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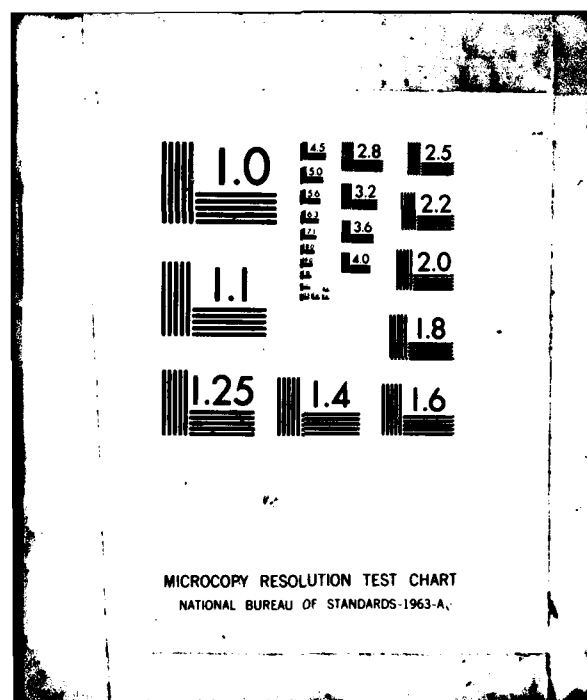
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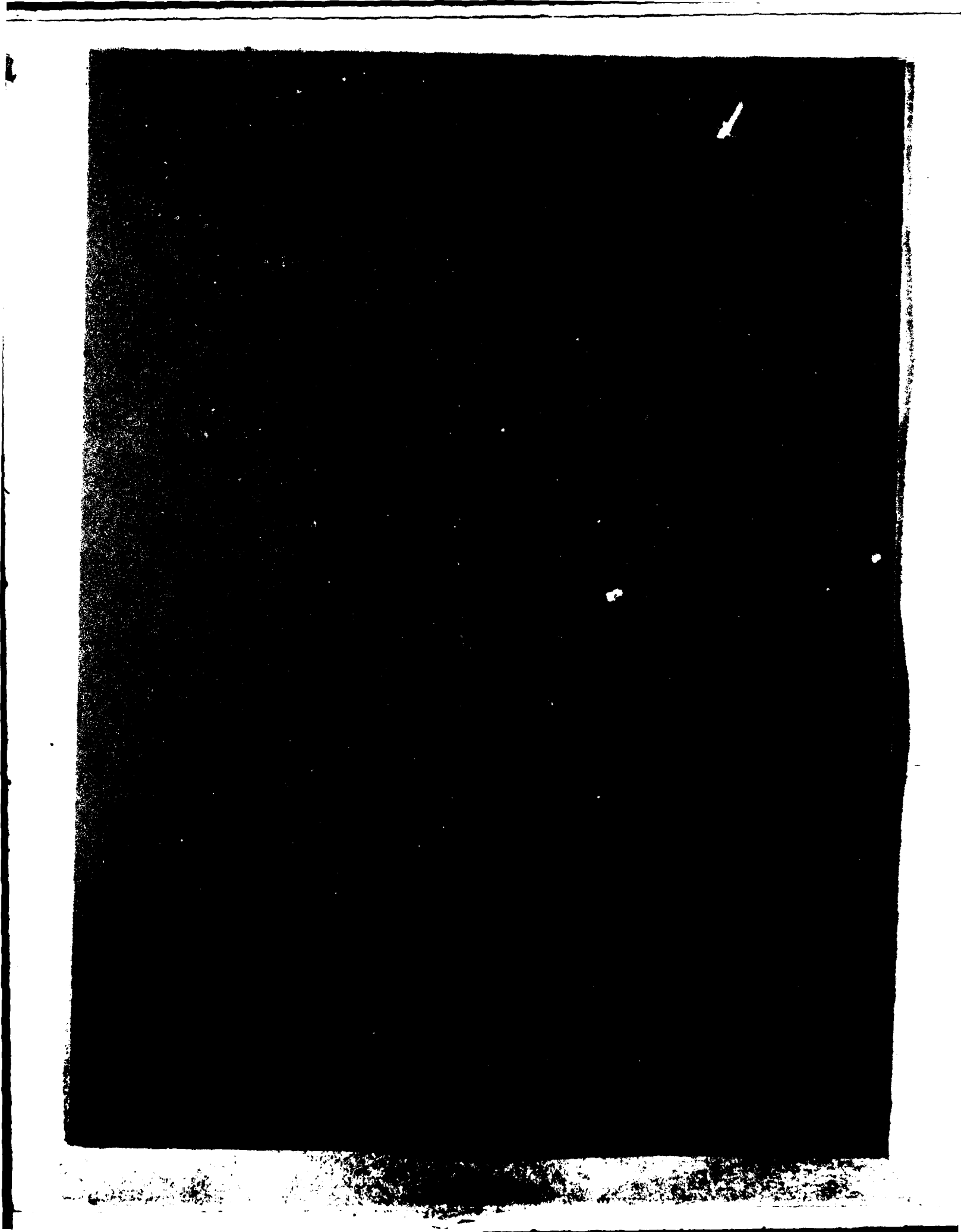
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RADC-TR-81-323	2. GOVT ACCESSION NO. AD-4777337	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) RASTER SCANNED CHARACTER RECOGNITION (RSCR)		5. TYPE OF REPORT & PERIOD COVERED Final Technical Report Oct 78 - Mar 81
		6. PERFORMING ORG. REPORT NUMBER N/A
7. AUTHOR(s) David W. Clark Kathryn Sands Przewlocki		8. CONTRACT OR GRANT NUMBER(s) F30602-78-C-0348
9. PERFORMING ORGANIZATION NAME AND ADDRESS Measurement Concept Corp. 39 1721 Black River Blvd. Rome NY 13440		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63701B 32030308
11. CONTROLLING OFFICE NAME AND ADDRESS Rome Air Development Center (IRRP) Griffiss AFB NY 13441		12. REPORT DATE November 1981
		13. NUMBER OF PAGES 96
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Same		15. SECURITY CLASS. (of this Report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Same		
18. SUPPLEMENTARY NOTES RADC Project Engineer: John R. Baumann (IRRP)		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Character Recognition Raster Processing Depth Sounding Automated Cartography		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The objective of the RSCR was to design and implement a software system which produces bathymetric depth sounding information for input to a digital data base. Input to the RSCR is raster scanned smooth sheets which consist of handwritten depth soundings. The RSCR system includes software to: (1) isolate smooth sheet hand drafted numeric depth soundings from raster scanned input, (2) provide		

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isolated characters to a character recognition routine, and (3) construct and locate output depth soundings in digital format for subsequent use by the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC).

The Hand-printed Symbol Recognition (HSR) software developed by computer Sciences Corp and the Naval Ocean Research and Development Activity (NORDA) is the character recognition routine used.

This report documents all of the above mentioned capabilities except the HSR software itself which has been documented separately by CSC and NORDA.

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1.0 INTRODUCTION

1.1 Purpose of the Report

This Technical Report for the Raster Scanned Character Recognition (RSCR) effort, contract number F30602-78-C-0348 summarizes the objectives and results of the RSCR effort. This effort was performed by Measurement Concept Corporation (Mc2) under contract to Rome Air Development Center (RADC) in support of the Defense Mapping Agency (DMA).

1.2 Purpose of the RSCR

The objective of the RSCR effort was the design, verification and implementation of a software system which creates bathymetric depth soundings for input to a digital data base through the use of raster scanning technology. To this end, the RSCR system includes software to isolate smooth sheet hand drafted numeric depth soundings from raster data input, provide these to a character recognition routine, and construct and output depth soundings in a digital format for subsequent use by DMA. The Handprinted Symbol Recognition (HSR) software developed by Computer Sciences Corporation for the Defense Mapping Agency Hydrographic Topographic Center (DMAHTC) and the Naval Ocean Research and Development Activity (NORDA) under contract to NASA is the character recognition routine used. HSR is documented under separate cover.

1.3 References

The following references have been used in the preparation of this Technical Report:

- o "Statement of Work for Raster Scanned Character Recognition", RADC, Feb. 1978.
- o "Automated Data Systems Documentation Standards", DOD Standard 7935.1-S, Sept. 1977.
- o "Raster Scanned Character Recognition Requirements Definition Document", Mc2, April 1979.
- o "Raster Scanned Character Recognition Functional Analysis", Mc2, June 1979.
- o "Raster Scanned Character Recognition System Specification", Mc2, November 1979.
- o "Raster Scanned Character Recognition Computer Operator Manual", Mc2, September 1981.
- o "Raster Scanned Character Recognition Program Maintenance Manual", Mc2, September 1981.

1.4 Terms and Abbreviations

The following acronyms are used in this document:

BDRS	Bathymetric Data Reduction Subsystem
CIDC	Cloud Identification Code
CRS	Hamilton Standard Color Raster Scanner
DMA	Defense Mapping Agency
DMAHTC	Defense Mapping Agency Hydrographic Topographic Center
HSR	Handprinted Symbol Recognition
Mc2	Measurement Concept Corporation
NORDA	Naval Ocean Research and Development Activity
RADC	Rome Air Development Center
RFP	Raster Finishing Plotter
RLC	Run Length Code
RSCR	Raster Scanned Character Recognition

1.5 Summary

The RSCR effort consisted of several major activities: requirements analysis, functional analysis, system design and software development. Requirements analysis resulted in the "Raster Scanned Character Recognition Requirements Definition Document" which collected, under one cover, the system requirements for the RSCR, including both those clearly documented in the Statement of Work and those clarified by the activity.

Functional analysis included investigation and analysis of alternate techniques and approaches for all functional elements of the RSCR system. This activity verified the feasibility of critical areas of RSCR system concepts and included:

- o algorithm development and validation for critical software processes
- o an extensive survey of technical literature to select the optimum software to recognize unconstrained handprinted numerics resulting in the selection of CHITRA (subsequently renamed HSR) under development at NORDA
- o throughput analysis to define technical risks and design implications associated with the stated throughput requirements

Recommendations included a design orientation towards proving an operational "baseline" RSCR system, a modular design specification for implementation on a conventional minicomputer system and peripherals, and continued close coordination with the NORDA HSR development.

System design was based upon the results of the functional analysis and followed a top-down structured approach. Warnier diagrams were used as a structured design tool. The DEC PDP-11 and RSX-11M were assumed to be the target hardware and operating system, respectively. Key points of the design included an RSCR Executive to serve as a user interface and to control processing of a run through the RSCR system as well as a Parameter File to serve as a repository for run parameters and statistics.

Software development involved a top-down implementation based upon the Warnier-Orr diagrams developed during the design activity. Live data was selected during visits to DMAHTC and scanned to provide input for testing various RSCR system capabilities. The interface with NORDA continued

throughout software development. The CHITRA package, which was modified by NORDA and renamed HSR, were incorporated into the RSCR software. Revised versions of HSR were incorporated into RSCR upon receipt. Test data and software to exercise the candidate character processing routines (e.g., fill) were supplied to NORDA. Revisions and additional test data were supplied as appropriate. Demonstrations of RSCR system capabilities were conducted for DMA and RADC personnel as major milestones were achieved, including:

- o isolation and extraction of candidate characters, preprocessing and input to CHITRA
- o implementation of the RSCR Executive, composition of soundings from the CHITRA output and generation of a proof plot
- o enhancement of the RSCR software to increase throughput and accuracy, separation of coalesced characters into individual candidates and incorporation of HSR.

Section 2.0 describes the RSCR system resulting from these activities.

2.0 SYSTEM DESCRIPTION

2.1 Capabilities

The Raster Scanned Character Recognition system generates a magnetic tape in Bathymetric Data Reduction Subsystem (BDRS) format containing depth sounding information obtained from a hand drafted bathymetric smooth sheet. The RSCR accepts as input the digital data tape created by scanning the smooth sheet on either the Hamilton Standard Color Raster Scanner (CRS) or the Raster Finishing Plotter (RFP). Candidate characters are isolated and extracted from this input data, and are preprocessed and passed to the HSR software. Preprocessing may include filling, smoothing, orientation determination, rotation and skeletonization as well as reformatting. The HSR results are composed into accurately positioned depth soundings. A Xynetics proof plot can then be obtained. Sounding data is output to magnetic tape in BDRS format.

Each input data set (i.e., scanned smooth sheet) is processed sequentially through the RSCR software as a run. The RSCR Executive initiates tasks and controls the job stream for a run. The user interface portion of the RSCR Executive provides the vehicle to:

- o initiate a run,
- o define/review/modify run parameters,
- o generate a run summary report,

and supplies default parameter values to simplify run definition. A Checkpoint Run task enables the user to review the current status/statistics for a run in progress and to optionally terminate a run.

2.2 System Logical Flow

Raster scanned data from the CRS or RFP are input to the RSCR on magnetic tape. Depth soundings are output on magnetic tape in BDRS format and/or Xynetics plot format. The logical flow of data through the RSCR system is depicted in Figure 2-1. Each major processing step consists of two or more programs (i.e., tasks); the entire job stream is under control of the RSCR Executive. Interim disk files serve as the vehicle for communicating data between programs. The "recognize characters" step can be iterative; all other steps are sequential, although a run can be repeated starting at any program in the job stream.

2.3 Components

The following sections describe the hardware, software, and data comprising the RSCR system. A brief description of the interim data files is also provided.

2.3.1 Hardware

The RSCR System was designed to execute on a DEC PDP-11 under the RSX-11M operating system. A DEC PDP-11/45 was provided by RADG on an interim basis early in the effort to enable experimental algorithm development in support of the functional analysis and preliminary system design for critical techniques. The RSCR system is implemented on this AN/GYQ-21V

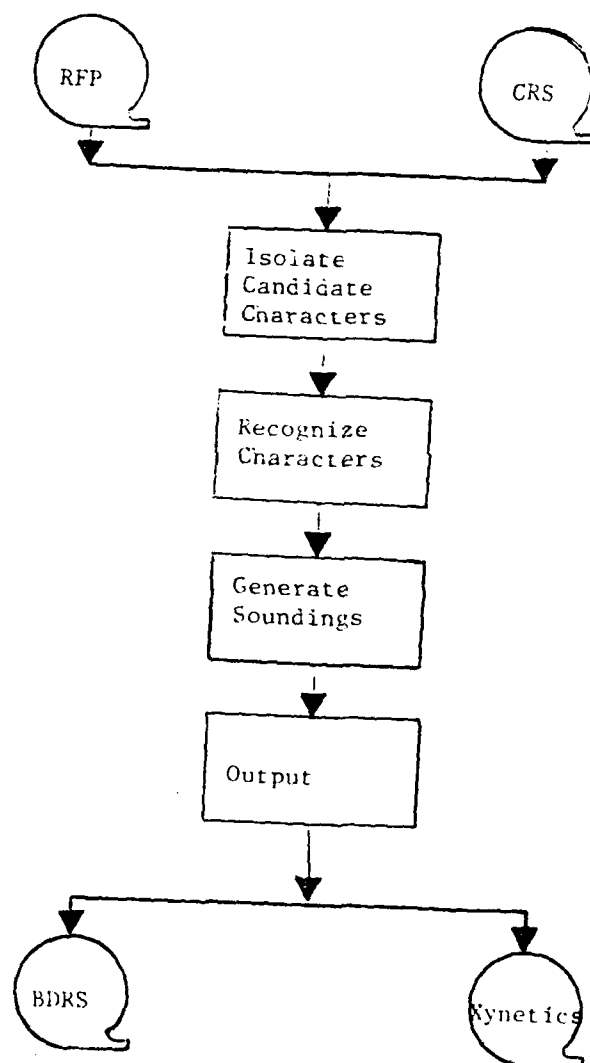


Figure 2-1 RSCR System Logical Flow

(PDP-11/45) under the RSX-11D operating system. The AN/GYQ-21V includes:

- o 120K words of memory
- o 2 RP03 removable disk drives (40 Mbytes per pack)
- o 2 9-track 800 bpi tape drives, TU10
- o high speed line printer
- o 1 VT05 alphanumeric terminal
- o 2 Ann Arbor 4080 alphanumeric terminals
- o 1 ASR-33 teletype

2.3.2 Software

The RSCR system consists of 14 tasks which control a run and perform the four major processes depicted in Figure 2-1. RSCR tasks, organized by process, include:

- o Control
 - RSCR Executive
 - Checkpoint Run
- o Isolate Candidate Characters
 - Input Magnetic Tape
 - Identify Sub-Clouds
 - Collect Sub-Clouds
 - Extract Candidate Character

- o Recognize Characters
 - Resolve Problem Clouds
 - Preprocess Candidate Clouds
 - Recognize Character

- o Generate Soundings
 - Sort Character File
 - Build Grid
 - Compose Soundings

- o Output
 - Generate Plot
 - Generate BDRS

The RSCR Executive allows the user to initiate a new run or to resume or delete an old run. The Parameter File contains parameters and statistics for the run. It is created, modified, reported and deleted by the RSCR Executive. Upon user command, the first task defined in the job stream for the run is initiated. When this task completes, the next is begun. This continues until the job stream is completed or is interrupted by the Checkpoint Run task. RSX-11D directives are used for intertask communication.

The Input Magnetic Tape task (either RFPIN or CRSIN) reads the input scan data tape, reformats the data, and creates a Run Length Code (RLC) File on disk. Optionally the scan data can be sectioned prior to output to the disk. The Identify Sub-Clouds task examines the RSCR RLC format data, assigning a Cloud Identification Code (CIDC) to each RLC, thus defining sub-clouds. A cloud is a collection of RLCs which are connected by overlap over a series of lines. RLCs which overlap are assigned the same CIDC. Two RLCs overlap if they are in consecutive scan lines and any

pixel from one RLC is within one scan resolution of any pixel from the other RLC. The Collect Sub-Clouds task examines CIDC values to identify sub-clouds which touch each other. Touching sub-clouds are grouped together as a primary cloud. This step is required since CIDC values are assigned a scan line at a time (e.g., in the case of an open top & the top "legs" do not appear connected until the "crossbar" is encountered). Each scan line can contain up to 62,000 pixels, therefore one line is examined at a time. The Extract Candidate Character task builds a Candidate File by extracting RLC data based on the CIDC values. A candidate is extracted for each primary cloud identified. The RLC data is processed a line at a time, extracting several candidates simultaneously. Repeated passes are made against the RLC data as necessary where too many candidates occur on a line to be processed simultaneously. Clouds which exceed candidate dimension parameters are identified as problem clouds.

The Resolve Problem Clouds task will separate multiple candidate clouds which have been coalesced by the scanner. The Preprocess Candidate Clouds task prepares the extracted candidates for input to the recognition routine. Preprocessing functions include:

- o data reduction
- o orientation determination
- o filling
- o smoothing
- o rotation
- o skeletonization

Data reduction performs a four-to-one reduction by examining two scan lines at a time, converting a 2x2 pixel matrix into a single pixel. Orientation determination calculates the vertical axis of a candidate cloud by constructing the two longest vectors across the candidate and bisecting the angle between the vectors. The algorithm assumes that the character is at least one pixel greater in height than in width. Filling eliminates holes along a scan line in each candidate less than or equal to a specified tolerance. Smoothing the edge of a candidate cloud is accomplished by computing a new endpoint for any RLC for which the corresponding endpoints of the RLCs on the lines above and below are within a specified tolerance. No smoothing is performed on RLCs which do not overlap. Rotation rotates the candidate cloud around its center according to the determined or user specified orientation angle. Skeletonization thins the candidate so that each line segment is one resolution unit wide. To do so, repeated passes are made against the candidate, removing pixels from the edge, much like peeling the skin from an onion. The size and shape characteristics of the original cloud are retained.

The Recognize Candidate Clouds task reformats the preprocessed candidates, passes them to HSR and stores the recognition decision in a Character File. The dimensions of each candidate are compared to specified tolerances. Candidates consisting of 2 or more coalesced characters fail dimension tolerance tests and are separated into several candidate characters prior to submission to HSR. This is done by the Resolve Problem Clouds Task.

The Sort Character File task creates a Sorted Character File in which characters are sequenced by ascending Y coordinate. This file is utilized by the Build Grid Index task to organize the characters based on their coordinate location in support of sounding composition. The Compose

Soundings task constructs depth soundings on the basis of character location, orientation and value. Each sounding is built as a string of characters, associating the closest character with a start character. User supplied ranges for the number of characters in the composed string and the resultant depth value are used to ascertain sounding validity.

The Generate Plot task creates a magnetic tape for input to the Xynetics Plotting System. Optionally, the plot can include valid soundings only, invalid soundings only, or all soundings. Symbology may be defined for the sounding positions only, depth values only, or sounding positions with the depth value offset. Differing colors and symbols are used to distinguish valid from invalid soundings. Each sounding is positioned at the correct coordinate location as determined by the Compose Soundings task, based on user supplied parameters. The plotted sounding size is determined from the height of the individual characters in the sounding.

The Generate BDRS task creates a magnetic tape in BDRS format containing the soundings. Each BDRS feature may contain up to 64 depth soundings. Valid and invalid soundings are output in separate BDRS features; invalid soundings are assigned a depth value of -1.

2.3.3 Data

Bathymetric smooth sheets in digital format are input to the RSCR System in the form of magnetic tapes containing scan data generated on either the Hamilton Standard Color Raster Scanner (CRS) on the Raster Finishing Plotter (RFP). The RSCR user also supplies information defining the input smooth sheet characteristics and various processing parameters. The RSCR System generates magnetic tapes containing sounding data in the Bathymetric Data Reduction Subsystem (BDRS) format and in Xynetics plot

format. A hardcopy Run Summary Report, including various run statistics e.g., time consumed, number of soundings) is produced for the user.

The following describes the interim data files created on disk for an RSCR run. Each of these files is given the Run ID as its filename and is identified by a unique file name extension. The Parameter File contains descriptive information, parameters, and statistics for a run. The Parameter File is the vehicle for transmission of parameters and statistics between RSCR tasks, provides the capability to suspend and resume a run, and enables the user to assess the performance of an RSCR run at any logical point in the run. The Status File contains the same information as the Parameter File and allows the user to review statistics and to specify run termination while the Parameter File is in use by an active task. The remaining files are described in the sequence in which they are created.

The Run Length Code (RLC) File contains run length code information (i.e., start-stop) for the colored portions of each scan line. The Cloud File contains the run length information from the RLC File, with Cloud Identification Code (CIDC) values assigned such that any two or more overlapping RLCs have the same CIDC value. The Cloud Identification Code Table contains an entry for each the sub-cloud, and is sequenced by ascending CIDC. The Collected CIDC Table contains information describing sub-clouds which have been collected into primary clouds. The Short CIDC Table contains summary information for each collected CIDC Table entry. The Candidate Cloud File contains the extracted RLC data defining each candidate characer.

The Preprocessed Candidate File contains candidate clouds which have been subjected to the preprocessing routines. Skeletonized candidates are stored in RLC format. The Character File contains an entry describing

each candidate submitted to HSR for recognition. Each entry includes the recognized character value (0-9) or a codified value indicating the reason for rejection. The Sorted Character File contains the same information as the Character File, with characters sequenced by ascending Y value. The Grid Index File is segmented into rectangular grid cells. Each character is stored in the appropriate grid cell, based on its coordinate location. The Sounding File contains the composed depth soundings. Each sounding entry includes the sounding position, height, orientation, depth, individual character values and a validity indicator.

3.0 CONCLUSIONS

3.1 System Performance

The RSCR accepts input data from either the CRS or RFP scanners. Sounding data is output in BDRS format. A Xynetics plot of accurately positioned depth soundings can be generated. Factors impacting RSCR throughput and correct sounding determination rate are addressed in the following section. The RSCR requires no preparation of the smooth sheet other than that required to insure a successful scan. The user interface is designed to be both friendly and flexible. Parameter input is designed for a display terminal and is segmented into pages. Functions supported include page forward, page backward, jump forward or backward without display and escape. Default values are supplied for all parameters. Run summary reports are supplied at four levels of detail and may be generated either on a line printer or at the user terminal. Unrecoverable errors are reported on the user terminal in textual form. The task which detected the error is also identified. In the event of a (hardware or software) system crash, the RSCR can be restarted by following the standard procedures for RSCR run information definition. The program which was active at the time of the crash must be repeated. No data created by previously completed programs will be lost (except in the case of disk pack destruction).

The RSCR software has been implemented in accordance with RADC structured control constructs (reference RADC Specification No. CP0787796100E) and following a structured design developed utilizing Warnier-Orr diagrams. The resulting code is therefore structured and exhibits a high degree of flexibility, maintainability and modifiability. In addition, each module was specified so as to exhibit a high degree of functional cohesion.

3.2 Constraints/Limitations

Smooth sheets selected for RSCR processing should be fairly "clean" (i.e., free of smudges), contain legible numerics and be of sufficient quality to ensure a successful scan (i.e., a minimum number of uncalibrated points). At the present time, the RSCR cannot resolve very large problem clouds and smooth sheets with depth contours running through many soundings will result in a lower correct sounding determination rate. The version of HSR currently integrated within the RSCR software has exhibited an unacceptably low character recognition rate.

RSCR response times are highly dependent upon the characteristics of the source smooth sheet. A more dense sheet requires considerably more processing time. Similarly, one large area requires longer than several smaller scan areas covering the same large area.

The RSCR deals with raster scan data which is, by its nature, large in volume. The process is scan line oriented (i.e., along the horizontal) and therefore the wider the scan area, the larger the volume of data which must be handled at one time. As a result, long, narrow vertical areas can be expected to achieve better throughput rates than wider, shorter vertical areas. Restrictions are placed on the volume of data which can be processed at one time. In general, the more dense the area, the shorter the scan line which can be processed. The RSCR user is notified when data volumes which cannot be handled are detected. The sectioning capability allows the input data to be segmented into smaller areas without repeating the scanning process.

At present, processing of the input scan tape and preprocessing of candidate characters consume the largest portion of processing time. Several steps can be taken at scan time to optimize RSCR throughput. The sheet should be oriented on the scanner so that the resultant scan has the maximum number of characters standing upright, to minimize the cloud rotation time. RSCR performance can also be enhanced by defining section areas so that:

- o a large and/or dense area is segmented into several smaller areas
- o each section area contains soundings with relatively the same orientation
- o non-sounding information (e.g., chart descriptive text) is excluded
- o each section area contains soundings within a (relatively) small range of depth values

Sectioning may be performed at scan time by limiting the scan area and performing several scans to create separate input tapes. Alternately, the entire area can be scanned with sectioning performed during the RSCR run setup.

3.3 Recommendations

Mc2 believes that the current RSCR software represents an operational baseline system which validates the feasibility of the RSCR concept of digital data base generation via raster scanning technology within the DMA

production environment. Mc2 recommends that DMA and RADC pursue further development of the program along the following lines:

- o acquisition of a dedicated minicomputer host system (e.g., PDP-11/70 or VAX-11) supported by a more advanced operating system (e.g., RSX-11M)
- o continued application of structured design and implementation techniques to the effort
- o development of the capability to resolve very large problem clouds
- o incorporation of HSR revisions which have been made since the most recent system demonstration to improve the recognition rate. This should be coupled with continued interface between the RSCR and character recognition software developers, including further investigation into the relationships between candidate preprocessing, recognition and resolution of recognition rejects.
- o development of an interactive edit capability to facilitate definition of indeterminate depth values and to insure data validity prior to release to the data base
- o enhancement of RSCR software to allow processing of larger data volumes and to enhance throughput

- o additional testing with a greater variety of scanned smooth sheets

- o implementation of a RSCR system, complete with hardware, software, documentation and training in the DMA production environment.

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1.0 GENERAL

1.1 Purpose of the Computer Operator Manual

The objective of this Computer Operator Manual for the Raster Scanned Character Recognition system project number F30602-78-C-0348 is to provide system users with the information necessary to effectively use the system.

1.2 Project References

The Raster Scanned Character Recognition (RSCR) system was developed by Measurement Concept Corporation (Mc2) under contract to Rome Air Development Center (RADC). The RSCR system isolates hand drafted numeric depth soundings from raster data input, provides these to a character recognition routine, and constructs and outputs depth soundings in a digital format for subsequent use by DMA.

The following references have been used in the preparation of this document:

- o "Statement of Work for Raster Scanned Character Recognition", RADC, Feb. 1978.

- o "Automated Data System Documentation Standards Manual", DoD Manual 4120.17-M, Dec. 1972.
- o "Raster Scanned Character Recognition Requirements Definition Document", Mc2, April 1979.
- o "Raster Scanned Character Recognition Functional Analysis, Interim Technical Report", Mc2, June 1979.
- o "Raster Scanned Character Recognition Program Maintenance Manual", Mc2, September 1981.
- o "Recognition of Handprinted Characters for Automated Cartography: A Progress Report", M. Lybanon, R. Brown, L. Gronmeyer.
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- "Cognitive Handprinted Input Trained Recursively Analyzing System for Recognition of Alphanumeric Characters (CHITRA)", Belur V. Dasarathy and K.P. Bharath Kumar.
- "DMA in Progress Review of NORDAs Optical Character Recognition R & D Program", 29 Sept. 1977.
- "An Overview of Optical Character Recognition (OCR) Technology and Techniques", DMA, June 7, 1978.

1.3 Terms and Abbreviations

The following acronyms are used in this document:

BDL	Bathymetric Data Library
BDRS	Bathymetric Data Reduction Subsystem
CHECK	Checkpoint Run

CRS	Color Raster Scanner
DMA	Defense Mapping Agency
DMAHTC	Defense Mapping Agency Hydrographic Topographic Center
Mc2	Measurement Concept Corporation
PRM	Parameter File
RADC	Rome Air Development Center
RFP	Raster Finishing Plotter
RSCR	Raster Scanned Character Recognition
RSEXEC	RSCR Executive
RUNID	Run Identification
STA	Status File

1.4 Security and Privacy

The RSCR system is Unclassified and is assumed to process only Unclassified data. Privacy restrictions do not apply to RSCR data.

2.0 SYSTEM OVERVIEW

2.1 System Application

The Defense Mapping Agency Hydrographic Topographic Center (DMAHTC) currently has a significant backlog of bathymetric survey data to be reduced to a digital form for retention in the Bathymetric Data Library (BDL). Although the Bathymetric Data Reduction Subsystem (BDRS), recently implemented at DMAHTC, provides digitization and editing capabilities for this data, additional capabilities are required to eliminate the backlog. The RSCR system will assist in generation of the BDL through the use of raster technology. Figure 2-1 illustrates the RSCR system processing environment. Hand drafted bathymetric smooth sheets are converted to a digital format via raster scanning on one of two hardware systems currently at DMAHTC, the Raster Finishing Plotter (RFP) or the Hamilton Standard Color Raster Scanner (CRS).

The RSCR system isolates candidate characters from the raster scanned input. These are then submitted to a character recognition routine. Recognized characters are combined into depth soundings which are converted to BDRS format and output on magnetic tape for incorporation into the BDL. The BDL provides depth

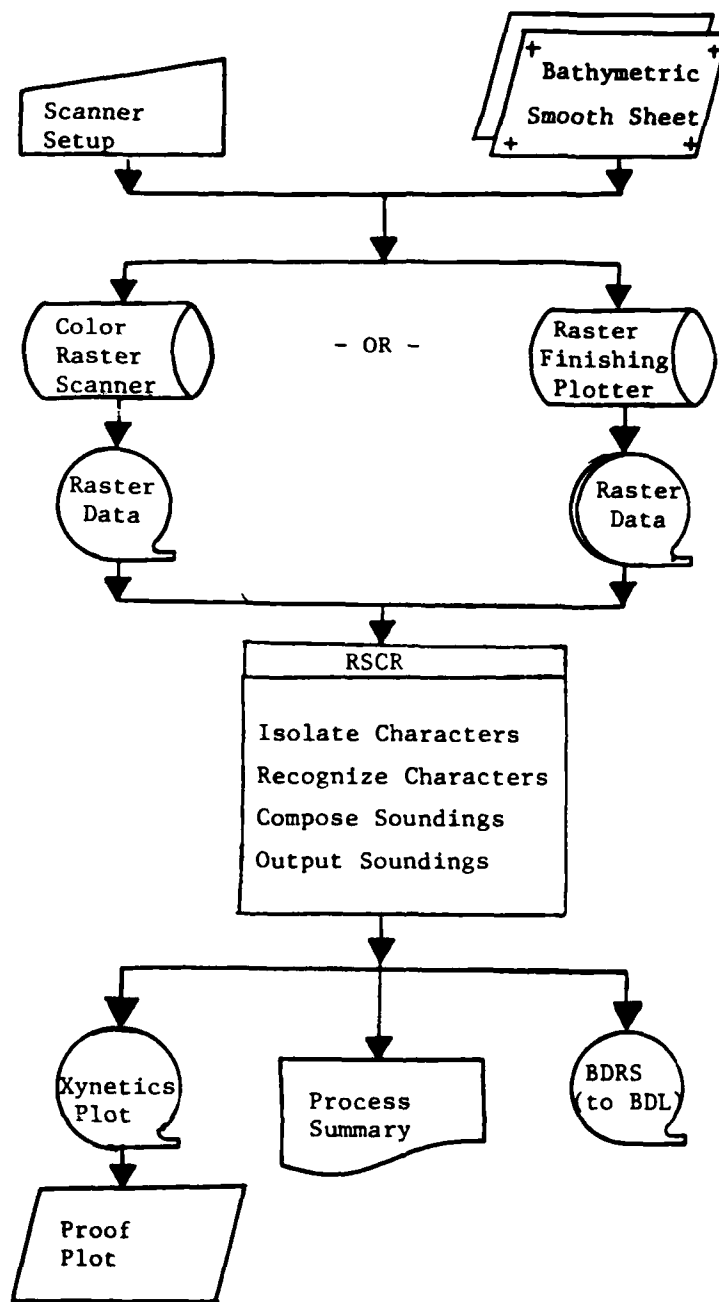


Figure 2-1 RSCR System Environment

contour and sounding source information for DMAHTC hydrographic chart products.

2.2 System Configuration

The RSCR was implemented on an AN/GYQ-21V (PDP-11/45) under the RSX-11D operating system.

The AN/GYQ-21V includes:

- o 120 K words of memory
- o 2 RP03 removable disk drives (40 Mbytes per pack)
- o 2 9-track 800 bpi tape drives, TU10
- o high-speed line printer
- o 1 VT05 alphanumeric terminal
- o 2 Ann Arbor 4080 alphanumeric terminals
- o 1 ASR-33 teletype

2.3 System Organization

Figure 2-2 illustrates the major functions performed by the RSCR software and indicates the tasks executed within each function. Each input data set is processed sequentially through the RSCR software as a run. The RSCR Executive (RSEXEC) initiates tasks and controls the job stream for a run. The user interface portion of RSEXEC provides the vehicle to:

- o initiate a run
- o define/review/modify run parameters
- o generate a run summary report

The Checkpoint Run (CHECK) task enables the user to review the current status/statistics for a run in progress and to optionally terminate a run on completion of the currently active task.

The RSEXEC task creates a Parameter File (PRM) when the run is initiated. The PRM File is a controlling vehicle utilized by all RSCR tasks; it contains:

- o run parameters

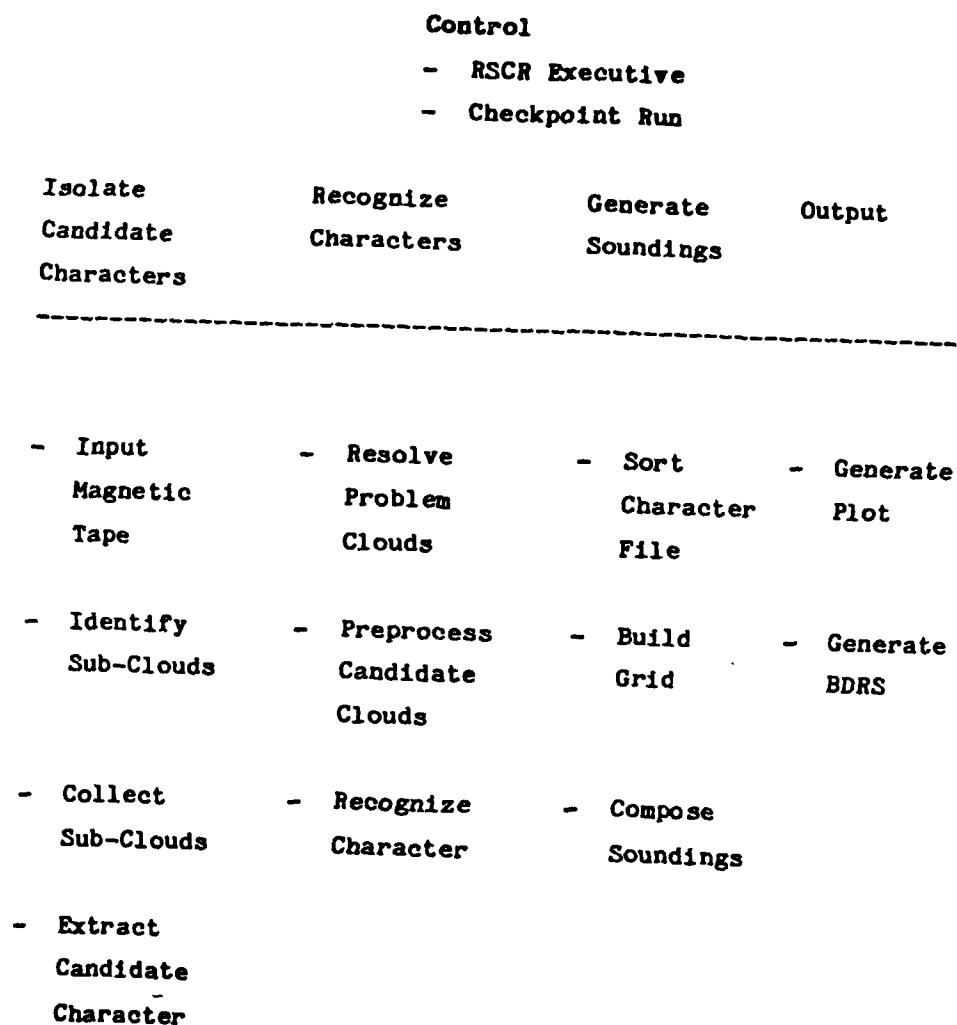


Figure 2-2 RSCR Functions

- o run statistics
- o file information
- o task status
- o file descriptive information
- o CRS tape header information

The user specified RUN ID is used as the filename for all files for the run. Each file has a unique extension (e.g., PRM). One or more intermediate files are generated by each task, as described in Section 2.6.

2.4 Performance

The RSCR accepts input data from either the CRS or RFP scanners. Sounding data is output in BDRS format. A Xynetics plot of accurately positioned depth soundings can be generated. RSCR response times are highly dependent upon the characteristics of the source smooth sheet. A more dense sheet requires considerably more processing time. Similarly, one large area requires longer than several smaller scan areas covering the same large area.

The RSCR deals with raster scan data which is, by its nature, large in volume. The process is scan line oriented (i.e., along the horizontal) and therefore the wider the scan area, the larger the volume of data which must be handled at one time. As a result, long narrow vertical areas can be expected to achieve better throughput rates than wider shorter vertical areas. Restrictions are placed on the volume of data which can be processed at one time. In general, the more dense the area, the shorter the scan line (i.e., less wide) which can be processed. The RSCR user is notified when data volumes which cannot be handled are detected. The sectioning capability allows the input data to be segmented into smaller areas without repeating the scanning process. At present, processing of the input scan tape and preprocessing of candidate characters consume the largest portion of processing time.

2.5 Program Inventory

The RSCR consists of fifteen major tasks which are divided into five categories. Figure 2-3 lists these categories and tasks and lists the subprograms used by each task. Several development utilities are also listed.

CONTROL

RSEXEC - RSCR Executive

- CLSEC - Convert Latitude/Longitude to Seconds
- CONUSR - Convert User Input
- CSECL - Convert Seconds to Latitude/Longitude
- GETCPS - Get Control Points
- GETPGM - Get Program Selections
- GETSEC - Get Section Areas
- PRMIN - Parameter Input
- READLL - Read Latitude/Longitude
- RPTERR - Report Error
- RPTOUT - Generate Run Summary Report

CHECK - Checkpoint Run

- RPTOUT - Generate Run Summary Report

ISOLATE CANDIDATE CHARACTERS

CRSIN - Input CRS Magnetic Tape

- PRESEC - Preprocess Section Areas
- SECTION - Section Scan Line
- CRSHDR - Save CRS Header Data

RFPIN - Input RFP Magnetic Tape

- PRESEC - Preprocess Section Areas
- SECTION - Section Scan Line

CLOUD - Identify Sub-Clouds

COLECT - Collect Sub-Clouds

XTRAC - Extract Candidate Cloud

XTRACR - Candidate Extractor

Figure 2-3 RSCR Tasks 1 of 3

RECOGNIZE CHARACTERS

PROBLM - Resolve Problem Clouds

PREPRO - Preprocess Candidate Clouds

FILL - Fill Candidate
LASPAS - Last Pass
ORIENT - Determine Orientation
REDUCE - Data Reduce
ROTATE - Rotate Candidate
SKELIN - Skeletonize Pass
SKELTN - Skeletonize
STRIPR - Strip Single Pixels

RECOGN - Recognize Character

GETCAN - Get Candidate
HSR - Handprinted Symbol Recognition
OUTCHR - Output Character
SETUP - Setup RECOGN
WRAPUP - Wrapup RECOGN

GENERATE SOUNDINGS

SRTCHR - Sort Character File

GRID - Build Grid Index

COMPOS - Compose Soundings

OUTPUT

PLOT - Generate Plot Tape

GBDRS - Generate BDRS Tape

LPDPDG - Convert Latitude PDP to DG
RPDPDG - Convert Real PDP to DG

Figure 2-3 RSCR Tasks 2 of 3

UTILITIES

CIDPRT - Print CIDCT

DKOUT - Disk Output

EXRCIZ - Exercise Preprocessing

IFINIT - Initialize Input File

OFINIT - Initialize Output File

PCLOUD - Print Cloud

VLOUD - Display Cloud

FILRLC - Fill RLC File

FPATCH - Patch File

GTRUTH - Define Ground Truth

TPCOPY - Tape Copy

Figure 2-3 RSCR Tasks 3 of 3

2.6 Data Base

A Parameter File (PRM) is created for each RSCR run. The PRM File serves as a vehicle for transmission of parameters and statistics between RSCR tasks. It also supports the user interface via the retention of user defined run parameters and the accumulation of statistics to support user assessment of the run status and performance. The PRM File is disk resident and is 6 256-word blocks long. A Status File (STA) is also maintained for each RSCR run. It is identical to the PRM File and allows user review of run statistics when the run is active. The STA File allows the user to checkpoint a run.

Intermediate disk files are created at each step in the RSCR job stream. These files vary in length depending upon the input data. All RSCR files (including PRM and STA) have the RUNID as a filename. Each file type has a unique extension, such as PRM. Figure 2-4 lists the files for an RSCR run in the order in which they are generated.

EXTENSION	NAME
PRM	Parameter File
STA	Status File
RLC	Run Length Code File
CLD	Cloud File
TB1	Cloud Identification Code Table (CIDCT)
TB2	Collected CIDCT
TB3	Short CIDCT
CAN	Candidate Cloud File
PRE	Preprocessed Candidate File
CHA	Character File
CH2	Sorted Charter File
GIF	Grid Index File
SND	Sounding File

Figure 2-4 RSCR Files

3.0 SYSTEM OPERATION

The following sections describe the procedures for an RSCR run. Each run represents the processing of a single data set, from scanning through output to the data base. Each run is uniquely identified by a 6-character alphanumeric RUNID.

3.1 Initiation Procedures

The following describes the steps which must be performed to run the RSCR on the AN/GYQ-21V at Building 240, RADC:

1. Power-up the AN/GYQ-21V (if necessary)
2. Depress the console HALT switch
3. Mount disk pack labeled "Measurement Concept Corporation" on drive 0 and power up
4. Power on
 - teletype — on-line
 - line printer — on-line
 - VT05 terminal(Note: rearmost knob on right side of terminal must be adjusted to stop horizontal roll.)

5. Set console address switches to 773100
depress LOAD ADDR; set console address
switches to 776716 lift HALT switch;
depress START switch
6. Enter correct date and time on VT05
terminal
7. Log-On with HEL [uic] where uic is your
user identification code
8. Install the RSCR software by entering:
INS @ [77,4] RSCR

Additional information concerning the system initiation procedures can be found in the RSX-11D Operator's Guide, DEC-11-0XDOA-A-D, Digital Equipment Corporation, Maynard, Massachusetts. This manual also describes RSX-11D utilities and error messages. Additional RSX-11D utilities, such as PIP, are described in the RSX-11D Utilities Procedures Manual, Digital Equipment Corporation, Maynard, Massachusetts.

3.2 Phasing

An RSCR job consists of three steps: smooth sheet preparation, scanning, and executing the RSCR run. An RSCR run is initiated by entering:

RUN RSEXEC (escape)

on the user terminal. The user is then prompted to enter the RUNID which must be 6 alphanumeric characters, beginning with an alpha character. The user is prompted to indicate if it is the resumption of an OLD run or the initiation of a NEW run. Run parameter definition is immediately invoked for a new run or may be selected by the user for an old run. The initial step of parameter definition is the identification of the programs to be included for the run. The programs are presented in the order in which they are executed, as shown in Figure 3-1. The user may select as many programs as desired to be included in the run. A program can not be included if the prerequisite program has not either been completed or requested; the user is notified when this condition occurs. The user may request that a completed program be included (i.e., repeated) in a run. Previously generated output files and accumulated statistics will be deleted subsequent to user validation of such a request.

3.3 Run Description

The following describes the procedures to execute an RSCR run.

1. MTIN
2. CLOUD
3. COLLECT
4. EXTRAC
5. PROBLM
6. PREPRO
7. RECOGN
8. SRTCHR
9. GRID
10. COMPOS
11. PLOT
12. GBDRS

Figure 3-1 RSCR Programs

3.3.1 Inputs

Preparation of input for an RSCR run involves four major steps:

- o smooth sheet selection and preparation
- o scanning
- o RSCR parameter derivation
- o RSCR run initiation

3.3.1.1 Smooth Sheet Selection

Smooth sheets selected for RSCR processing should be fairly "clean" (i.e., free of smudges), contain legible numerics and be of sufficient quality to insure a successful scan (i.e., a minimum number of uncalibrated points). At the present time the RSCR cannot resolve very large problem clouds; smooth sheets with depth contours running through many soundings will result in a lower correct sounding determination rate. Presently, the RSCR requires no preparation of the smooth sheet other than that required to ensure a successful scan.

3.3.1.2 Scanning

Specific procedures for operation of the CRS and RFP scanners are documented under separate cover. The RSCR requires scan input data to be on a 9-track 800 bpi magnetic tape for the RADC AN/GYQ-21V. The sheet must be examined to determine the optimum scan resolution, which will vary depending upon the character size, line weight and ink density. In general, the larger the characters and/or the heavier the line weight and/or the denser the ink then the larger the scan resolution should be. As a rule of thumb, characters less than 0.1" high should be scanned at 1 mil, from 0.1" to 0.2" high at 2 mils and greater than 0.2" high at 4 mils.

Several steps can be taken to optimize RSCR throughput. The sheet should be oriented on the scanner such that the resultant scan has the maximum number of characters standing upright. RSCR performance can also be enhanced by defining section areas such that:

- o a large and/or dense area is segmented into several smaller areas
- o each section area contains soundings with relatively the same orientation

- o non-sounding information (e.g., chart descriptive text) is excluded
- o each section area contains soundings within a (relatively) small range of depth values

Sectioning may be performed at scan time by limiting the scan area and performing several scans to create separate input tapes. Alternately, the entire area can be scanned and sectioning can be performed during the RSCR run. Section area upper left and lower right coordinates must be input to the RSCR. They may be specified in the scanner coordinate scheme. If the CRS is used, section area coordinates may be identified by CRS control point number. This requires that these points be entered as control points during scanner set-up and that the control point numbers be manually recorded for subsequent input to the RSCR. The RSCR accepts up to 10 section areas (i.e., 20 control points). Registration control points can be defined in a similar fashion. In addition to each control point number, the geographic coordinates corresponding to each point should be manually recorded. A maximum of ten (10) registration control points are accepted by the RSCR. A single control

point may be applied as both a registration and section corner point. The RSCR uses only the first 30 CRS control points defined. CRS post-processing functions need not and should NOT be performed against scan data for input to the RSCR.

The CRS allows for the definition of chart descriptive information. The RSCR optionally records appropriate information in the BDRS output. Those items applied from the CRS header are listed in Figure 3-2. This information can be defined at scanner set-up or during RSCR run definition.

3.3.1.3 RSCR Parameter Derivation

Input parameters to the RSCR describe geographic characteristics of the sheet (e.g., projection), user options (e.g., plot pen code), and program parameters dependent upon source data characteristics. The smooth sheet must be examined to determine the latter type of parameter. Using a loop, a sampling of characters should be measured to determine

- o minimum character dimension (at scan orientation)

Chart Name

Chart Number

Country of Origin

Date of Publication

Projection

Spheroid

Figure 3-2 Recorded CRS Information

- maximum character dimension (at scan orientation)
- minimum character height or width (at scan orientation)
- average character rotation from the horizontal
- minimum character height (standing upright)
- maximum character height (standing upright)
- maximum character width (standing upright)
- minimum difference between sounding orientation and the horizontal
- maximum difference between sounding orientation and the horizontal
- maximum distance between character centers within a sounding

Additional information which will be required to describe the smooth sheet includes:

- o desired color
- o overall dimensions
- o minimum number of characters/sounding
- o maximum number of characters/sounding
- o minimum depth value
- o maximum depth value

The application of this information is addressed in greater detail in the following section.

3.3.1.4 RSCR Run Initiation

System initiation procedures are described in Section 3.1. Once logged onto the system, the procedures outlined below should be followed to initiate a run. User responses are underlined.

```
MCR > INS @[77,4]RSCR
```

```
MCR > RUN [77,4]RSEXEC (escape)
```

```
----- RSCR -----
```


ENTER RUN ID: MYJOB1

ENTER RUN TYPE: O = OLD, N = NEW O

---- RSCR ----

1. DESCRIBE/REVIEW RUN PARAMETERS
2. EXECUTE RUN
3. DELETE RUN
4. PRINT REPORTS
5. TERMINATE RSCR

ENTER SELECTION NUMBER — 1

The RUNID must be 6 alphanumeric characters with the leftmost being alpha; the prompt to enter RUNID is repeated until 6 alphanumerics are supplied. Run type must be entered as N or O. When a new run is specified, a new Parameter File is initialized with default values and option 1 - Describe/Review Run Parameters is automatically selected. (NOTE: RSCR design included safeguard checking to ensure against accidental reinitialization of an existing PRM File via RSX-11M capabilities. These capabilities have not been implemented and the user must BE CAREFUL NOT TO SPECIFY AN EXISTING RUNID AS NEW.) The following describes run procedures for each of the five options.

Describe/Review Run Parameters allows the user to review and modify programs to include in the job stream, run parameters, section areas, and control points. At any point in this process, the user can enter @ to escape. Escape causes update of the PRM File to reflect any changes and return to the 5-option menu. Selection of programs to include in the job stream was discussed in Section 3.2. Briefly, the page illustrated in Figure 3-3 is presented to the user. At the start of a new run, all programs except PROBLEM, which is not currently implemented, are INCLUDED. (Note: PROBLEM will resolve very large problem clouds; smaller problem clouds are resolved by RECOGN.) The following scenario illustrates the options and limitations of run information modification:

ENTER N FOR NEXT PAGE, PROGRAM NUMBER TO UPDATE,
OR @ TO ESCAPE 11
ENTER CHOICE: E=EXCLUDE, I=INCLUDE N=NO CHANGE,
OR R=REDISPLAY STATUS I
PREREQUISITE MUST BE INCLUDED OR PROGRAM MUST B
E EXCLUDED
ENTER I TO INCLUDE PREREQUISITE OR E TO EXCLUDE
PROGRAM I

-- PARAMETER FILE DEFINITION --

----- RUN ID: MY10B1

----- RUN INFORMATION -----

1. MTIN - COMPLETED
2. CLOUD - COMPLETED
3. COLECT - COMPLETED
4. EXTRAC - COMPLETED
5. PROBLM - EXCLUDED
6. PREPRO - COMPLETED
7. RECOGN - COMPLETED
8. SRTCHR - INCLUDED
9. GRID - INCLUDED
10. COMPOS - EXCLUDED
11. PLOT - EXCLUDED
12. GBDRS - EXCLUDED

ENTER N FOR NEXT PAGE, PROGRAM NUMBER TO UPDATE, OR @ TO ESCAPE -

Figure 3-3 RSCR Run Information

At this point Run Information, as shown in Figure 3-3, is redisplayed; programs 8-11 show a status of INCLUDED. The user is again prompted:

```
ENTER N FOR NEXT PAGE PROGRAM NUMBER TO UPDATE,  
OR @ TO ESCAPE 7  
ENTER CHOICE: E=EXCLUDE, I=INCLUDE N=NO, CHANGE,  
OR R = REDISPLAY STATUS E  
ILLEGAL TO EXCLUDE COMPLETED OR ABORTED PROGRAM  
ENTER N FOR NEXT PAGE PROGRAM NUMBER TO UPDATE,  
OR @ TO ESCAPE 7  
ENTER CHOICE: E=EXCLUDE, I=INCLUDE N=NO, CHANGE,  
OR R = REDISPLAY STATUS I  
COMPLETED OR ABORTED PROGRAM HAS BEEN REQUESTED  
OUTPUT FILES MUST BE DELETED  
ENTER Y TO CONTINUE WITH DELETE Y  
ENTER N FOR NEXT PAGE, PROGRAM NUMBER TO UPDATE,  
OR @ TO ESCAPE N
```

At this point the first page of run parameters is displayed. Each run parameter is identified by an item number. After each action the user is prompted to:

```
ENTER N FOR NEXT PAGE, R TO REDISPLAY CURRENT PAGE,  
@ TO ESCAPE, OR ITEM NUMBER TO UPDATE
```

At any point the user may specify any item number. A total of six (6) pages are displayed to the user for review and update, as illustrated in Figure 3-4. This figure depicts, for each item, the displayed text, default value, and program using the parameter. Further description of the derivation and application of each item is provided in Figure 3-5. These explanations can be correlated to the previous figure by item number.

Section areas and control points, when specified, are the final parameters to be reviewed. Both follow similar procedures; unique options are first supplied. These include the sources of section area coordinates and of control point scan coordinates and if data is to be retained internal to or external to the specified section area(s). The user can then optionally review the current section areas (or control points). Once review is complete one or more areas (control points) can be updated. Once all parameters have been reviewed or upon user selection of escape (@), the 5-option RSCR menu is redisplayed.

Selection of 2. EXECUTE RUN causes each program INCLUDED in the RSCR Run Definition to be executed. The operator is prompted to mount magnetic tapes as necessary for the MTIN, PLOT, and GBDRS programs.

ITEM	DISPLAYED TEXT	DEFAULT	PROGRAM
1.	Input Type; 1 = RFP, 2 = CRS	2	MTIN
2.	Desired Color; Black = 1-RFP or 2-CRS	2	MTIN
3.	Review CRS Header: 0 = No, 1 = Yes	0	MTIN
4.	Use CRS Header 0-No 1-Control PTS 3-All	3	MTIN
5.	Scan Resolution In Microns	25	*
6.	Source Characteristic: 0 - No Dots; 1 = Dots	0	*
7.	Scan Data Fill Threshold - In Resolution Units	0	MTIN
8.	Number of Section Areas (0-10)	0	*
9.	Number of Control Points	0	*
10.	Minimum Character Height or Width-Res Units	3	COLECT
11.	Maximum Character Height or Width-Res Units	255	COLECT
12.	Minimum Character Height Plus Width Res Units	12	COLECT
13.	Data Reduction; 0=Exclude, 1=Include	1	PREPRO
14.	Data Reduction Threshold	3	PREPRO
15.	Character Fill Threshold-In Resolution Units	3	PREPRO
16.	Smooth Threshold-In Resolution Units	2	PREPRO
17.	Rotation Selection 0=No Rotation, 1=Rotate	1	PREPRO
18.	Standard Orientation 400=Non-Standard	400	PREPRO
19.	Orientation Threshold	9	PREPRO
20.	Minimum Number of Points in Valid Candidate	5	RECOGN
21.	Maximum Number of Points in Valid Candidate	200	RECOGN
22.	Minimum Character Height	4	RECOGN
23.	Maximum Character Height	255	RECOGN
24.	Maximum Character Width	255	RECOGN
25.	Grid Cell X Size - In Resolution Units	1000	GRID
26.	Grid Cell Y Size - In Resolution Units	1000	GRID
27.	Sounding Orientation - Lower Limits - Degrees	0	COMPOS
28.	Sounding Orientation - Upper Limits - Degrees	0	COMPOS
29.	Max Distance Between Character Centers	100	COMPOS
30.	Desired Position; 1=LL, 2=UR, 4=LR, 5=C	1	COMPOS
31.	Min Number Characters/Sounding	2	COMPOS
32.	Max Number Characters/Sounding	6	COMPOS
33.	Minimum Depth Value	1	COMPOS
34.	Maximum Depth Value	32767	COMPOS
35.	Plot Type; 1=Soundings, 2=Indeterminate, 3=1+2	3	PLOT
36.	Plot Symbology; 1=Depth, 2=Position, 3=Both	1	PLOT
37.	Plot Height Source; 1=Standard, 2=Dynamic	2	PLOT
38.	Plot Standard Height	80	PLOT
39.	Desired Pen Code (1-4)	1	PLOT
40.	Indeterminate Pen Code (1-4)	4	PLOT

Figure 3-4 RSCR Parameter Definition 1 of 2

41.	Units; 1=M.M, 2=FT.FT, 4=FATH.FATH	1	GBDRS/PLOT
42.	Projection; 1=UTM, 2=Mercator	1	GBDRS/PLOT
43.	Quadrant; 1=NE, 2=NW, 3=SW, 4=SE	1	GBDRS
44.	Spheroid Code (1-13)	1	GBDRS
45.	UTM Zone Number	0	GBDRS
46.	Scale	0.	GBDRS
47.	Major Axis Earth Model Ellipsoid	0.0000	GBDRS
48.	Minor Axis Earth Model Ellipsoid	0.0000	GBDRS
49.	First Eccentricity	0.0000	GBDRS
50.	Second Eccentricity	0.0000	GBDRS
51.	Chart Left Longitude		
	0 DEG 0 MIN 0.00 SEC E		GBDRS
52.	Base Latitude		
	0 DEG 0 MIN 0.00 SEC N		GBDRS
53.	Chart Central Meridian		
	0 DEG 0 MIN 0.00 SEC E		GBDRS
54.	Upper Standard Parallel		
	0 DEG 0 MIN 0.00 SEC N		GBDRS
55.	Lower Standard Parallel		
	0 DEG 0 MIN 0.00 SEC N		GBDRS
56.	Top Latitude		
	0 DEG 0 MIN 0.00 Sec N		GBDRS
57.	Bottom Latitude		
	0 DEG 0 MIN 0.00 SEC N		GBDRS
58.	Left Longitude		
	0 DEG 0 MIN 0.00 SEC E		GBDRS
59.	Right Longitude		
	0 DEG 0 MIN 0.00 SEC E		GBDRS
60.	Source ID		GBDRS
61.	Document Number		GBDRS
62.	Sheet Number		GBDRS

Figure 3-4 RSCR Parameter Definition 2 of 2

The user is informed upon completion of all requested programs and the 5-option RSCR menu is redisplayed.

Upon selection of 3 - DELETE RUN the user may review the Parameter File (see option 4, below). Following user verification of the delete request, all files belonging to the current RUNID are deleted and the RSCR Run is terminated. (Note: The capability to delete files from RSEXEC is dependent upon RSX-11M and is not presently implemented.

A run can be deleted by entering:

```
MCR>~PIP RUNID.*;*/DE
```

(Warning: BE VERY VERY CAREFUL WHEN YOU ENTER THIS OR YOU MAY UNINTENTIONALLY DESTROY VALID DATA.)

Option 4 - PRINT REPORTS can be selected to review the parameters and statistics contained in the PRM File. The RSCR Run Summary report is described in Section 3.3.2.

Upon selection of 5 - TERMINATE RSCR, the run is terminated and RSEXEC exits.

3.3.2 Outputs

The RSCR generates depth soundings for input to the digital data base. These soundings are contained on a magnetic tape in the BDRS format. The RSCR will also create a magnetic tape for generation of a Xynetics plot to allow proofing of the determined depth soundings. Options available for the plot are described in Figures 3-4 and 3-5 as item numbers 30 and 35-40.

An RSCR Run Summary report can be created to assess the performance and/or status of an RSCR run. Available report types include:

1. COMPLETE REPORT
2. PARAMETER
3. STATISTICS
4. STATISTICS SUMMARY

Each type may be generated on either the user terminal or on the line printer. Report type 4 summarizes items of interest (such as number of recognized characters) from report type 3.

ITEM	EXPLANATION
1.	Scanner source
2.	Scanner color code to be extracted as soundings
3.	N/A
4.	Application as run parameters
5.	25, 50, or 100
6.	For sounding positioning
7.	Largest space on any scan line which will be filled in; depends on source graphic and scan resolution, as a rule of thumb: 25 microns - fill = 3, 50 microns - fill = 1, 100 microns - fill = 0
8.	N/A
9.	0-10 areas for registration; does not include any control points used to define section area corner coordinates
10.	Minimum dimension at scan orientation, data smaller than this is not considered as characters; approximately the line weight
11.	Maximum dimension at scan orientation cannot exceed 255, data larger than this is considered problem clouds; obtained from smooth sheet measurements
12.	Minimum sum of character dimensions at scan orientation, can be used to eliminate dots; obtained from smooth sheet measurements
13.	Include causes a 2 to 1 reduction is the size of extracted candidate clouds; selection depends on the original character size and line weight and the scan resolution; include for larger characters and/or smaller resolution (resultant candidates should be approximately 35-70 resolution elements tall)
14.	Number of black pixels required in a 2x2 matrix for a black pixel to be output, range of 1-4; increases as line weight increases
15.	Largest space on any scan line within a (reduced) candidate which will be filled; depends on source graphic, scan resolution, and data reduction
16.	Maximum horizontal distance across two scan lines on a (reduced) candidate which will be smoothed; depends on source graphic, scan resolution, and data reduction
17.	Include causes rotation of candidate characters
18.	Standard orientation is angle in degrees between character center line and the vertical axis, all candidates are rotated according to the standard orientation; non-standard orientation (i.e., 400) causes software to be executed to determine the orientation of each candidate
19.	Smallest angle, in degrees, that any candidate character will be rotated; reflects tolerance of character recognition routine to orientation

Figure 3-5 RSCR Parameter Explanations 1 of 3

- 20. Smallest valid (reduced) rotated, skeletonized candidate related to character size, scan resolution and data reduction
- 21. Largest valid (reduced) rotated, skeletonized candidate, related to character size, scan resolution and data reduction
- 22. For a (reduced), rotated, skeletonized candidate, related to character size, scan resolution and data reduction
- 23. See 22
- 24. See 22
- 25. Decrease for more dense source; Minimum must be twice maximum distance between character centers
- 26. See 25, generally should be same as 25
- 27. Minimum angle formed between a valid sounding and the horizontal as measured against the positive axis
- 28. Maximum angle formed between a valid sounding and the horizontal is measured against the positive axis; a zero value for both items 27 and 28 causes soundings to be considered valid at any angle
- 29. Maximum distance in resolution elements between character center coordinates in a valid sounding, maximum = 181
- 30. Sounding coordinate to be applied as sounding location; 1=lower left, 2 = upper left, 3 = upper right, 4 = lower right, 5 = center
- 31-34. Define range of valid soundings
- 35. Type = 1 will result in a plot of only valid soundings, Type = 2 will result in a plot of only invalid soundings, Type = 3 will result in a plot including all soundings
- 36. A depth plot includes the determined depth value positioned according to item 30; a position plot includes a symbol positioned according to item 30 - a graticule (+) represents valid soundings and a triangle (Δ) represents invalid soundings; a plot of both includes the position symbology with the depth value offset according to item 30 for each sounding
- 37. Height is applied to both sounding symbology and to depth value characters; dynamic height is determined from the width of the sounding
- 38. Plot height in mils to apply as standard and/or for single character soundings
- 39. Pen assignment for valid soundings
- 40. Pen assignment for invalid soundings
- 41. Depth sounding unit of measure; 1=meters.meters, 2 = feet.feet, 3 = fathoms.feet, 4 = fathoms.fathoms

Figure 3-5 RSCR Parameter Explanations 2 of 3

42. N/A
43. Quadrant; 1 = Northeast, 2 = Northwest, 3 = Southwest, 4 = Southeast
44. Spheroid Code; 1 = CLARK 1866
2 = CLARK 1858
3 = CLARK 1858
4 = BESSEL
5 = HOUGH
6 = WGS 72
7 = WGS 80
8 = INTERNATIONAL
9 = KRASSOUSKY
10 = EVEREST
11 = AUSTRALIAN
12 = FISCHER
13 = AIRY

45-62. N/A

Figure 3-5 RSCR Parameter Explanations 3 of 3

3.3.3 Restart/Recovery

Following a (hardware or software) system crash, the RSCR may be restarted by following the standard procedures for RSCR Run Information definition. The program which was active at the time of the crash should be INCLUDED. No previously completed programs need be repeated with the following EXCEPTION. If EXTRAC is to be repeated, COLECT must also be repeated.

The user may review the status of an active run by entering:

```
MCR > RUN [77,4]CHECK (escape)
```

CHECK responds by prompting the user to supply the RUNID. Parameters, statistics and status of the run may be reviewed. The procedures are the same as those followed to PRINT REPORTS. The user may specify the currently active run to be checkpointed. A checkpoint request causes RSCR to be terminated for the run upon completion of the currently active program.

Unrecoverable errors are reported on the user terminal in textual form and the RSCR is aborted. The program which detected the error is also identified. RSCR errors are listed in Figure 3-6. The probable cause and recovery procedures are listed as appropriate. In the event of a software error, the error code, conditions at the time of the error and a complete run summary report should be provided to software maintenance personnel.

FILE ERRORS

Recovery procedures are the same for all files. Errors are listed below with xxx in place of the file type extension.

ERROR	CAUSES(S)	RECOVERY
xxx FILE OPEN	File open by another user. File open as a result of abort. File not found (accidentally deleted). New file already exists. Other errors.	None. >PIP filename.xxx/UN Repeat previous step to recreate. In use by another user. *
xxx FILE CLOSE	Various.	*
xxx FILE READ	End of file. Other errors.	* *
xxx FILE WRITE	Record number too large. Other errors.	* *

* Hardware and/or software error - report all error messages and codes and conditions at time of error to maintenance programmer.

MAGTAPE ERRORS

May result from:

- o Failure to issue MOU(NT) command
- o Mag tape drive on wrong unit number
- o Mag tape drive off-line
- o Mag tape not securely on drive
- o Failure to place a write ring on output tape
- o Bad mag tap (e.g., causes parity error)

Figure 3-6 Errors/Recovery 1 of 5

Once these conditions are checked and the problem reappears, the maintenance programmer should be notified. Mag tape errors include:

ATTACH MAGTAPE
DETACH MAGTAPE
REWIND MAGTAPE
TAPE READ
TAPE WRITE

RECOVERABLE ERRORS

Several errors may result from parameter settings unsuited to the input data or from a very large and/or dense input source. These errors are, in general, recoverable, although the aborted task must be repeated.

ERROR	CAUSE(S)	RECOVERY
MTIN Statistics (# Lines=0)	Bad scan or scanner type Section areas beyonds bounds of scan data	Repeat scan Redefine section areas
CLOUD Statistics (# sub-clouds=0)	No RLC data in scan No RLC data in section areas	Repeat scan Redefine section areas
COLECT Statistics (# candidate clouds=0)	All primary clouds were smaller than or exceeded dimension tolerances	Adjust parameters
EXTRAC Statistics (# passes of CLD file=0)	Software error	Notify maintenance programmer
PROBLM Statistics	Does not occur	-
PREPRO Statistics (# preprocessed candidates=0)	Software error	Notify maintenance programmer
RECOGN Statistics (# recognized=0)	Incorrect preprocessing or character size parameters	Adjust parameters

Figure 3-6 Errors/Recovery 2 of 5

ERROR	CAUSE(S)	RECOVERY
SRTCHR Statistics (# CH2 records=0)	Software error	Notify maintenance programmer
GRID Statistics (# active cells = 0)	Software error	Notify maintenance programmer
COMPOS Statistics (# soundings=0)	Incorrect sounding criteria parameters	Adjust parameters
PLOT Statistics (# soundings=0)	Software error	Notify maintenance programmer
GBDRS Statistics (# features=0)	Software error	Notify maintenance programmer
Y OUT OF SEQUENCE	Bad scanner tape Software error	Repeat scan Notify maintenance programmer
Scan Line too long	Input is too wide or dense	Section into vertical strips
Illegal RFP Mode	Scan not done in RLC mode	Repeat scan
CIDCT ENTRY NOT FOUND	Too many sub-clouds Very large problem cloud	Section input Ignore
CIDCT OVERFLOW	Too many sub-clouds	Section input
CIDC ALREADY ROLLED	Too many sub-clouds Very large problem cloud	Section input Ignore
MAXIMUM # RLCS ANY CANDIDATE=0	No candidates were extracted (all are problems)	Adjust candidate cloud dimension parameters

Figure 3-6 Errors/Recovery 3 of 5

ERROR	CAUSE(S)	RECOVERY
CANDIDATE TOO BIG	Candidate too large for preprocessing	Perform data reduction/increase scan resolution
BLANK CANDIDATE	Small candidate input to reduce (probably a dot)	Ignore
NO RLCS PREVIOUS LINE	Blank line in candidate	Notify maintenance programmer
NO RLCS CURRENT LINE	Blank line in candidate	Notify maintenance programmer
NO RLCS NEXT LINE	Blank line in candidate	Notify maintenance programmer
TOO MANY STRINGS	CHA File is too large for sort	Section input
CANDIDATE TOO BIG FOR HSR	Skeletonized candidate has >200 points	Perform data reduction/increase scan resolution
HSR RETURNED ERROR	Software	Notify maintenance programmer
STRING NOT FOUND	Software	Notify maintenance programmer
INSUFFICIENT BUFFERS	Source too wide	Increase grid cell X size or section input
CHARACTER OUT OF BOUNDS	Software	Notify maintenance programmer
CANNOT REQUEST ACTIVE TASK	Task was (manually) aborted	Reset program to "INCLUDED"

Figure 3-6 Errors/Recovery 4 of 5

ERROR	CAUSE(S)	RECOVERY
CANNOT REQUEST ABORTED TASK	Task aborted	Reset prerequisite program to "INCLUDED"
USER REQUESTED CHECKPOINT	Via CHECK	-
USER REQUESTED ABORT	Upon review of CRS header	-

OTHER ERRORS

Additional errors may result from defective hardware and/or software. The conditions at the time of the error and all error messages and codes should be reported to maintenance programmer personnel. These errors are listed below:

UNDEFINED ERROR CODE
 COMPUTED GO TO
 GET TASK PARAMETERS DIRECTIVE
 CLREF DIRECTIVE
 REQUES DIRECTIVE
 WAITFR DIRECTIVE
 SETEF DIRECTIVE
 SEND DIRECTIVE
 RECEIV DIRECTIVE
 QIO DIRECTIVE
 WTQIO DIRECTIVE

Figure 3-6 Errors/Recovery 5 of 5

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1.0 GENERAL

1.1 Purpose of the Test Analysis Report

The Test Analysis Report for the Raster Scanned Character Recognition system, Project F30602-78-C-0348 is written to fulfill the following objectives:

- o To document the results of the implementation test.
- o To provide a basis for allocating responsibility for deficiency correction and follow-up.
- o To provide a basis for the preparation of the statement of project completion.
- o To establish user confidence in the operation of the system.

1.2 Project References

The Raster Scanned Character Recognition (RSCR) software was developed under contract to Rome Air Development Center and is intended for use by the Defense Mapping Agency. The following references have been used in the preparation of this document and will support testing:

- o "Statement of Work for Raster Scanned Character Recognition", RADC, February, 1978.
- o "Automated Data System Documentation Standards Manual", DoD Manual 7935.1-S, September, 1977.

- o "Raster Scanned Character Recognition Requirements Definition Document", Measurement Concept Corporation, April 1979.
- o "Raster Scanned Character Recognition Computer Operator Manual", Measurement Concept Corporation, September, 1981.
- o "Raster Scanned Character Recognition Test Plan", Measurement Concept Corporation, September, 1981.

1.3 Terms and Abbreviations

The following terms and abbreviations are used in this document:

BDRS	Bathymetric Data Reduction Subsystem
HSR	Handprinted Symbol Recognition
RSCR	Raster Scanned Character Recognition
RSEXEC	RSCR Executive

1.4 Security and Privacy

No security or privacy restrictions apply to the RSCR system test.

2.0 TEST ANALYSIS

The following describes the results from the three phases of RSCR System Test as described in Section 5.0 of the RSCR Test Plan.

2.1 System Function/Performance

The following describes system functions and performance as demonstrated by each of the RSCR software components. Overall, the RSCR successfully accepted the defined inputs and generated properly formatted depth sounding outputs.

2.1.1 RSCR Executive

The RSCR Executive (RSEXEC) provided a simple yet flexible mechanism for the user to define RSCR input parameters, control the processing of the job stream and to examine the results of the run. Parameters which may be specified by the user include section area coordinates, geographic control points and geographic information describing the smooth sheet (e.g., projection). In addition, the user can specify characteristics of the input data, such as the valid range of depth values and the orientation of the majority of the soundings. Specific program options, such as the capability to plot valid, invalid or all soundings, can also be specified. RSEXEC also enables the user to restart an RSCR run at any point in the job stream.

2.1.2 Checkpoint Run

The Checkpoint Run task enables the user to examine the parameters and statistics for a run which is in progress. The capability to cause an orderly termination of the run at any point in the job stream was successfully demonstrated.

2.1.3 Input Magnetic Tape

The capability to input raster scanned data from a tape obtained on the Hamilton Standard Color Raster Scanner was demonstrated. The specified section area was successfully extracted from the input data. The user can specify up to ten (10) section areas which can be either internal or external. The user can also specify the color to be extracted. Input data generated on the Raster Finishing Plotter was unavailable.

2.1.4 Identify Sub-Clouds

Sub-clouds were correctly identified within the input data.

2.1.5 Collect Sub-Clouds

Sub-clouds were collected correctly. Each primary cloud was identified as a candidate or a problem based on its dimensions and the supplied parameter values.

2.1.6 Extract Candidate Characters

The isolated, identified candidate clouds were successfully extracted from the scan data. Repeated passes were made against the data as necessary when large numbers of candidates were contained on the same scan line.

2.1.7 Preprocess Candidate Clouds

Extracted candidate clouds were successfully filled, smoothed, reduced in size, rotated at the user specified or determined orientation and skeletonized without losing their characteristics. The rotation process was deemed to consume excessive processing times.

2.1.8 Recognize Character

The preprocessed candidates were reformatted and submitted to the Handprinted Symbol Recognition (HSR) routines. Candidates which failed dimension tolerance tests were identified and not submitted to HSR. Coalesced candidate characters were identified as too large and were successfully separated and submitted to HSR individually. Table 2-1 contains the recognition results for a series of characters examined within a smooth sheet area of approximately 3 inches by 5 inches. Results obtained via a manual recognition and via HSR are shown. The three sets of HSR results represent the application of different candidate cloud preprocessing parameters.

2.1.9 Sort Character File

The Character File was successfully sorted in ascending Y.

2.1.10 Build Grid

The Grid Index was built successfully.

MANUAL ID	RUN 1					RUN 2					RUN 3				
	OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED		
			REJECT	SM	LG			REJECT	SM	LG			REJECT	SM	LG
?	X					X					X				
DOT 2			X		X			X		X				X	
1	X					X					X				
3	X					X					X			X	
DOT 5	X				X	X				X			X		
DOT 0					X					X				X	
8	X		X			X		X			X				
0			X					X			X				
6			X					X			X				
6			X					X					X		
DOT 8					X					X			X		X
8	X	X				X	X				X				
4	X					X				X			X		
DOT 0					X					X				X	
1			X					X			X		X		
7			X					X			X				
8			X					X					X		X
DOT 3			X		X			X		X			X		
60						X		X						X	X
DOT 5	X				X	X				X	X			X	
DOT 4					X					X				X	
0	X		X			X		X			X		X		
5			X					X					X		
5	X					X					X				
1	X					X					X				
DOT 7					X					X				X	
DOT 7					X	X				X				X	
508	X				X	X					X				X
6			X					X		X			X		
DOT 6					X					X				X	
DOT 65					X					X				X	X
7						X		X					X		
3			X					X					X		
7			X					X					X		
7	X					X						X			
DOT 6			X		X			X		X			X		X
DOT								X		X			X		X

Table 2-1 Character Recognition Results (Page 1 of 6)

MANUAL ID	RUN 1					RUN 2					RUN 3				
	OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED		
			REJECT	SM	LG			REJECT	SM	LG			REJECT	SM	LG
DOT 4	X				X	X				X			X		X
2			X					X					X		
0			X					X			X				
9			X					X					X		
6					X					X					X
5			X					X					X		
DOT 7			X		X			X		X			X		X
DOT 7			X		X			X		X			X		X
DOT 6			X		X			X		X			X		X
DOT 3	X					X				X					X
8		X					X				X		X		
5			X					X					X		
1	X					X					X				
3	X					X					X				
5	X					X							X		
DOT 7					X			X		X					X
DOT 7			X		X			X		X			X		X
DOT 6			X		X			X		X			X		X
DOT 5			X		X			X		X			X		X
DOT 7			X		X			X		X					X
1	X					X					X				
7	X					X					X		X		
DOT 5			X		X			X		X			X		X
DOT 5			X		X			X		X			X		X
DOT 6			X					X					X		
0	X				X	X				X					X
DOT 7					X	X		X		X					X
8	X					X		X					X		X
3			X					X					X		
2			X					X					X		
6			X					X		X			X		
DOT 6					X					X					X
DOT 6			X					X					X		
7	X					X							X		
5	X					X							X		
3		X											X		
8					X		X			X			X		
DOT 3	X					X		X					X		
3	X		X										X		
7					X										X
DOT 8	X				X	X				X					X

Table 2-1 Character Recognition Results (Page 2 of 6)

MANUAL ID	RUN 1					RUN 2					RUN 3				
	OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED		
			REJECT	SM	LG			REJECT	SM	LG			REJECT	SM	LG
DOT 7	X			X		X			X		X			X	
3			X					X					X		
9			X					X			X				
DOT 880				X	X				X	X				X	X
5	X			X		X			X				X		
DOT 6			X					X					X		
0			X					X			X				
8	X			X		X			X		X			X	
DOT 6			X					X					X		
6			X					X					X		
9			X					X					X		
DOT 5				X					X					X	
5	X					X					X				
5	X		X			X		X			X				
2													X		
DOT 5			X					X					X		
1				X					X					X	
1	X					X					X				
1	X					X					X				
1	X					X					X				
DOT 4				X					X					X	
DOT 4			X					X					X		
20					X					X					X
DOT 1				X					X					X	
58	X				X	X					X				X
1	X					X					X				
DOT 2			X					X						X	
7						X					X				
1	X					X					X				
1	X					X					X				
4			X					X					X		
DOT 1			X					X			X				
9			X					X					X		
9			X					X					X		
DOT 6			X					X					X		
DOT 60				X	X				X	X				X	X
DOT 2				X					X					X	
3			X					X						X	
1	X					X					X				

Table 2-1 Character Recognition Results (Page 3 of 6)

MANUAL ID	RUN 1					RUN 2					RUN 3				
	OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED		
			REJECT	SM	LG			REJECT	SM	LG			REJECT	SM	LG
DOT 8					X					X				X	
3			X					X					X		
8			X					X					X		
4			X					X					X		
00					X	XX									X
DOT 6			X		X			X		X			X		X
DOT 3			X		X			X		X			X		X
DOT 8			X		X			X		X			X		X
2			X					X			X				
78					X					X			X		X
DOT 40					X					X				X	X
7			X		X	X		X		X			X		
5	X		X			X		X					X		
4			X					X			X		X		
DOT 7			X		X			X		X				X	
DOT 7	X				X	X				X			X		X
DOT 3					X					X				X	
8			X					X					X		
5	X		X			X		X					X		
2			X					X					X		
DOT 7	X				X	X				X			X		X
8			X			X		X					X		
0	X					X		X			X		X		
DOT 7					X					X				X	
8			X					X					X		
59			X		X			X		X			X		X
DOT 8					X					X				X	
2			X					X			X				
850					X					X			X		X
DOT 2			X		X			X		X			X		X
DOT 3			X		X			X						X	
3			X					X			X		X		
4	X					X							X		
DOT 4					X					X				X	
2			X					X					X		
6			X					X			X				
88					X					X					X

Table 2-1 Character Recognition Results (Page 5 of 6)

MANUAL ID	RUN 1					RUN 2					RUN 3				
	OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED			OK	SUB	UNRECOGNIZED		
			REJECT	SM	LG			REJECT	SM	LG			REJECT	SM	LG
DOT				X					X					X	
25				X	X				X	X				X	X
DOT				X					X					X	
3	X														
6			X					X					X		
DOT				X					X					X	
1	X														
7			X					X					X		
1	X												X		
1	X												X		
6			X					X				X			
DOT				X					X			X		X	
9			X					X					X		
4			X					X					X		
8			X					X				X			
DOT				X					X					X	
DOT				X					X					X	
1			X					X					X		
7			X					X				X			
?			X					X				X			
?			X					X				X			
?			X					X				X			

TOTAL NUMBER OF CHARACTERS: 822
 TOTAL POSSIBLE RECOGNIZED: 510
 NUMBER RECOGNIZED CORRECTLY: 193
 NUMBER OF REJECTS: 317
 NUMBER MISRECOGNIZED: 10
 PERCENT RECOGNITION: 37.8%

Table 2-1 Character Recognition Results (Page 6 of 6)

2.1.11 Compose Soundings

Individually recognized and indeterminate characters were successfully composed into soundings. Each sounding was correctly identified as valid or invalid based on:

- o the number of characters in the sounding and the specified number of characters in a valid sounding
- o the depth value of the sounding and the specified valid range of depth values
- o inclusion of an indeterminate character in a sounding

Dots on the smooth sheet which indicate sounding location were identified as indeterminate characters. The capability to exclude these dots from the composed soundings was demonstrated. Table 2-2 depicts results of the sounding composition process.

2.1.12 Generate Plot

Several tapes were generated and successfully plotted on the Xynetics. Plot options which were demonstrated included the capability to specify color for both valid and indeterminate soundings. Plots were generated which included only valid soundings, only invalid soundings, and all soundings. Sounding location was precisely indicated by either a position symbol or the depth value. Optionally, the depth value was included near to and offset from the position symbol. All valid soundings were plotted in one color and all invalid soundings were plotted in another color. Position symbology was a graticule for valid soundings and a triangle for invalid soundings. Indeterminate characters within a depth value were plotted as a question mark. The name of the file, associated geographic information and the date the plot tape was generated were included along the margin of the plot.

VALUE	SOUNDING	RECOGNITION	
	COMMENT	MANUAL	HSR-RUN 3
860		860	??0
870		870	???
750		750	??0
765	65 coalesced	7?	4?
792		792	???
755		755	???
780	78 coalesced	70	70
835		835	???
880	coalesced	?	?
960		960	??0
1155		1155	1125
1120	20 coalesced	11?	11?
991		991	??1
105	05 coalesced	1?	1?
1120		1120	112?
1320		1320	1220
960	60 coalesced	9?	??
700	00 coalesced	7?	??
800	00 coalesced	8?	8?
745		745	74?
707		707	70?
228		228	??8
362		362	362
811		811	811
323	3 on edge	32	32
488		488	488
531		531	??1
508	coalesced	?	?
477		477	???
650		650	??0
618		618	???
651		651	???
623		623	???
733		733	???
593		593	???
556		556	???
584	58 coalesced	74	??
614		614	???
721	21 coalesced	7?	??
531		531	4?1
640		640	??0
632		632	???
605	coalesced	?	?
683		683	???
778	78 coalesced	7?	??
828		828	???
850	coalesced	?	?
884	88 coalesced	74	??
961		961	???
1074	074 coalesced	1?	1?

Table 2-2 Sounding Composition Results (Page 1 of 2)

SOUNDING		RECOGNITION	
VALUE	COMMENT	MANUAL	HSR-RUN 3
60		60	?0
60	coalesced	?	?
61		61	?1
63		63	??
66	coalesced	?	?
73		73	?3
77		77	??
76		76	??
78		78	78
86		86	8?
112		112	112
172		172	172
360	60 coalesced	3?	??
412		412	?1?
450		450	?50
590	coalesced	?	?
330		330	33?
348		348	?4?
402	40 coalesced	?2	??
537		537	???
598	59 coalesced	?8	??
433		433	??3
625	25 coalesced	6?	??
492	edge	4	?
51		51	?1
54		54	??
53		53	?3

TOTAL NUMBER OF SOUNDINGS: 77
 TOTAL CORRECT MANUAL RECOGNITION: 52
 PERCENT CORRECT MANUAL RECOGNITION: 67.5%
 TOTAL CORRECT HSR RECOGNITION: 5
 PERCENT CORRECT HSR RECOGNITION: 6.4%

Table 2-2 Sounding Composition Results (Page 2 of 2)

2.1.13 Generate BDRS

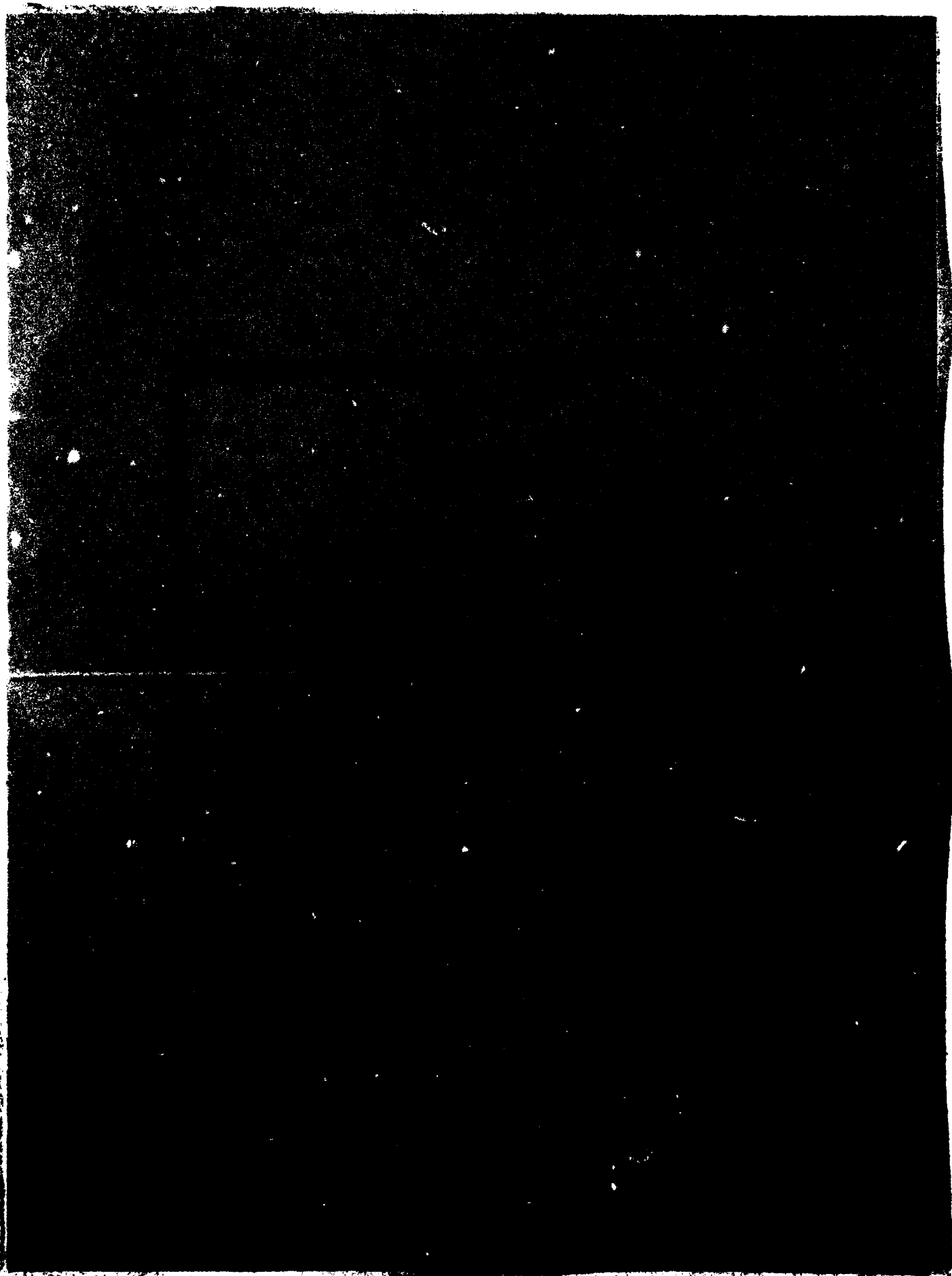
A magnetic tape was generated which contained the generated depth soundings. Each had the correct depth value and was properly positioned. A maximum of 64 soundings were contained in a single depth feature. Invalid soundings were assigned a depth value of -1 and were contained in separate features from valid soundings. The BDRS was unavailable to enable testing of the tape via inputting.

2.2 Parameter Performance

Parameters performed according to their descriptions as contained in the RSCR Operator's Manual. The parameters associated with the size of a candidate cloud and the size of a preprocessed candidate appeared to be critical. The recognition software appeared to be sensitive to the rotation of the candidate character.

2.3 Data Performance

The RSCR accepted inputs and generated outputs as described in the Computer Operator Manual. The quality of the scan data appears to be a critical factor in obtaining successful results from the RSCR.



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