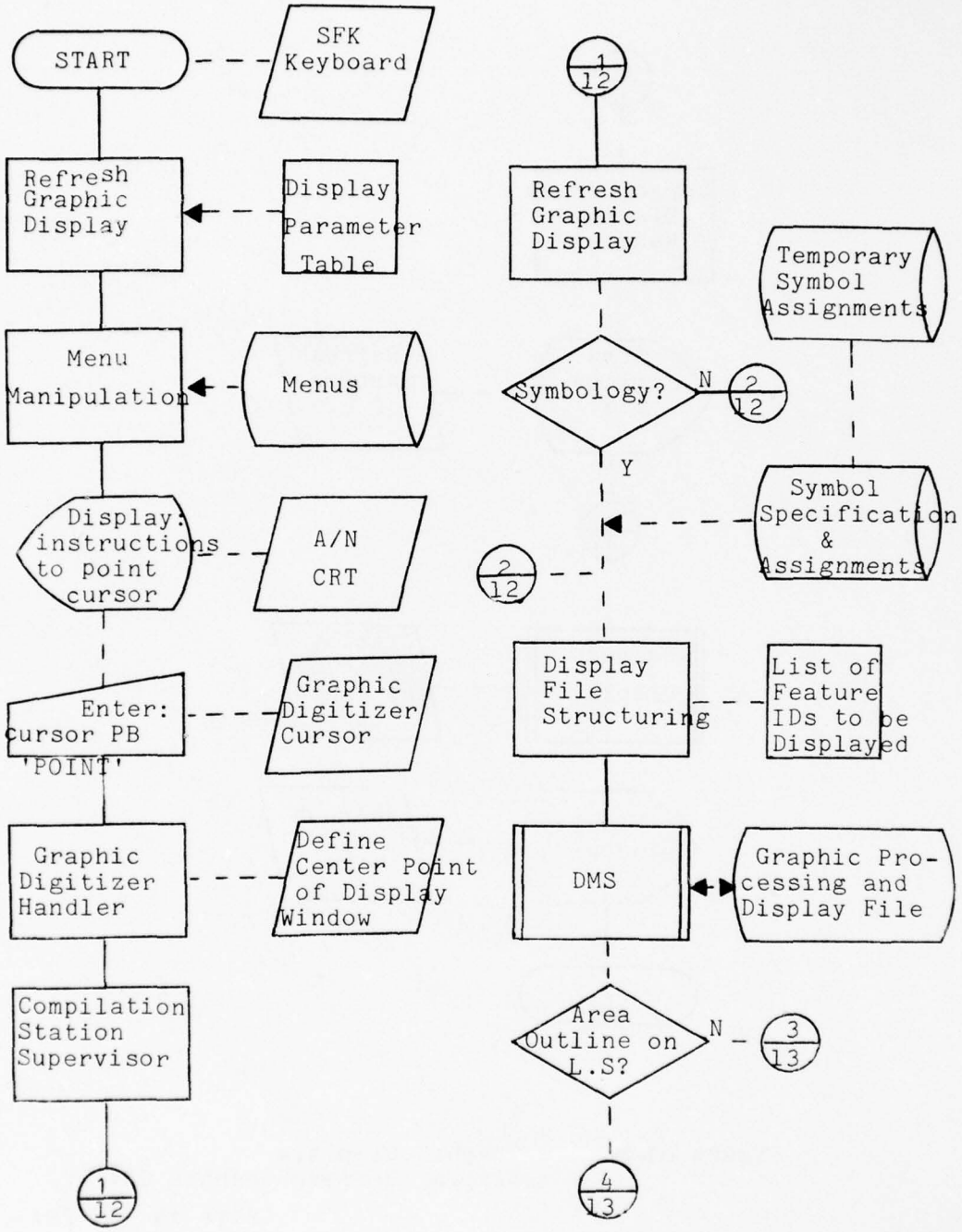


Figure III-24 - Graphic Display-
Refresh Graphic Display
(Page 12 of 22)

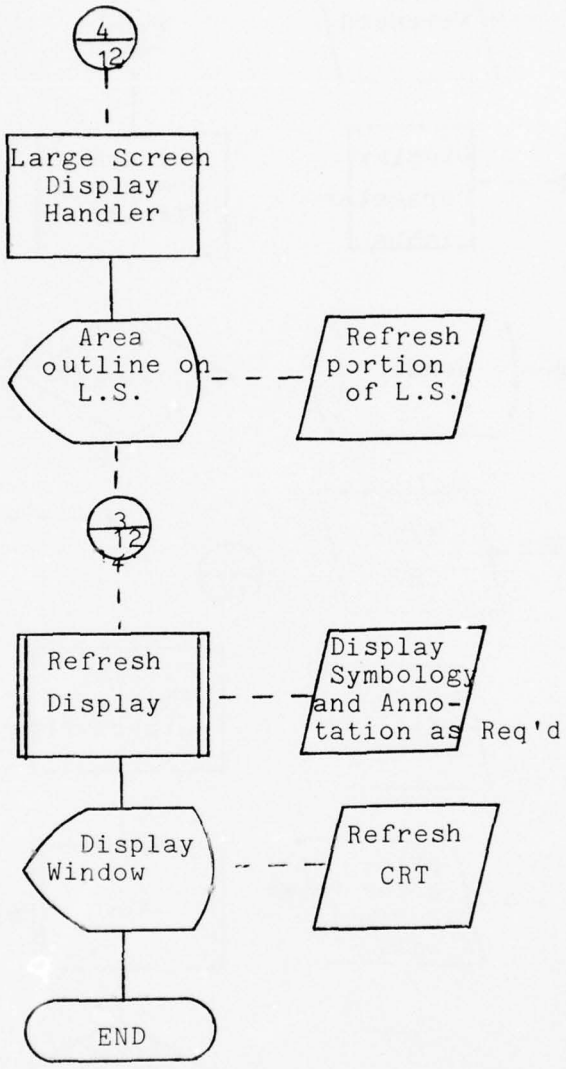


Figure III-24 - Graphic Display-
Display Refresh Graphic CRT

(Page 13 of 22)

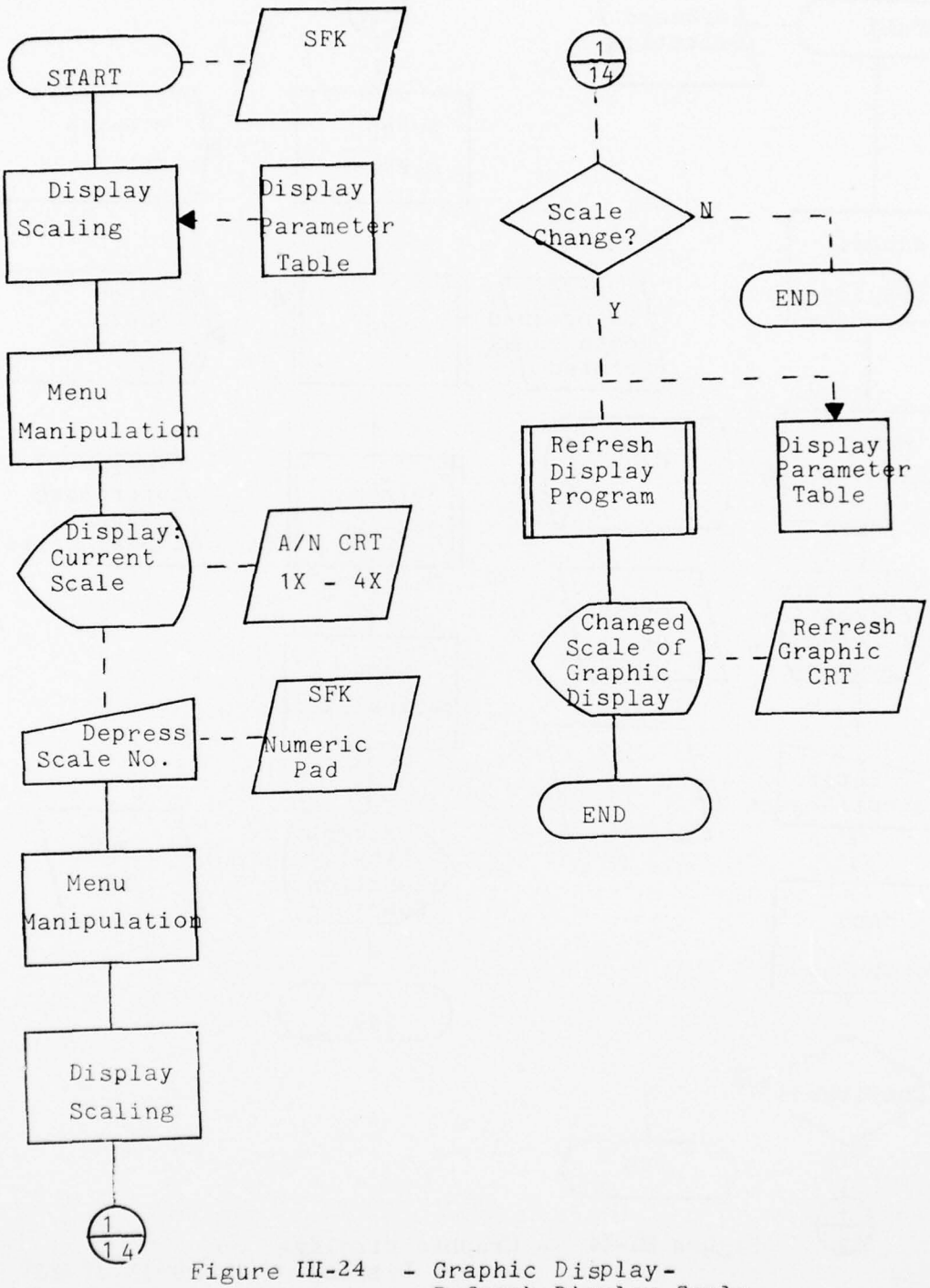


Figure III-24 - Graphic Display-
Refresh Display Scale

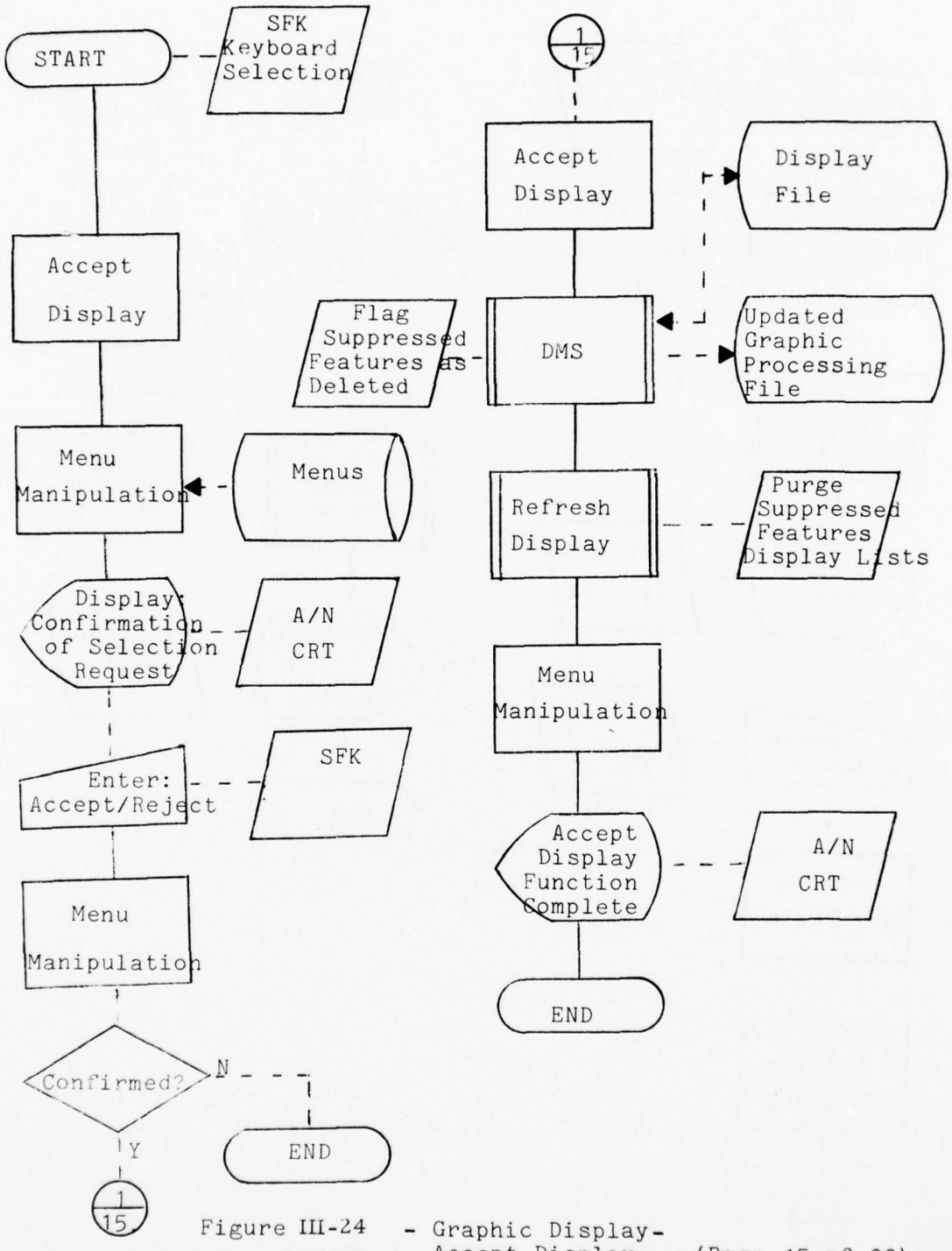


Figure III-24 - Graphic Display- Accept Display (Page 15 of 22)

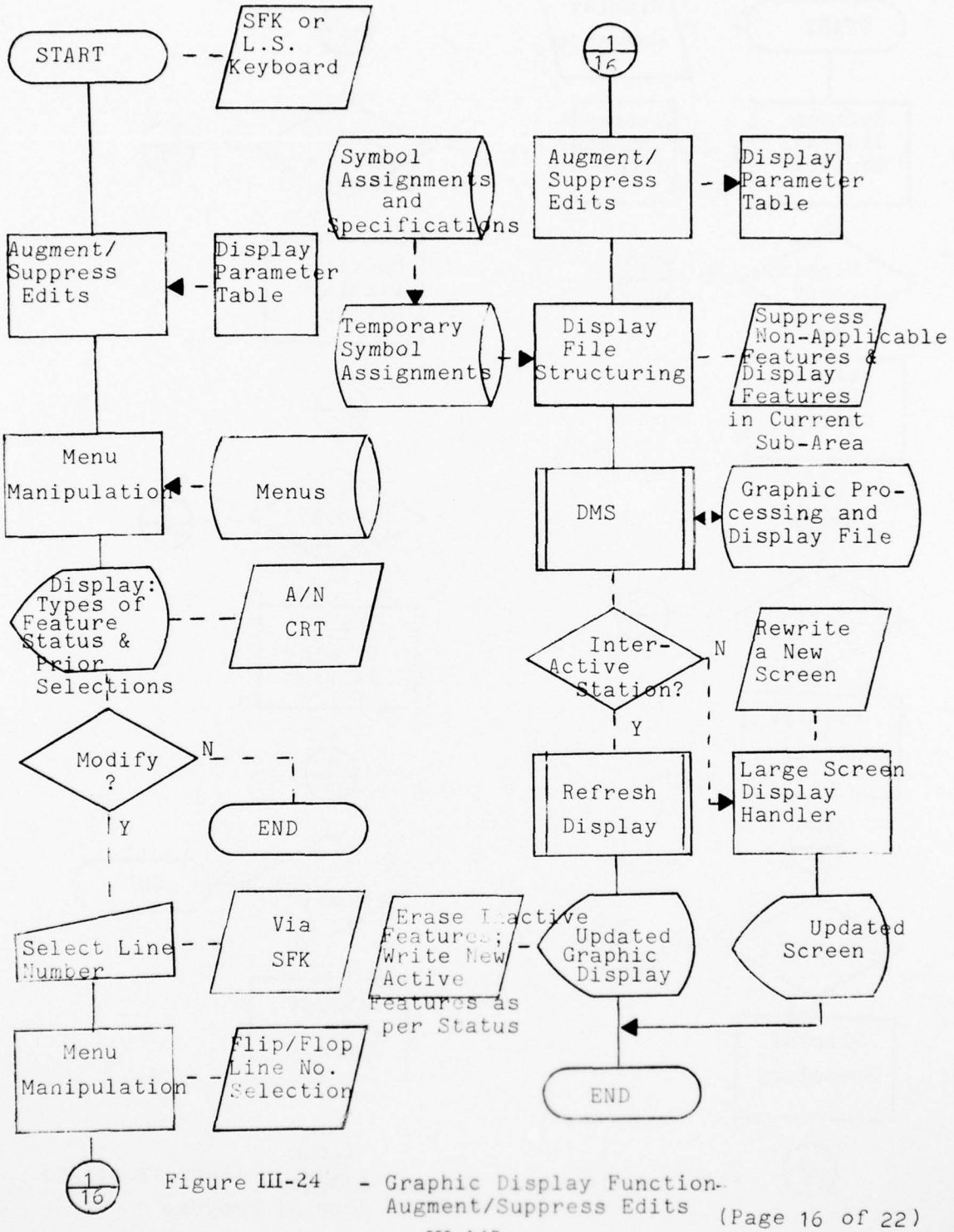


Figure III-24 - Graphic Display Function-
Augment/Suppress Edits (Page 16 of 22)

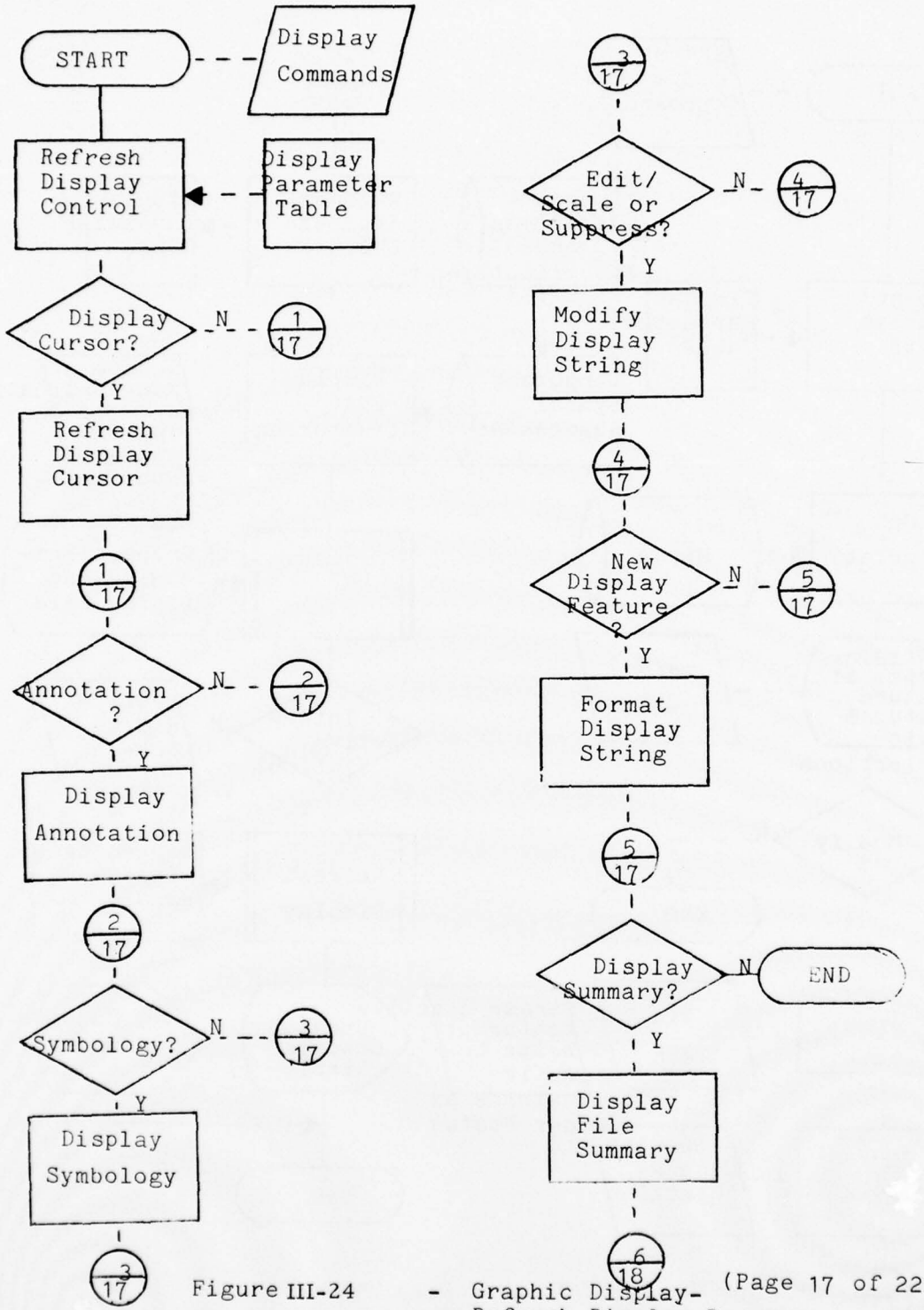


Figure III-24 - Graphic Display- Refresh Display Program (Page 17 of 22)

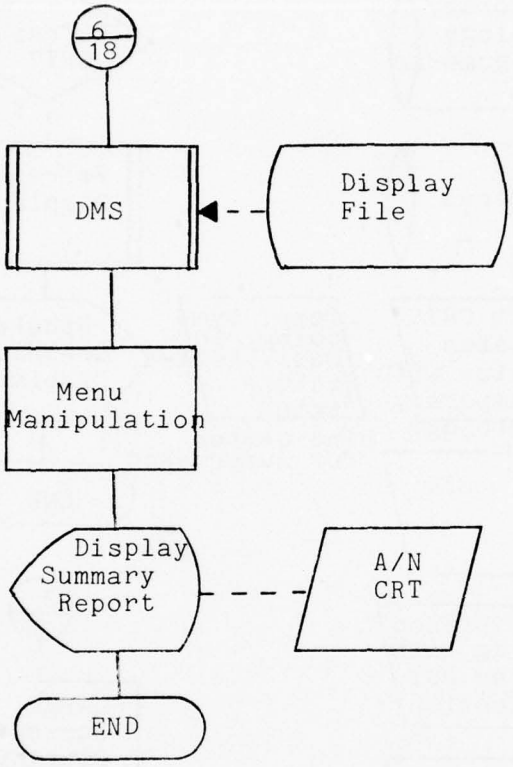


Figure III-24 - Graphic Display.
Refresh Display Program

(Page 18 of 22)

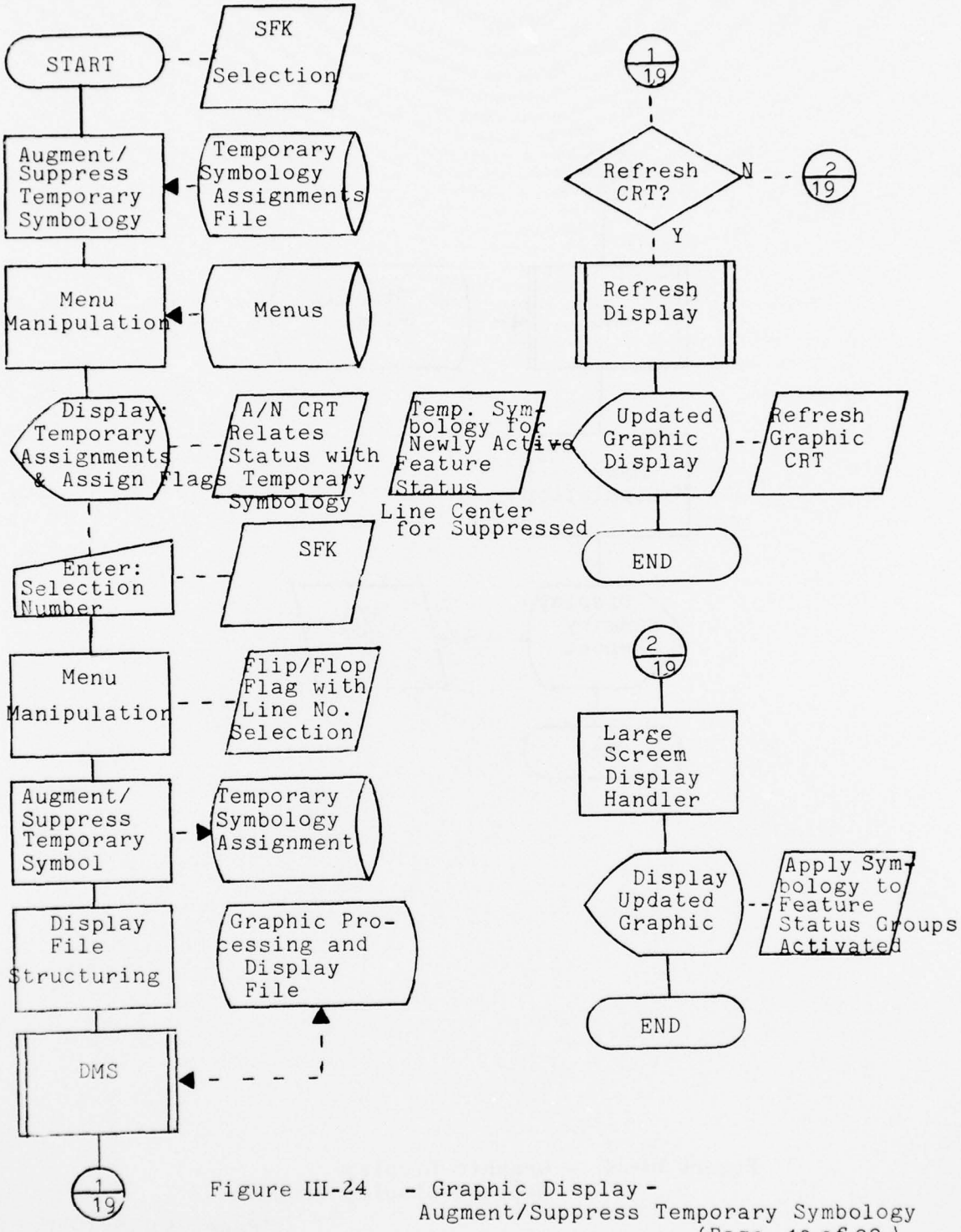


Figure III-24 - Graphic Display - Augment/Suppress Temporary Symbology (Page 19 of 22)

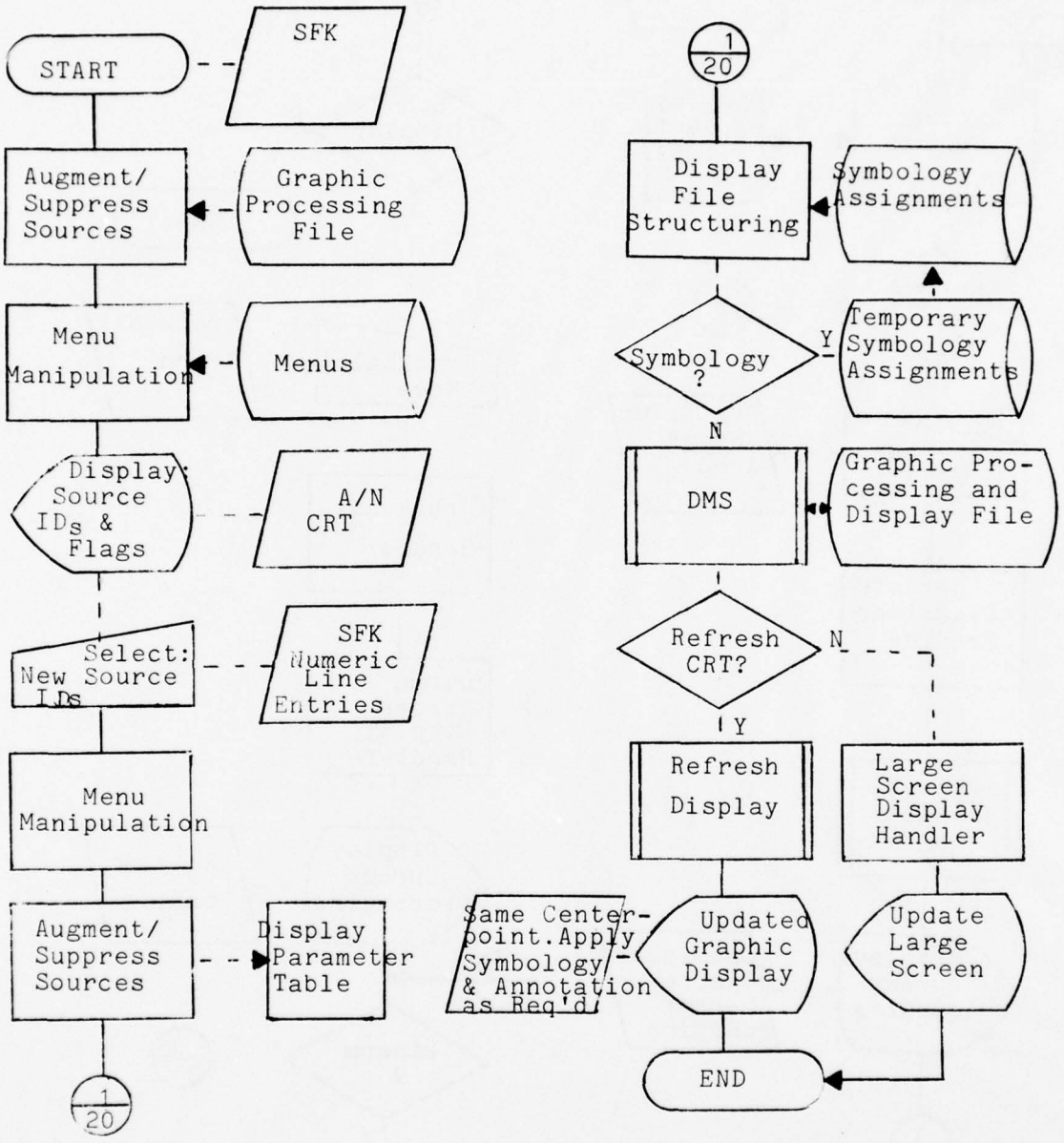


Figure III-24 - Graphic Display-
Augment/Suppress Sources
(Page 20 of 22)

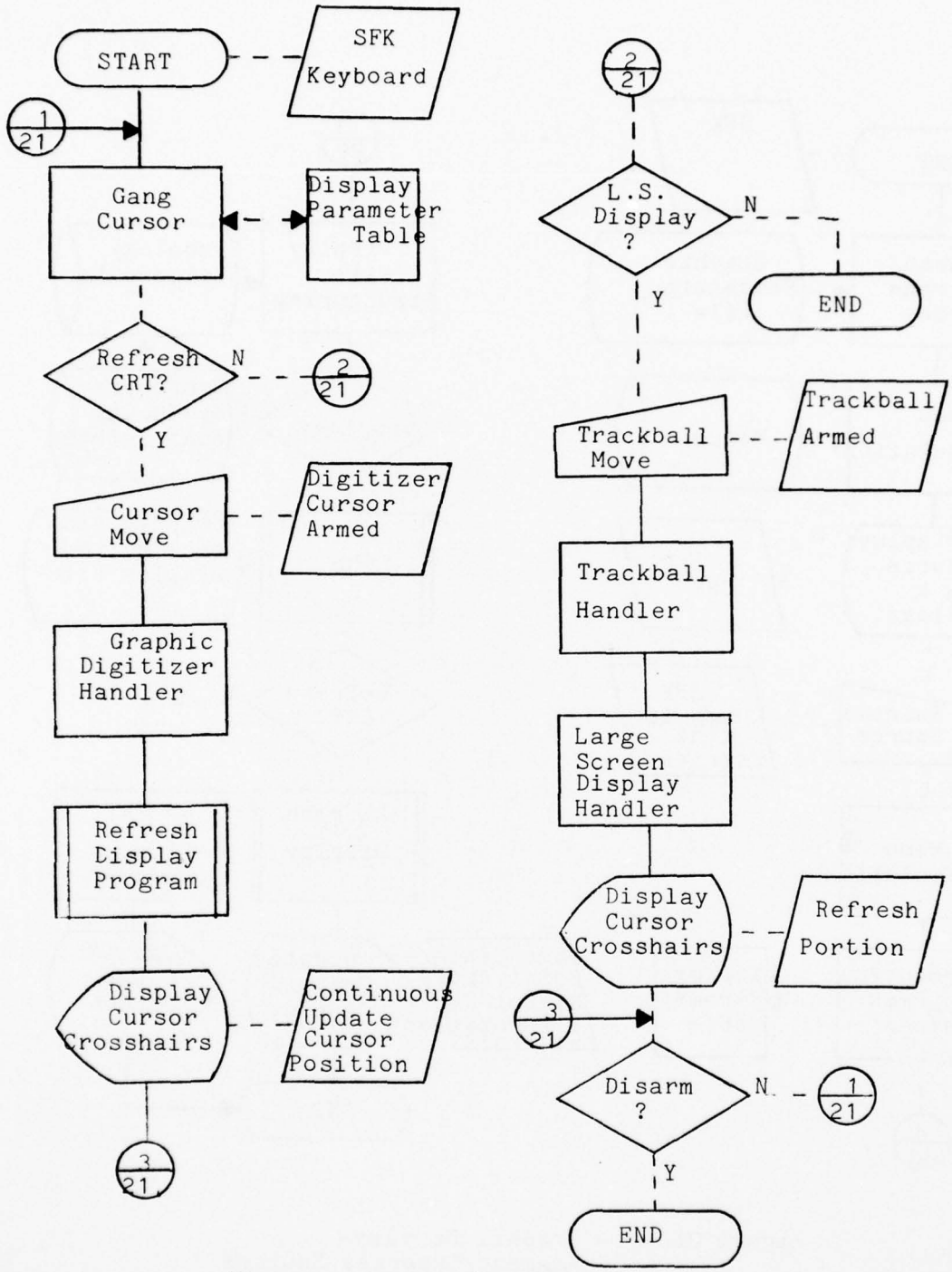


Figure III-24 - Graphic Display-
Gang Cursor

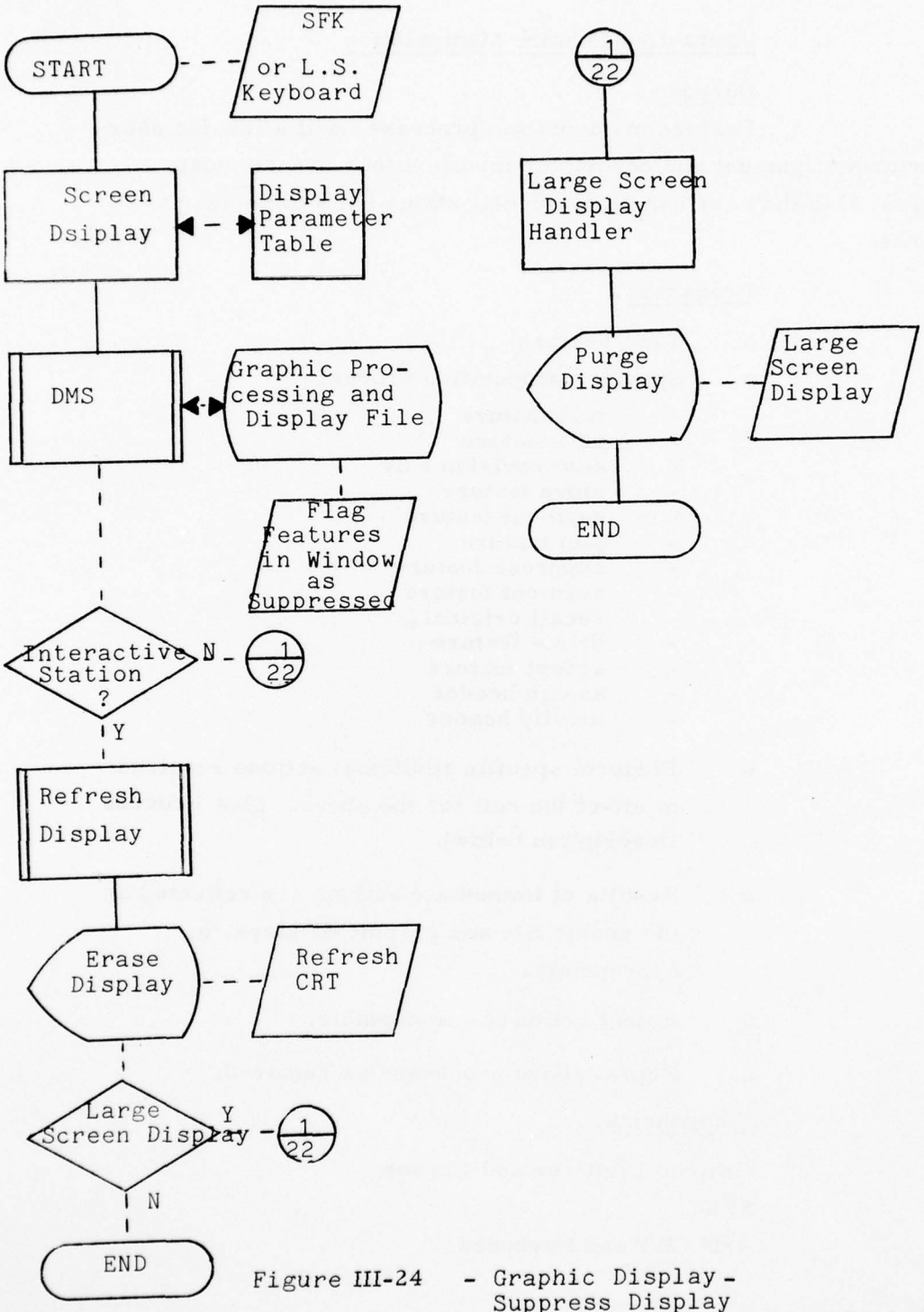


Figure III-24 - Graphic Display - Suppress Display

f. Interactive Feature Manipulation

Purpose

Feature manipulation processes will allow the user to perform alignment and descriptor modifications to individual features; also the user can apply special status flags to pertinent features.

Processes

- o Find Feature
- o Specify manipulation process
  - pull feature
  - edit feature
  - auto revision edit
  - move feature
  - segment feature
  - join feature
  - suppress feature
  - augment feature
  - recall original
  - delete feature
  - accept feature
  - assign header
  - modify header
- o Perform specific additional actions required to effect the edit for the above. (See Process Description below).
- o Results of immediate actions are reflected on the update file and graphic displays, as appropriate.
- o Reject action if unacceptable.
- o Repeat above processes as required.

Components

Graphic Digitizer and Cursor
SFK
A/N CRT and Keyboard

Large Screen Display (optional)
Refresh CRT

Process Descriptions

Feature manipulation processes are primarily performed at the Graphic Digitizer and Cursor with verification of transactions presented at the Refresh CRT and A/N CRT. The tracking tool for feature manipulation is the digitizing cursor and associated "ganged" CRT cursor. Feature manipulation processes can be immediately preceded by the "Find Feature" step for locating the "current feature" to be manipulated. Any feature manipulation function can be applied to a current feature. The appropriate SFK key is depressed to initiate the desired manipulation process. The user can perform a particular edit type to any number of features without reissuing the SFK command. Any transaction performed by the user at the Interactive Station can be negated by depression of the "NULLIFY" SFK. Certain manipulation processes can optionally be performed at the Large Screen Display by using the A/N CRT and Trackball. Those manipulation processes currently defined for the Large Screen Display include: delete, accept, assign header, header modification, and recall original. Figure III-25 presents a hardware/software flow for feature manipulation processes.

- Find Feature

  The "Find Feature" is performed by positioning the cursor on a feature line and depressing the FIND cursor key. The located feature is "highlighted" on the display device and its header is displayed on the A/N CRT for verification of the correct feature. This sequence can be repeated until the desired feature is located. Following the feature find process the user can invoke a particular manipulation process by depressing the applicable function button on the SFK. Menu instructions for performing a manipulation process will be displayed on the A/N CRT, when applicable.

- Pull Feature

  The user will depress "PULL FEATURE" on the SFK. The user will find 2 endpoints of the feature segment to be shifted via the digitizer cursor and POINT cursor key. The graphic CRT will display the located endpoints of the defined segment. The user will then define "pull points" for stretching the feature segment using the cursor and POINT cursor key. Depression of the EDIT cursor key will display the original and edit segments on the graphic CRT until the user depresses the STOP cursor key, progresses to another function, or rejects the edit (NULLIFY SFK).

- Edit Feature

  The user will depress EDIT FEATURE SFK. The user will define the endpoints of the edit via positioning of the digitizer cursor and depression of the POINT cursor key. The edit points and segment to be replaced will be highlighted on the Refresh CRT for user verification. The user will then depress the EDIT cursor key and retrace the replacement segments (i.e., TRACE/POINT). The user can verify the edit, before and after, and if acceptable the STOP cursor key is depressed.

- Auto Revision Edit

  The user will depress the AUTO REVISION SFK. An update feature segment will be located via the FIND cursor key. The feature segment will be highlighted on the Refresh CRT along with the highlighted "current feature," and the segment header will be displayed on the A/N CRT. The user will depress the EDIT cursor key. The feature segment will be smoothly merged with the original feature line. The replaced segment will be highlighted (e.g., dotted) on the Refresh CRT. If the user accepts the edit he will depress the STOP cursor key.

- Move Feature

  The user will depress the MOVE FEATURE SFK. The move can be performed as a feature translation or a combination of translation, scaling, and rotation.

  Translation - the user via the POINT cursor key defines a point on the original feature line and a point representing the desired position of the feature point 'EDIT' key. A copy of the feature line is translated to the new location and added to the graphic CRT display. The user can view the original and edited feature and reject the edit or progress to another function.

  Translate, Rotate, and Scale - same as a basic translation except the user defines two feature points and two re-position points. The feature line will be transformed to fit the re-position points and subsequently added to the graphic CRT display.

- Segment Feature

  The user can locate any point on the current feature via the digitizer cursor and POINT key. The point of segmentation will be highlighted on the graphic CRT. The user will depress the EDIT cursor key to perform the segmentation. The user can then progress to other related processes (e.g., delete feature, modify header, suppress feature, etc.) for completing the desired edit.

- Join Feature

  The user depresses the JOIN FEATURE SFK. The user finds the secondary feature which is highlighted by the Graphic CRT. If the correct feature was located, the user directs the joining of the two features via the EDIT cursor key. The header of the new feature is copied from the first feature located.

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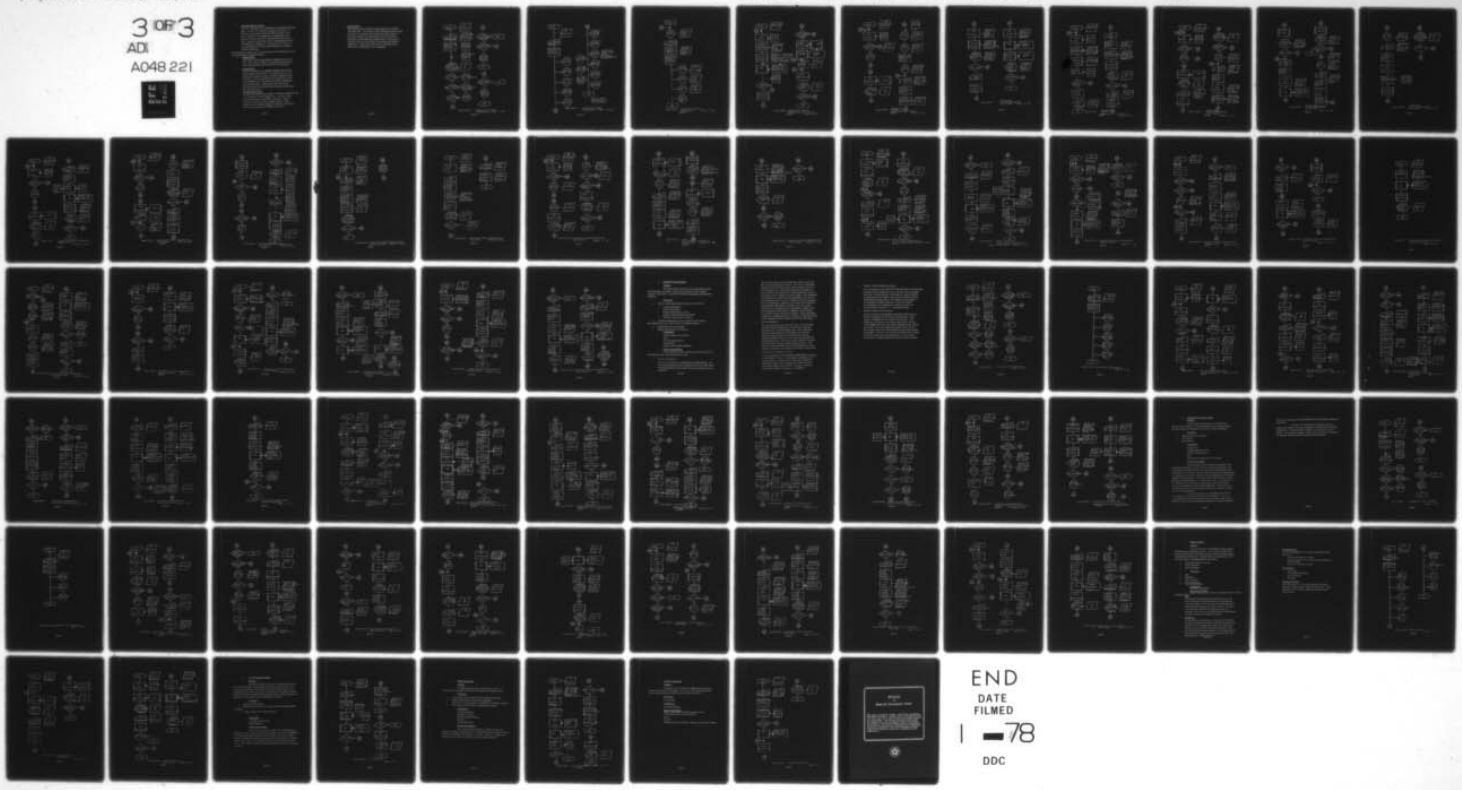

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- Augment/Suppress Feature

  The user will depress the AUGMENT or SUPPRESS FEATURE SFK. The user can augment or suppress any number of features by sequentially using the FIND and EDIT cursor keys. Features to be suppressed are highlighted on the Refresh CRT and removed by depressing the EDIT cursor key. Features located which are to be augmented to the current display are highlighted. Depression of the EDIT cursor key results in the feature being displayed according to assigned symbology.

The following processes may be performed at the Proofing Station as well as the Interactive Compilation Station:

- Modify Header

  The header of the current feature is displayed on the A/N CRT. The user can modify any element of the header via use of the text editor with the A/N CRT and Keyboard.

- Assign Header

  The user will depress the ASSIGN HEADER SFK followed by the selected numeric SFK. The numeric SFK corresponds to the sequence number of headers displayed on the A/N CRT. The user will then locate features via the cursor and FIND key. The located feature will be highlighted on the Refresh CRT. Depression of the EDIT cursor key will result in the selected header being associated with the "current feature."

- Accept/Delete Feature

  The user will depress the ACCEPT or DELETE FEATURE SFK. A "current feature" is then flagged (i.e., accept or delete flag) via depression of the EDIT cursor key. Deleted features are erased from the graphic display. Other features can be similarly flagged by using the Find Feature service and depression of the EDIT cursor key.

- Recall Feature

  This process will be initiated by depression of the RECALL FEATURE SFK. The standard FIND FEATURE sequence using the cursor (or trackball) will result in the original feature line being displayed, in addition to the current version of the feature, on the applicable display device. Depression of the EDIT cursor key will replace the modified line with the original line. This service will allow for proofing of line edits prior to finalization of the compilation.

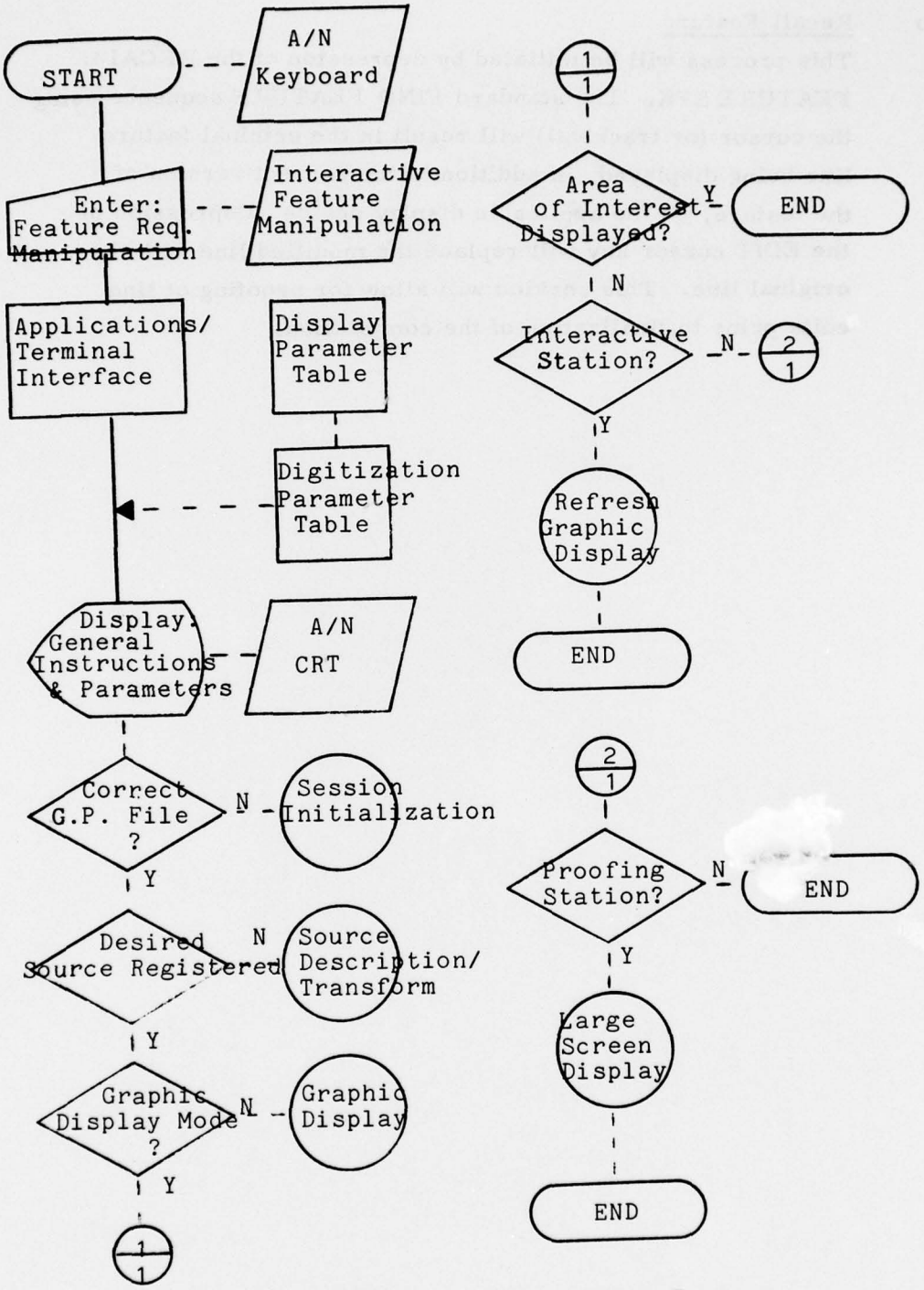


Figure III-25 - Interactive Feature Manipulation (Page 1 of 30)

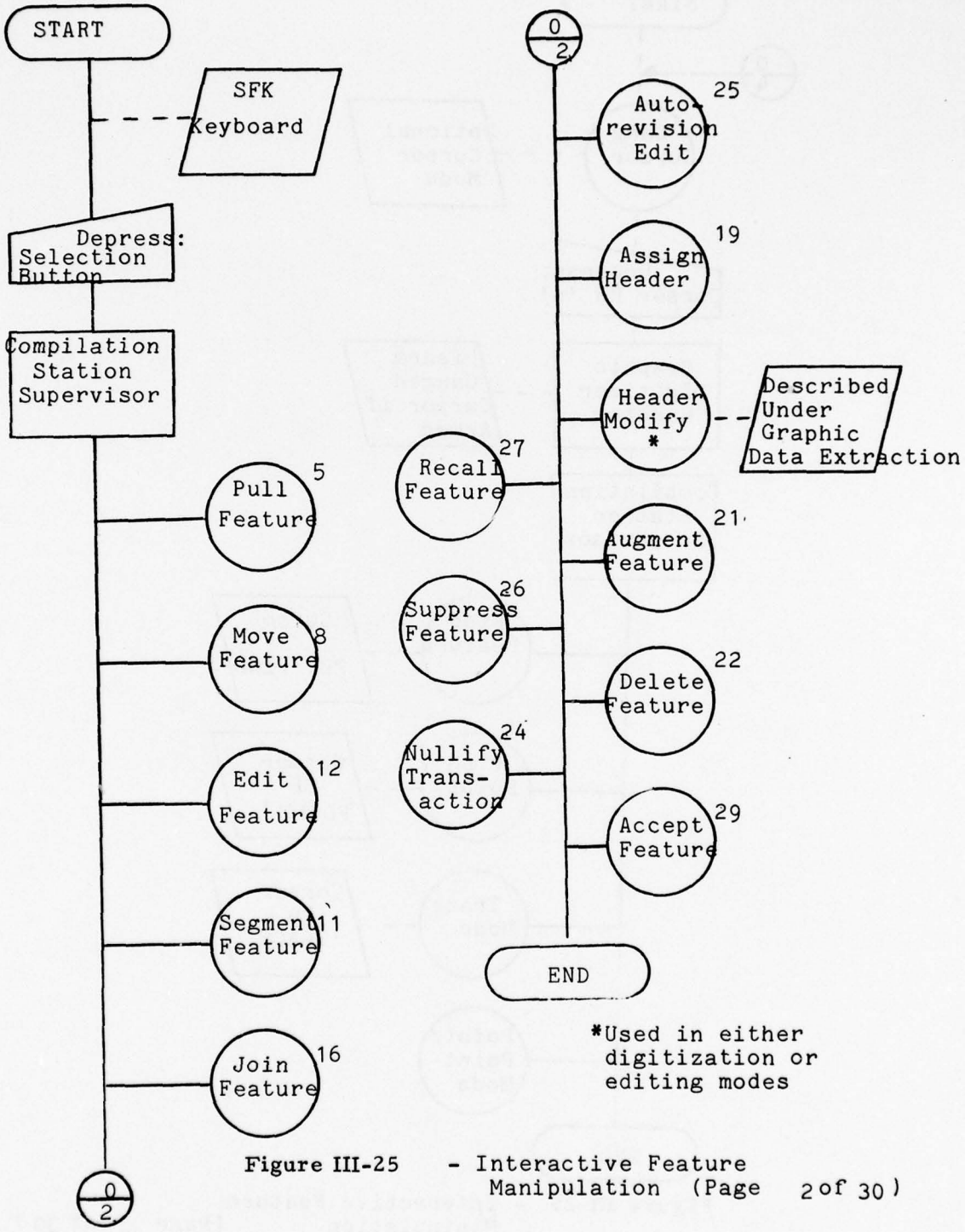


Figure III-25 - Interactive Feature Manipulation (Page 2 of 30)

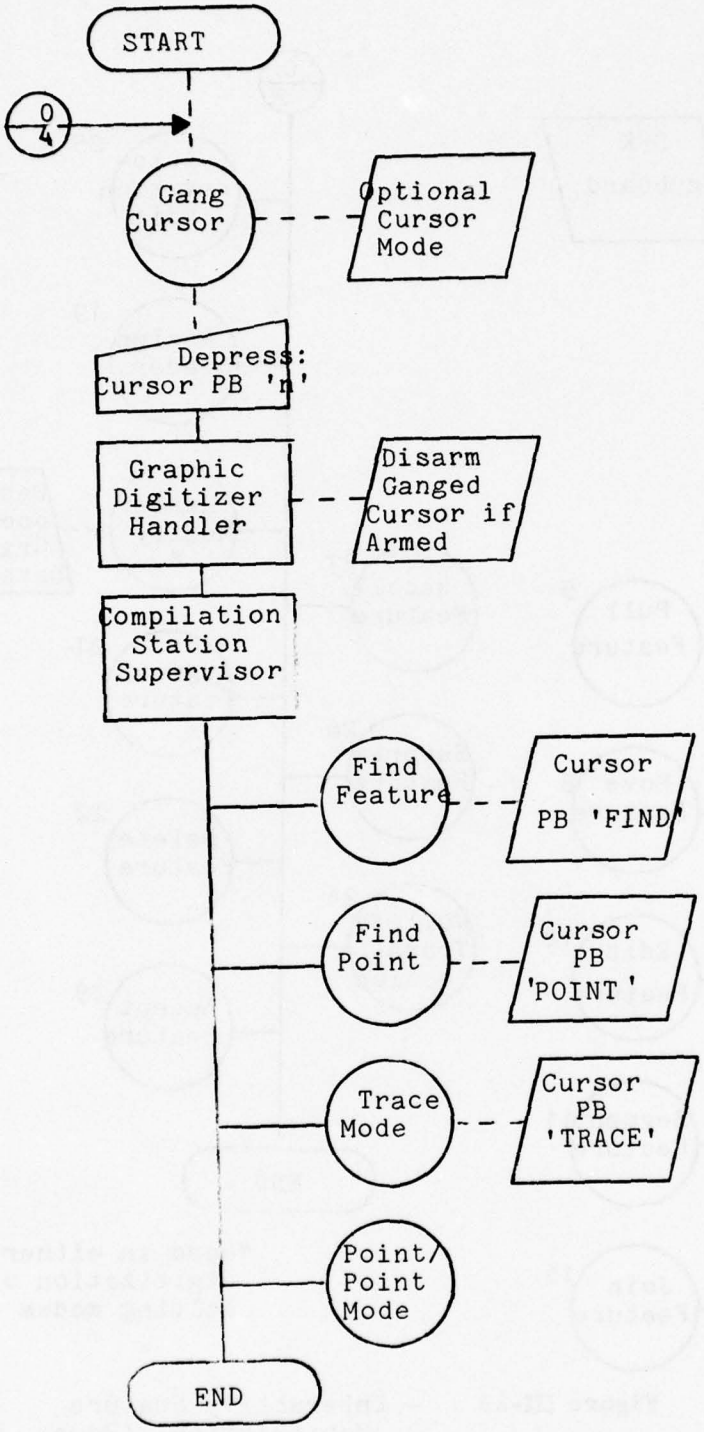


Figure III-25 - Interactive Feature Manipulation (Page 3 of 30)

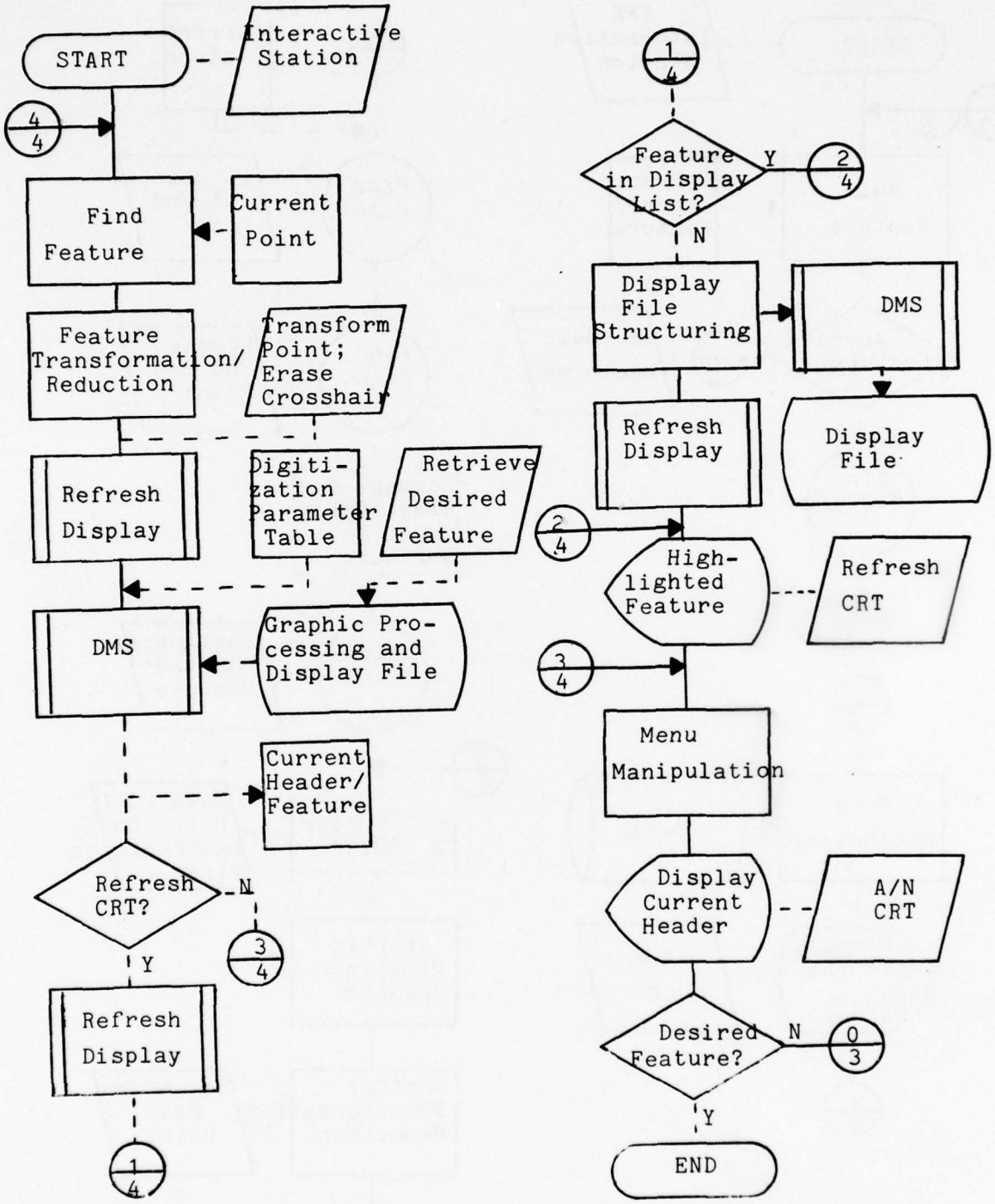


Figure III-25 - Interactive Feature Manipulation Find Feature

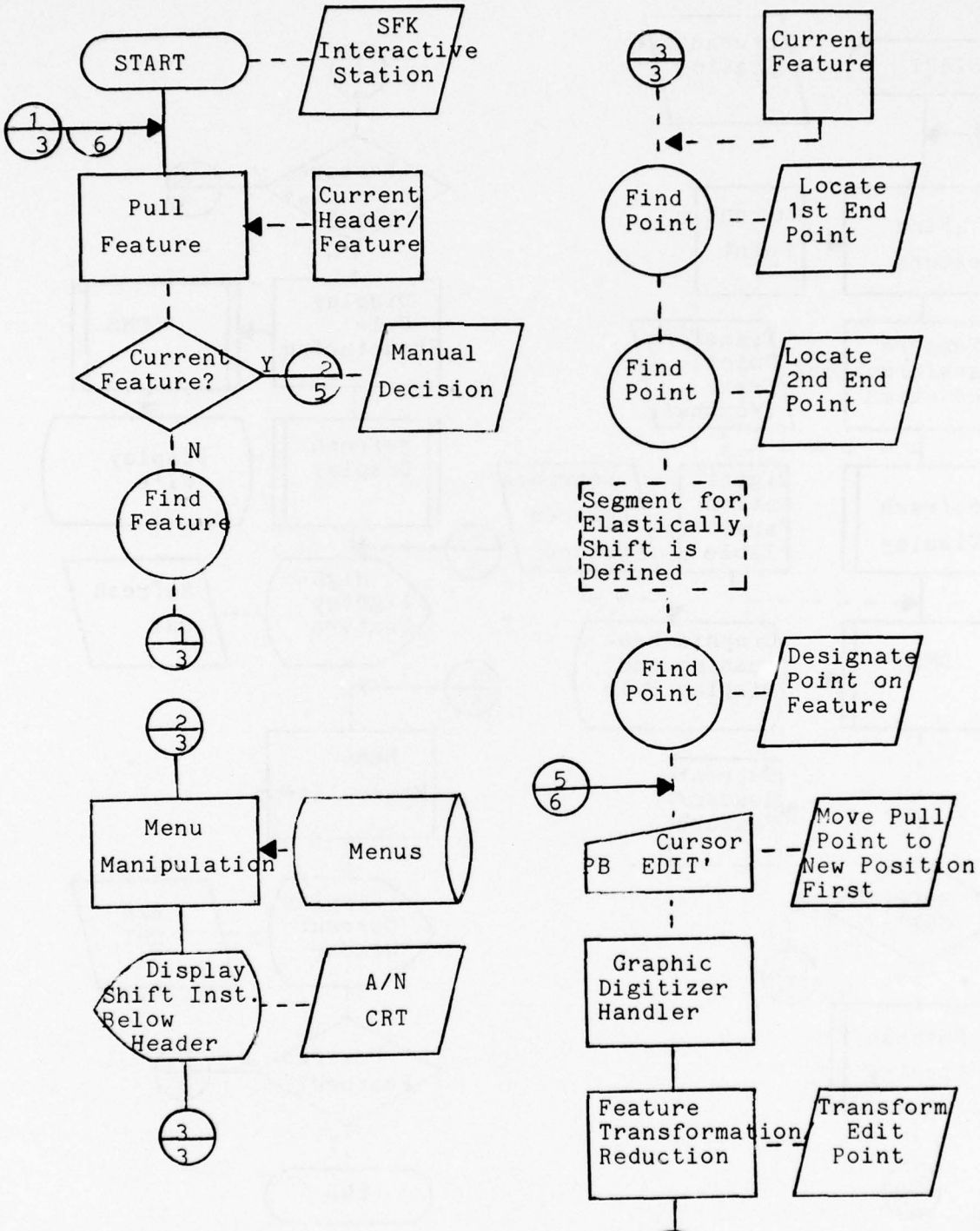


Figure III-25 - Interactive Feature Manipulation Pull Feature

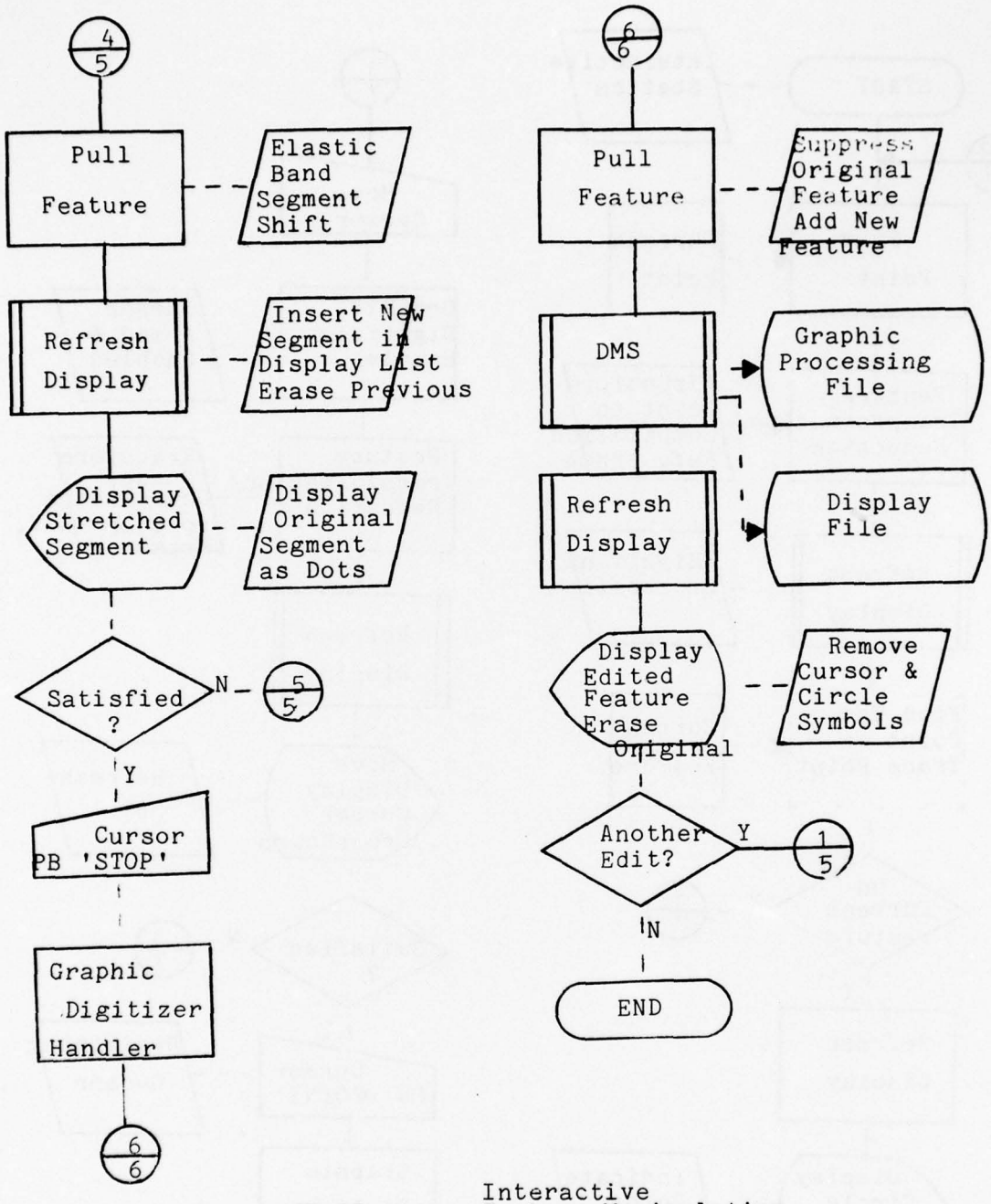


Figure III-25 - Interactive Feature Manipulation Pull Feature (Page 6 of 30)

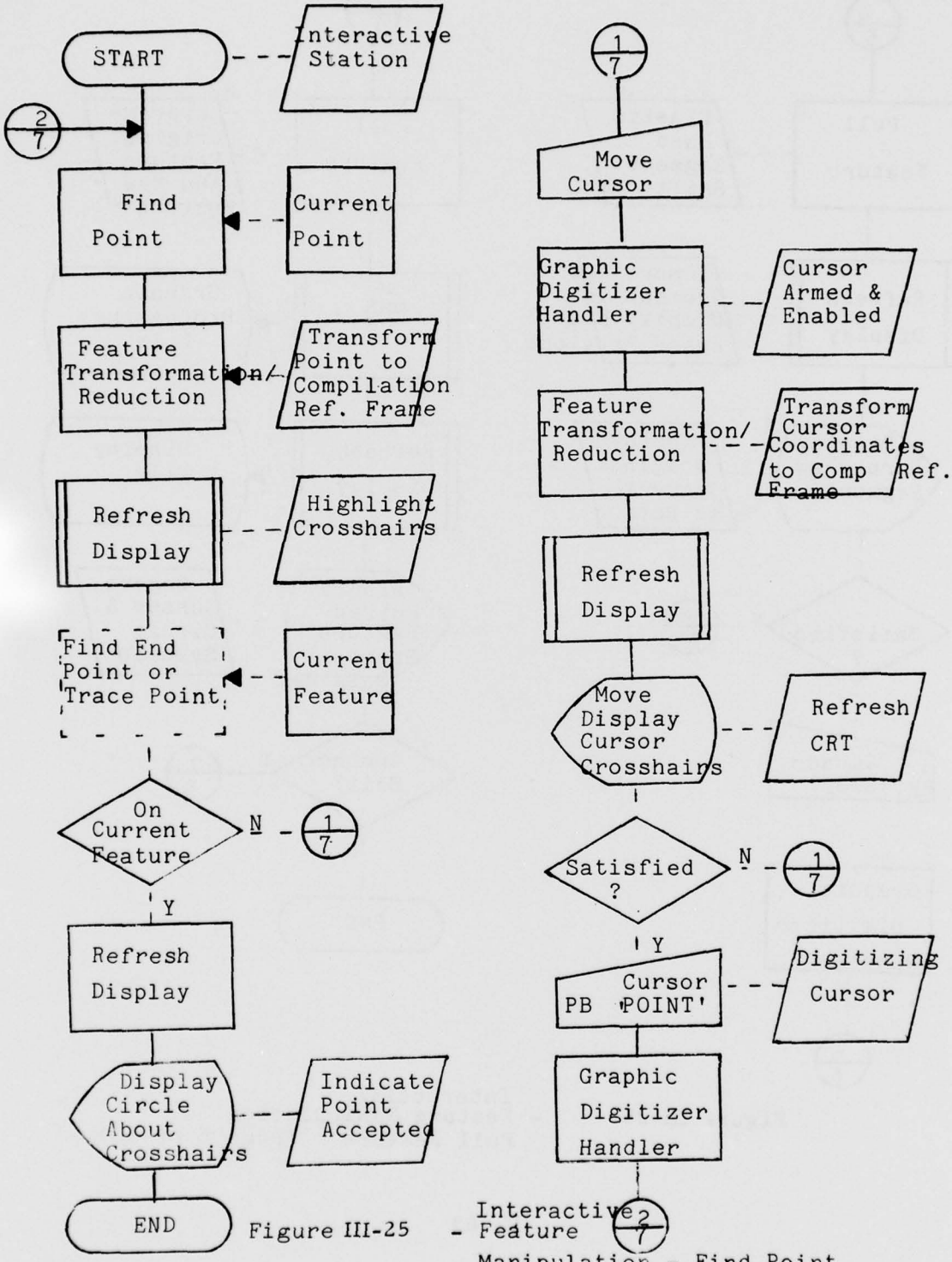


Figure III-25 - Interactive Feature Manipulation - Find Point

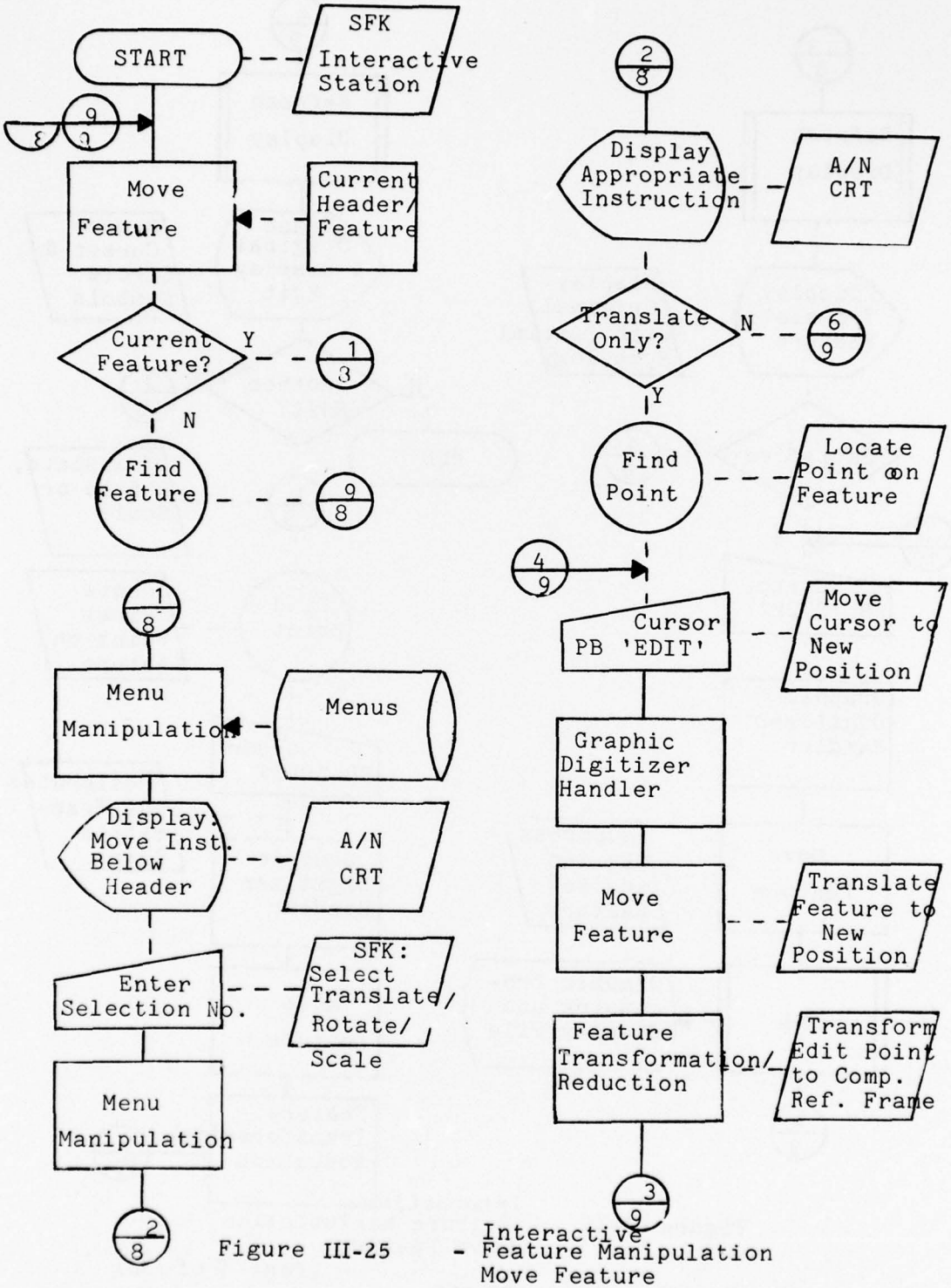


Figure III-25 - Interactive Feature Manipulation Move Feature

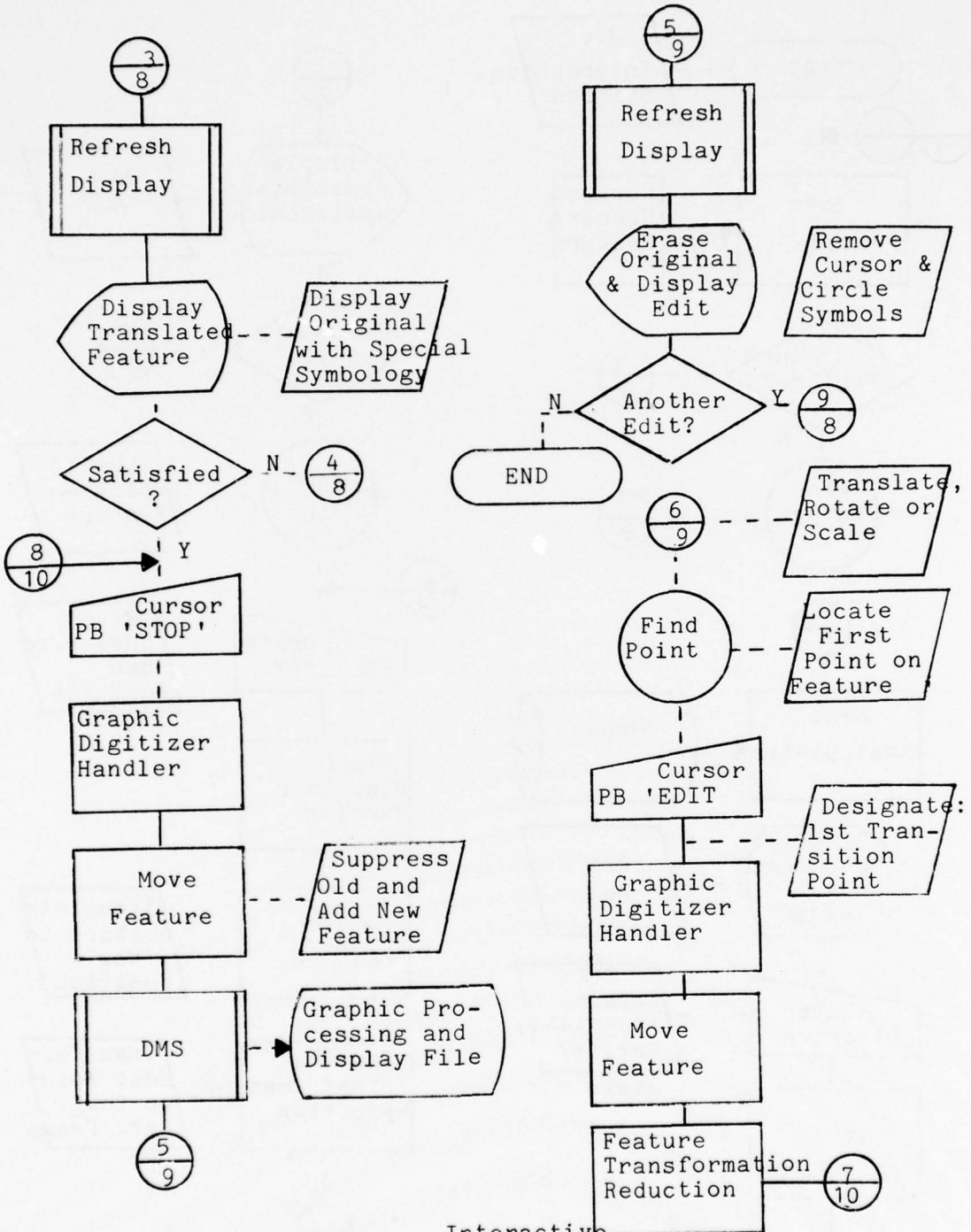


Figure III-25 - Interactive Feature Manipulation Move Feature

(Page 9 of 30)

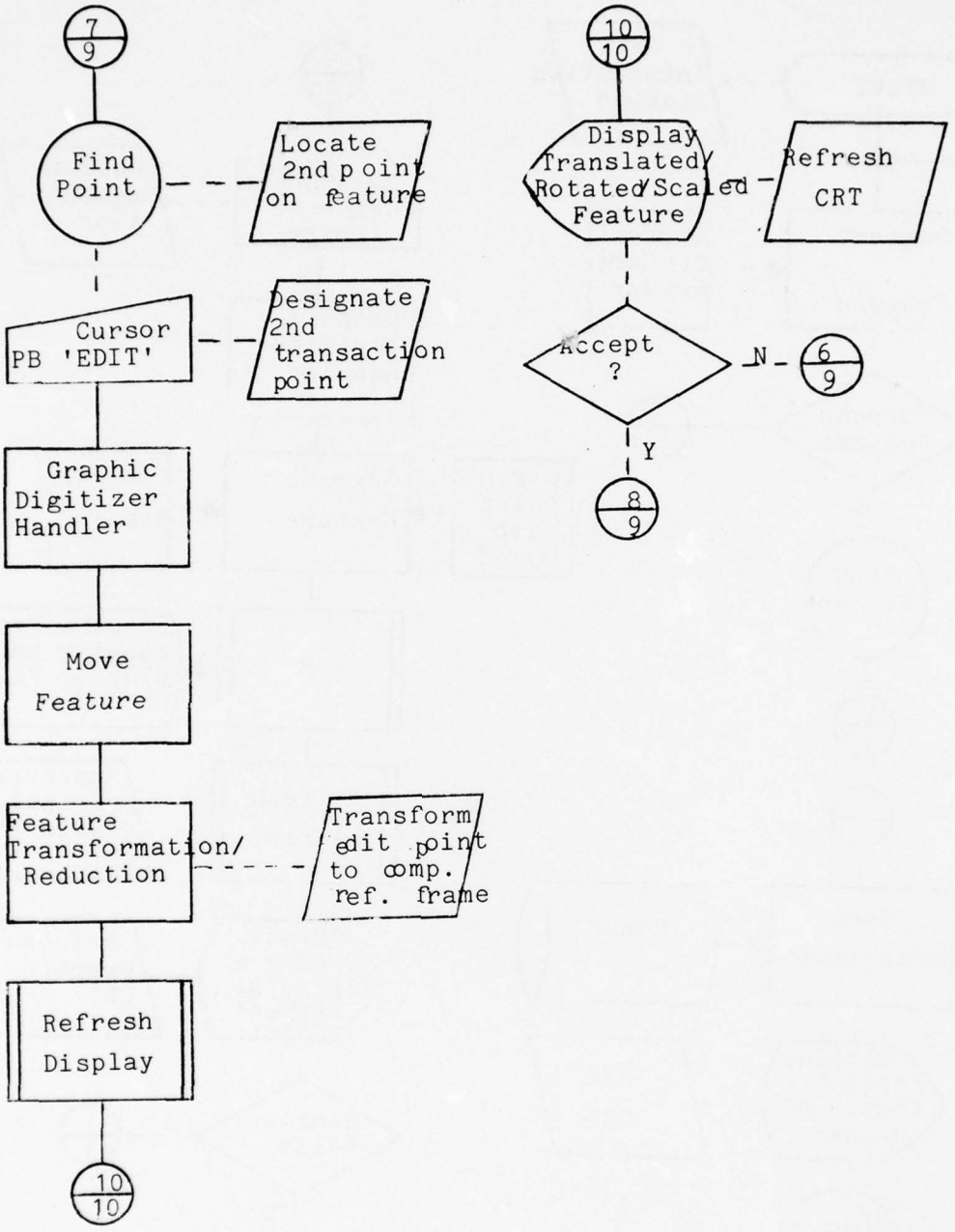


Figure III-25 - Interactive Feature Manipulation - Move Feature (Page 10 of 30)

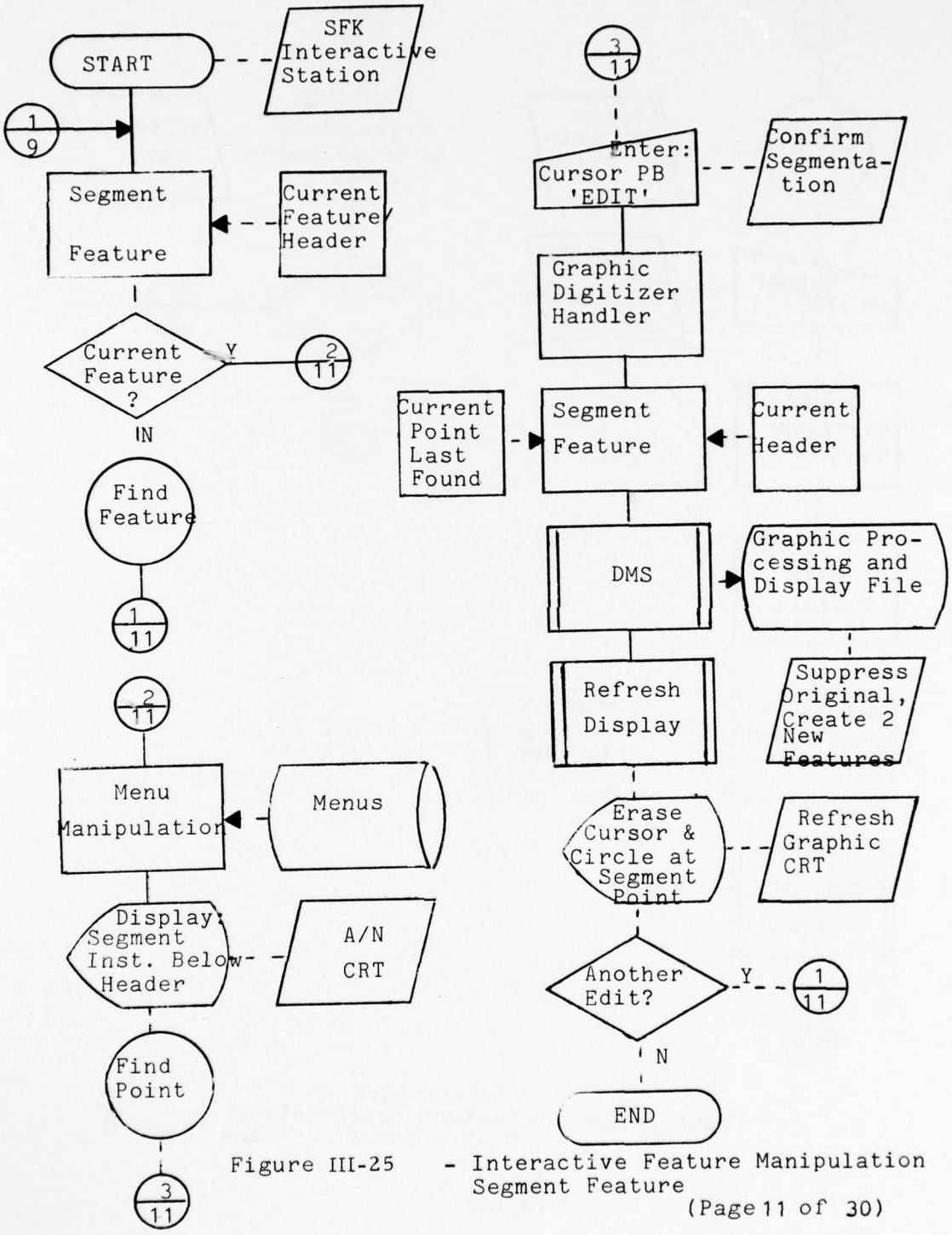


Figure III-25 - Interactive Feature Manipulation Segment Feature

(Page 11 of 30)

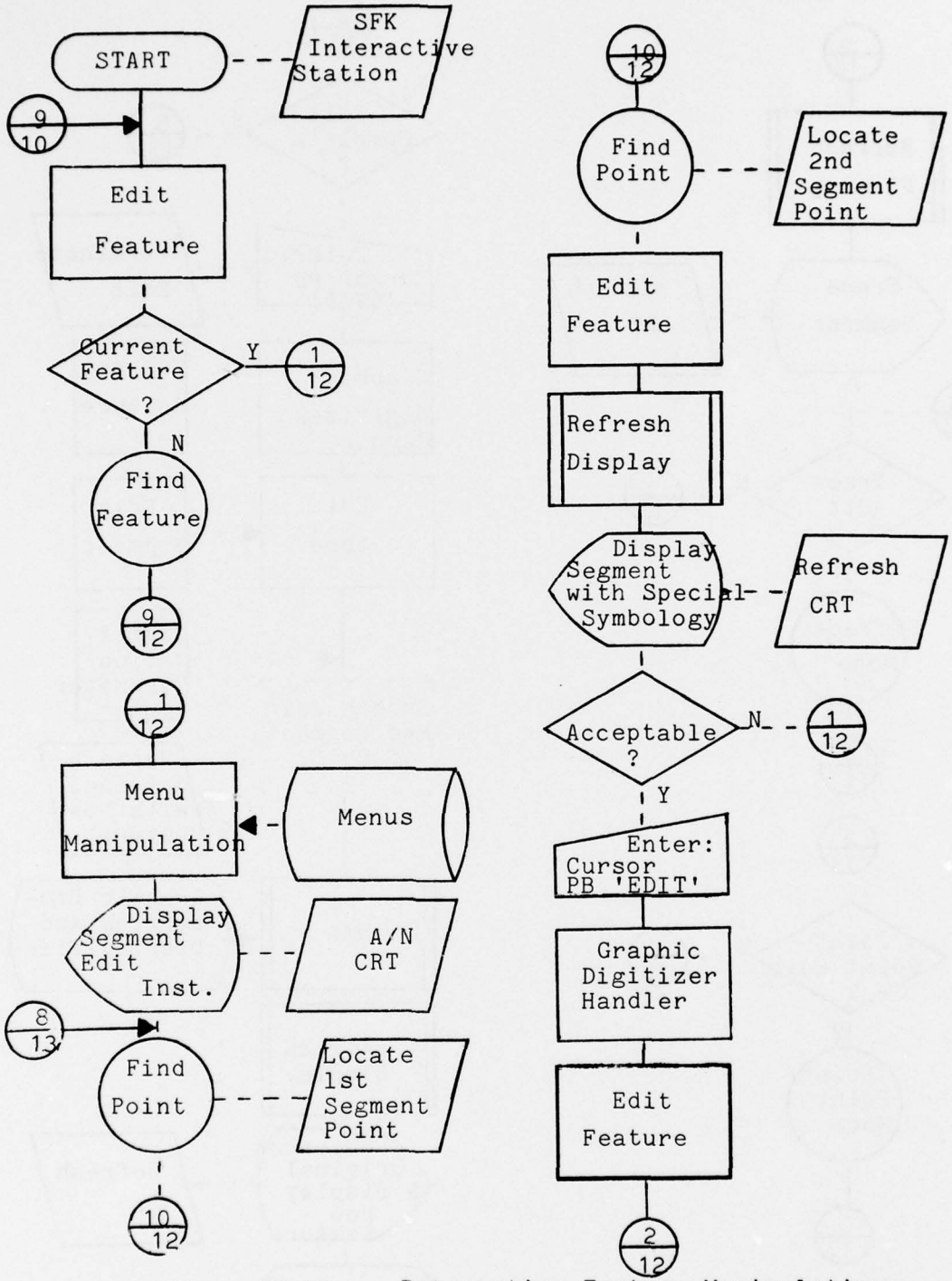


Figure III-25 - Interactive Feature Manipulation
Edit Feature (Page 12 of 30)

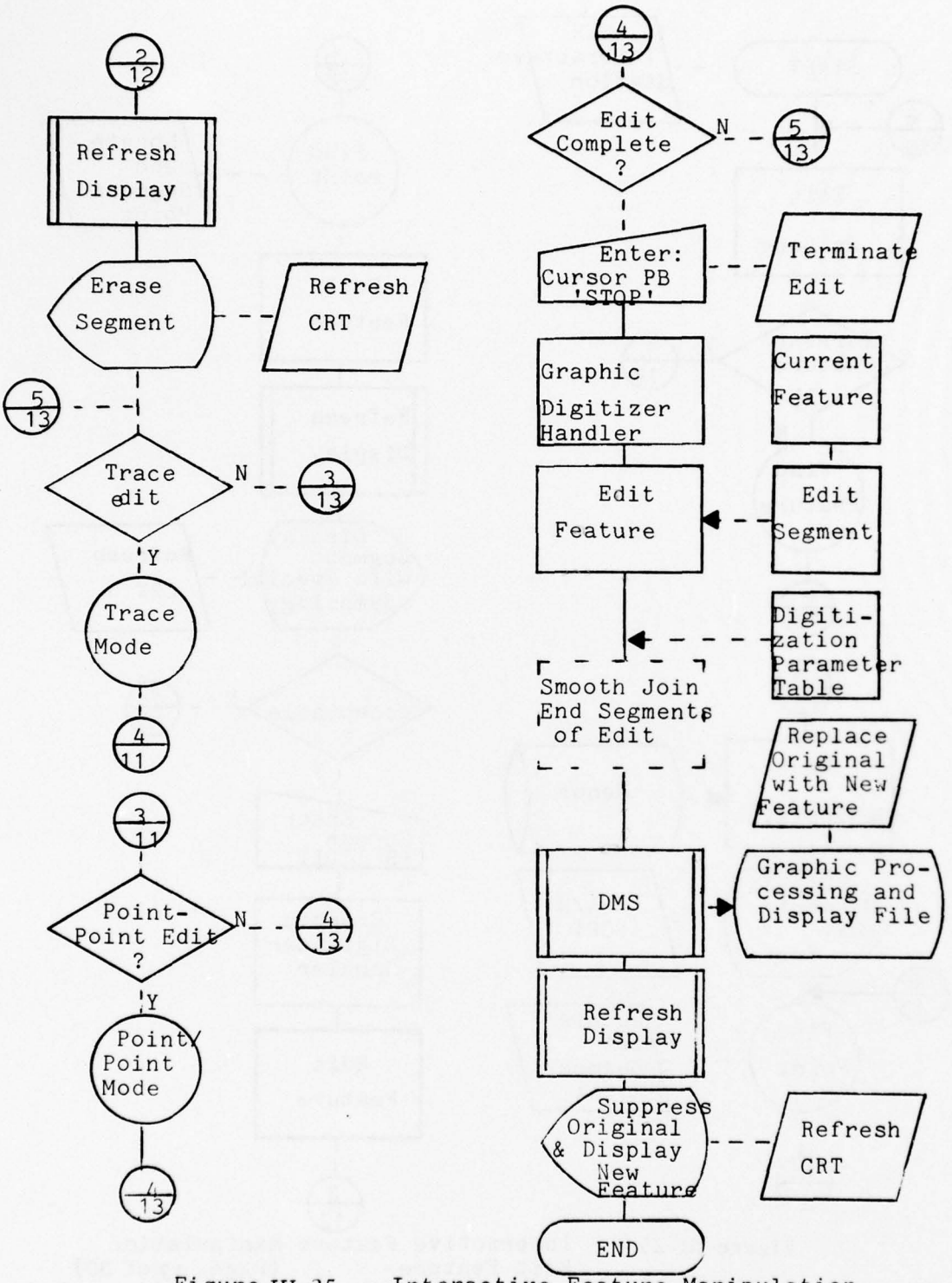


Figure III-25 - Interactive Feature Manipulation
Edit Feature (Page 13 of 30)

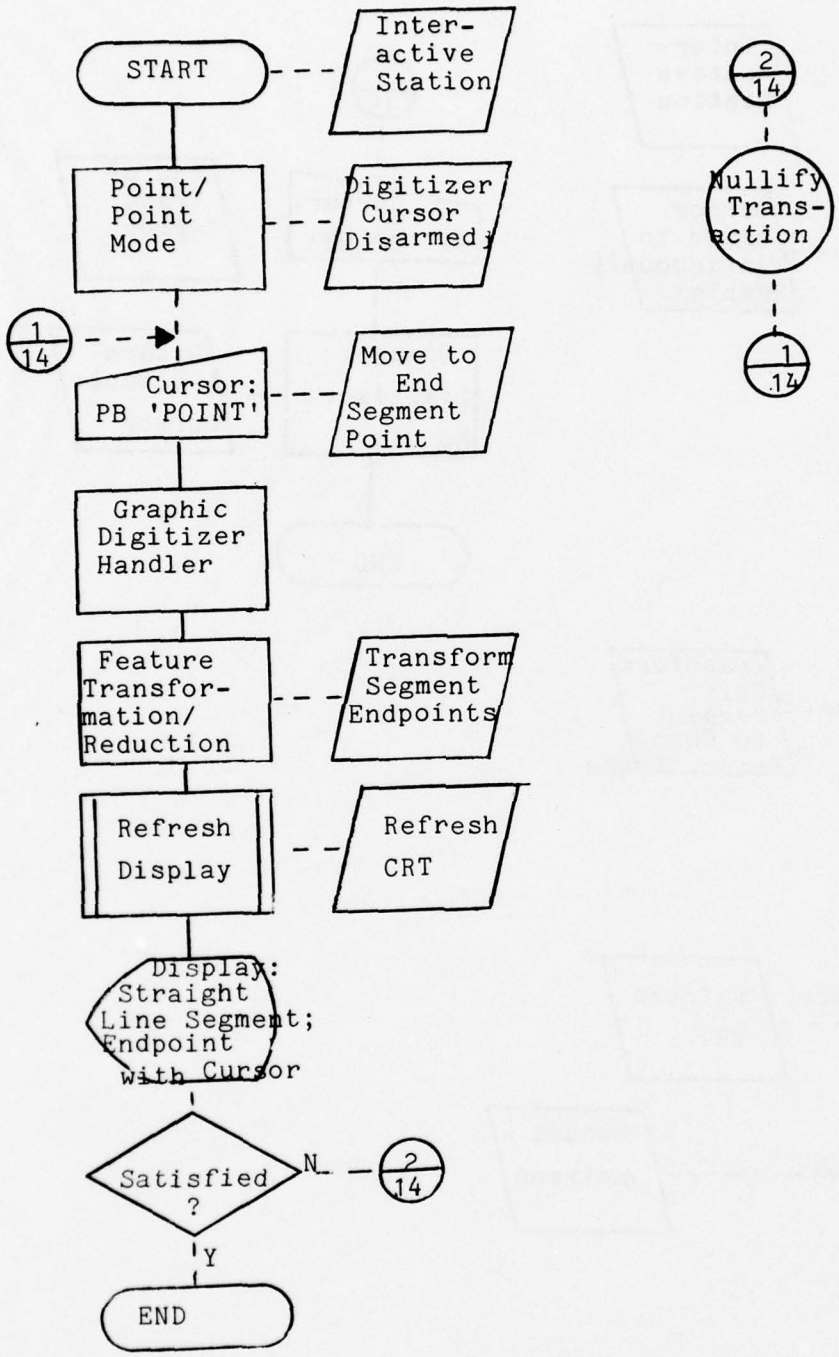


Figure III-25 - Interactive Feature Manipulation
Point/Point Mode (Page 14 of 30)

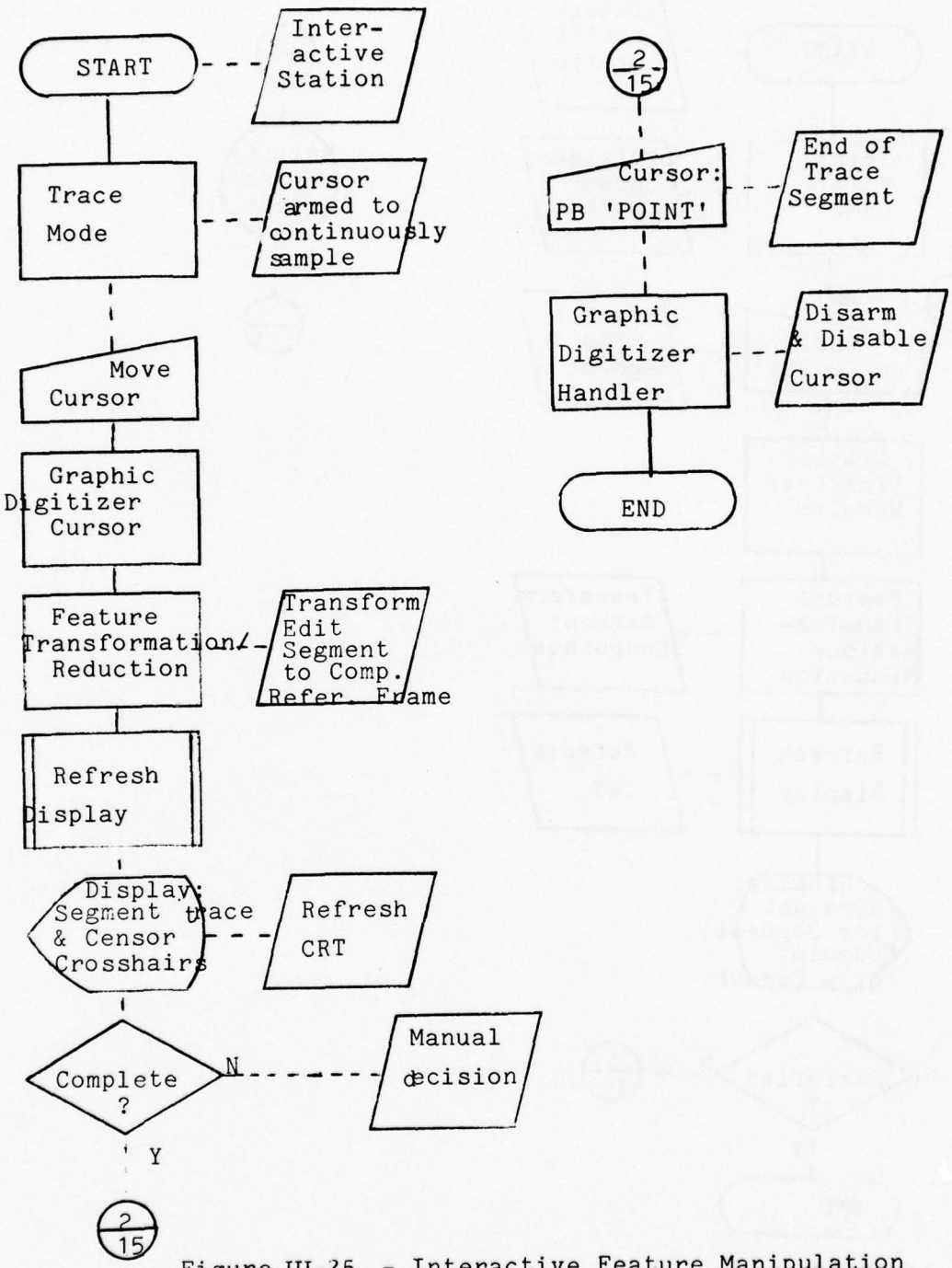


Figure III-25 - Interactive Feature Manipulation Trace Mode (Page 15 of 30)

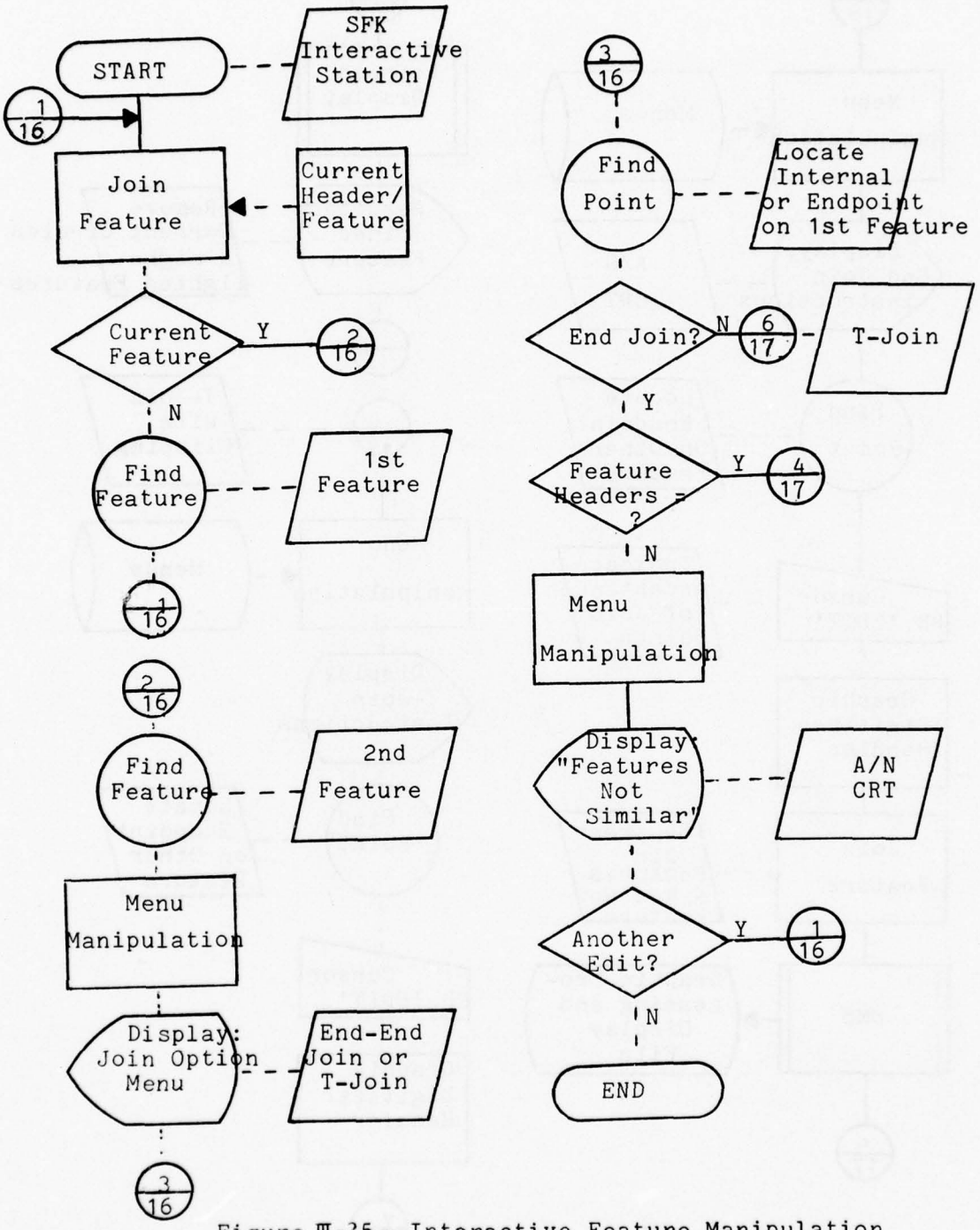


Figure III-25 - Interactive Feature Manipulation
Join Feature (Page 16 of 30)

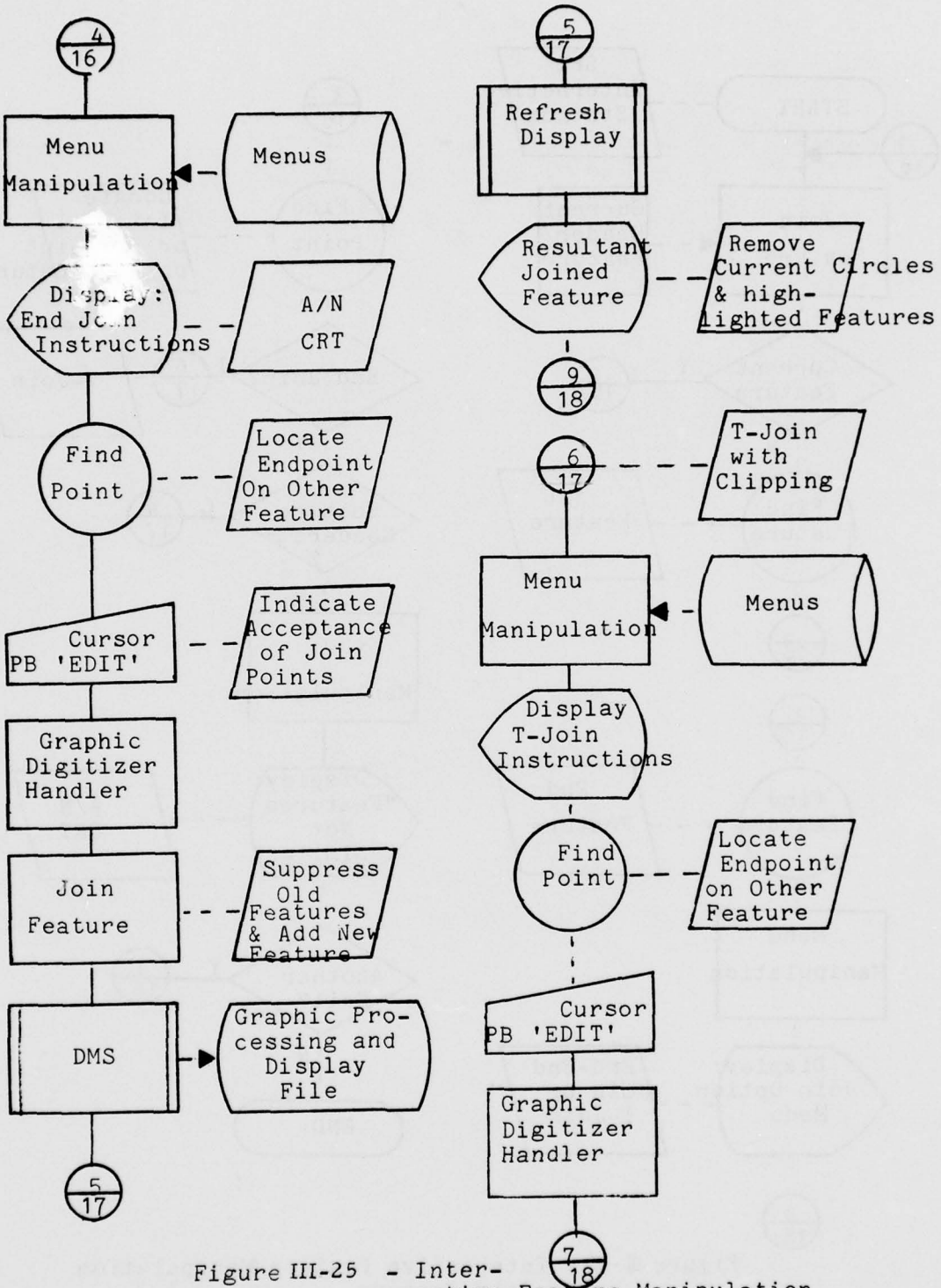


Figure III-25 - Interactive Feature Manipulation
Join Feature (Page 17. of 30)

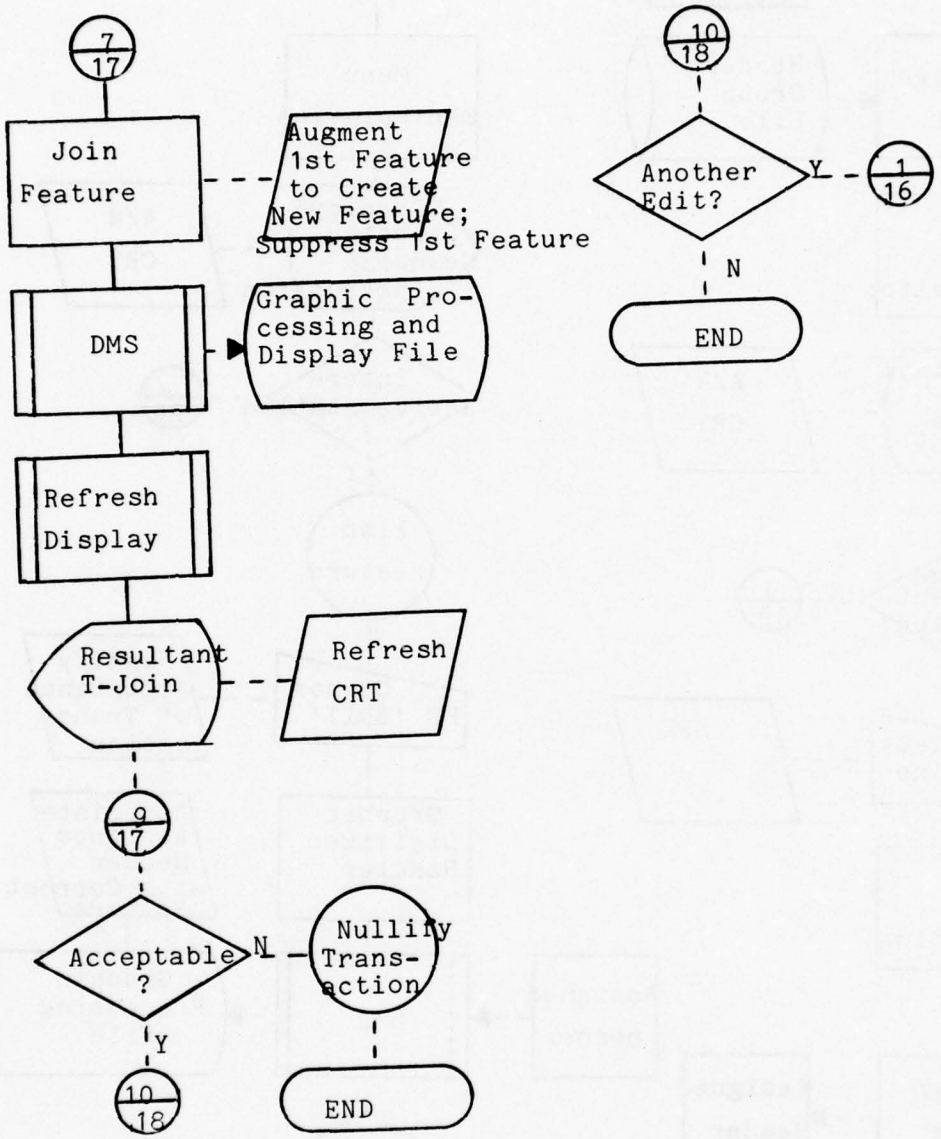


Figure III-25 - Interactive Feature Manipulation
Join Feature (Page 18 of 30)

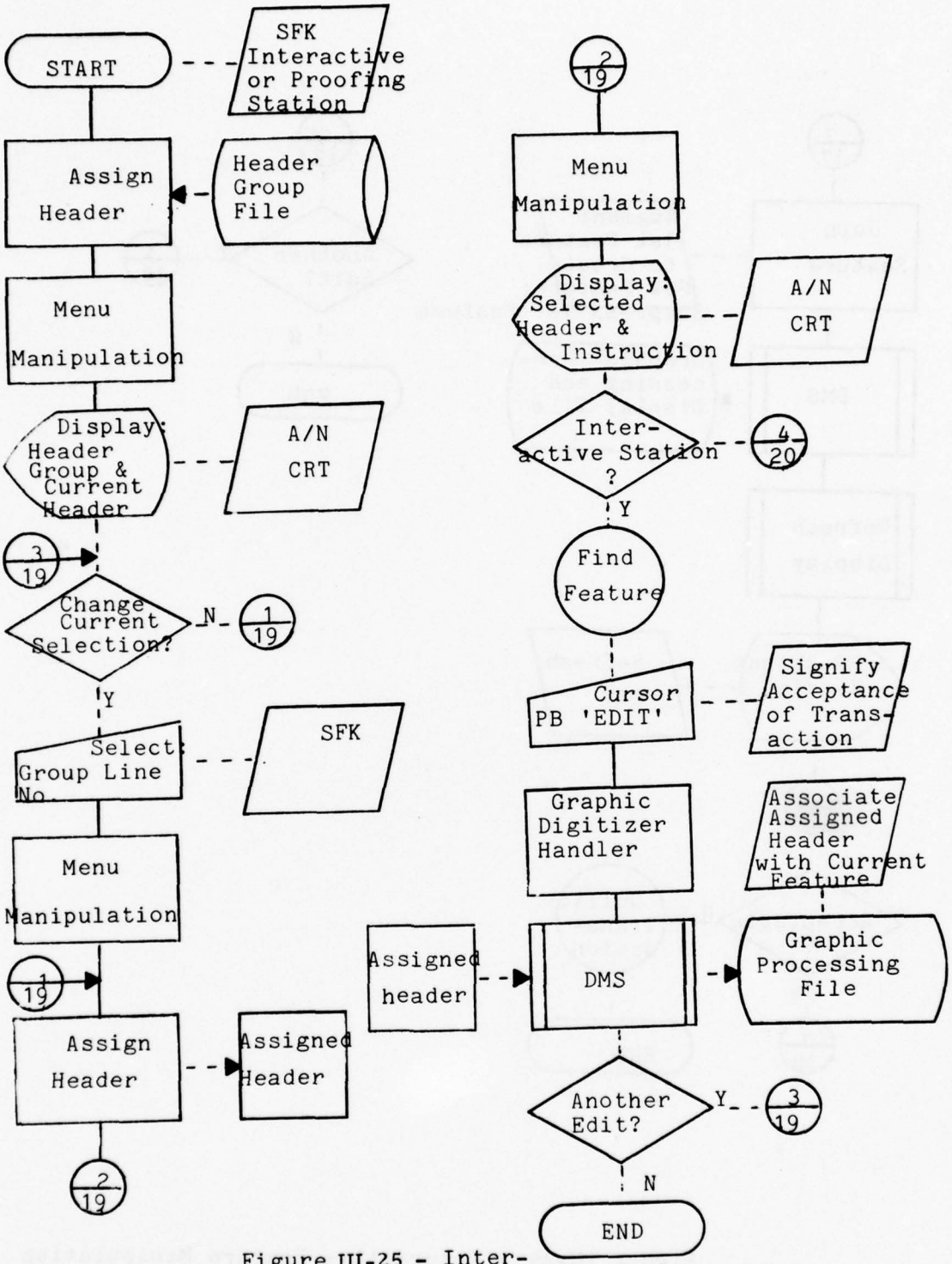


Figure III-25 - Inter-active Feature Manipulation Assign Header (Page 19 of 30)

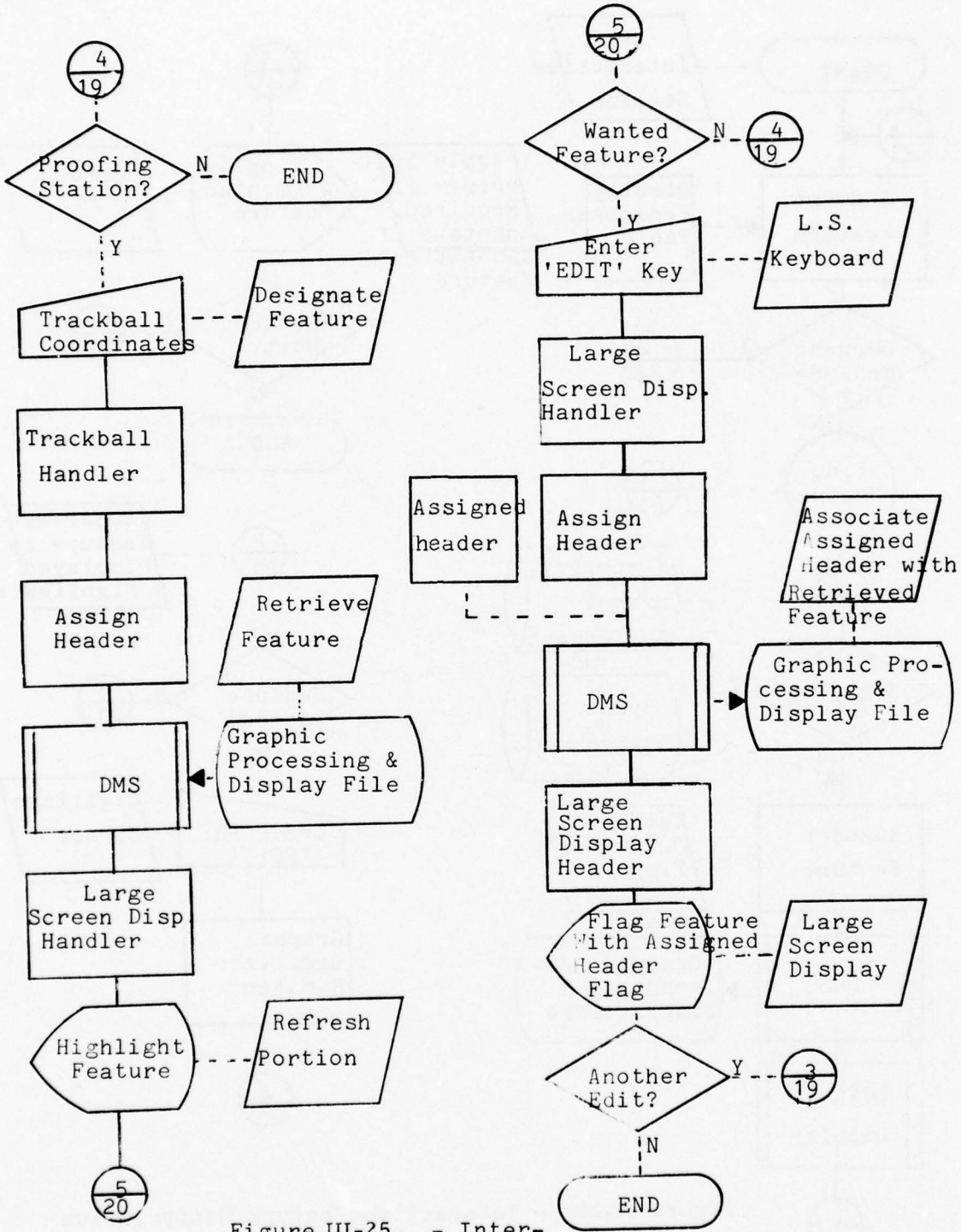


Figure III-25 - Interactive Feature Manipulation Assign Header (Page 20 of 30)

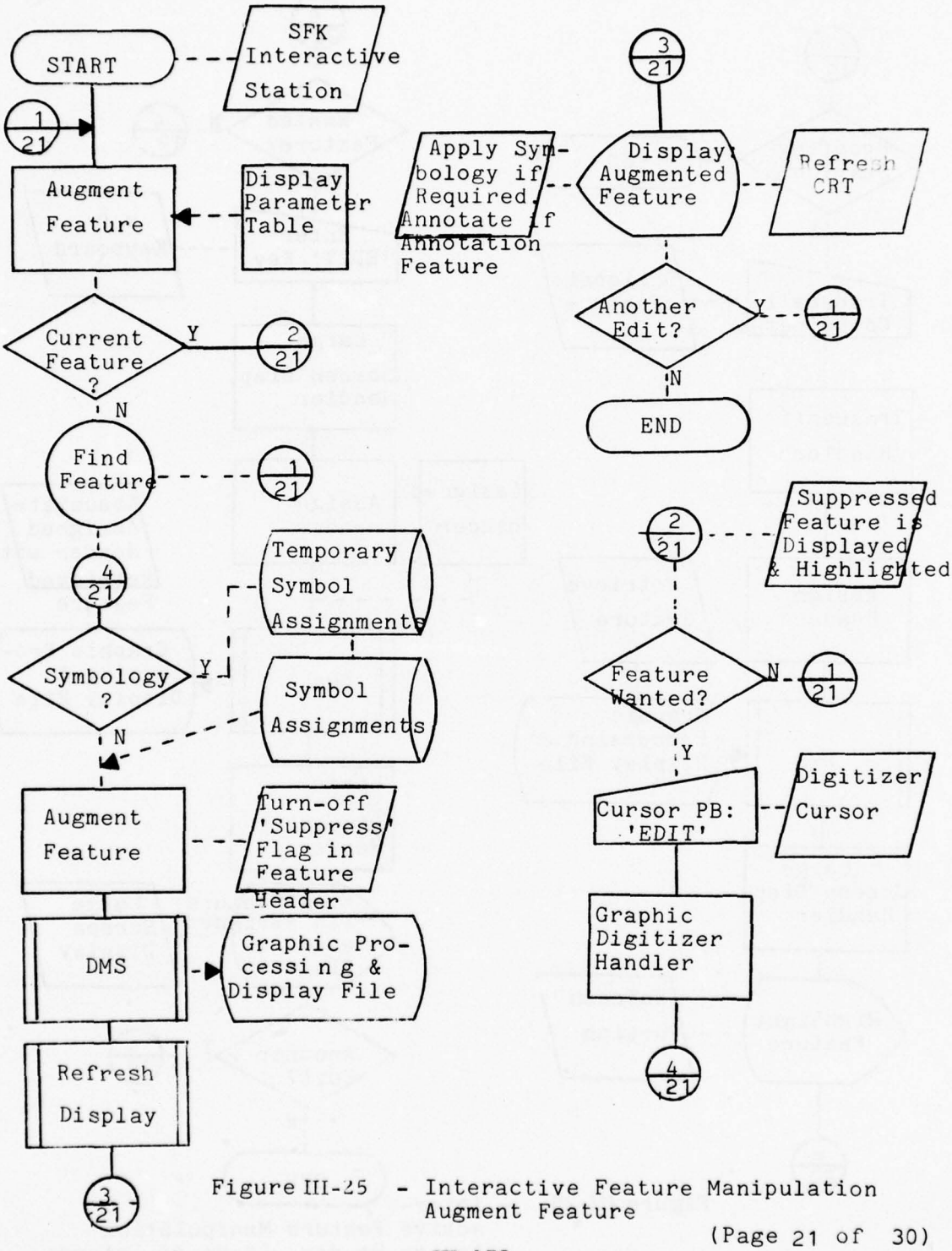


Figure III-25 - Interactive Feature Manipulation
Augment Feature

(Page 21 of 30)

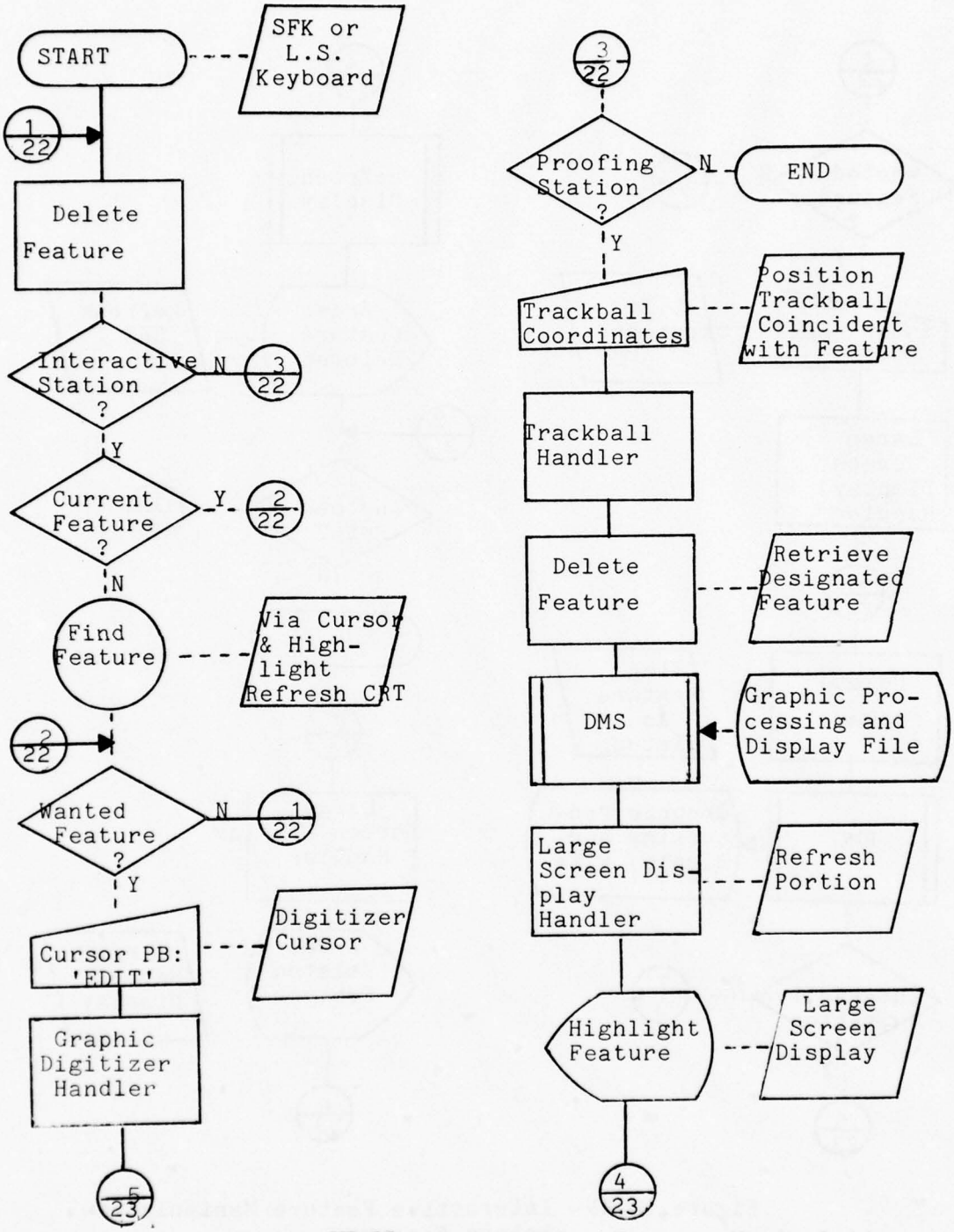


Figure III-25 - Interactive Feature Manipulation
Delete Feature (Page 22 of 30)

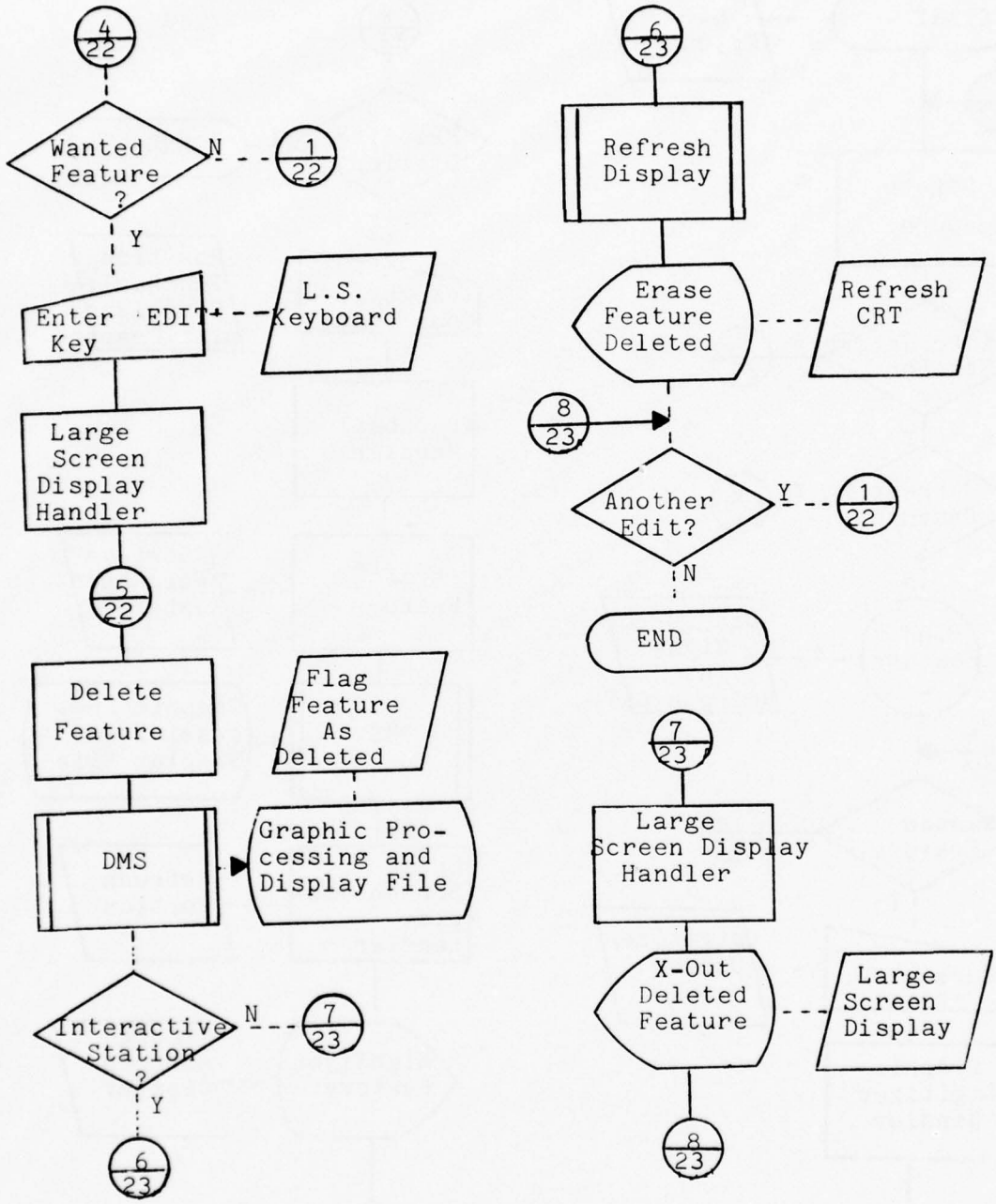


Figure III-25 - Interactive Feature Manipulation
Delete Feature
(Page 23 of 30)

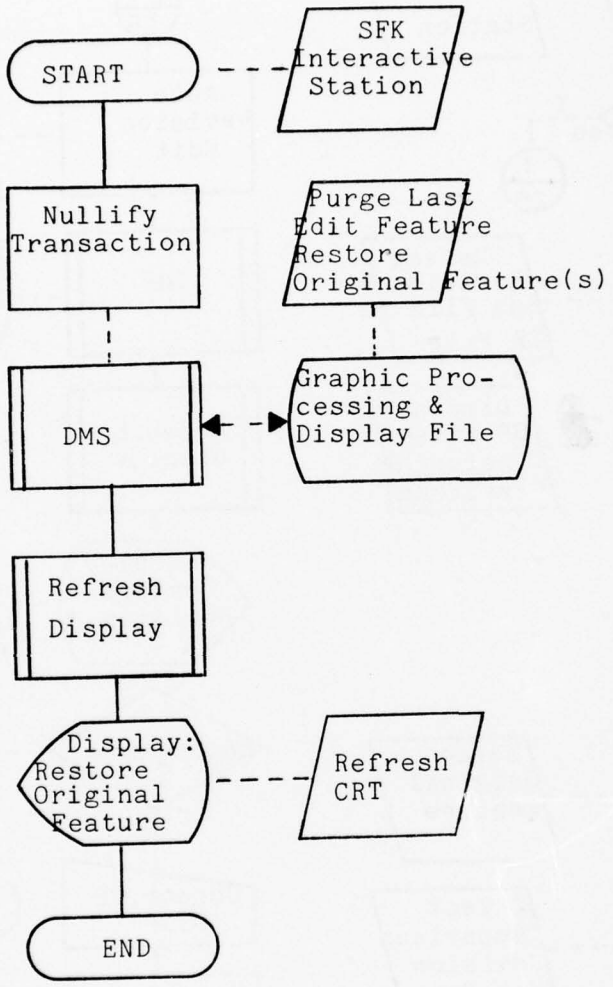


Figure III-25 - Interactive Feature Manipulation
Nullify Transaction
(Page 24 of 30)

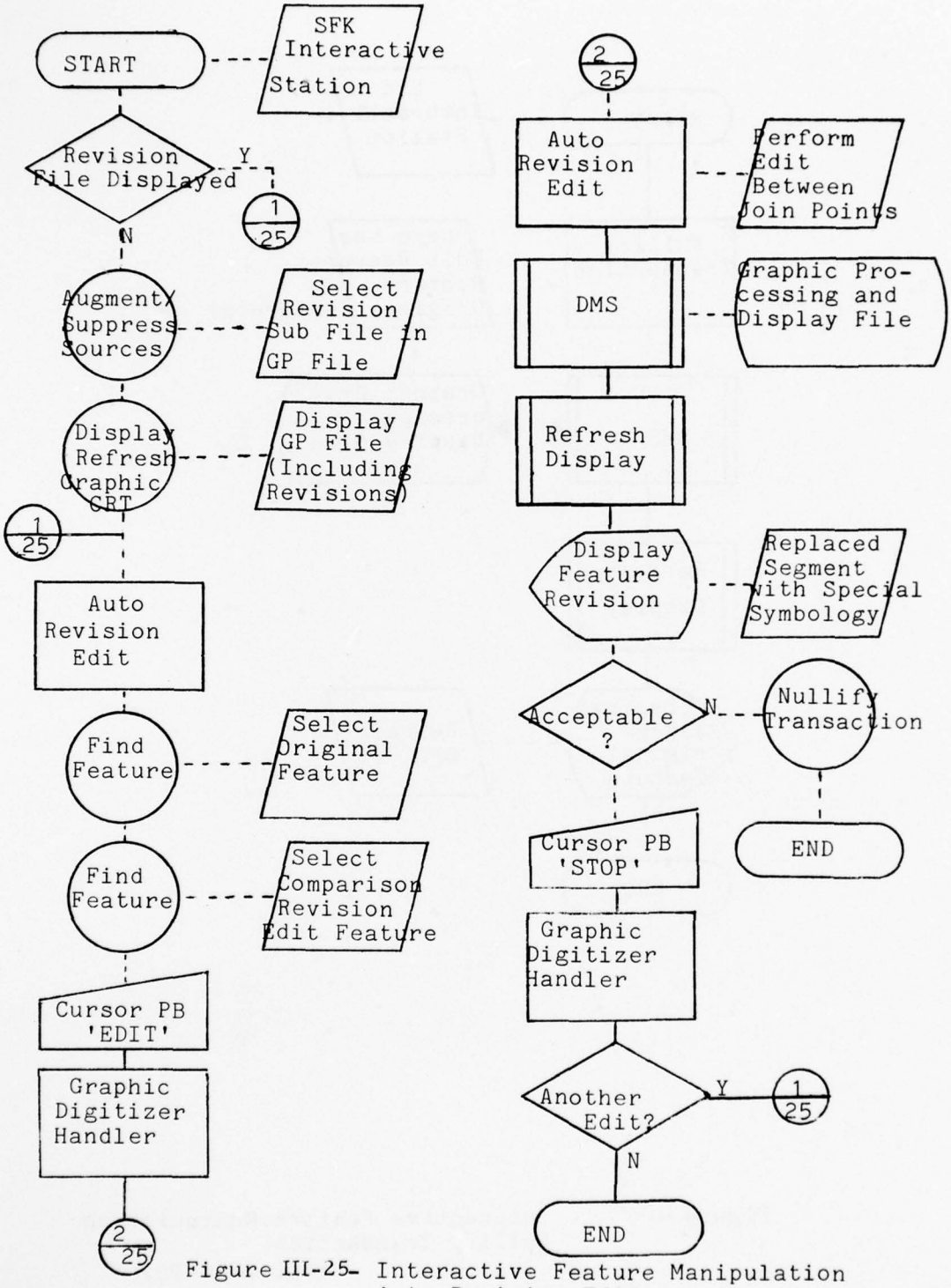


Figure III-25- Interactive Feature Manipulation
Auto Revision Edit (Page 25 of 30)

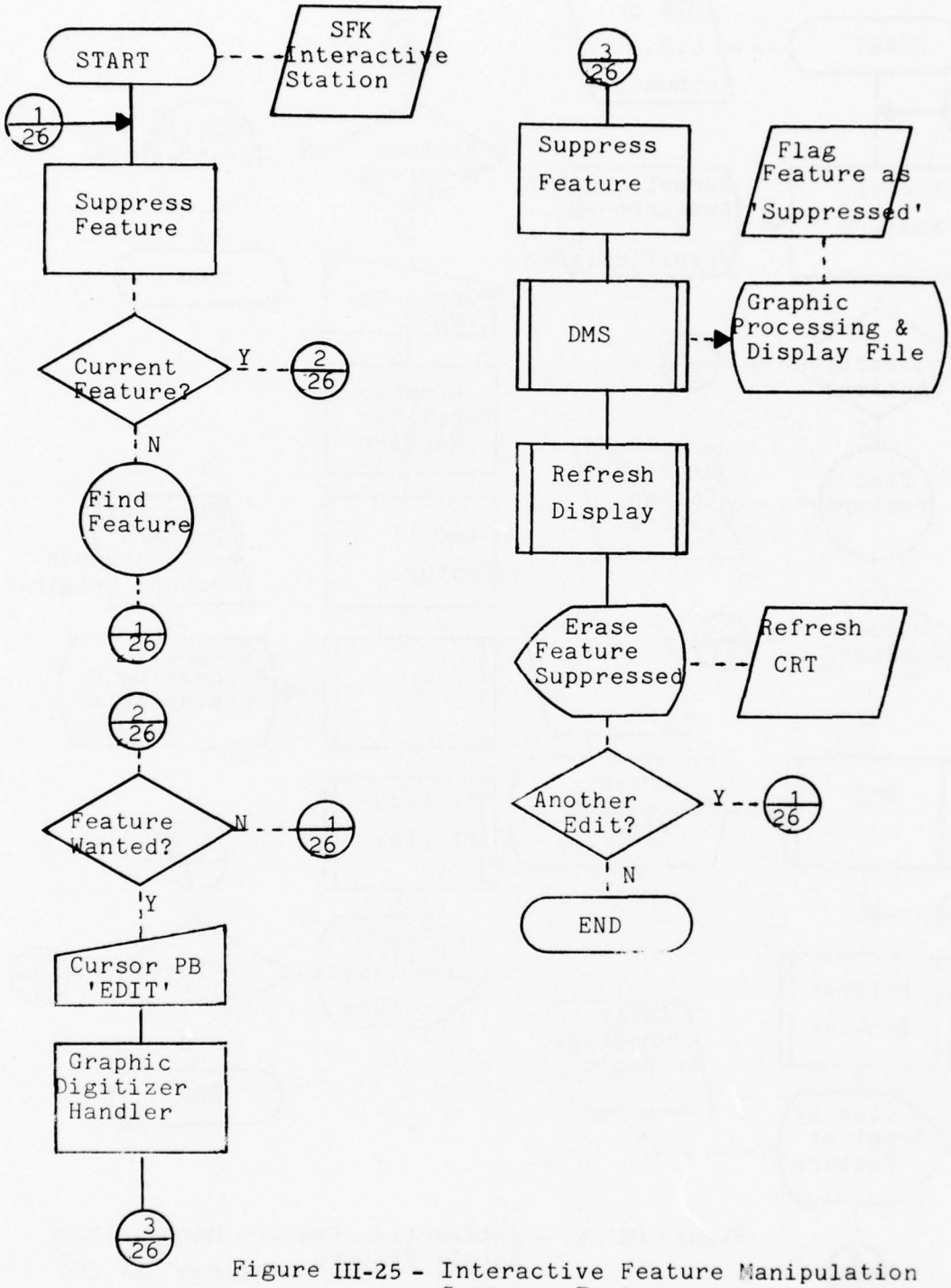


Figure III-25 - Interactive Feature Manipulation
Suppress Feature

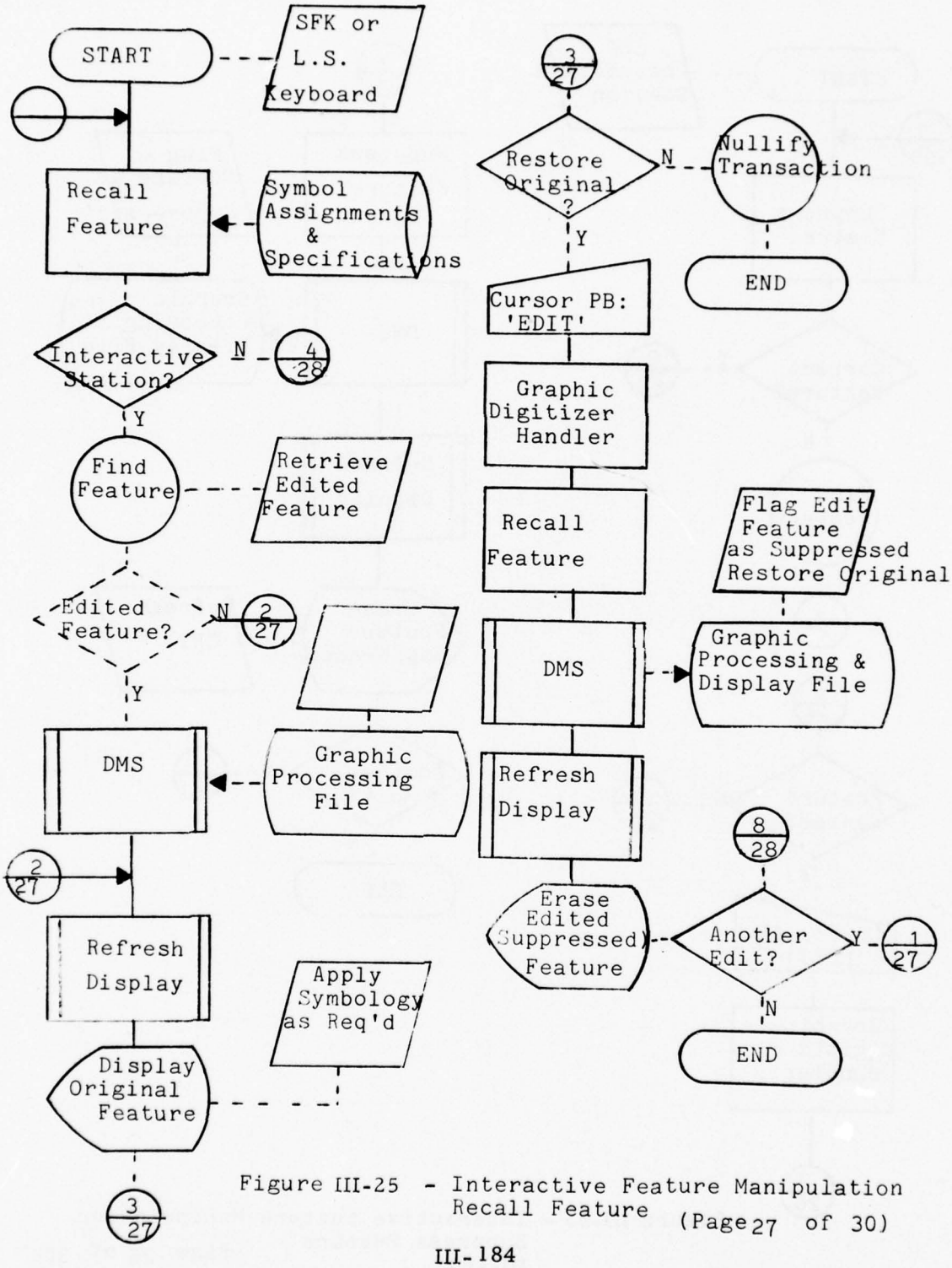


Figure III-25 - Interactive Feature Manipulation
Recall Feature (Page 27 of 30)

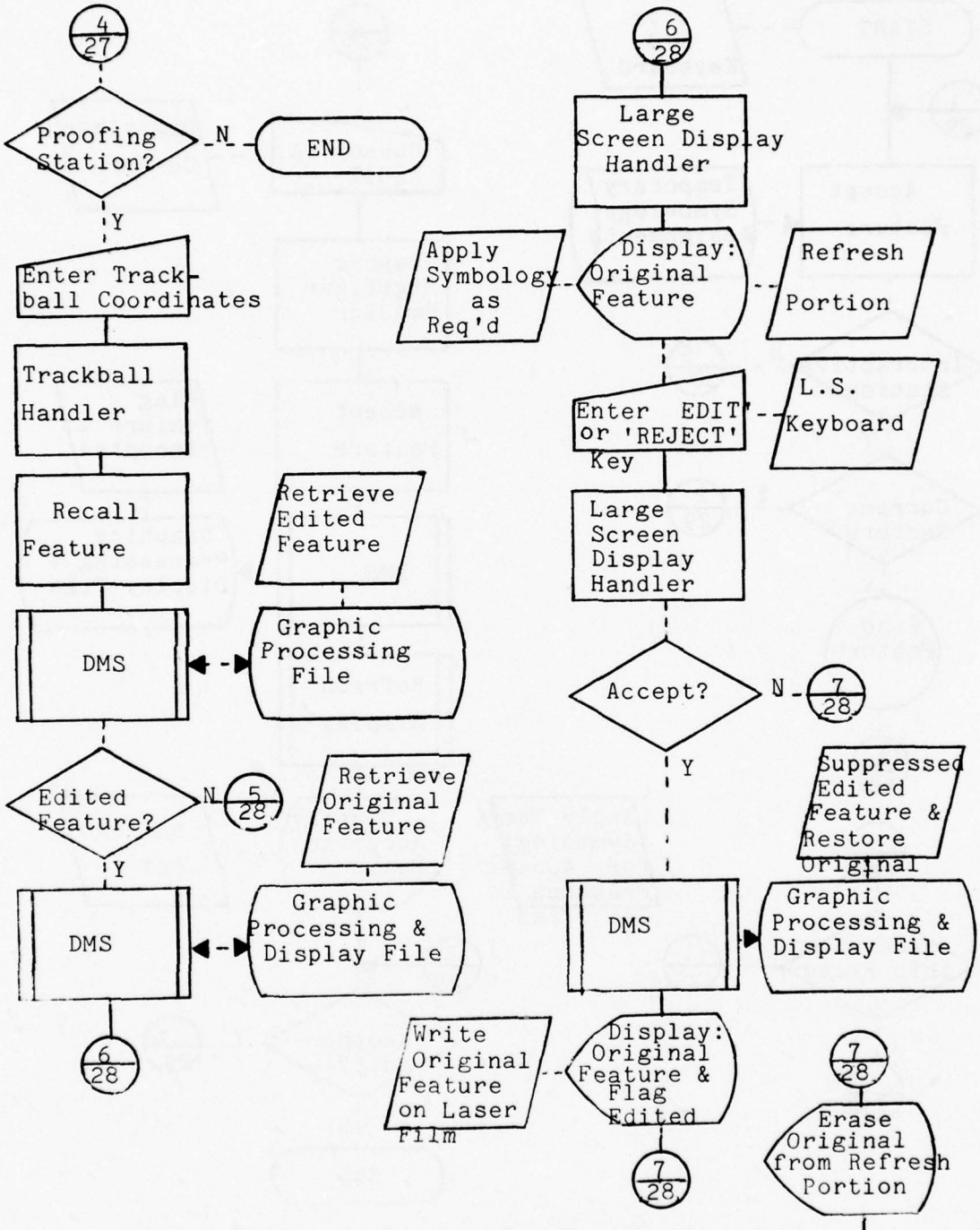


Figure III-25 - Interactive Feature Manipulation - Recall Feature

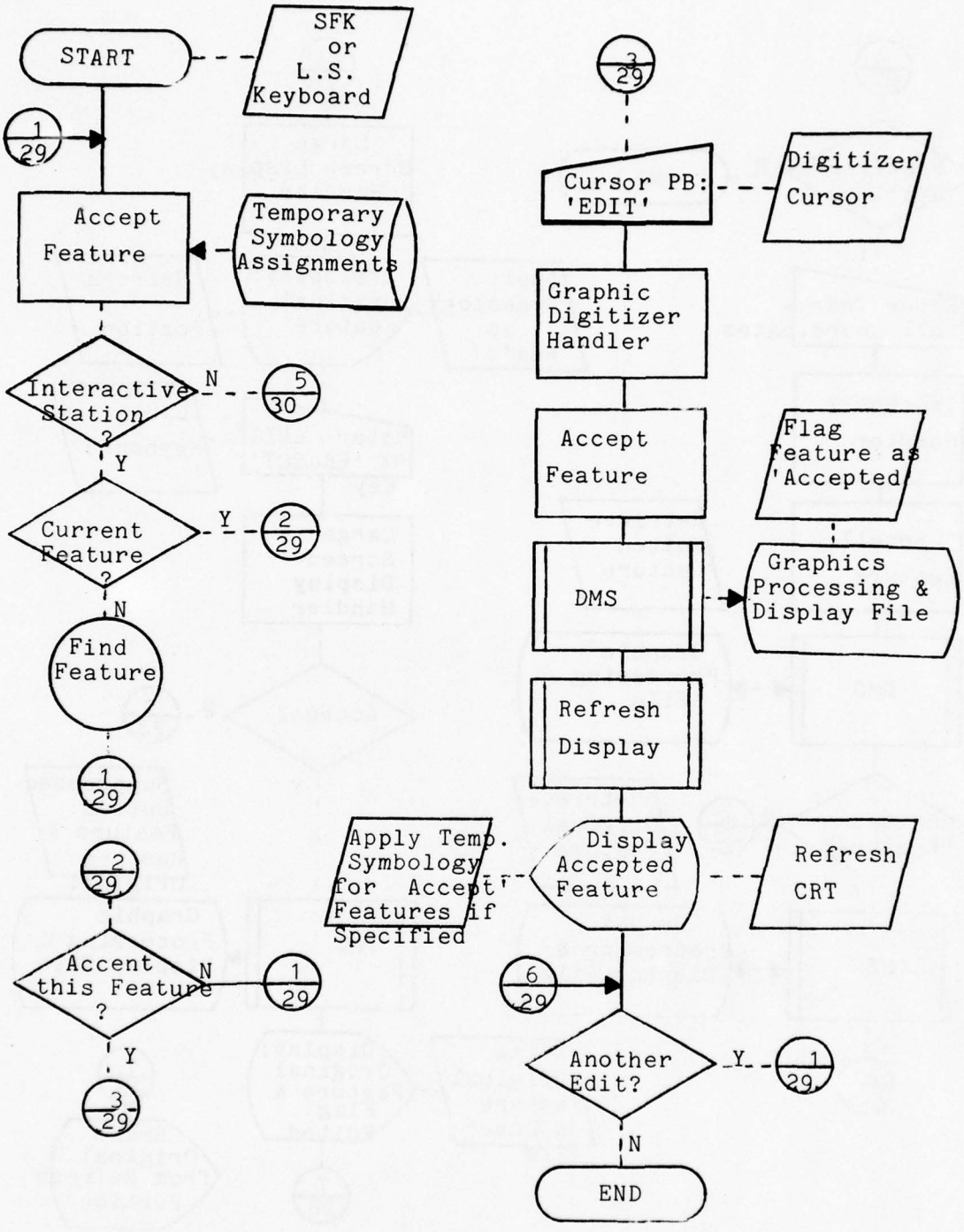


Figure III-25 - Interactive Feature Manipulation
Accept Feature (Page 29 of 30)

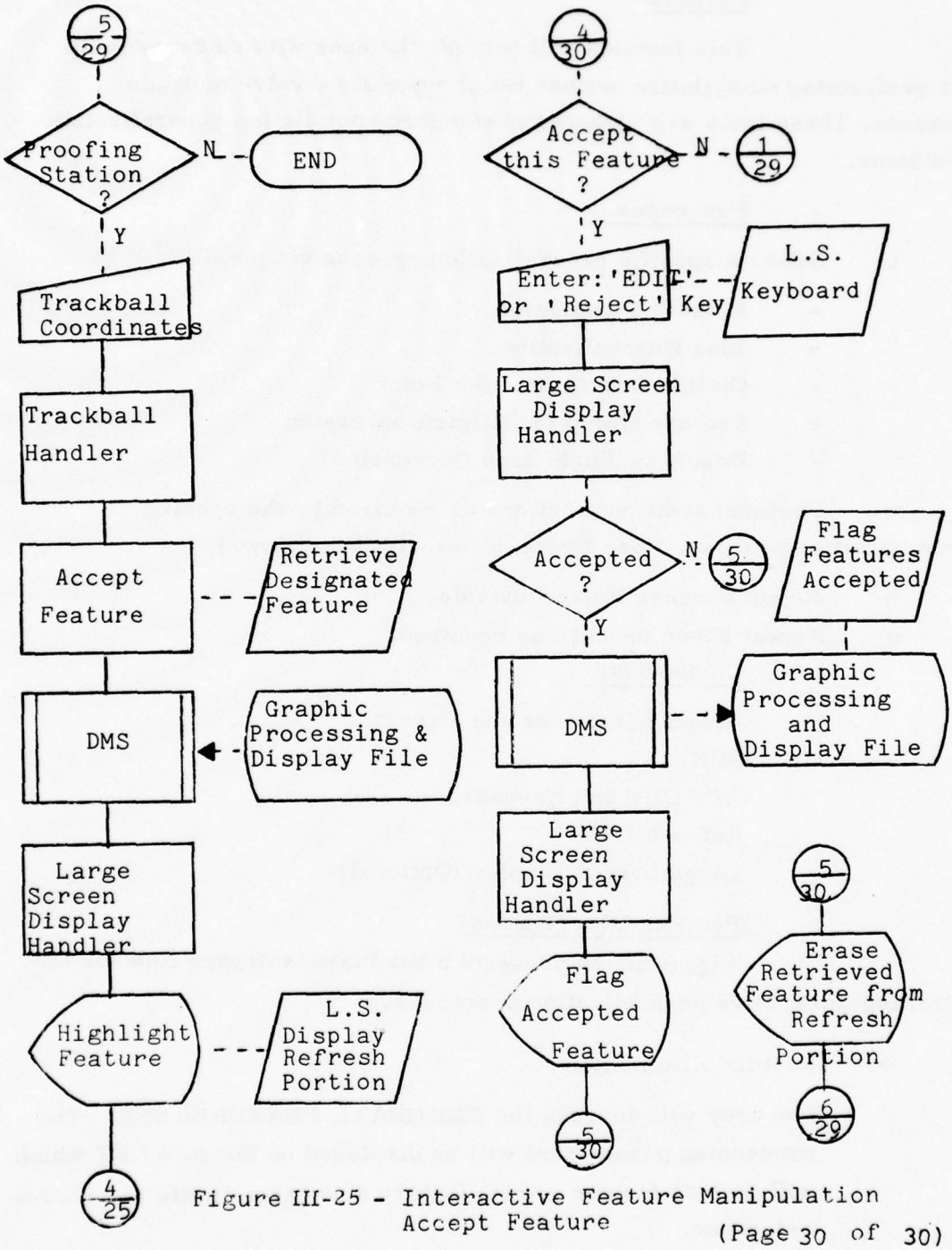


Figure III-25 - Interactive Feature Manipulation
Accept Feature

(Page 30 of 30)

g. Interactive Generalization

Purpose

This function will provide the user with software tools for performing compilation actions which typically involve multiple features. These tools are directed at standard compilation generalization problems.

Processes

- o Select a specific generalization process via the SFK.
  - Feature Elimination
  - Line Generalization
  - Outline Conversion to a Point
  - Feature Group to Outline Conversion
  - Double to Single Line Conversion
- o Perform additional actions as required by the specific generalization process. (See Process Descriptions below.)
- o Reject process if unacceptable.
- o Repeat above process as required.

Components

Graphic Digitizer and Cursor
SFK
A/N CRT and Keyboard
Refresh CRT
Large Screen Display (Optional)

Process Descriptions

Figure III-26 presents a hardware/software flow for the following interactive generalization processes.

- o Feature Elimination

  The user will depress the ELIMINATE FEATURES SFK. The processing parameters will be displayed on the A/N CRT which will include feature group, feature size, area limits and source reference.

The user can modify any of the parameter values via the A/N CRT and associated cursor devices. The user can selectively eliminate feature subsets based on feature groups, sub-area, and/or feature size. The feature groups will be defined via the A/N CRT as any subset of the currently displayed features. The feature size is intended to include length or area definitions. The defined area, if other than the total display area, will be cursor defined by the user as any polygon and will be displayed for user verification. Following verification of the parameter values the user will depress the EDIT cursor key and the feature(s) to be eliminated will be highlighted or appear with special temporary symbology (if assigned) from the display (or annotated on the Large Screen Display). If the elimination results are acceptable the user will depress the EDIT key again, and the eliminated features will be erased from the display.

- Line Generalization

  The user will depress the LINE GEN SFK. The processing parameters will be displayed on the A/N CRT, including: specific feature, feature group(s), area, and smooth type. The user at the Interactive Work Station can invoke the "specific feature" option and selectively find features, depress the EDIT cursor key, and review the generated line on the Refresh CRT. The same sequence applies to multiple features based on defined feature group(s) and area. The user at the Proofing Station will typically augment a current display or generate a new display of generalized feature lines.

- Conversion of an Outline to a Point

  The user depresses the OUTLINE TO POINT SFK and uses the "Find Feature" service. After graphic verification via the Refresh CRT the computed center point will be displayed. Following acceptance (or continuance to another function) the original outline will be deleted. The user can iterate this process until the working area is completed.

- Feature Group to Outline Conversion

  The user depresses the GROUP TO OUTLINE SFK. The processing parameters will be displayed on the A/N CRT: feature group(s) and area. Normally the user will modify the area parameters by digitizing the area outline, after which the interior features of the defined feature group can be deleted from the display by depressing the EDIT cursor key. If the area outline was requested to be maintained as a feature the user can select/modify the header for a new outline feature.

- Double to Single Line Conversion

  The user depresses the DOUBLE TO SINGLE LINE SFK and locates two features via the Find Feature Process. Each feature is highlighted on the Graphic Refresh CRT. If the double line conversion is less than the full feature, the user via the POINT cursor key, then defines endpoints of the desired conversion. The user depresses the EDIT cursor key and the computed center line representation for the defined length is displayed. The user can reject the conversion which results in only the original lines being displayed. The new center line feature is actually augmented to the first feature located.

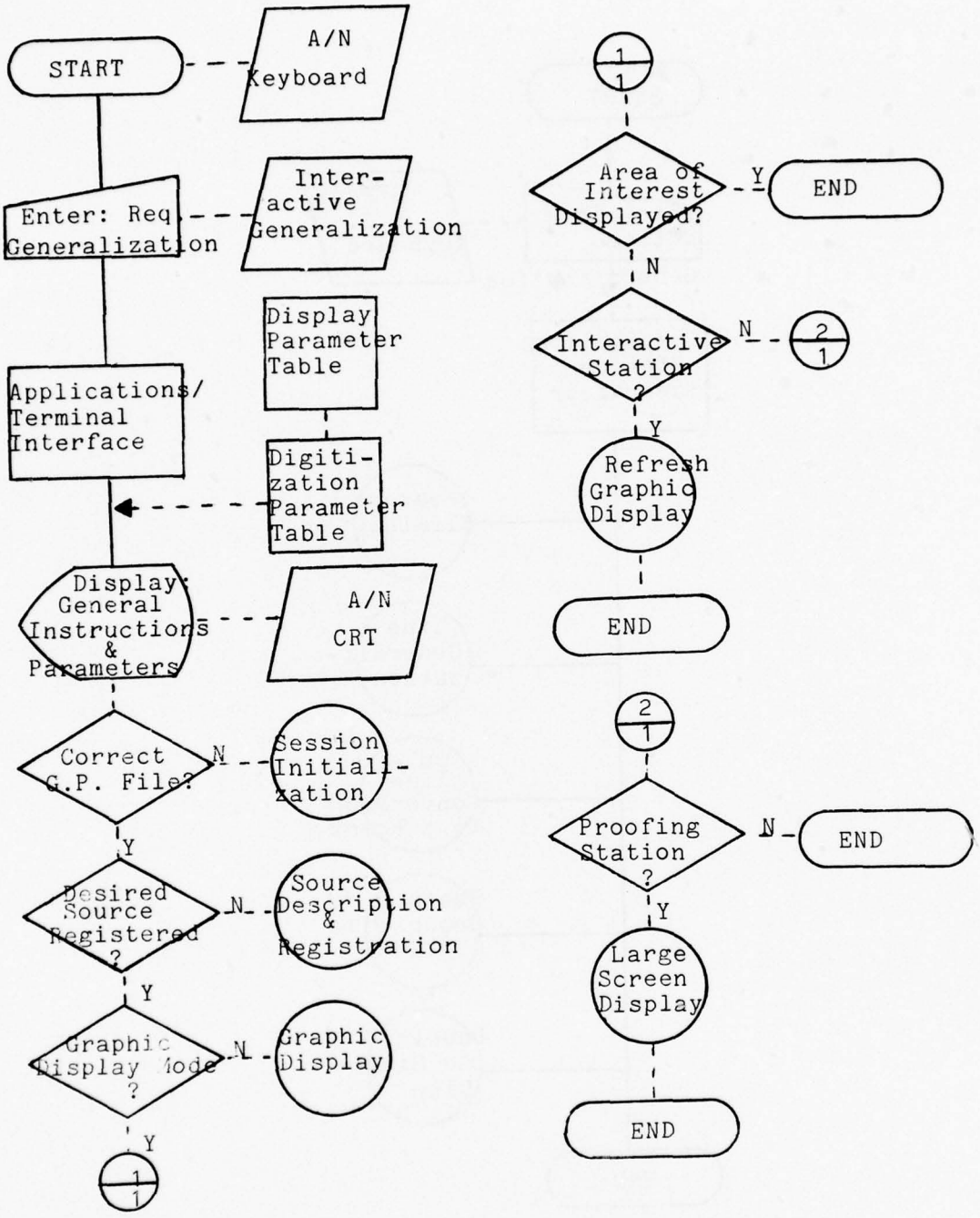


Figure III-26 - Interactive Generalization
(Page 1 of 16)

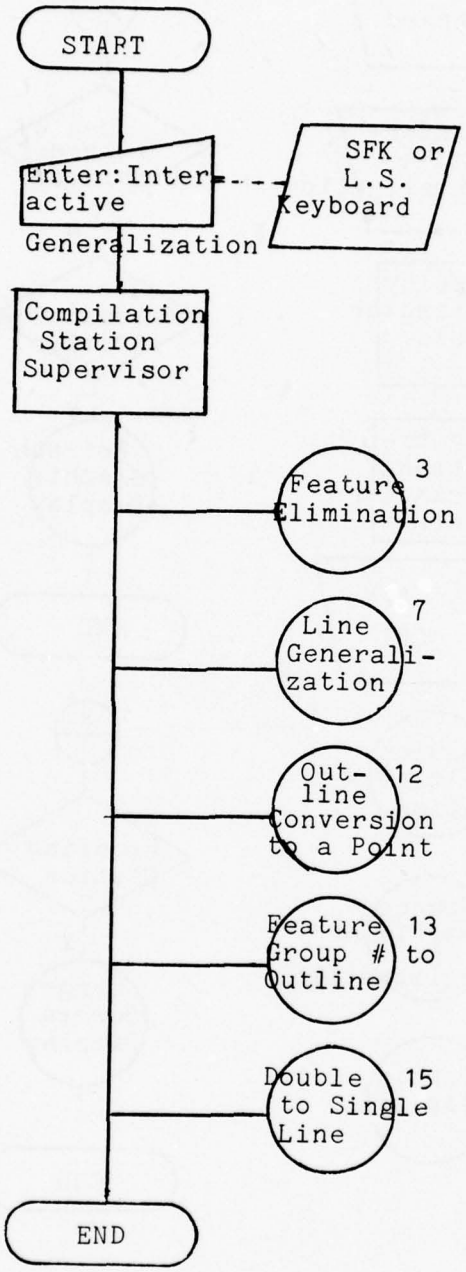


Figure III-26 - Interactive Generalization
(Page 2 of 16)

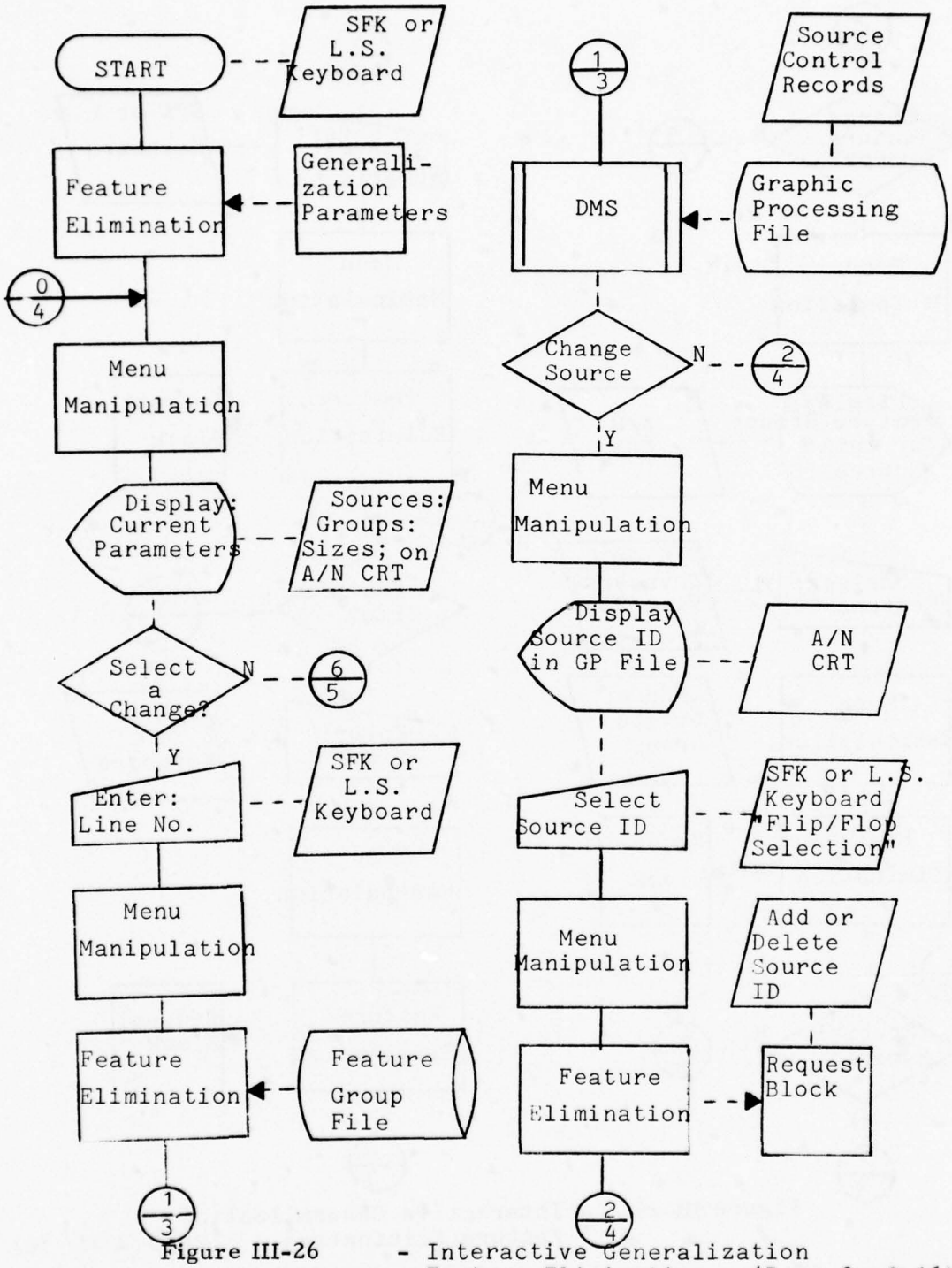


Figure III-26 - Interactive Generalization Feature Elimination (Page 3 of 16)

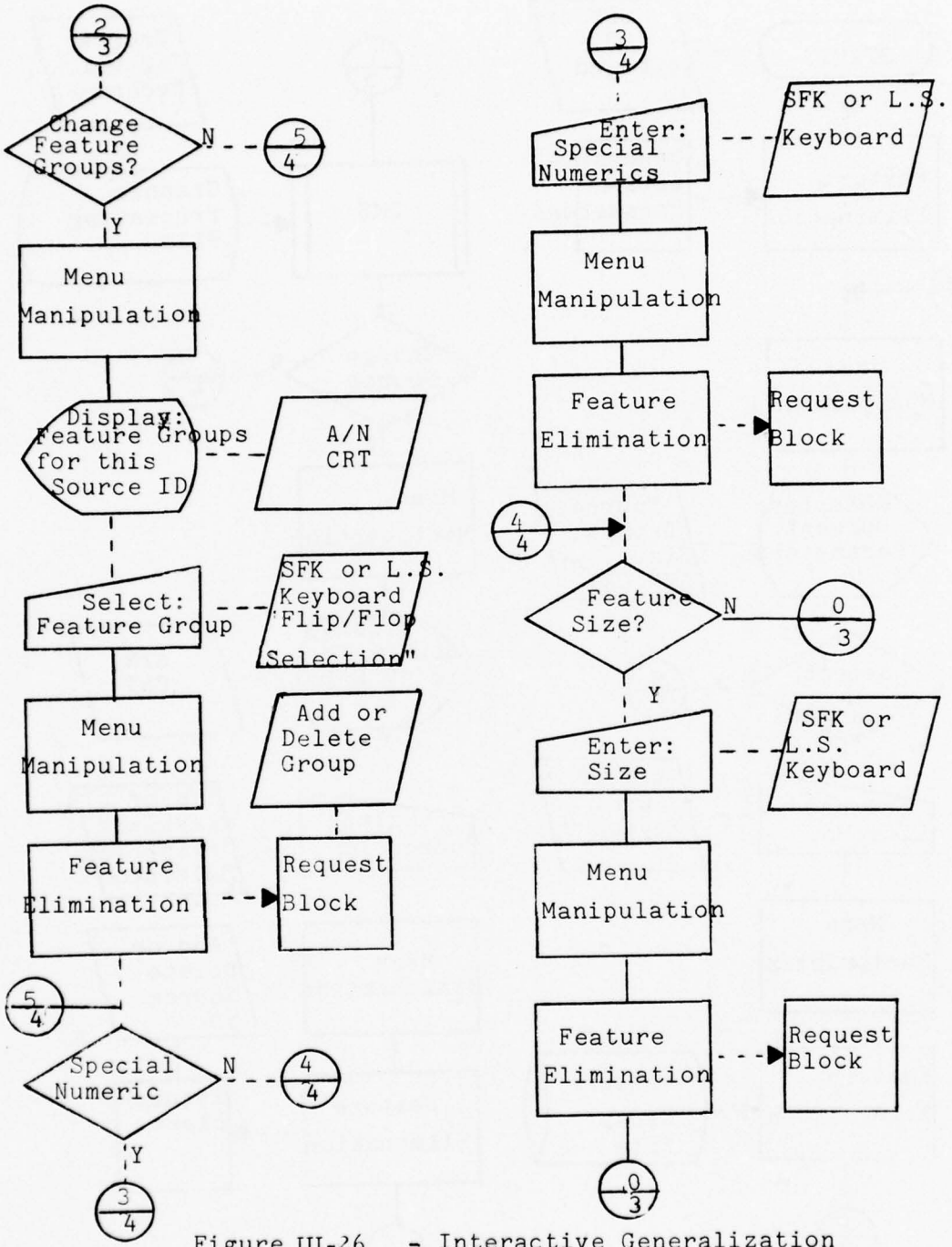


Figure III-26 - Interactive Generalization
Feature Elimination (Page 4 of 16)

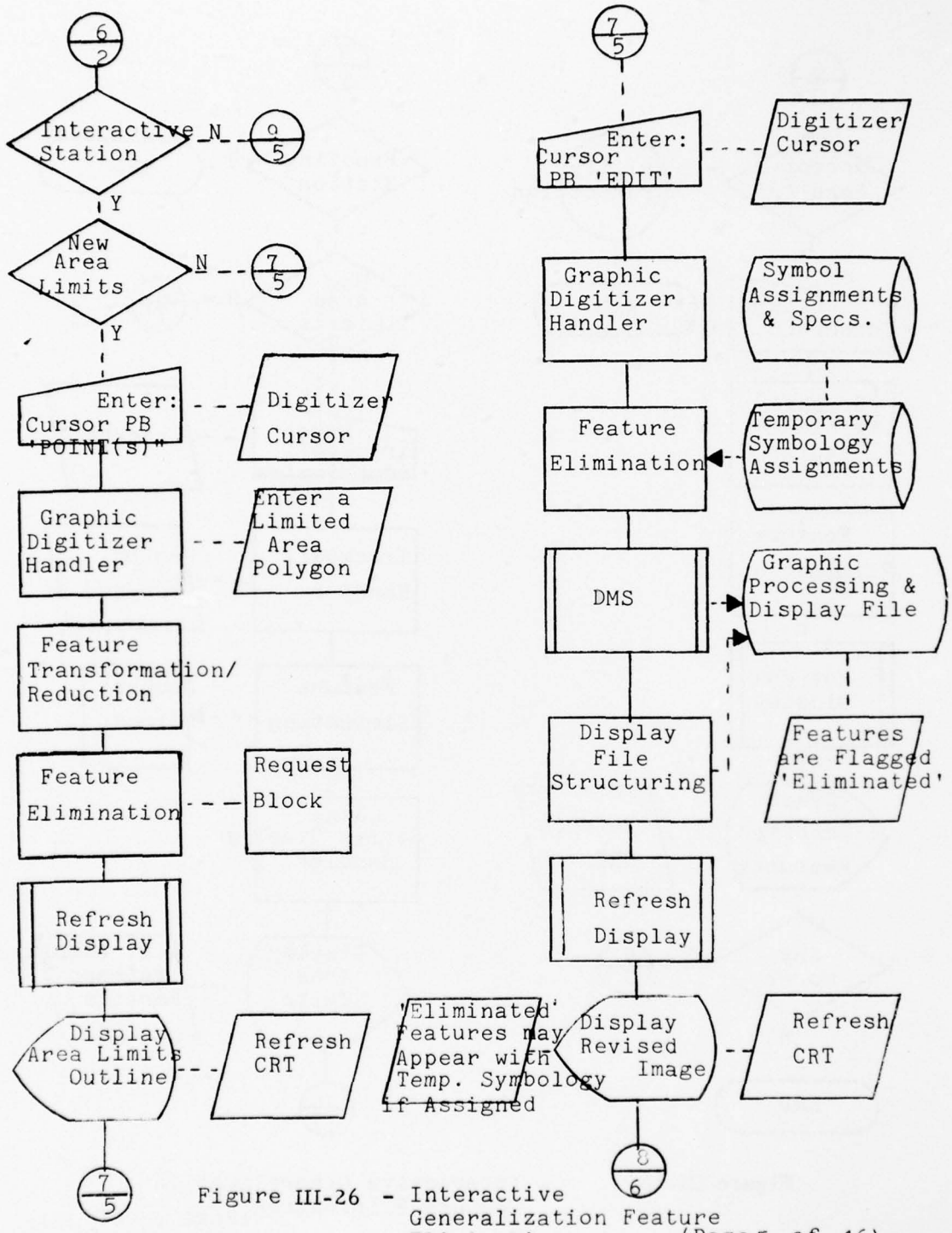


Figure III-26 - Interactive Generalization Feature Elimination (Page 5 of 16)

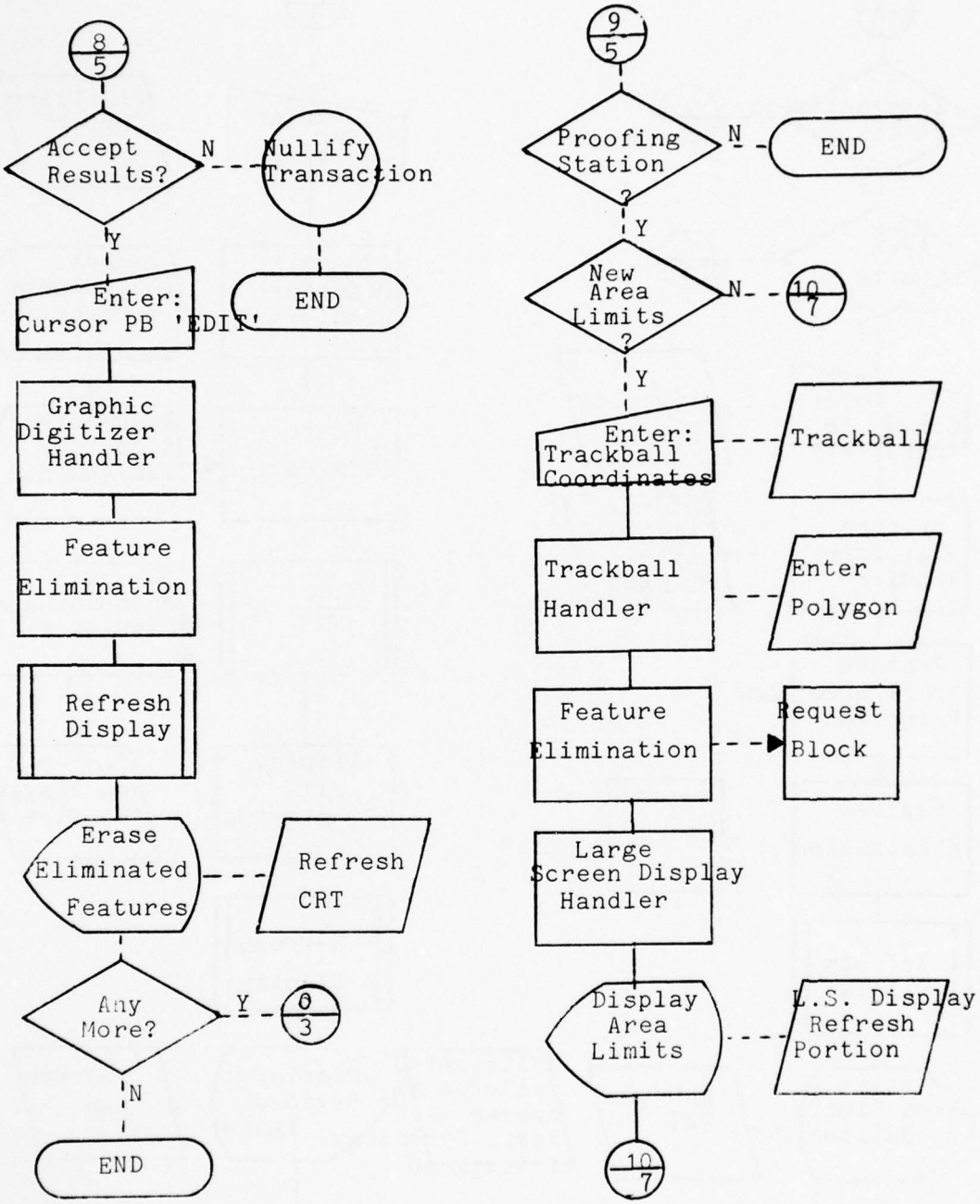


Figure III-26 - Interactive Generalization Feature Elimination (Page 6 of 16)

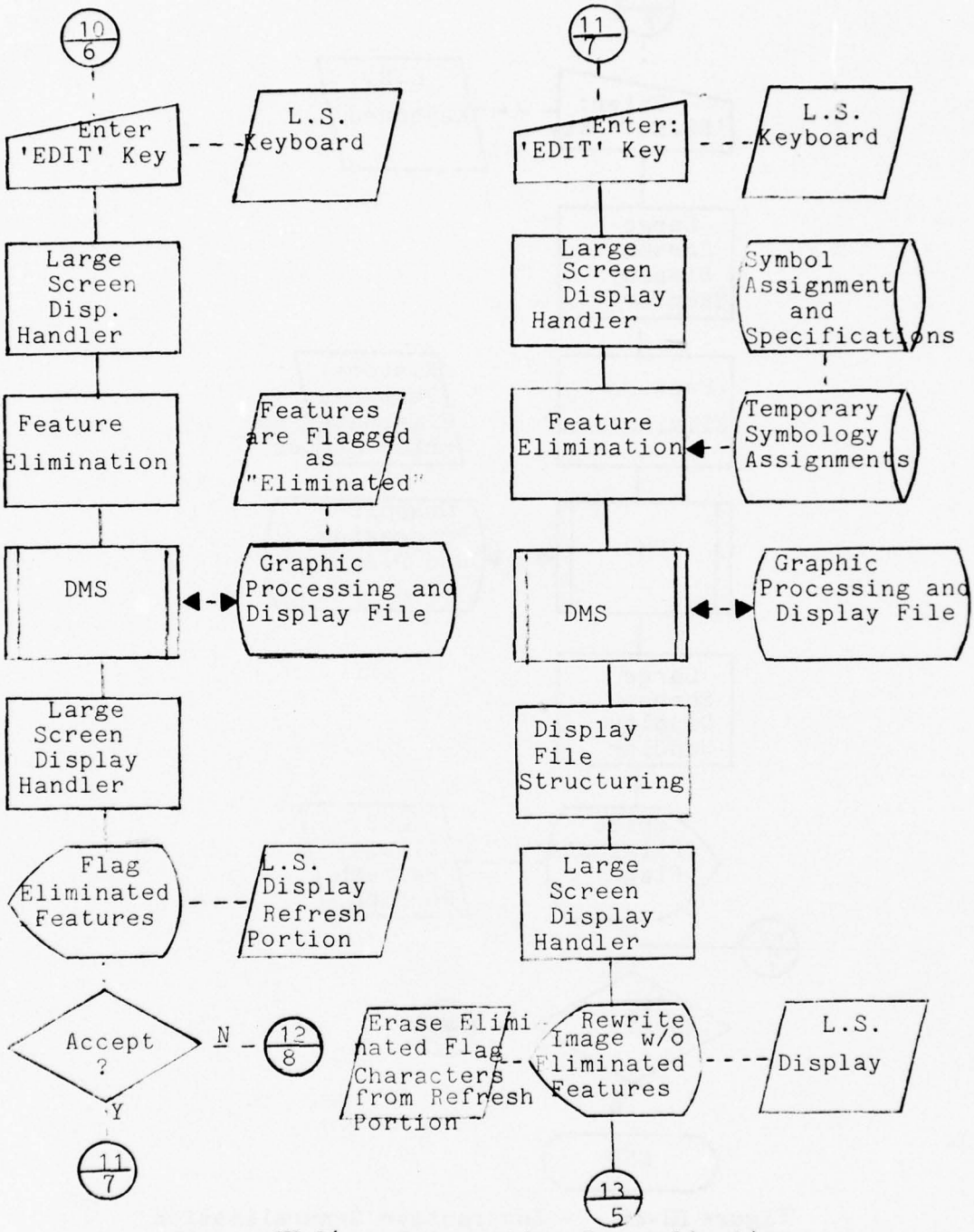


Figure III-26 - Interactive Generalization
Feature Elimination (Page 7 of 16)

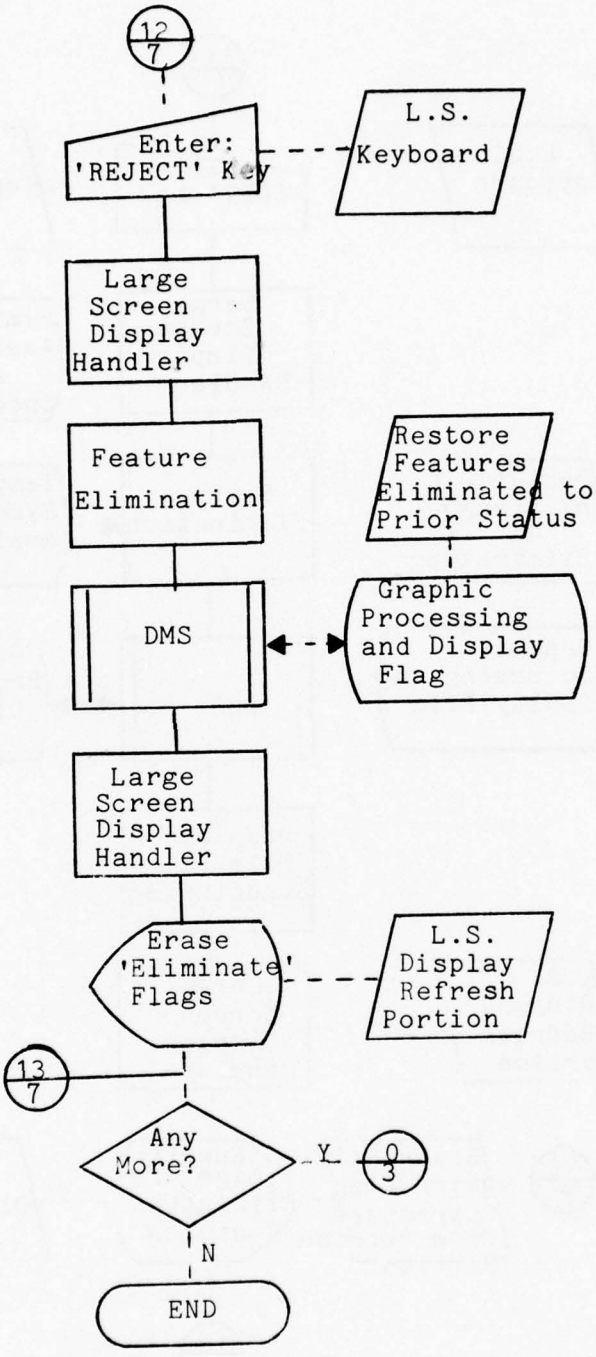


Figure III-26 - Interactive Generalization
Feature Elimination
(Page 8 of 16)

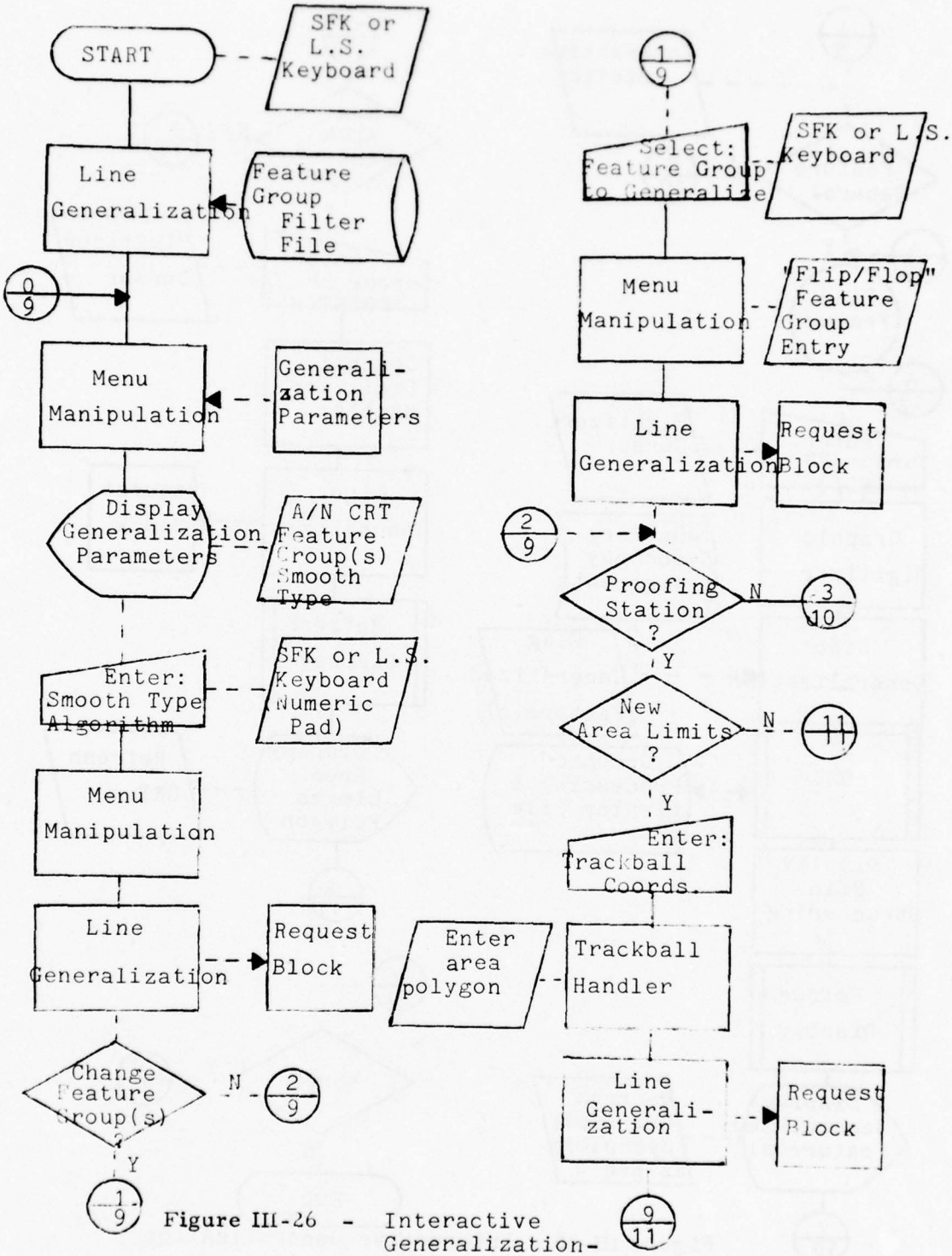


Figure III-26 - Interactive Generalization- Line Generalization (Page 9 of 16)

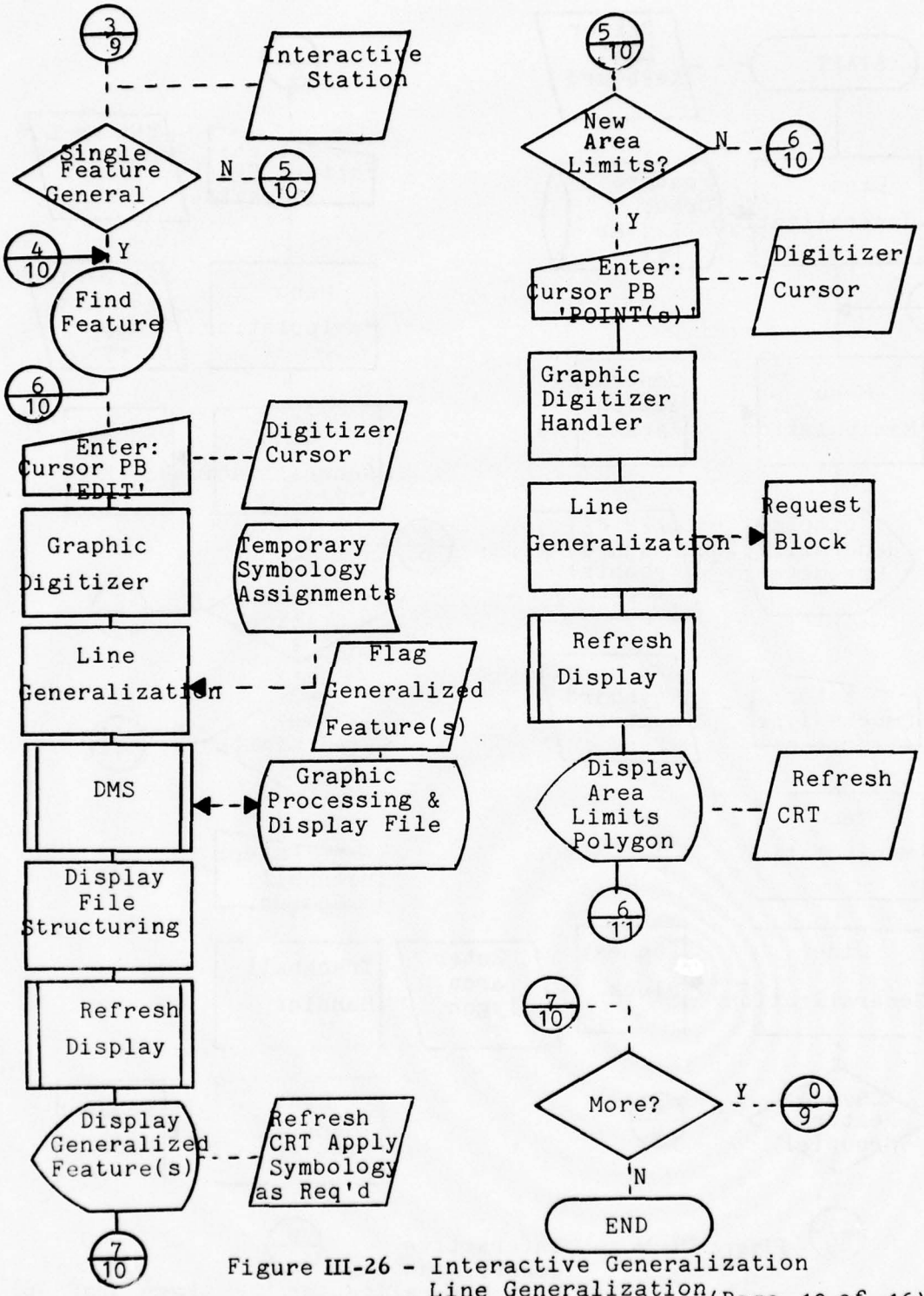


Figure III-26 - Interactive Generalization
Line Generalization (Page 10 of 16)

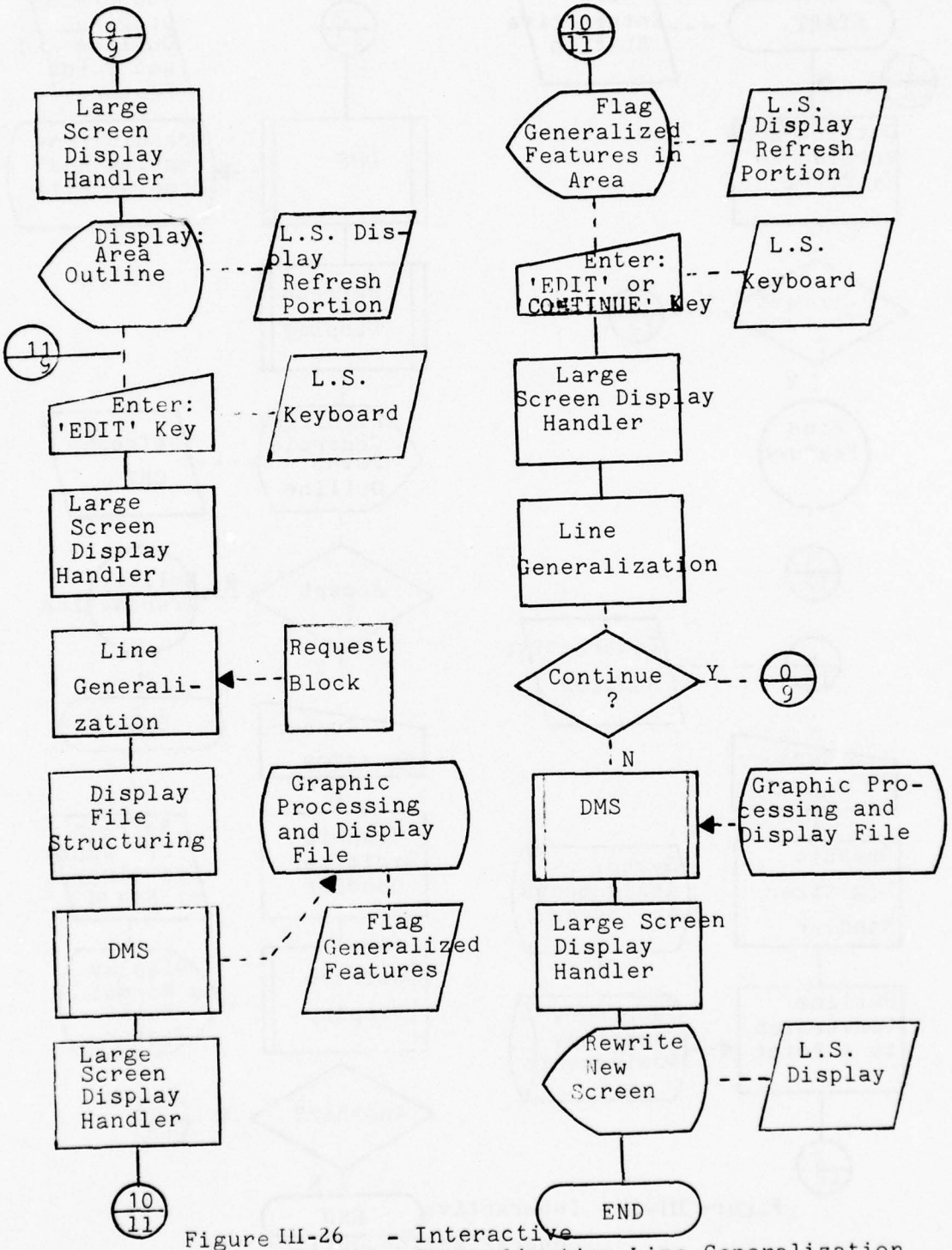


Figure III-26 - Interactive Generalization-Line Generalization (Page 11 of 16)

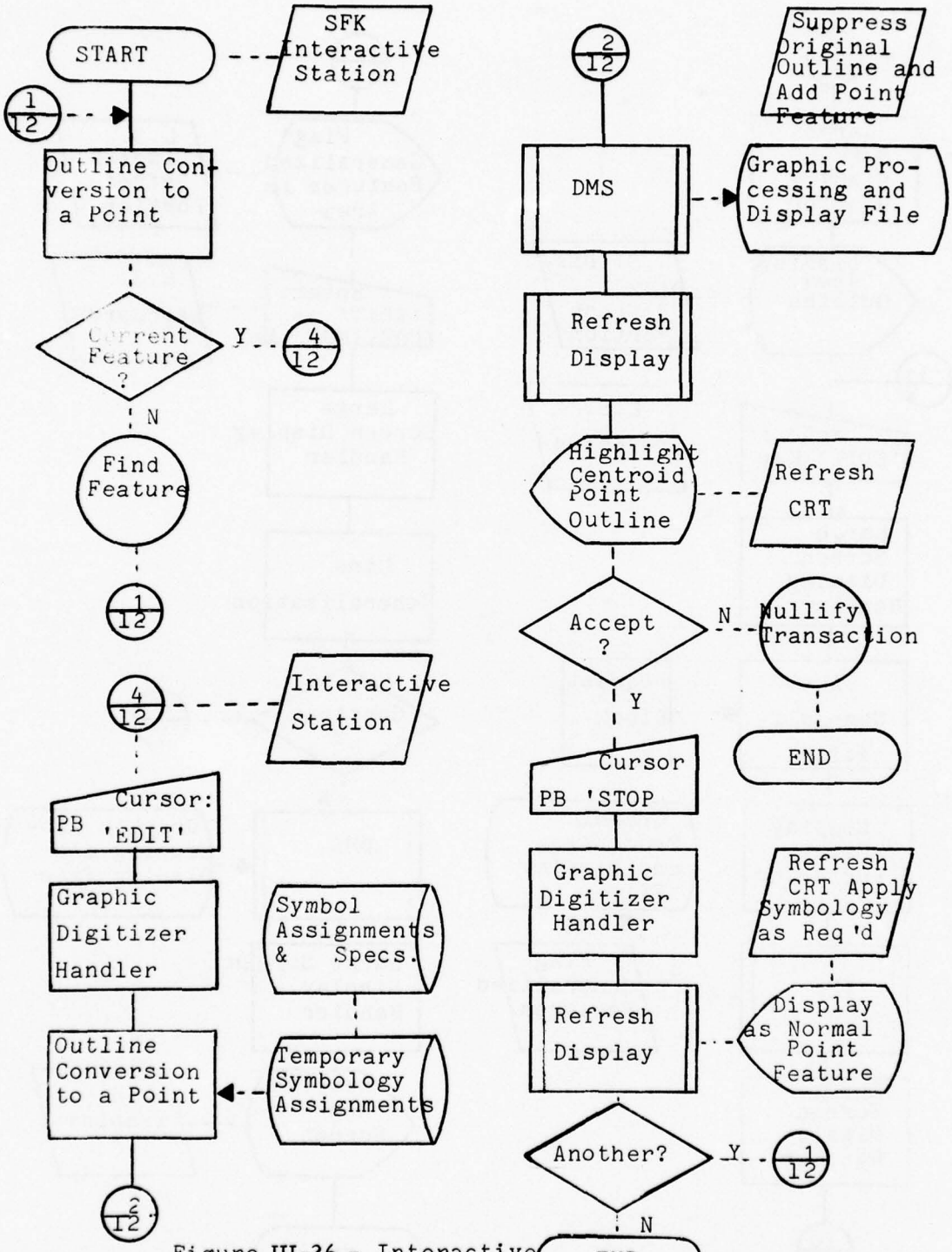


Figure III-26 - Interactive Generalization-Outline Conversion to Point (Page 12of 16)

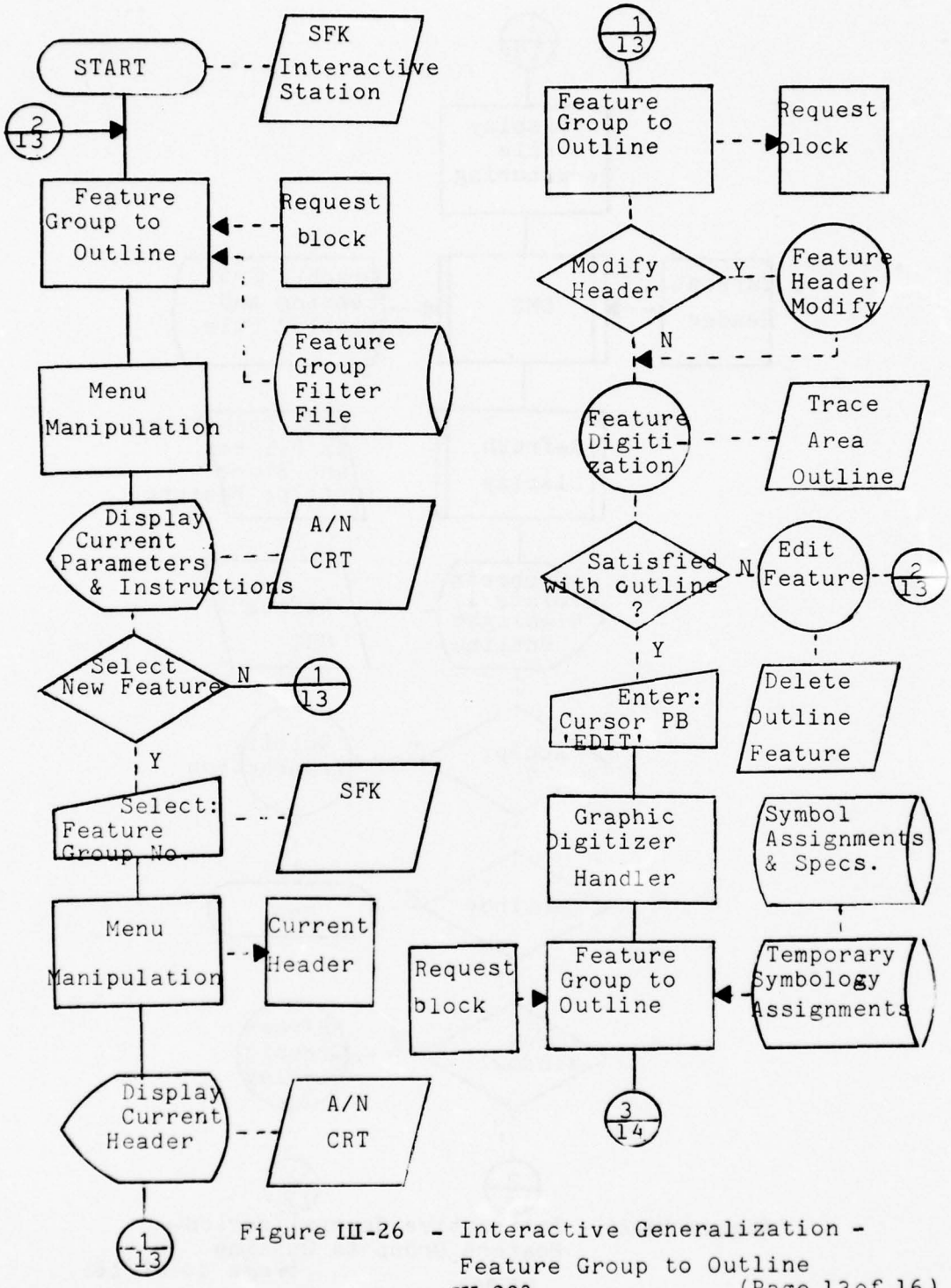


Figure III-26 - Interactive Generalization - Feature Group to Outline

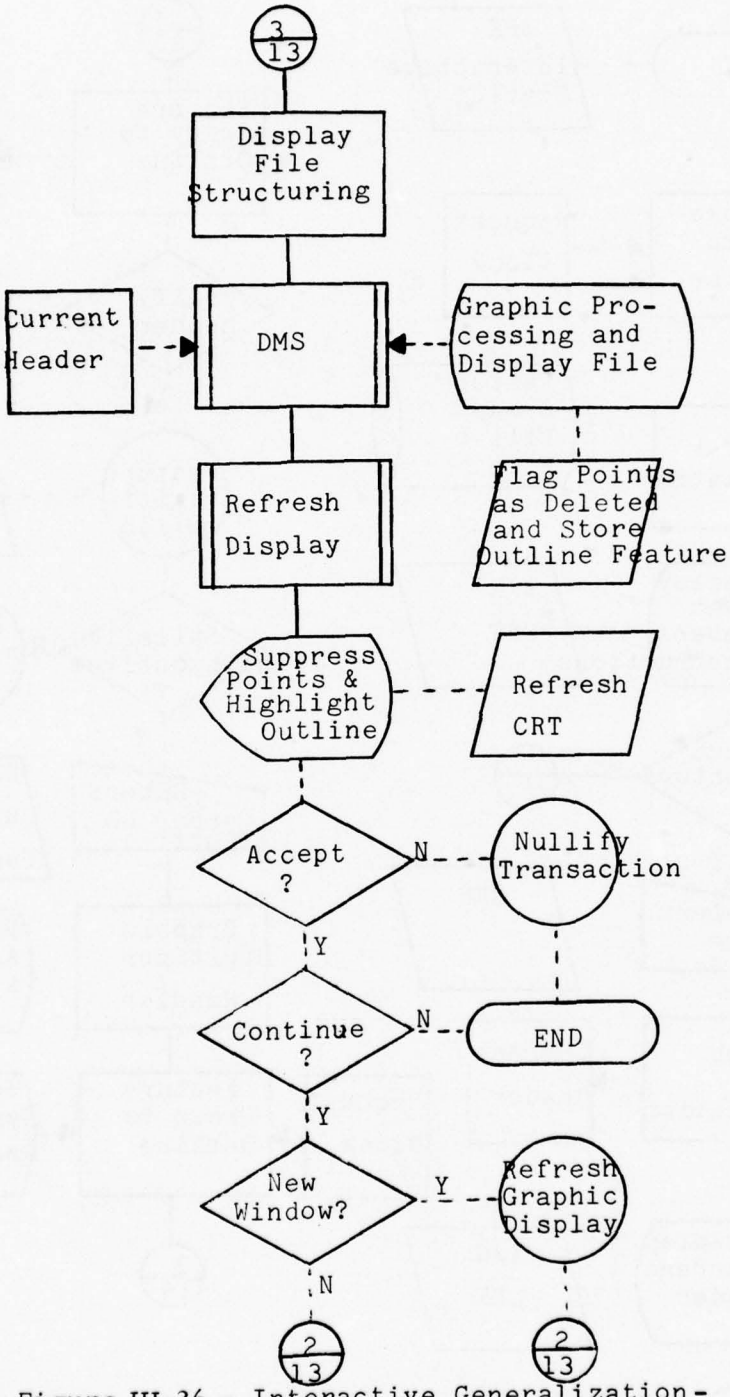


Figure III-26 - Interactive Generalization - Feature Group to Outline

(Page 14 of 16)

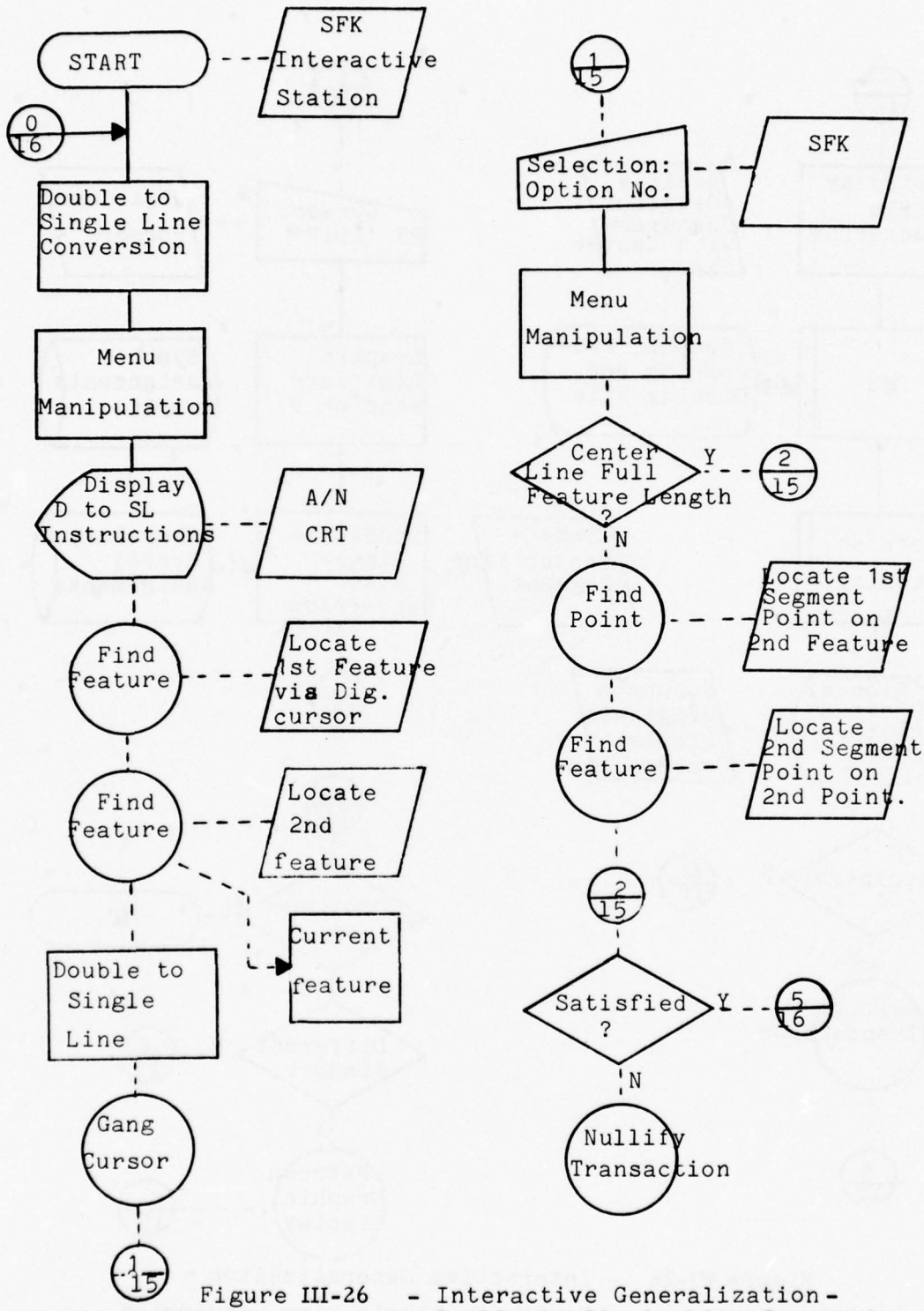


Figure III-26 - Interactive Generalization - Double to Single Line Conversion

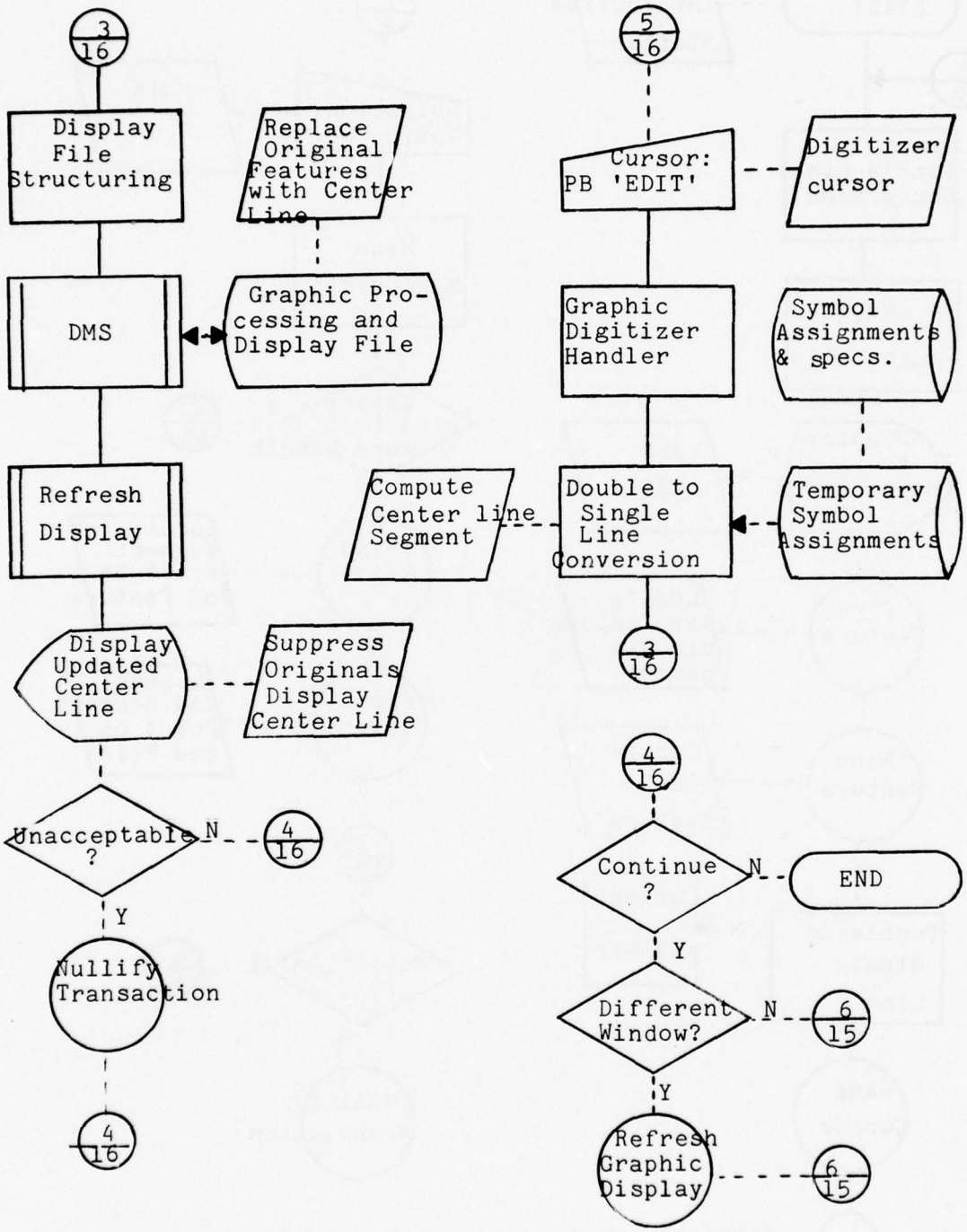


Figure III-26 - Interactive Generalization - Double to Single Line Conversion (Page 16 of 16)

h. Alphanumeric Text Placement

Purpose

This function will allow the user to display the name of a current feature, enter and position names and annotations, and flag features for selection on the names overlay compilation.

Processes

- o Display Name and Annotation
- o Move Names
- o Select Names

Components

Refresh CRT
Graphic Digitizer/Cursor
A/N CRT and Keyboard
SFK
Large Screen Display Device/Trackball

Process Description

The user depresses the NAMES PLACEMENT SFK. Using the Find Feature Service, the name of any located feature will be displayed on the Refresh CRT or Large Screen Display Device (Refresh mode). The user can use the A/N CRT to enter new alphanumerics or modify any current text. Standard names positioning will be initially applied to the text string. These rules will be based on feature group and feature representation (i.e., point, line, area). The baseline for the displayed text is viewed as a unique feature line by the system and can be manipulated by the MOVE NAMES SFK. The user can use the Find Point Service to translate the text string (1st point) or rotate the text string (2nd point).

The user can enter a new annotation on the system by entering a new text string at the A/N CRT keyboard. The user then positions the cursor to the desired start location, depresses the EDIT key, and the text is immediately displayed in a standard position.

The user can now use the MOVE NAMES Process to further position the text string.

The user can indicate that a particular feature is selected for naming on the final compilation by depressing the SELECT NAMES SFK. While the SELECT NAMES is activated any "current feature" will be properly flagged. Figure III-27 presents a description of the hardware/software flow for text placement processes.

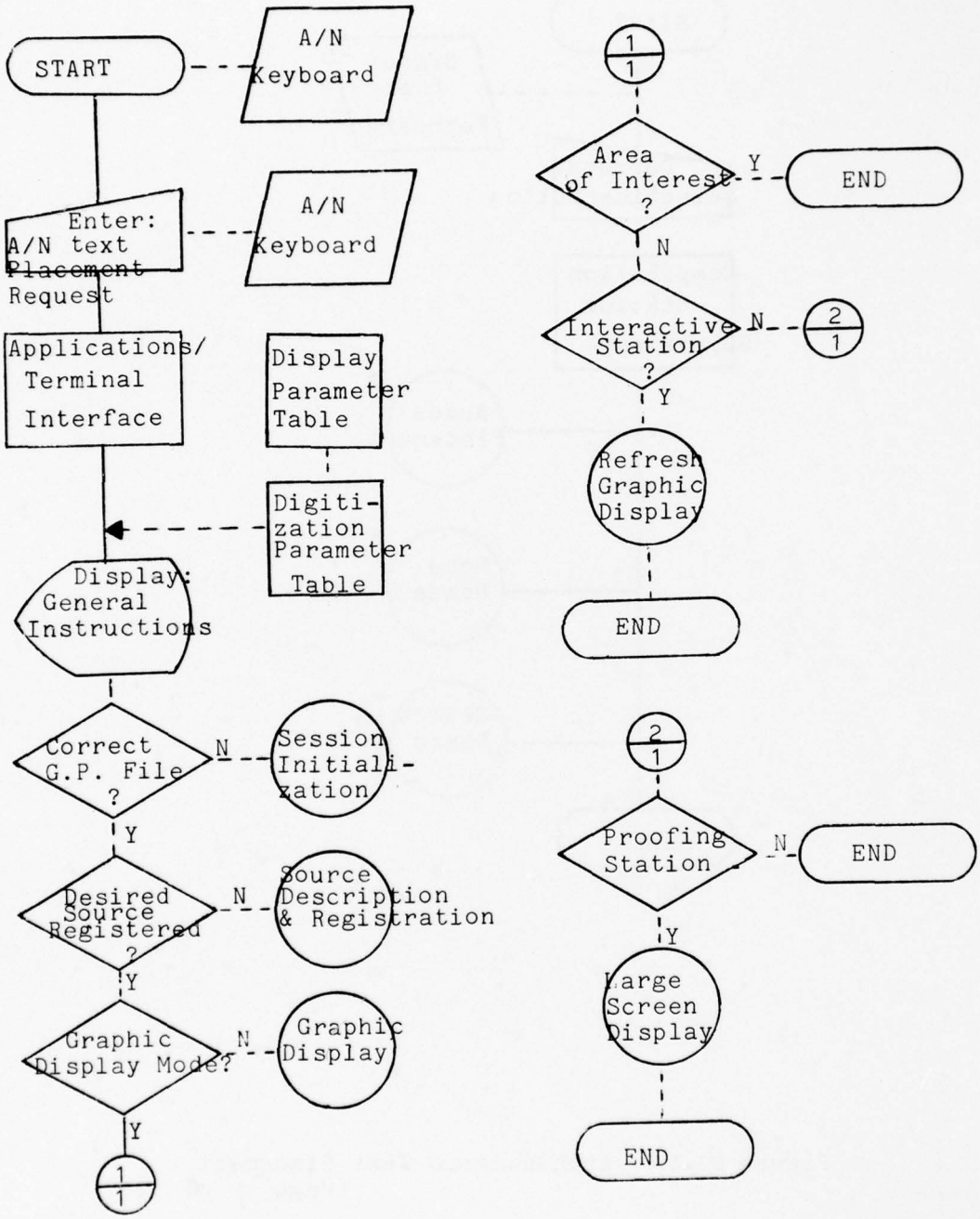


Figure III-27 - Alphanumeric Text Placemamt
(Page 1 of 14)

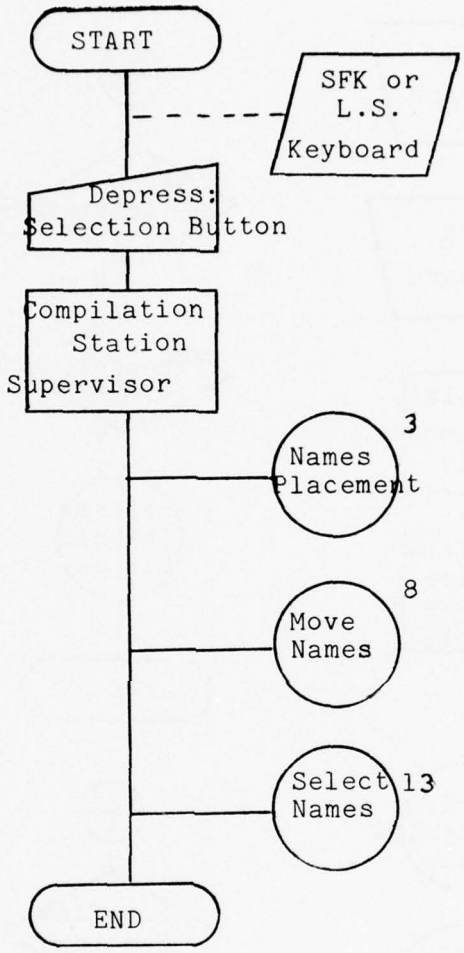


Figure III-27 - Alphanumeric Text Placement
(Page 2 of 14)

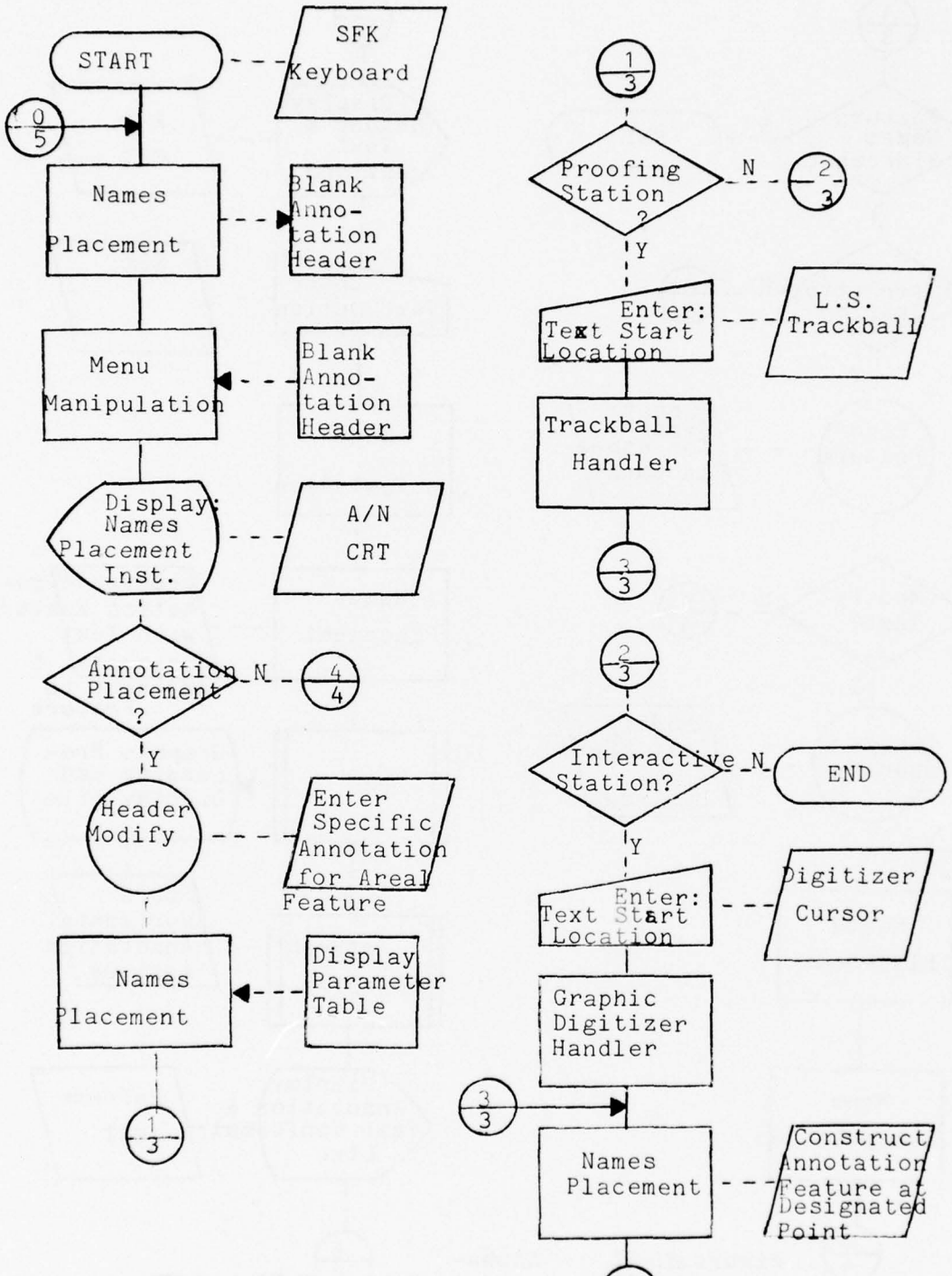


Figure III-27 - Alphanumeric Text Placement - Names Placement (Page 3 of 14)

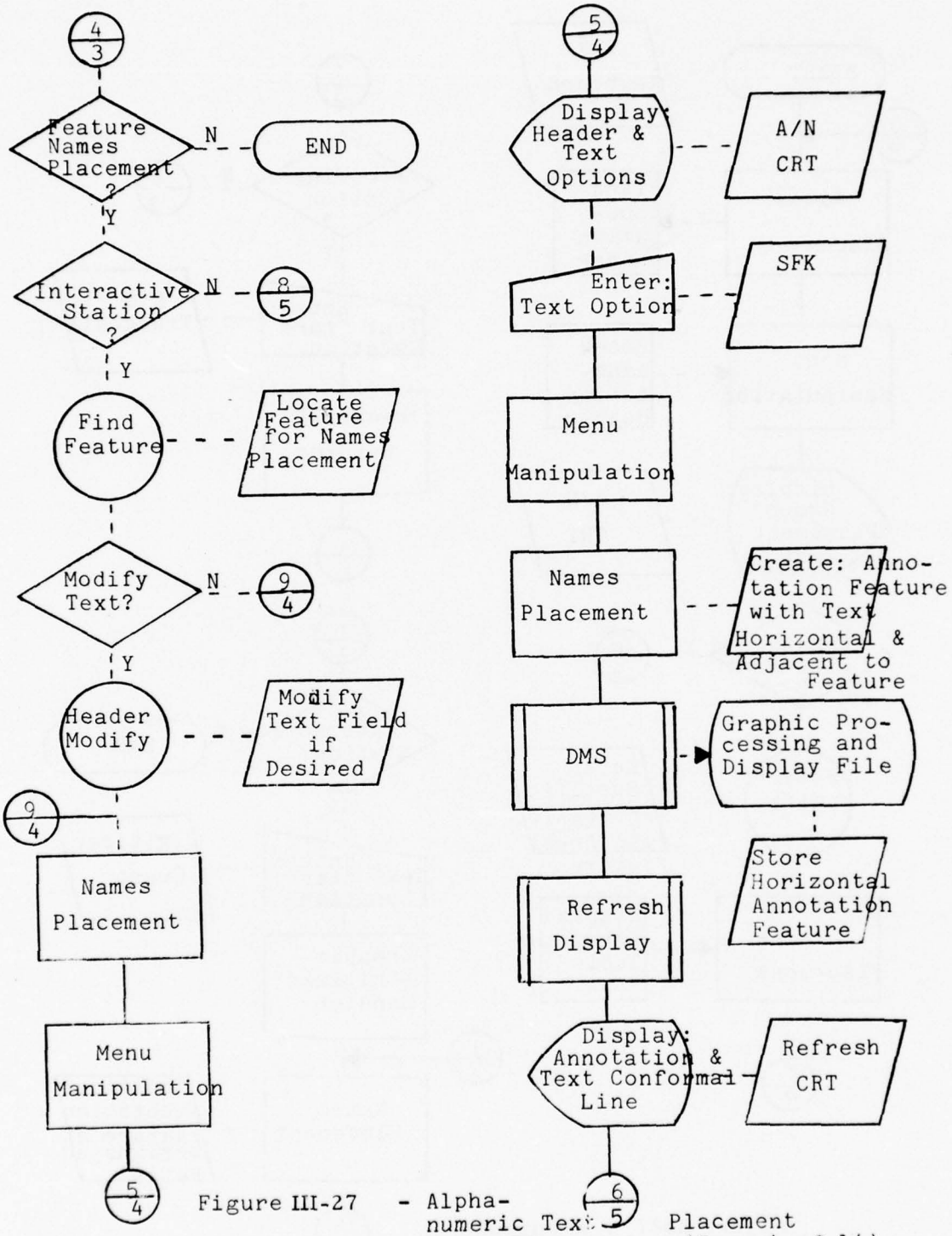


Figure III-27 - Alpha-numeric Text Placement Names Placement (Page 4 of 14)

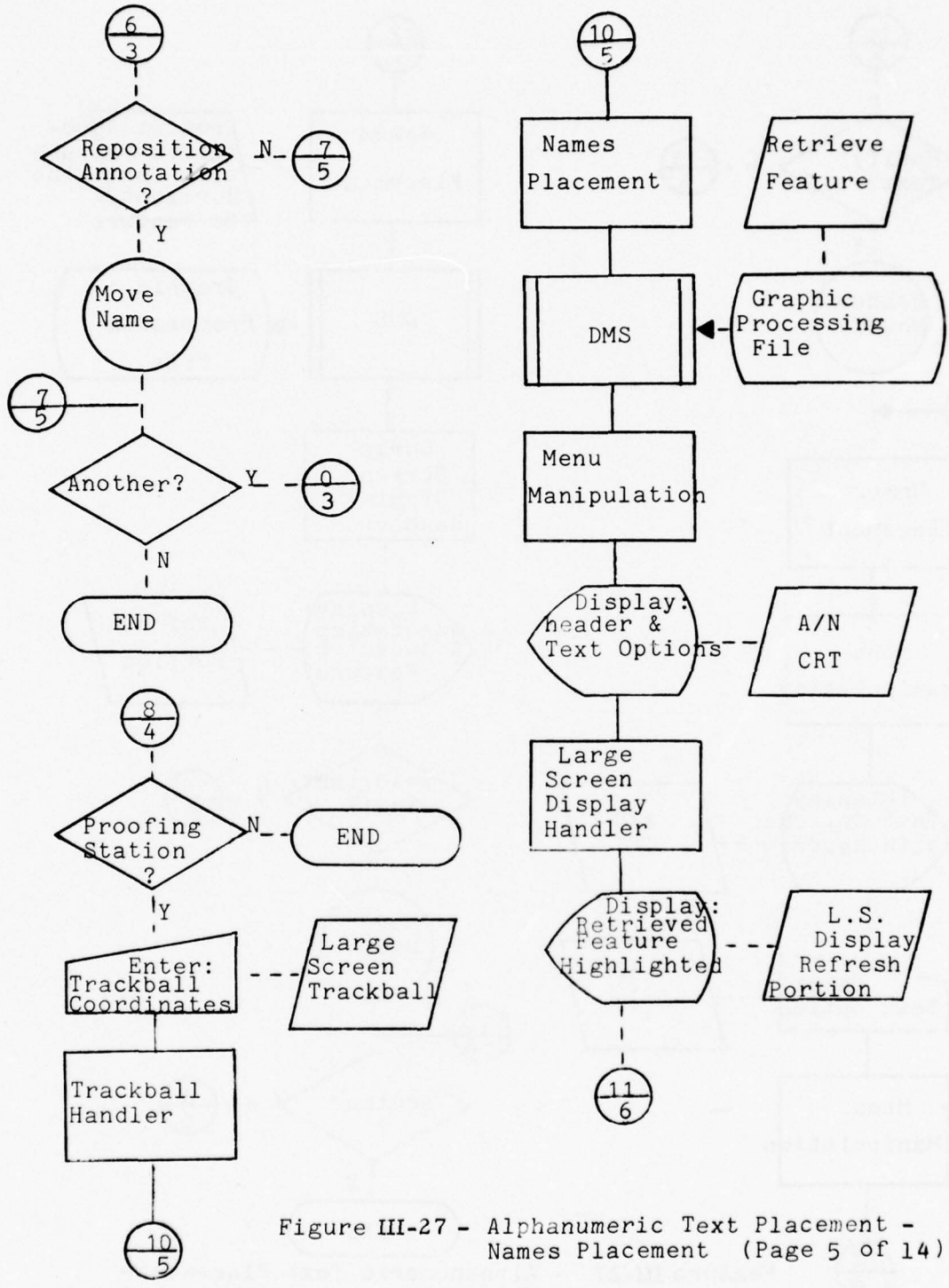
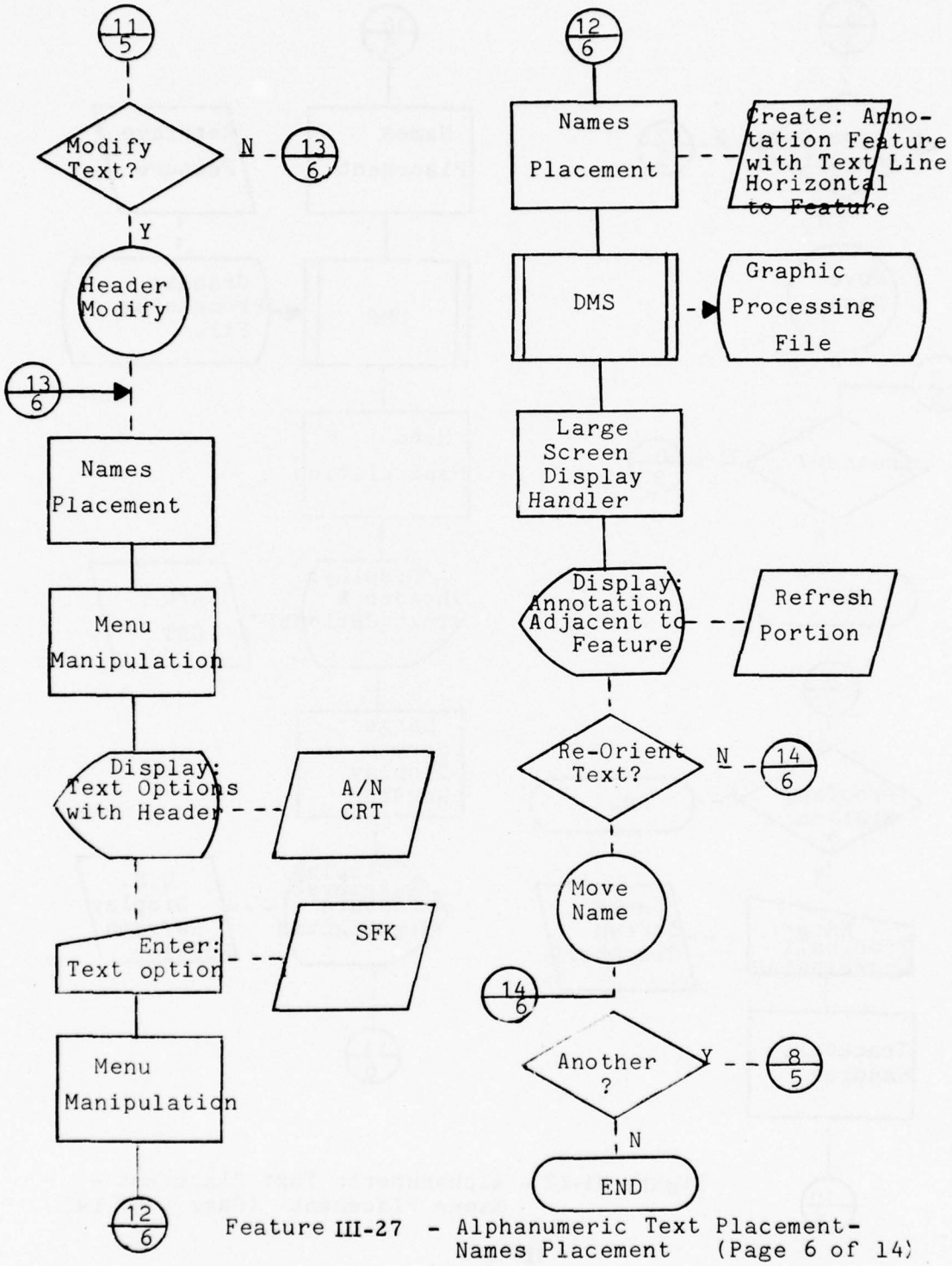


Figure III-27 - Alphanumeric Text Placement - Names Placement (Page 5 of 14)



Feature III-27 - Alphanumeric Text Placement-
Names Placement (Page 6 of 14)

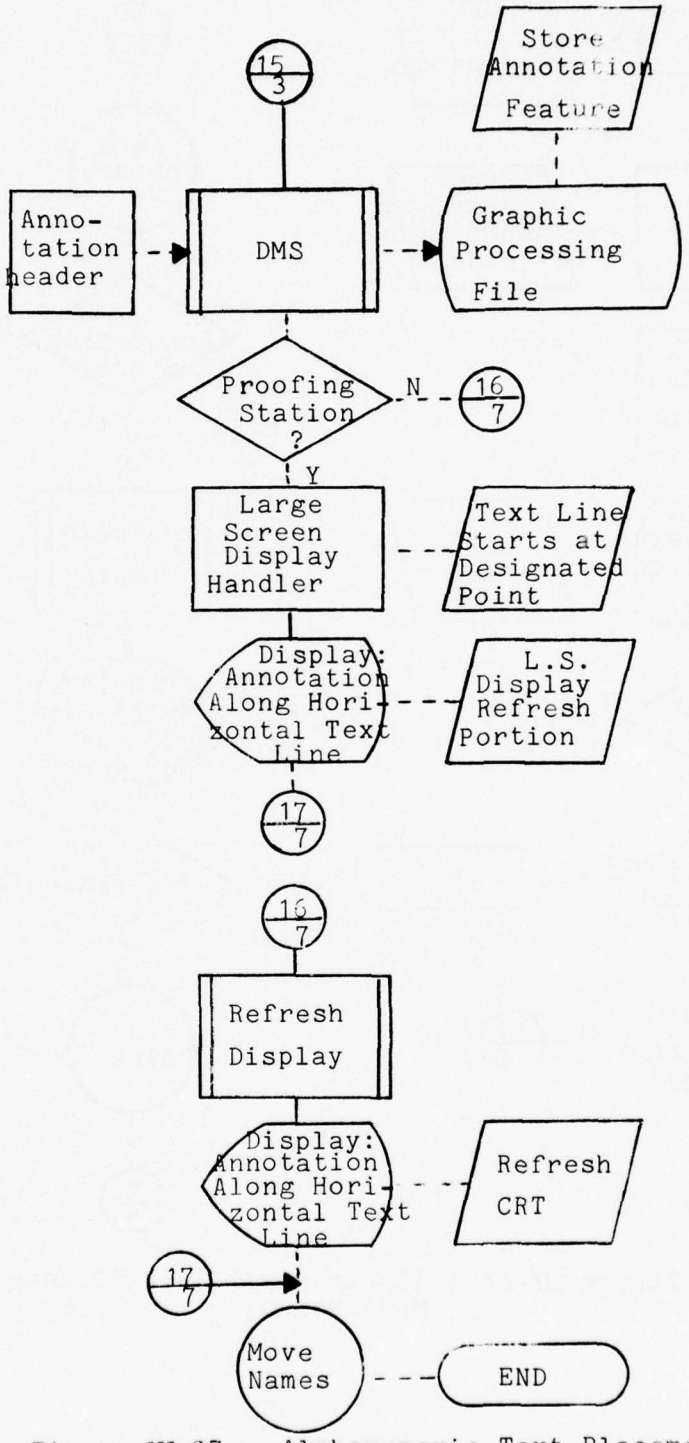


Figure III-27 - Alphanumeric Text Placement-Names Placement (Page 7 of 14)

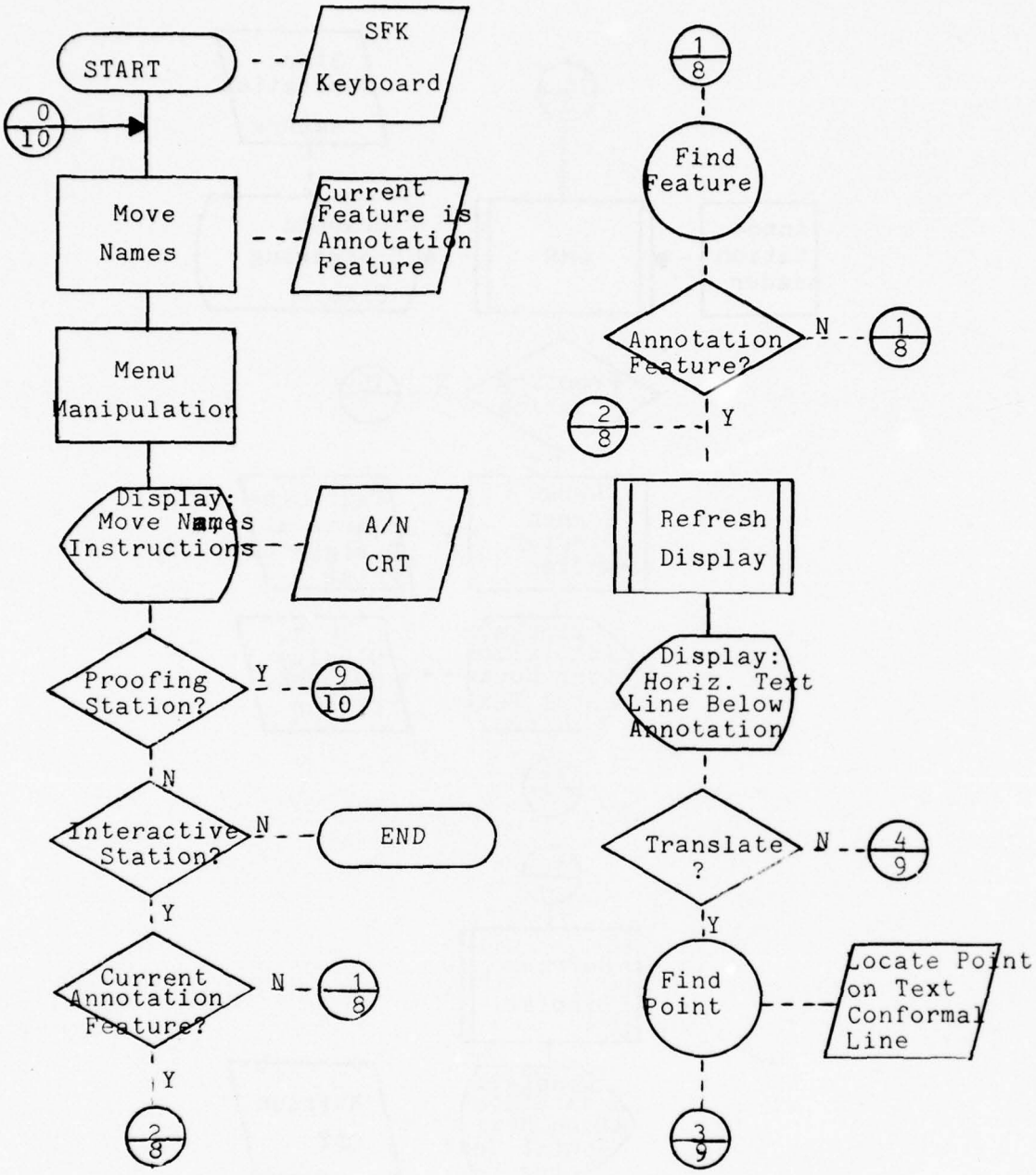


Figure III-27 - Alphanumeric Text Placement - Move Names (Page 8 of 14)

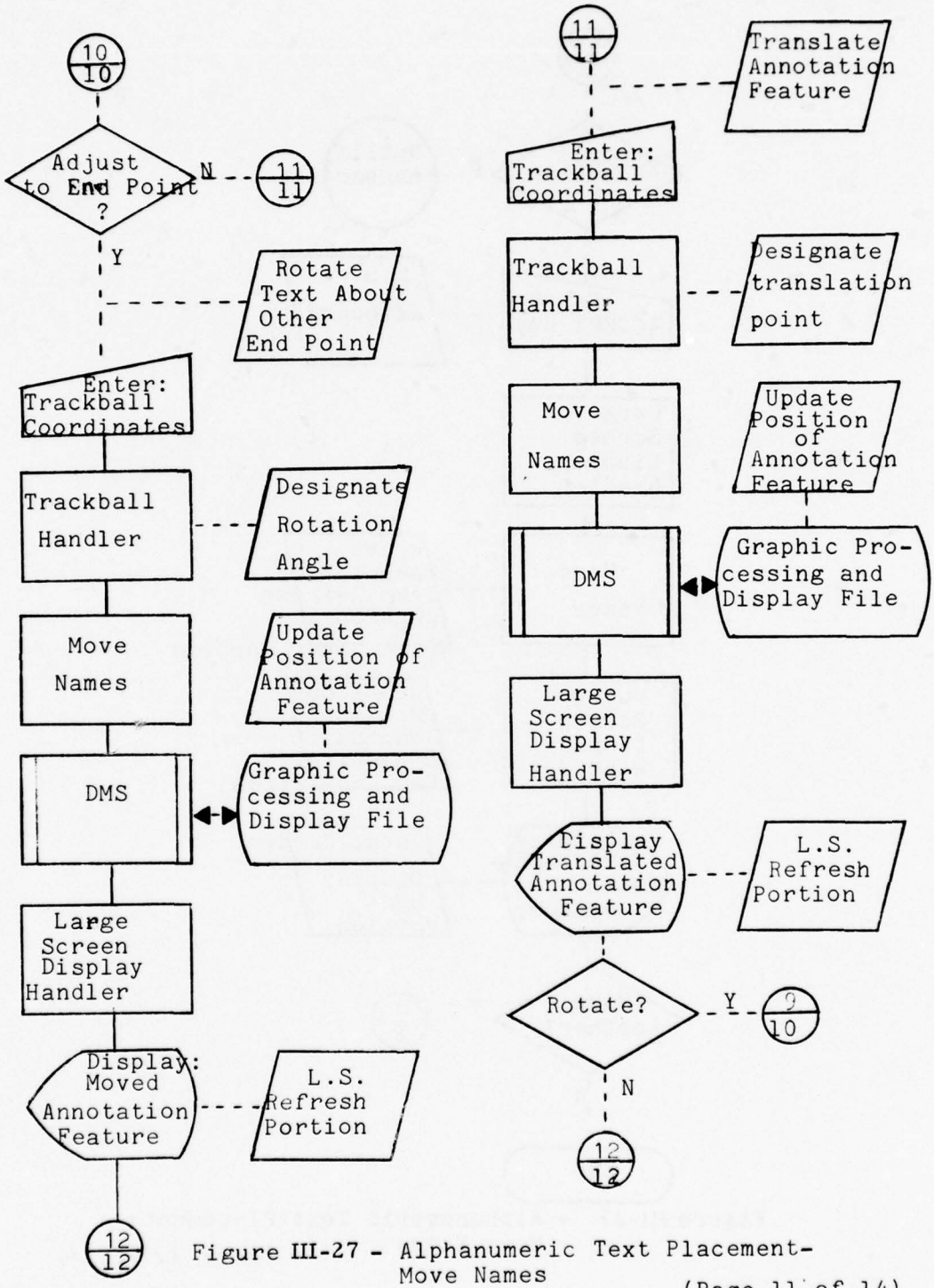


Figure III-27 - Alphanumeric Text Placement-Move Names

(Page 11 of 14)

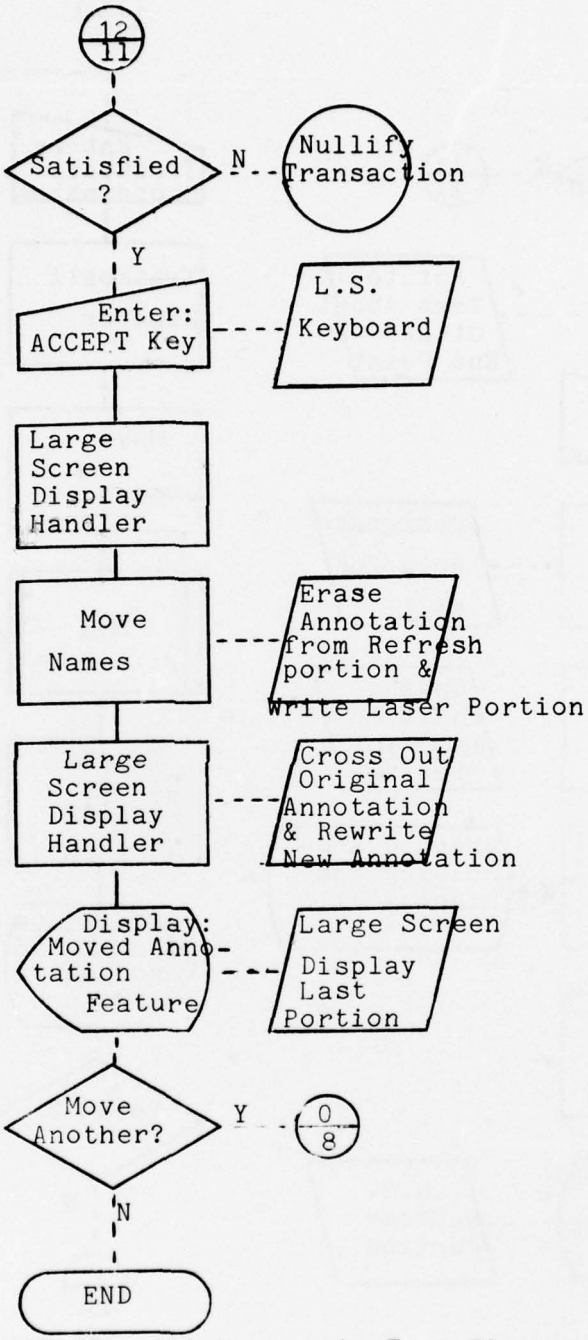


Figure III-27 - Alphanumeric Text Placement - Move Names

(Page 12 of 14)

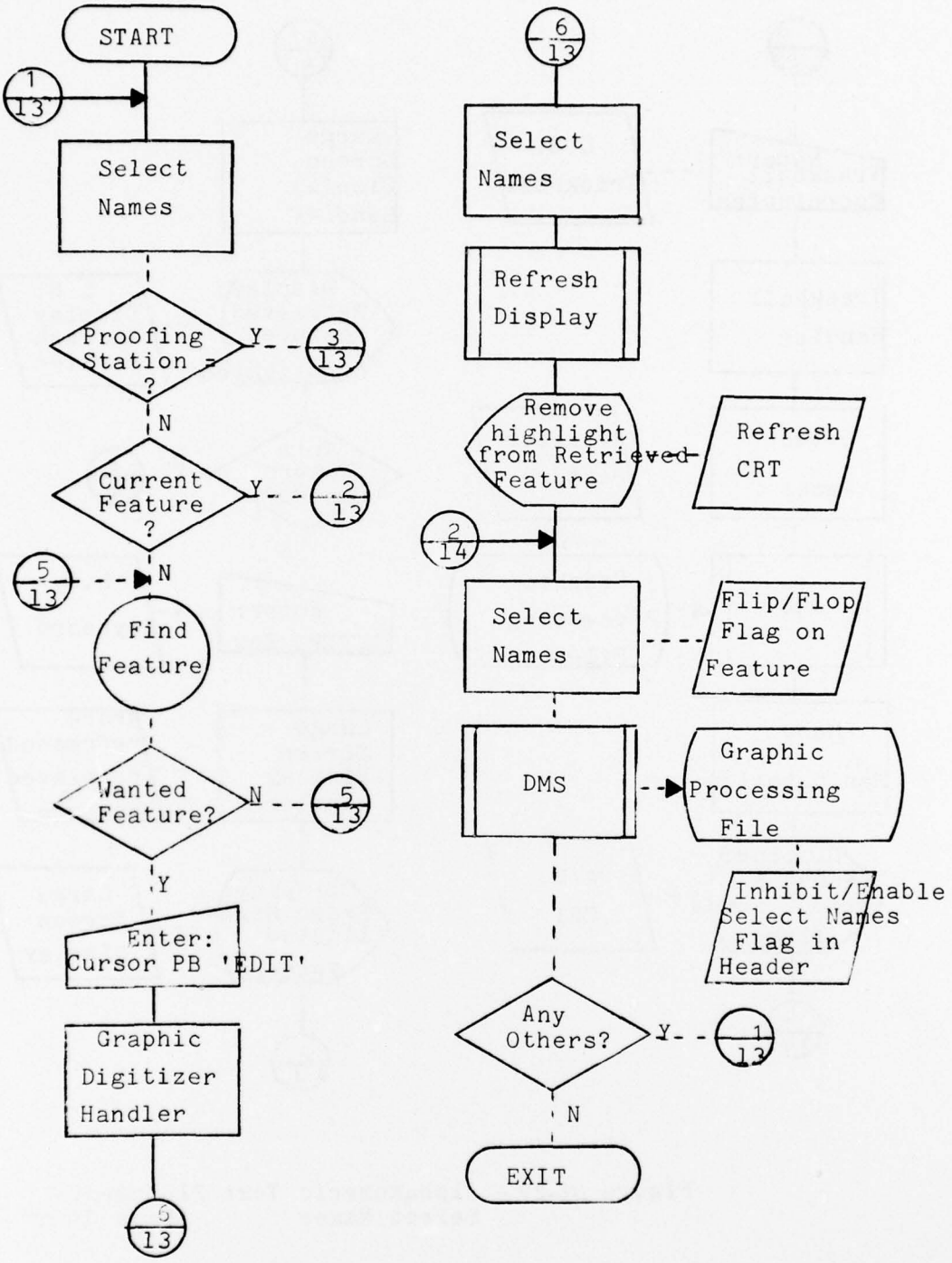


Figure III-27 - Alphanumeric Text Placement- Select Names (Page 13 of 14)

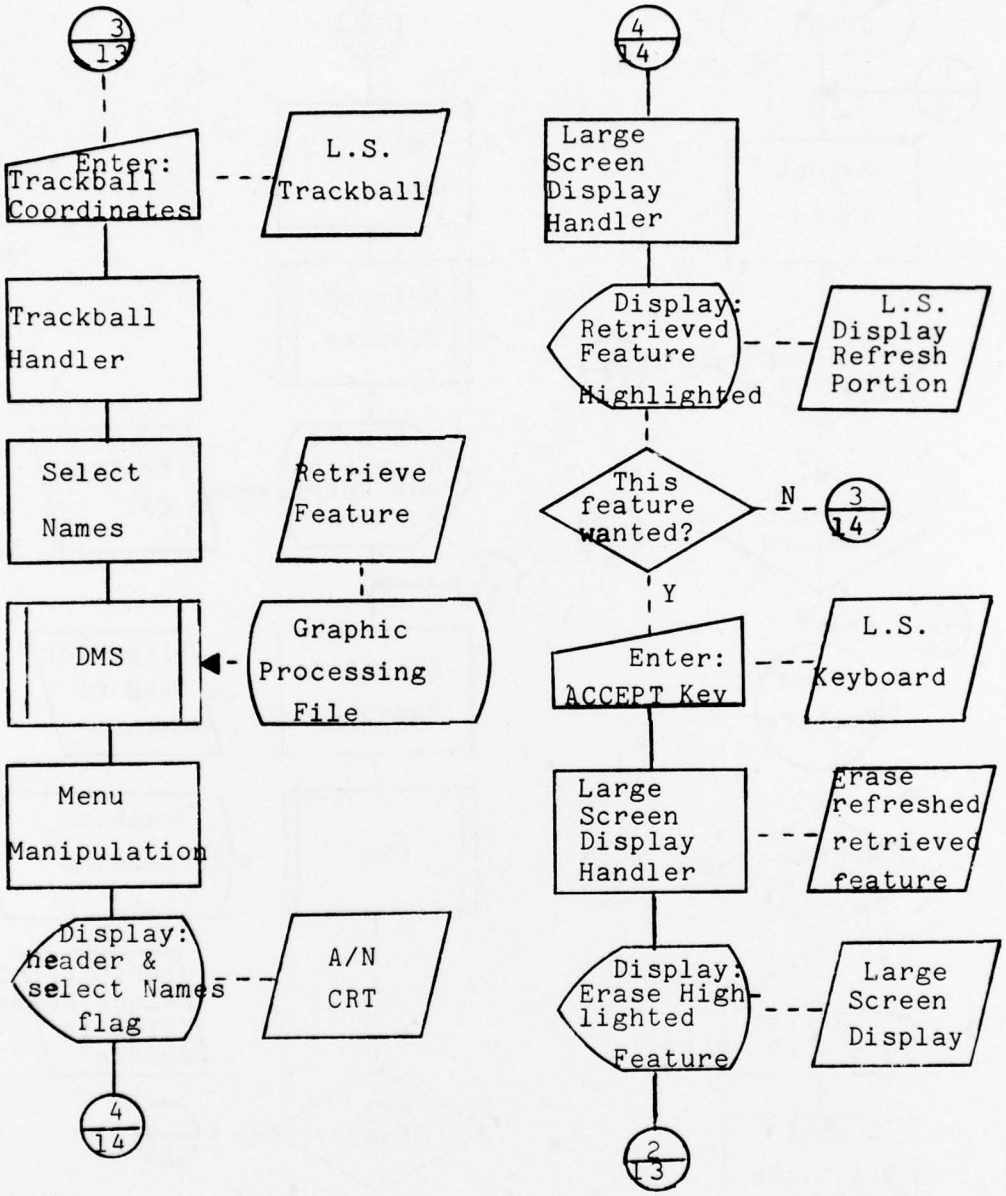


Figure III-27 - Alphanumeric Text Placement - Select Names (Page 14 of 14)

i. System Services

Purpose

The user will have at his disposal a set of system maintenance and diagnostic services. These services differ from the job reporting in that the latter produces reports directly relating to standard production jobs. System services is expected to be an evolving function, although primarily falls under:

- o Functional guidance to users
- o System diagnosis
- o File maintenance

Processes

- o Help
- o Diagnostics
- o File data dump
- o File maintenance
- o Library subroutines

Components

All major components.

Process Description

Figure III-28 presents a hardware/software flow for major system services.

- o Help

  The process when requested will provide the user with major function status and guidelines for performing the next logical steps. The user can enter the HELP request from the system console, A/N CRT, or SFK. This process should be requested by inexperienced users or situations where the user is indefinite about function status or actions required to complete a function.

- o Diagnostics

  To support system maintenance, and in fact development testing, it is planned to provide a standard set of test data and procedures for diagnostic testing. The diagnostics package can be exercised at specified intervals or when system integrity is being questioned. The package will define benchmarks which the system should conform if all components are working properly.

- File Maintenance

  A set of file handling services will be provided to allow the user to:

  - generate formatted data dumps
  - clean-up a file based on interactive edit actions and associated flags
  - purge files from disc storage

- File Transfer
  - File merge
  - Proof plotter formatting
  - File transforms
  - File filter

- Library Subroutines

  This will consist of a collection of multi-use software subroutines which support application processes. These subroutines do not directly support functional requests from the user.

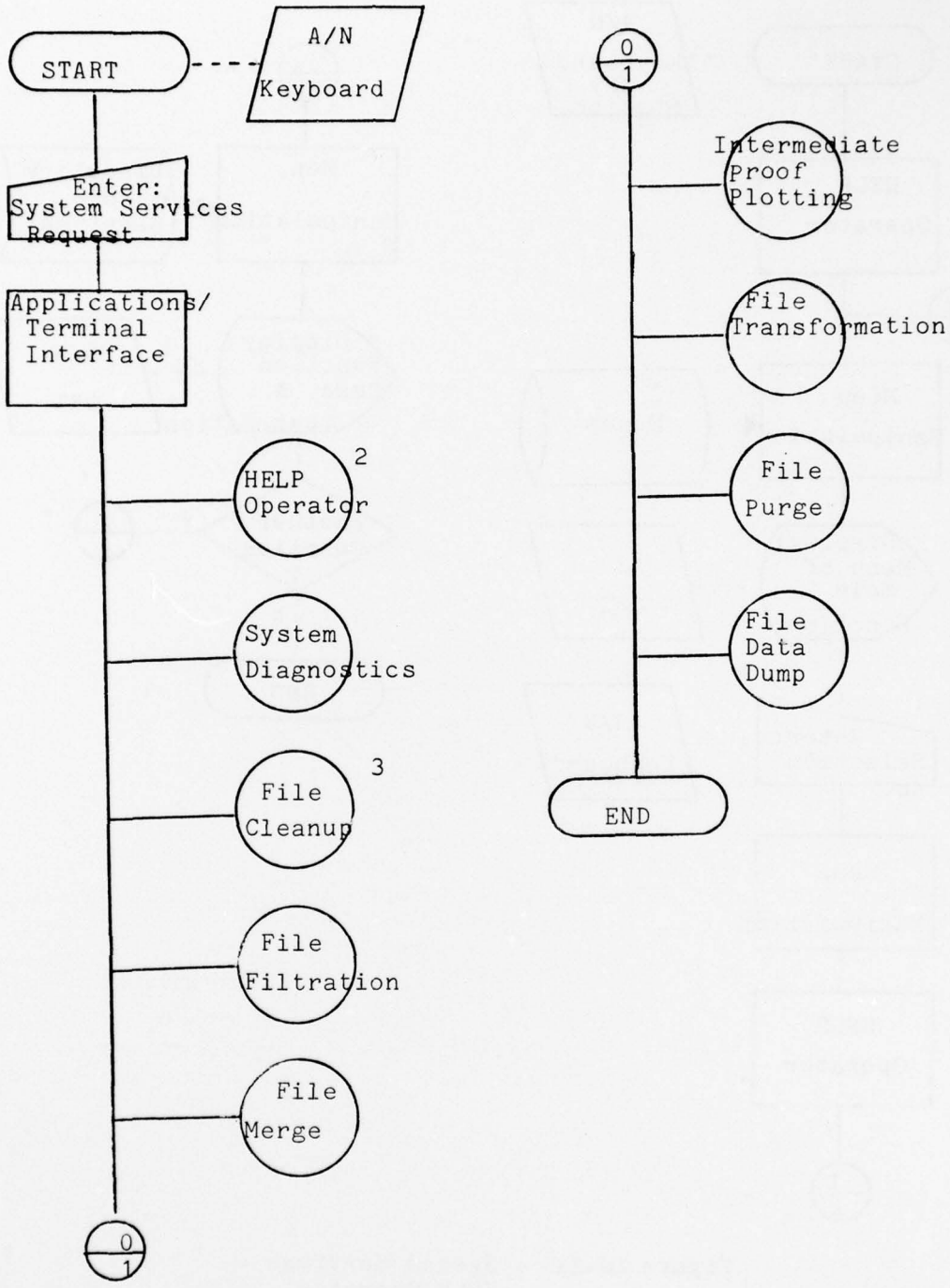


Figure III-28 - System Services
(Page 1 of 3)

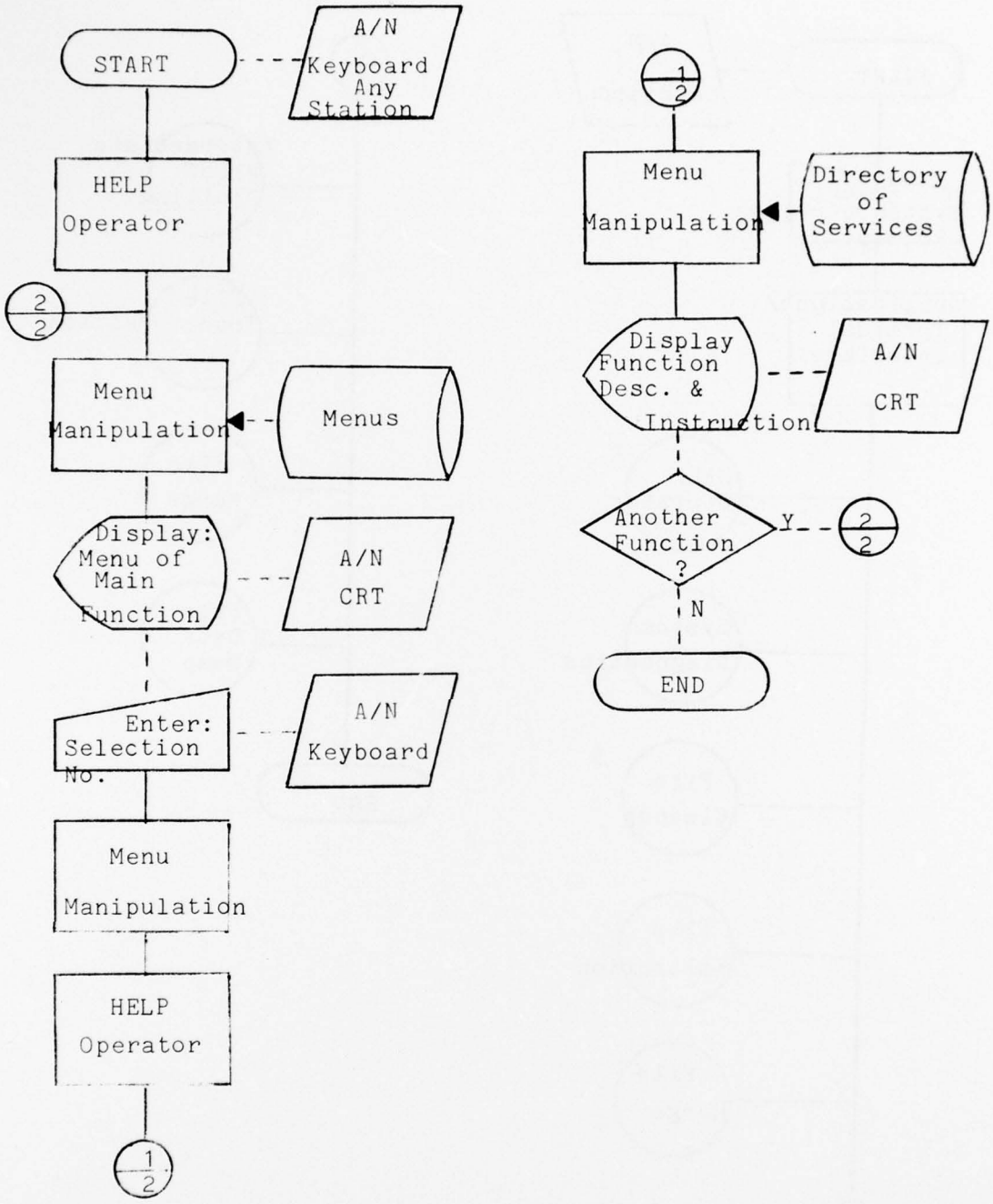


Figure III-28 - System Services -
HELP Operator

(Page 2 of 3)

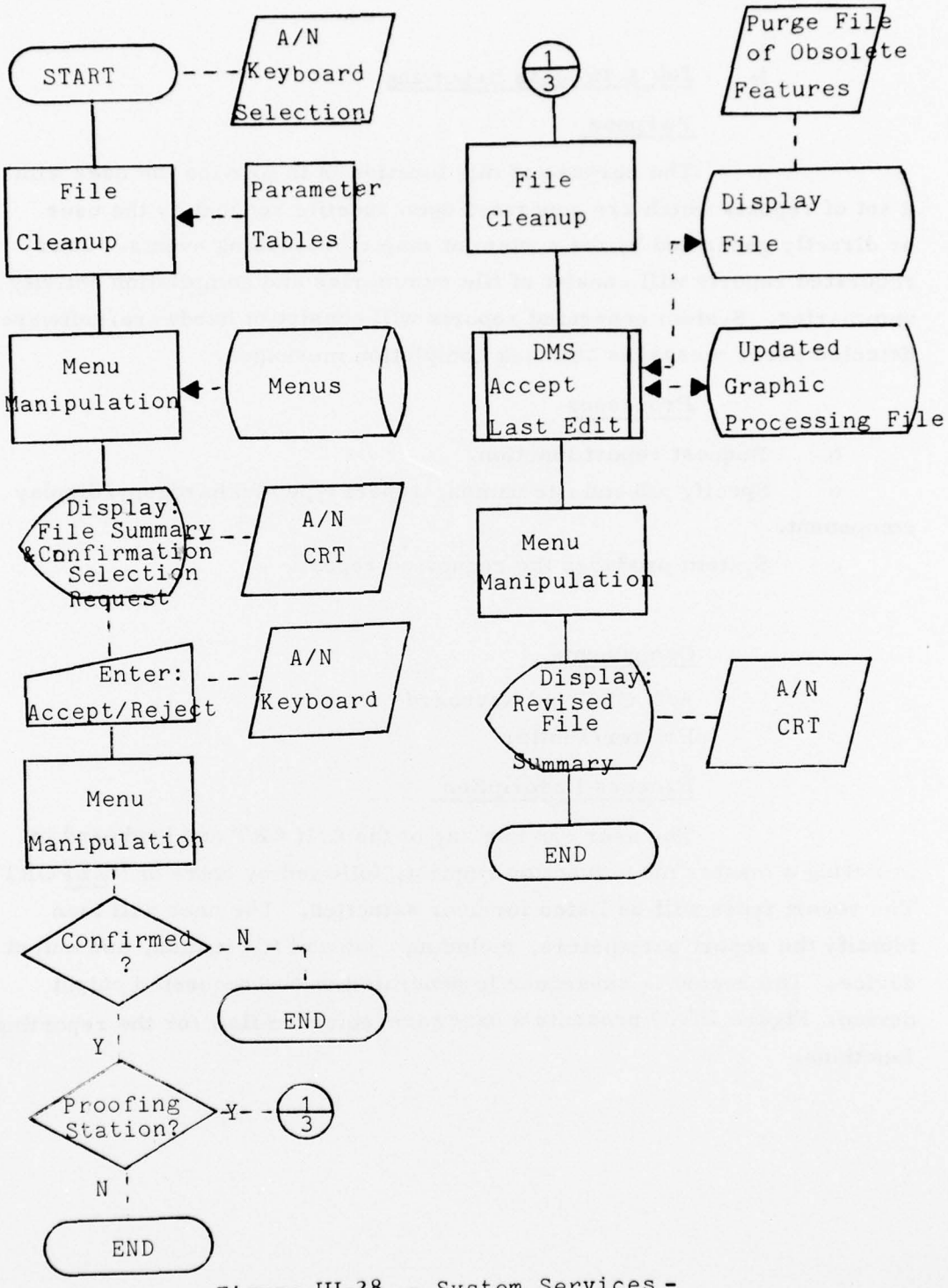


Figure III-28 - System Services - File Cleanup (Page 3 of 3)

j. Job & Process Reporting

Purpose

The purpose of this function is to provide the user with a set of reports which are generated upon specific request by the user or directly generated by the system at major processing events. User requested reports will consist of file summaries and compilation activity summaries. System generated reports will consist of hardware/software detected error messages and task completion messages.

Processes

- o Request report function.
- o Specify job and file names, report type and hardcopy/display component.
- o System produces the requested report.

Components

A/N CRT and Keyboard
Printer/Plotter

Process Description

The user can use any of the A/N CRT and keyboard by initiating a master mode function request, followed by entry of "REPORT". The report types will be listed for user selection. The user will then identify the report parameters, including: job and file names, and output device. The report is subsequently generated on the requested output device. Figure III-29 presents a hardware/software flow for the reporting functions.

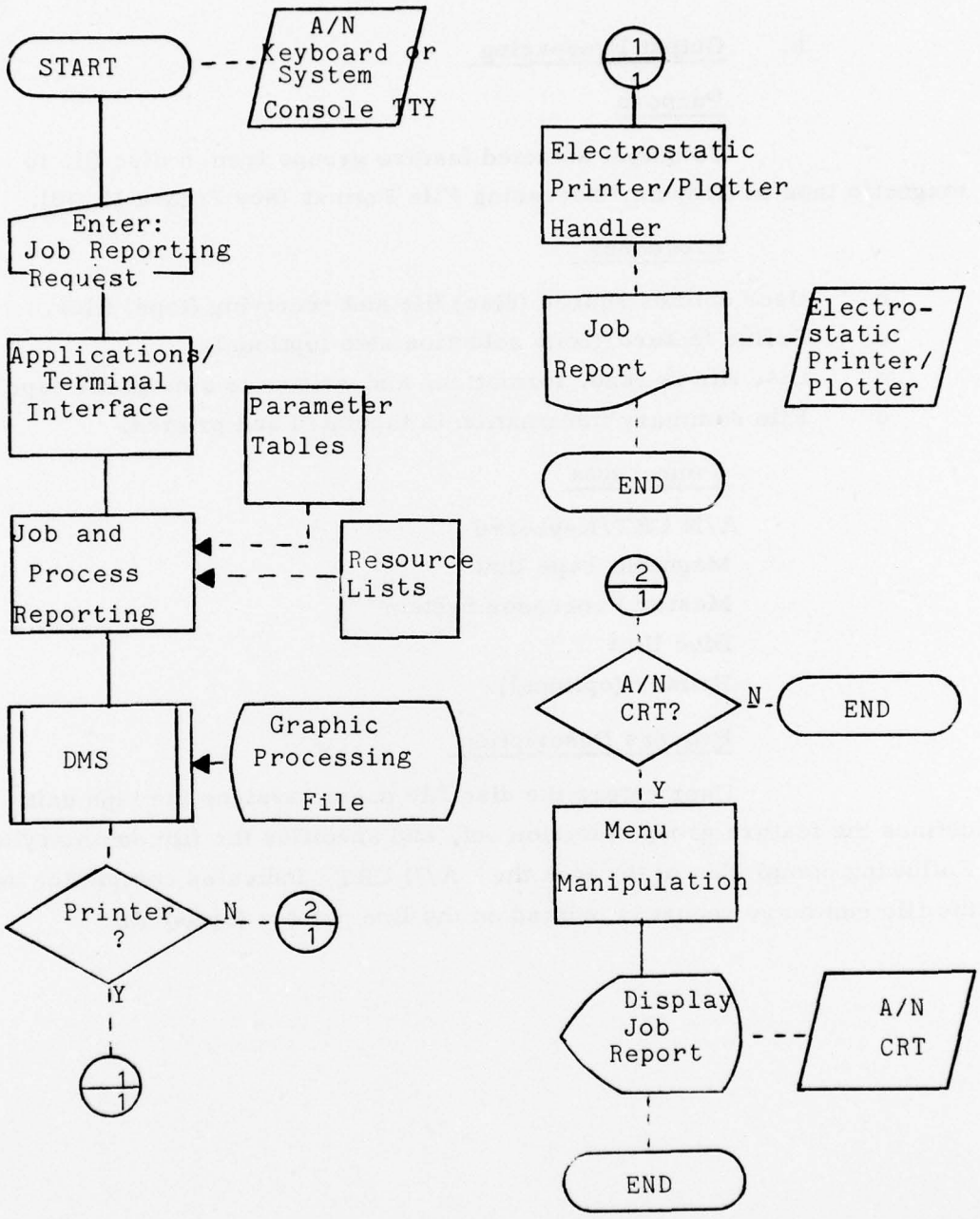


Figure III-29 - Job Reporting

(Page 1 of 1)

k. Output Processing

Purpose

To output selected feature groups from a disc file to magnetic tape in Graphic Processing File Format (see Figure III-30).

Processes

- o User defines source (disc) file and receiving (tape) files.
- o Define feature group selection sets (optional)
- o Disc file is read, formatted, and written to a magnetic tape file.
- o File summary information is tabulated and printed.

Components

A/N CRT/Keyboard
Magnetic Tape Unit
Master Processor System
Disc Unit
Printer (optional)

Process Description

User enters the disc file name, assigns the tape unit, defines the feature group selection set, and specifies the file summary option. Following completion of the task the A/N CRT indicates completion and the file summary report is printed on the line printer (optional).

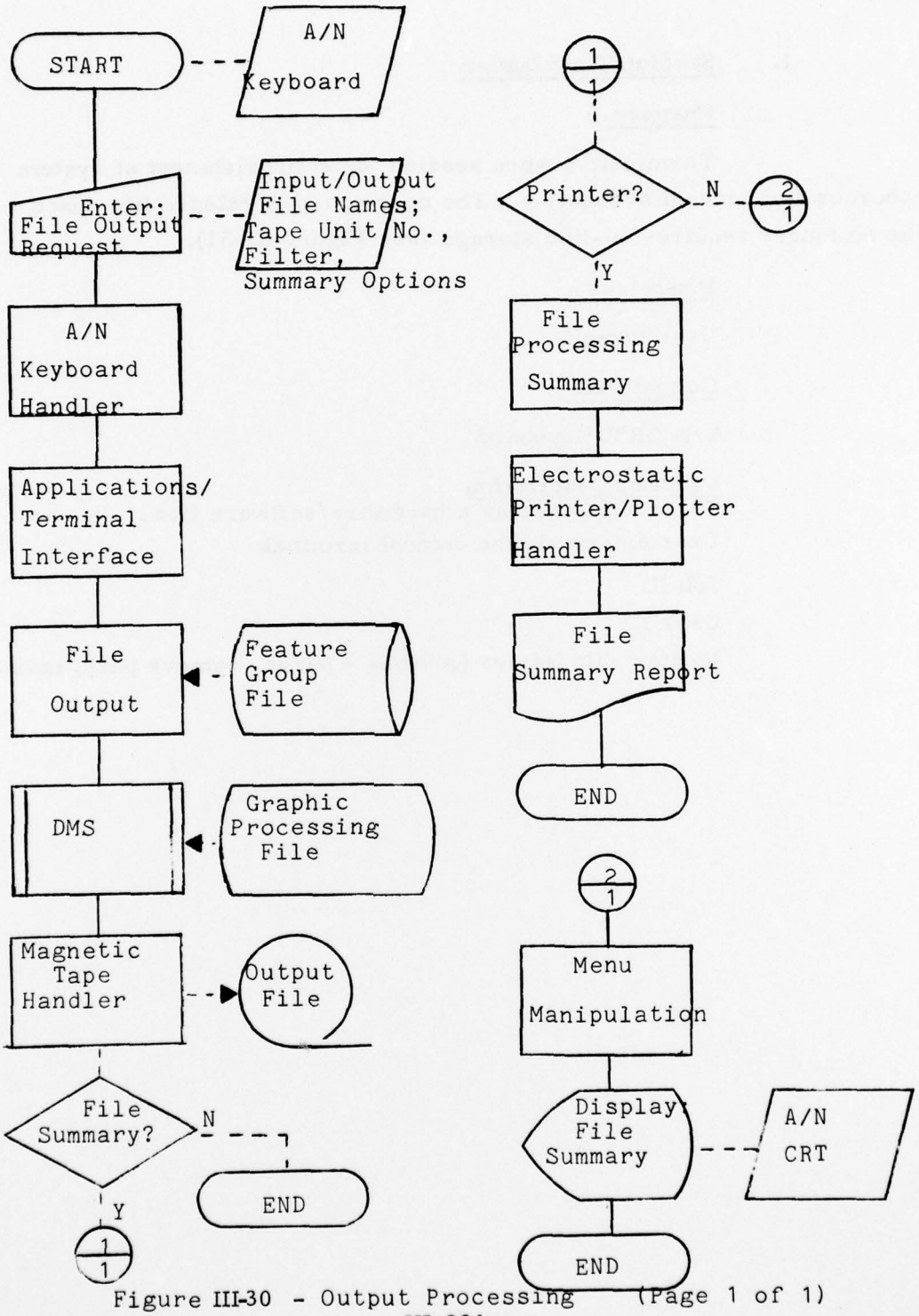


Figure III-30 - Output Processing (Page 1 of 1)

1. Session Termination

Purpose

Terminate a work session for relinquishment of system resources and general accounting. The user can also release file space if he no longer requires on-line storage (see Figure III-31).

Processes

User log-off.

Components

A/N CRT/Keyboard

Process Description

Figure 16 presents a hardware/software flow.

User enters via the control terminal:

Job ID

User ID

Master File Names (Actions - purge, remove pack, maintain)

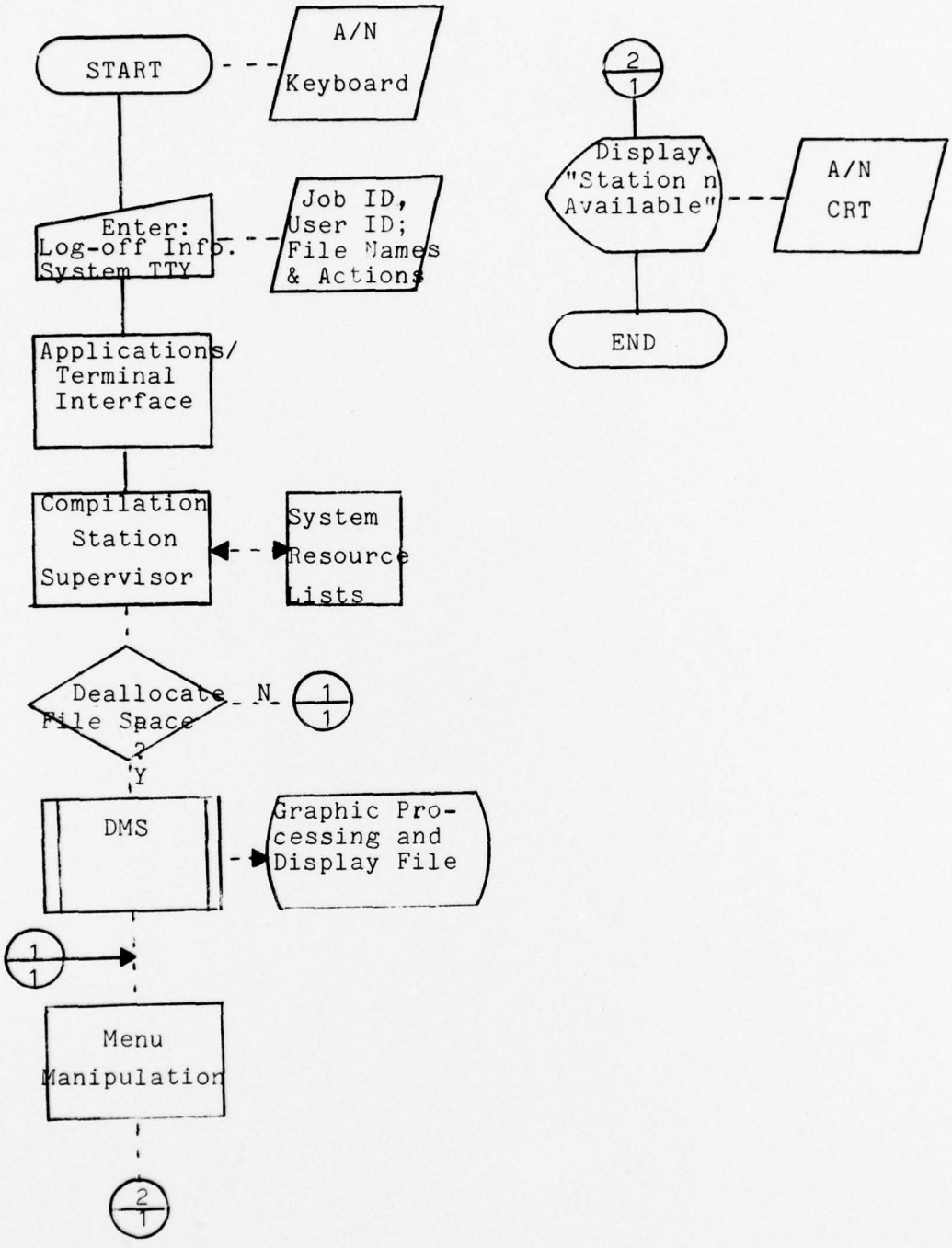


Figure III-31 - Session Termination

(Page 1 of 1)

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RADC plans and conducts research, exploratory and advanced development programs in command, control, and communications (C^3) activities, and in the C^3 areas of information sciences and intelligence. The principal technical mission areas are communications, electromagnetic guidance and control, surveillance of ground and aerospace objects, intelligence data collection and handling, information system technology, ionospheric propagation, solid state sciences, microwave physics and electronic reliability, maintainability and compatibility.