REPORT ON
CONVERSION OF NCDC MICROFILMS TO ELECTRONIC FILES
WITH FOSDIC

M. Leighton Greenough

Greenough Data Associates
Rockville, MD  20850
REPORT ON
CONVERSION OF NCDC MICROFILMS TO ELECTRONIC FILES
WITH FOSDICTC

M. Leighton Greenough
Greenough Data Associates
Rockville, MD  20850
for

National Climatic Data Center
National Oceanographic and Atmospheric Administration
United States Department of Commerce

Prepared under P.O. A5129 with
The Orkand Corporation

October 30, 1998
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Foreword and Reader’s Guide

This report describes the project for converting data contained on approximately 3,000 reels of microfilm to a magnetic storage medium. These reels contain approximately 12,000 images each of tabulating cards punched with past weather observations. The equipment utilized was the author’s FOSDIC, an instrument for scanning 16 mm roll films.

The report begins with a list of the specific decks and reels involved in the conversion in Section 1. Readers interested primarily in results of the process are referred to Section 4, where performance quality indicators are reviewed. The process itself is outlined in Section 2, a brief description of the equipment, and in Section 3 covering the scanning program in moderate detail. Section 5 on remnant actions lists remaining tasks relative to the scanner and to the sponsoring agency. Section 6 contains notes pertinent to the processing of each deck. More detailed notes relating to processing of individual reels are available from the author.

Appendix A provides a conversion table showing the recorded characters for punched data in the card columns. The remaining Appendices provide a listing of the source program components which make up the scanning program.

Acknowledgement

While the author was responsible for the scanning program, the subject of the bulk of this report, acknowledgement must be made of the contributions of Nevell L. Greenough, who developed the associated programs for preparing the final data output.
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1.0 Introduction

This report covers a project undertaken by the author to convert archival microfilms of punched cards containing climatic data to modern computer form, using proprietary scanning equipment called FOSDIC. Some 3,000 rolls of 16mm film, or approximately 36 million cards, were processed. These films were made under special conditions to facilitate scanning by equipment of this type.

1.0.1 List of films scanned

The films listed below were included in the project work statement. A few films were unavailable at the time of this report. These are marked with comment notes following the list.

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<td>23</td>
<td>122</td>
<td>0     (2)</td>
</tr>
<tr>
<td>CD-184</td>
<td>British Marine</td>
<td>April 1953-1961</td>
<td>53</td>
<td>63</td>
<td>63    (3)</td>
</tr>
<tr>
<td>CD-185</td>
<td>USSR Marine</td>
<td>1957-1958</td>
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</tr>
<tr>
<td>CD-187</td>
<td>Japanese Whaling</td>
<td></td>
<td>2</td>
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<td>2</td>
</tr>
<tr>
<td>CD-189</td>
<td>Dutch Marine</td>
<td></td>
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<tr>
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<td>CG Log Book</td>
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<tr>
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</tr>
<tr>
<td>CD-194</td>
<td>British Marine</td>
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<td>341</td>
<td>339</td>
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</tr>
<tr>
<td>CD-195</td>
<td>Navy Ship Logs</td>
<td>1945-1945</td>
<td>54</td>
<td>54</td>
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</tr>
<tr>
<td>CD-196</td>
<td>German Marine</td>
<td>1949-1953</td>
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<tr>
<td>CD-197</td>
<td>Danish Marine</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>CD-256</td>
<td>Surface Marine</td>
<td>1963-</td>
<td>72</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>CD-258</td>
<td>Surface Marine</td>
<td></td>
<td>4</td>
<td>170</td>
<td>0     (5)</td>
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<tr>
<td>CD-281</td>
<td>Navy MAR</td>
<td>Beg. -1945</td>
<td>17</td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td>CD-541</td>
<td>US RAOBS</td>
<td>1941-1947</td>
<td>21</td>
<td>1</td>
<td>1     (6)</td>
</tr>
<tr>
<td>CD-547</td>
<td>Payerne RAOBS</td>
<td>1942-1948</td>
<td>1</td>
<td>0</td>
<td>0     (7)</td>
</tr>
<tr>
<td>CD-608</td>
<td>Hungary RAOBS</td>
<td>1954-1958</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CD-650</td>
<td>Formosan RAOBS</td>
<td>1952-1960</td>
<td>7</td>
<td>7</td>
<td>7</td>
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<tr>
<td>CD-690</td>
<td>Israel RAOBS</td>
<td>1957-1961</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Totals as of date 10-30-98 .................................................. 3046 ...... 3061 ...... 3061
Totals after completion of Deck 194 .................................... 3046 ...... 3063 ...... 3063
Totals if missing reels received ....................................... 3046 ...... 3088 ...... 3088

Notes: (applicable 10-30-98)

(1) deck 118, reel 119 not recvd  (4) deck 194, reels 062, 089 not recvd
(2) deck 129, deleted at later NCDC request  (5) deck 258, deleted at later NCDC request
(3) deck 184, reel 012 not recvd  (6) deck 541, 20 reels not recvd
(7) deck 547, 1 reel not recvd

The missing reels will be scanned when received
1.1 Background

The name FOSDIC is an acronym accurately describing its function, Film Optical Sensing Device for Input to Computers. Since the early 1950s ten models of these machines have been produced. Many, including the original, were designed for Census use. The first Fosdic for the Weather Bureau was developed at the Bureau of Standards in the middle 1950s. Subsequently two more machines were introduced. For use with Fosdic, extensive files of weather data contained on punched cards were microfilmed in a style readable by the machine. This greatly compressed the size of the files. The intended goal at the time was to perform data processing operations from the films, it being faster and more convenient than working directly with punched cards. However with advances in computers and magnetic storage techniques, and given the fragility of film, it became more practical to apply the machines to simply converting the data from the microfilms to computer language. By the end of the useful life of these machines, tens of millions of cards had been converted, still leaving many more inaccessible. This led to approaching the Census Bureau, which had remaining scanners from the 1990 operation. Feasibility was demonstrated but production was unavailable because of later machine decommissioning. Then construction of the author’s scanner was completed. Feasibility of Fosdic use for this application was again demonstrated and the present project established.

The project began after demonstration scanning of sample films obtained from the Climatic Data Center. A relatively straight-forward program for scanning these films had indicated overall feasibility. At initiation of the project, the program was expanded to take into account certain anticipated difficulties. Not surprisingly, other problems appeared as the work progressed. Modifications to the program became necessary from time to time, resulting in a final version of appreciable sophistication. Among its important features is the ease of introducing custom modifications, often needed for successful processing of individual reels. It is the latest version which is the subject of the documentation included in this report.

Measures for monitoring quality evolved during the course of work. In particular, tests for comparison of the data from duplicate runs, required under the contract on only an initial sample, were eventually performed on every deck. Numerous other criteria for evaluating data quality were introduced as the work progressed.

1.2 Films of punched cards

The films of interest were made in several modified Recordak rotary microfilm cameras. This type of camera involves continuous synchronized movement of the film and the object, here the direction across the narrow dimension of the punched cards. A slot in the direction of movement, together with the velocity, combine to control the exposure time. With illumination in back of the cards, light reaches the film to produce exposure at the hole locations and between the cards. These areas then appear dense on the (negative) films. Original films so produced are the ones scanned. In a few cases only copy films of the same polarity were available.

1.3 Camera modifications

The commercial cameras were modified in several respects for this application. First, the normal lens was supplemented by adding an attachment known as an anamorphic lens. This lens
has magnification of close to 2X in one axis and none in the other, perpendicular axis. It is the basic element in the Cinemascpe process for motion picture films. It is here used to double the number of cards on a roll of film, allowing over 12,000 cards on a 100-foot film roll. Of additional benefit is the fact that it makes the rectangular punched holes more nearly square, for a better match to the round scanning beam. With the anamorphic lens, the camera reduction ratio is approximately 24X across and 45X along the film.

The second modification was to add a scale made up of 81 bars whose thickness and location match the card stock web space between columns of punched data. These bars are parallel to film movement. The original purpose of the scale was to allow dependable access to each column despite the limitations of then available digital-to-analog converters. Such restrictions are no longer applicable but the outside scale bars remain beneficial for registration purposes. With this scale placed in close contact with the cards in the filming aperture, light can only reach the film in the spaces between the bars. Properly registered cards then show as full-width hole patterns in the overall card image.

Figure 1-1 on the next page is a drawing showing details of typical films. Overall, the effect on aspect ratio due to the anamorphic lens is evident in the lesser than normal short dimension of punched cards and the nearly square holes. The card stock itself, being relatively opaque to the illumination, appears clear or nearly so. Around the card and through the punched holes, the film is dense. The scale bars, as mentioned above, block light to produce clear lines at their positions. Finally there is a clear card bar at beginning of every card location. This bar appears even during card misfeeds.

The Card Bar appears at nominally regular intervals along the film. It is not always distinguishable, particularly in the leader sections of the film, in misfeeds or when the camera stops. Typically along a roll there are many visible card bar images not accompanied by cards. Nevertheless every readable card must have a clearly legible, well positioned Card Bar. Its proper position is with its left side coinciding with the left side of the card image as shown in Figure 1-1.

In the course of scanning, numerous departures from the ideal conditions shown in Figure 1-1 arose. Some expected and unexpected conditions are next covered along with the remedial measures it was found neccessary to include in the scanning program.

1.4 Variability in films

This section describes the properties of the films with which a successful scanning routine must cope. Important variables related to films are 1) overall condition, 2) density and 3) variation in image geometry. To these potential problems, the punched cards contribute those of 4) punch misregistration, 5) expansion or contraction of card size, 6) color of card stock and 7) excessive clipping of corners. The discussions which follow cover some anticipated concerns, experiences in the course of scanning and such remedial measures as could be worked out.

1.4.1 Film condition

These are old films, some as much as forty years. There was an initial apprehension
about their physical condition, with regard to stickiness and fragility. The former never became evident. Fragility is an issue because high speed film transport is essential for efficiency in throughput. Film movement for instance accounted for 40 percent of roll processing time. Despite applied cushioning in acceleration and deceleration, the rapid start and stop motion can result in film breakage; this happened in the trailer end of two films.

In microfilms of this age, blemishes in the form of small spots are not uncommon. These original films are negatives, with the result that their opacity simulates that of punched holes. The artificial data so created depends of course upon specific locations. Sometimes the result is an asterisk indicating an illegal punched character, creating data loss rather than substitution. The most effective measure against blemishes is to identify the strongest signal in a numeric or the two strongest in an expected alphabetic, column. Then any blemishes weaker than punching drop out. As is mentioned later in the discussion of quality control, an excessive count of asterisks, when followed up by review scanning, is an important tool for evaluating blemishes. The general conclusion at the end of the project is that, while some were present, the contribution to errors was not major.

Blemishes at certain other locations may produce apparent departures from true rectangularity in the card images. Such distortions are detectable so that erroneous information from this cause can be screened out.

1.4.2 Density variation

At project initiation it was anticipated that appreciable variation in overall film density (logarithm of inverse transmittance) might be encountered. This turned out to be an unfounded concern. Some elaborate measures for handling density variation were developed but later discarded as unnecessary complexities. The few occasions of overly dense or light reels were treated with ad hoc customizations.

Some reels were of cards filmed by both transmitted and reflected light. The latter represented an attempt to preserve printed information on the card face. Printing of this nature reduces the difference between the hole signals and the background, complicating the process of thresholding between hole and background signals. For example the double illumination may darken the background area surrounding holes to less than half of that obtained with transmitted light. Considerable experimentation was performed to deal with this factor. The final program contains provisions for automatic recognition of this variable density in the background card stock.

An unexpected density-related problem in the scale zone became noticeable on certain cameras. The common evidence was that card misfeeds caused the camera to decelerate and stop before reducing the illumination. This produced overexposure in the scale bar area immediately following card images. Then the resultant unsuccessful search for scale bars created calibration failures. This was one of the most common causes of such failures.

1.4.3 Geometric variation

Microfilm cameras of nominally the same type can be expected to show minor differences
in reduction ratio; a typical tolerance is in the order of three percent. Adding the anamorphic attachment increases the possible longitudinal variation (the short card dimension) to possibly five percent. These are steady state conditions fixed in each camera. Automatic size calibration in the Fosdic program finds four corner locations on every card, computing from them the locations of the 960 hole coordinates. This produces 79 equal intervals from columns 1 to 80 and 12 from the top of the card to the "9" row.

Aside from this fixed geometry, variations arise. A possibility is that cards may enter the filming aperture on a slant. Particularly the first few cards filmed from a stack may show a slant of up to one-half degree, approximately the height of a punched hole. The clue to the presence of such slant is the difference in the measured horizontal (in scanner coordinates) locations at columns 1 and 80 on a card. This difference must be scaled accordingly for every column and applied as a correction to its 12 computed hole locations. There is also a vertical (in scanner orientation) shift accompanying any slant; its magnitude is considerably smaller. Correction for this was deemed not worthwhile in view of its complexity and cost in computing time.

A surprisingly common variation in geometric fidelity is evident on the films. In card terms, rows appear out of place, being either above or below their nominal positions. This displacement can reach as much as one-half of the height of a hole. It may possibly be due to fluctuating synchronism between motion of the cards and the film during the time of exposure due to backlash in gearing, or else simply misregistered row punching. The result is the same, that is, dividing the top-to-bottom dimension of a card image by 13 intervals does not always define the row location on an image. The displacement is least in the upper and lower rows and greatest in the central ones.

Another observed phenomenon is that several reels showed a variation equivalent to a photographic stretching of the narrow card dimension, cycling as much as 10 percent with a periodicity of perhaps 30 cards. Watching the viewing screen during processing gave the impression of "breathing" in size.

Finally the most frequent problem observed on the films was due to lateral (columnar) misregistration of the cards with respect to the scale bars during filming. Improper registration, either at the time of punching or of filming, produces partially-occluded, narrowed images of the holes. These create problems for scanning. First, the resultant loss in apparent hole size translates into signal reduction. Besides this, the residual hole images are inherently off-center from the normal position because the occlusion occurs from one or the other side of the hole images.

As is described in some detail in regard to the scanning program, the remedial measure for either type of misregistration is to search for the best response in multiple adjacent positions around the nominal hole center. Misregistered holes have only partial coverage by the scanning spot, yielding weakened signals. In the adopted scanning program a fractional response at any nominal hole center hole triggers five rescans of the entire card at modified positions and sensitivity. This greatly reduces the number of missed holes. At the same time, the loss in overall throughput is minimal because the rescans take place only when necessary. Typically this adds a few percent to the running time for reels.

1.5 (begins on next page)
1.5 Variability in punched cards

Misregistered punching is of course the principal concern with regard to introduced problems. It can take several forms. Oversized cards, brought about by high humidity in storage before filming, mostly have shown good matching at the column-80 side but with “thin” holes at the opposite side of the cards. Earlier correction techniques, such as shifting the reading positions leftward for the lower-numbered columns, showed considerable benefit, as indicated by fewer dropped punches in designated column groups. It was the method of choice for many initial runs. It has the disadvantage of being time consuming to execute, along with introducing a minor prejudice for properly located punching.

In many instances individual cards showed a combination of zones of excellent and bad hole images. Again the card left side was the location of most occurrences. This suggests that the punching took place in more than one machine.

The color of card stock has some influence on image density. Semi-transparent material should produce denser background, leaving less difference between background and hole signals. The same image condition also appears as a result of filming by reflected light, as was evident on several dozen reels. For this reason the signal thresholding formula in the scanning program includes background density in the computation, performed individually for every column.

Excessively trimmed corners on possibly a hundred cards altogether resulted in calibration failures. On occasion the clipping at top or bottom extended into the cards as much as ten columns. It was possible to observe these incidents by calling for a programmed halt on such failures. For these there was no countermeasure beyond program modification to tolerate clipping for up to three columns.

The final version of the scanning program, with its provision for complete card rescan on any doubtful signal, proved to be the best method for handling the problems brought about by card misregistration in either punching or filming. In the rescan procedure, the examination for holes reads with a small displacement on each side of the nominal center, also above and below, as well as at the center, all with elevated sensitivity. This technique eliminated the need for a great deal of the run-time program customization.
2.0 Summary description of Fosdic

All Fosdics have had in common the basic principle of flying spot scanning of film images, using a cathode ray tube which is directed by computer programs. In this arrangement the screen of the Crt is focused by a lens onto the film image and the transmitted light collected by a phototube. Any desired location on the image can then be probed by suitable positioning of the Crt spot by hardware which converts digital instructions to analog deflection. Interactive scanning allows determination of line centers or edge positions. This arrangement is in contrast to conventional systems wherein an entire image is scanned, stored in memory and analyzed. In a Fosdic the photographic image becomes the memory. Increased throughput can therefore result from confining the scanner attention solely to the areas of interest.

One of the useful characteristics of later Fosdics is that in addition to being positionally programmable, the size of the scanning spot is also controllable by the computer. As applied to scanning of images of punched cards, it allows aggregation of film transparency over most of a hole area with a single reading. The distribution of the enlarged disk-like spot is uniform, making multiple readings unnecessary for clustering. Such a characteristic minimizes effects from scratches on the film. Independently of the size of the spot, its incremental movement can be a small fraction of hole dimensions when desired. As is described later these abilities are fully utilized in the scanning program.

Aside from its speed, another detail of the present Fosdic is useful for this service. A reverse illumination system superimposed on the scanning optical path projects a bright 16X enlarged image on a viewing screen showing the film within the scannable aperture. From this enlarged portrayal, it is readily possible to identify the punched holes on the cards by using a simple paper scale. This facilitates comparing optical and electronic records for evaluating the accuracy of data conversion. In addition to the enlarged projection, a smaller image appears on the scanning Crt face. Registration with the scanning pattern is exact because both the projection and scanning beams pass through the same lens. With an 8X close-focus telescope it is possible to evaluate visually the precision of the scanning pattern with respect to the film image.

Scanning takes place while the film is stationary, usually requiring approximately one-twentieth of a second for eight cards. As a result the system is capable of processing about 5500 cards per minute or slightly over 90 per second.

2.1 Components of Fosdic

The latest version of Fosdic is that constructed by the author and shown in Figure 2-1 through 2-4 beginning after the next page. It occupies two cabinets, one containing the computer and power supply, the other comprising the optical and electronic systems. The computer, a 486 DX-66, is at the left in a mini-tower case. Above it is the Iomega Zip disk drive, in which the final output of the project is recorded. Underneath the computer monitor is the scanner control box with power switches and panel counter showing card counts. At the top right in Figure 2-1 is the viewing screen which displays the 16X magnified film image. Film travels from left to right through the film gate where the scanning takes place. Windows on each side of the film gate allow observation of the Crt face with the telescope.
Figure 2-2 is a front-on picture of an image on the viewing screen. The next illustration, Figure 2-3, is a closer photograph of the film-handling panel, showing the windows for Crt observation and the telescope in its adjustable mount. Punched holes are visible as dark spots in the card images. Finally Figure 2-4 shows the Crt face itself with its smaller projected image, about 3.5X the size of the scanned film. As mentioned earlier, this projected image on the Crt and the scanning spot are always in precise registry with each other.

The film transport system presents images to the scanning head in an asynchronous manner, starting and stopping upon command. A motor-driven capstan pulls film through the gate, moving it about three-quarters of an inch at a time. Idler arms in the film path actuate motors on the supply and takeup reels. Small velvet pads at the entrance to the film gate act to remove any extraneous material on the film. Film advance is rapid, typically one-thirtieth of a second for eight card images. The present Fosdic has the ability to examine an area of about one inch of film length, which is equivalent to 10 or 11 cards.
FIGURE 2-2  VIEWING SCREEN SHOWING IMAGES OF NCDC MICROFILMS
FIGURE 2-3  FOSDIC FILM PANEL
FIGURE 2-4  PROJECTED FILM IMAGE ON FACE OF CATHODE RAY TUBE
3.0 Scanning program

All of the operations in connection with Fosdic are conducted in the personal computer environment, where the basic operating system is Microsoft DOS, for Disk Operating System. The scanning program has three major components, whose names and actions are:

**LDR.EXE**
- Run in the film leader, accept typed identifying information for the reel, measure calibration parameters for the reel and generate a Param file with the combined information

**PCSCAN.EXE**
- Perform actual scanning of the approximately 12,000 punched cards on the reel, recording the output data in 80-byte strings in a large file called Datout

**TLR.EXE**
- Generate a Trailer file containing processing and quality monitoring summaries

These separate programs execute as called for in a short batch file with the name GO.BAT. The Appendices furnish a detailed copy of the source programs in assembler language together with extensive commentary. However an understanding of the language is not required for the present discussion of program actions. The immediate next sections take up the functions performed by the three programs above.

At the end of scanning, additional processing routines combine the three files from above into the primary output data file for the reel and some secondary log files. These routines are the subject for later description in Section 3.5 and 3.6.

3.1 Leader program LDR.EXE

Once a reel of film is installed on the optical panel, action begins when the operator types the characters GO and presses the Enter key. This causes the batch file to start executing through its list of programs which constitute the overall processing system.

The batch file first issues an instruction to disable caching of file recording in order to guarantee later that the temporary RAM memory containing scanned data for a group of 640 cards is fully recorded on the computer hard disk before more scanning occurs.

The leader source program is LDR.ASM, expressed in mnemonics and subsequently assembled to direct machine instructions. It calls for several subroutines in the course of execution; these will be introduced as the description progresses.

Fosdic reads entirely by enabling (turning on) the Crt beam, creating a spot of light at a position on the Crt face determined by the previously-supplied horizontal and vertical coordinates. The active period of a few microseconds is followed by programmed movement to the next desired position. The time for repositioning is dependent upon the magnitude of positional shift. For the small change between rows in a column, this inactive time is less than the active beam-on time. Thus with exclusively spot reading, this Fosdic differs from previous models where stroke scanning was the operating mode.
3.1.1 FRAME subroutine

To begin, a procedure (subroutine) called FRAME turns on the Crt beam, generating a vertical column of dots near the left center of the scannable aperture. The film drive capstan also begins movement. Because this is at the start of a reel, the film image is of the scale bars, substantially opaque. The scan pattern effectively waits until the first card appears as indicated by light through the relatively clear card image. When this information reaches the computer, it stops the FRAME routine, disabling the Crt beam and telling the capstan to assume its holding mode. After a pause of a few milliseconds for deceleration and settling, the system is ready for the next action.

The first image should be that of an identification card which has punching in the first three columns to designate the deck number and in the last half of the card, a large visual representation of the reel number. No scanning takes place on this card. In the viewing screen the identification card appears near the left side.

3.1.2 WIPE

After FRAME a series of calibration procedures are performed. First there is WIPE, which drives a full raster across the Crt face to activate the phosphorescent screen. This is to counteract a fading phenomenon associated with this type of very fast phosphor.

3.1.3 GAIN and BKGN

Next come two calibration subroutines GAIN and BKGN (for Background). The former measures the film transmittance in the nominally clear, unexposed film outside of the card area. Its purpose is to compensate for the maximum transmittance of the film, which depends upon the film type and development conditions. It then adjusts the overall optical sensitivity of the system for constant signal amplitude. The system thereafter responds in a uniform manner regardless of whether the film stock is very clear or partially opaque. Images from cards then always produce signals less than the reference level target of 980 units resulting from Gain calibration. It may be mentioned here that signals from the punched holes, which are almost opaque, typically range from 80 to 200 on the same scale.

The Background subroutine attempts to determine the general level of signals from the two areas, the card stock and the dense border near the Card Bar and column 1. On account of several factors, including varying illumination in the exposure areas in cameras, the former measurement is of questionable usefulness. It was eventually supplanted by a background reading in every column. The dense border information is obtained from multi-spot readings spanning the border. It shows the lowest signal which can be expected on the film, typically around 60 units. Both GAIN and BKGN utilize weighting schemes to minimize effects from film blemishes. The parameters obtained from these subroutines appear in a file called Param.

3.1.4 CAL DSPL

Results from the aforementioned calibration appear in a display on the computer monitor for operator evaluation with respect to normalcy. The subroutine called CAL_DSPL performs this function.
3.1.5 **ENTRY**

The last subroutine in the leader program is ENTRY. It begins execution with waiting for operator typing of Deck and Reel identification numbers. The system accepts minimal typing in not requiring leading zeroes. In any case, ENTRY places the deck number into the Param file as it is typed, with or without leading zeroes. Any lower case alphabetic characters are automatically capitalized by the subroutine for consistency in display.

The leader program LDR ends by recording the 100-byte Param file, which also contains other information on processing date and start time. All of this is specific to the particular run; the file is written over at the start of the next reel.

### 3.2 Punch card scan program PCSCAN

This and its subroutines form the main part of the scanning system. It has two major components, SCAN which reads the data from eight cards and FRAME which moves the film to the next group of eight. SCAN itself calls other subroutines, all of which return directly to the caller without further branching. FRAME is the same subroutine mentioned before as used by the LDR program. While some of the subroutines execute only once in reel processing, as in the leader program, many are set up for multiple use on every card. Again the subroutines are brought into the discussion here as needed.

Before calling for SCAN to start reading card data, certain preparatory actions are in order. PCSCAN begins with reading the Param file to extract the contained parametric values and typed identification data mentioned above. The first subroutine called is JUSTIFY, which aligns the typed deck and reel numbers into the DOS convention of eight-digit name and three-digit extension.

#### 3.2.1 JUSTIFY

This subroutine accepts up to eight characters for reel number, aligning them to the right and supplying leading zeroes to make up a full eight-digit name. It does the same for the reel number, placing the filled reel number in the extension field. It also adds a separating period digit, thereby forming a message which later becomes the name of the file recorded for each reel.

#### 3.2.2 Return to PCSCAN, the MSK file

The next action is to read in an auxiliary mask file carrying information specific to the deck regarding the expected type of punched data in each of the 80 columns. This essentially is an interpretation of the column-by-column information in the Reference Manuals. Two types of encoding are accessible in the present scanning program, single digit and alphanumeric with overpunch. Switching between these is the function of the mask file.

Before considering the mask file in detail, it is worthwhile to review the available possibilities. To start, the Fosdic program reads the 12 row positions in every column and sorts the results in order of the three strongest signals above a threshold. The benefits of restricting data coding to the single strongest signal in blemish tolerance have already been touched upon.
Thus encoding for the single strongest response is desirable whenever applicable. The other encoding style accommodates overpunching in the ‘Y’ (12) row, ‘X’ (11) row, and a single punch in the numeric ‘0’ through ‘9’ rows. By rendering all of these, it guarantees proper interpretation of valid punched data in the cards. It would be the universal style of choice except that experience has shown increased pickups (false holes) from film blemishes.

The purpose of the .MSK file is to specify to the scanning program those columns requiring alphabetic/overpunch coding. Then the remaining columns can have the benefits of blemish tolerance provided by recording the single strongest digit. To implement this function, a special 80-character mask file is created beforehand for every deck. These files are named with the deck number and .MSK as the extension. Deck identification for selecting the desired mask file is derived from the typed data in the Param file.

Initially in the project activity this approach was applied rigorously until a significant problem became apparent. Many instances were observed where multiple punching occurred in columns other than those designated in the Reference Manuals. Often the extra (usually double) punching appeared in adjacent columns. To take care of these cases as well as possible misunderstanding of instructions in the Manuals, a “learning” approach was adopted. Its introduction is considered an important step in evolution of the scanning program.

Learning applies to columns not already designated as needing encoding for alphanumeric or overpunch data. In double-punched but not so specified columns, an arbitrary number of single reads is permitted, after which the column becomes converted to the full encoding. It remains in that pattern for the remainder of the reel. In effect a potential for substitution is traded for accurate reproduction of multiple punches when shown to be needed. At the same time maximum protection against blemishes is retained as long as feasible. In the adopted implementation, the second instance of double punching in a column converts its encoding for the rest of the reel to the full alphanumeric/overpunched form.

In setting up the learning approach, the 80-character mask file contains either a ‘2’ for two single read encodings or a ‘0’ for multiple punch interpretation. The file is first loaded with ‘0’ for those columns known to require full encoding. The remaining columns are filled with ‘2’ or other values. Then if unexpected double punching is found in a scanning a column, the appropriate character is decremented by one. When it reaches ‘0’, decrementation is stopped and column interpretation is kept as alphanumeric/overpunch until the end of the reel. A list of mask file contents for all decks is included in Appendix J-2.

At this stage PCSCAN calls for the .MSK file with the appropriate deck name carried by Param and transfers its contents to a memory section for later reference. After some housekeeping actions, PCSCAN calls the subroutine SCAN which controls the actual scanning of up to eight cards. On the subsequent return from SCAN, a loaded data file contains the punched information along with status indicators and memory pointer.

3.3 SCAN program

This is the subroutine responsible for control of other subroutines which perform the actual work of searching and extracting data from the card images. One of its primary actions is to supply parameters to the called functions. Examples are geometric coordinates, directional
indicators and signal thresholds. All of the called functions return to SCAN which when completed goes back to PCSCAN.

3.3.1 Coordinate scales

The system has three basic axes, horizontal or X, vertical or Y, and tilt or skew. In the first two the units of movement are expressed in mils, one thousandth of an inch, with a range of 0 to 32,767. This scale comes from digital-to-analog converters of 13 bits. In this scale the center is 16,384; deflection of the Crt beam to this value in both axes brings the spot to the center of the scannable aperture. The scannable aperture extends from approximately 5,000 to 27,000 mils horizontally and 9,000 to 23,000 mils vertically. The polarity of movement is that increasing coordinate values cause rightward and downward motion on the Crt and viewing screens.

This scale factor matches a microfilm reduction ratio of 24X very closely, that is, the least programmable unit of one bit produces a movement on the filmed original of one mil. On this basis the dimensions of a card are:

Card width: 7,375 mils nominal  
Movement in this direction is in the Fosdic vertical (Y) axis
Card height: 1750 mils nominal  
Horizontal (X) movement
Hole width: 58 mils nominal in Y axis
Hole height: 63 mils nominal in X axis
Scale length: 430 mils approximately in X

Because the card images are oriented transversely on the film, horizontal movement in Fosdic corresponds to row-to-row excursion in the card images. Increasing horizontal coordinate values therefore proceed down a card. Vertically the opposite is true; higher values are associated with the left side of cards or lower column numbers.

Fosdic has the additional programmable coordinate of Tilt (skew), producing a pattern rotation about the center of the Crt screen. Its range results from ten bits or 0 to 1023, covering the range from approximately 4 degrees counterclockwise to the same clockwise. Here the middle value 512 represents zero tilt.

3.3.2 Scan origin

SCAN begins with setting the coordinate origin which is the reference for almost all subsequent action. For the purposes of the present discussion, references to position are with respect to the visual orientation on the Crt or viewing screens unless otherwise noted. The horizontal position of the origin is slightly to the left of the first of a group of the eight central cards of the ten normally visible after film advance. After setting the origin, SCAN calls for the GAIN subroutine.

3.3.3 GAIN

This is the same procedure used earlier in the leader program. As before it is performed in the clear unexposed zone near the top of the screen. The effective output of the procedure is
to generate the proper input to its associated circuits in the scanner to bring the maximum signal amplitude to the nominal level of 980. It then returns to SCAN to prepare for VTRACK which finds the vertical position of the card images.

3.3.4 VTRACK

It is necessary to search for the lateral location of card images to compensate for significant differences in placement among cameras. The specific action of VTRACK is to locate the vertical position of the visual bottom of the first card, its left edge in terms of card orientation. The procedure output is a variable called YCMargin, where the ‘C’ refers to the coarse coordinate scale whose least programmable bit is 4 mils. The completion of VTRACK marks the end of initialization before undertaking actual card reading.

The procedure uses an array of 12 columns of 16 reading positions about 2 inches (in card dimensions) square. Horizontally the array begins at the origin, thus it covers parts of the scale zone as well as part of the card image. In each of 12 downward columns it finds the transition from clear card stock to dense band below the first card. The mean location of the four most downward transitions is the product of simple calculations. This algorithm hence rejects contributions from other than the desired positions. With a minor downward shift to approximate the center of the dense band, the resultant becomes YCMargin, the basic reference for proceeding with reading the eight card images in the frame.

In as much as high precision is not a requirement for this measurement, the Crt spot size is large, about 100 mils. The procedure is interactive in that the vertical strokes stop upon detection of the dense band. Its proper action is therefore visible on the face of the Crt. YCMargin typically changes in steps equal to the spot size, allowing easy verification. The relatively coarse resolution is quite adequate for the next action, which is to start the search process for the first card after return to SCAN.

Return to SCAN, preparation for Card Bar Search

The process for finding and reading each of the eight cards is substantially identical from this point. In summary it begins with generating an approximate horizontal reference from the Card Bar visible in Figure 1-1. Then comes a short series of actions to locate the position of the nearby corner of the card. This series repeats with appropriate changes in direction to locate all four corners. From the resultant set of coordinates, hole positions are thereafter calculated. Figure 3-1 on the next page is an enlarged drawing of the scanning actions in the vicinity of the first corner of a card image.

A called subroutine named CENTROID creates a multi-dot stroke horizontally across the Card Bar. This is a universal procedure, requiring prior data on position, dot spacing, number and direction of dots in the stroke, spot size and signal threshold. With these specified in SCAN, calling CENTROID produces the horizontal position of the center of the Card Bar. The vertical coordinate of the stroke, YCMargin, remains unchanged.

3.3.5 CENTROID

Centroid as used for finding the horizontal center of the Card Bar is a multi-dot dot stroke
FIGURE 3-1 SCAN SEARCH PATTERNS
of relatively large step and spot size. It also is interactive, ending when it has found the target, offering similar benefits for ready verification by early termination. Its maximum length is approximately three-quarters of the card to card spacing, so that it can assuredly cross the Card Bar when film movement is complete. This is the mechanism for handling variability in stopping position.

CENTROID operates by computing the center of gravity based upon signal amplitudes above a threshold. As the stroke moves across a clear line, signals rise to a peak and decay following the peak. Movement stops and calculations begin when the signals fall below the threshold. The formula for calculation uses moments, the sum of the product of amplitudes and positions, this sum being divided by the sum of amplitudes. The result is derivation of the effective center of the Card Bar. This process is capable of considerable precision, as is necessary for its next usage in finding the centers of Scale Bars.

Return to SCAN, preparation for Scale Bar Search

A few films have shown so much variability in card size in the narrow dimension along the film that use of a fixed interval is not feasible. Accordingly the program calls for CENTROID a second time, directed to the Card Bar for the next card. Subtraction of the coordinates produces the true card interval within the limited resolution of this usage of CENTROID. This card-to-card distance is an element in later determination of corner locations.

The center of the Card Bar defines the stopped horizontal position of card images insufficiently well at this stage to be directly usable for scanning the punch holes. Both horizontal and vertical coordinates need further refinement. This is accomplished by changing to another set of scales in the scanner.

Fosdic has provision for additive Coarse and Fine scale movements, which differ by a factor of four. The Coarse scale covers the range from zero to 32,767, the Fine from zero to 8191. On the coarse scale the smallest programmable increment is four mils, on the fine scale, one mil. So far movements up through recognition of the Card Bar have been on the coarse scale. Once any card has been located approximately using coarse coordinates, further actions such as exact positioning and reading of punched holes involve use of the fine scale exclusively. These actions in the fine scale are replicated for every card, superimposed on the coarse positioning derived from Card Bars.

The next actions form a sequence aimed at finding the precise locations of the corners of a card. These subroutines involved are CENTROID again and EDGES, with a supplemental determination of threshold by STRGREAD (for String Read).

The first object of interest is the vertical location in (fine) Fosdic coordinates of the position of the first column in the scanned card. This corresponds to the center of the dense area between the two bottom-most scale bars. The process involves CENTROID to find the center of the lowest bar, followed by a small upward jump to advance the spot to the column center. Here input parameters to the subroutine facilitate the maximum possible precision.

Preparation for this more critical execution of CENTROID consists of reducing spot size
for highest optical resolution, changing to upward vertical motion in fine steps and allowing customizable thresholding. The search vertical origin is in line with the card border at column 1, as is visible in Figure 3-1. Its horizontal location is approximately in the center of the scale between cards, as set by a fixed leftward displacement from the Card Bar.

Aside from the positional preparatory data for locating the scale bar, the threshold for signal amplitudes is most important. Of all of the variables requiring alteration for special film conditions, this is the one most frequently changed. Often the scale area is heavily exposed in filming, resulting in scale bars of reduced thickness or partial transmittance. Both of these conditions lower the useful signal amplitudes. Unless corrected for, higher rates of calibration failure commonly occur. The standard operating procedure has been to allow operator modification of the threshold, expressed as an increment above the signal amplitude at search start location.

3.3.6 Scale Bar Search, CENTROID

As in the previous use of the CENTROID subroutine, computation based on moments determines the center of the first scale bar. The search stops when signals fall below the threshold, again enabling visual evaluation of performance. An advance upward of one-half the nominal column spacing then furnishes a vertical reference for the location of the first column.

Return to SCAN, preparation for STRGREAD

STRGREAD, for StringRead, is a small subroutine added to measure the transmittance of the card stock in preparation for finding the top edge (in card orientation) of cards. Preparation includes coordinate insertion and spot enlargement for blemish rejection.

3.3.7 STRGREAD

The procedure develops the mean amplitude of four spot readings of film transmittance at the border of the card. The basic assumption is that this transmittance is representative of that prevailing at the top of the card (card orientation) near column 1. Typically the output mean amplitude ranges from 900 (on the scale of 0 to 1023) for clear card stock images down to 400 for heavily or reflectively exposed films.

Return to SCAN, preparation for EDGES

Coordinates for the card edge search are indicated in Figure 3-1. After the scale bar search, the vertical position is at the center of the first scale bar, determined by CENTROID. Strgread returns without change to the coordinates at the time of calling, bringing the spot back to the bar center. However as is apparent in the illustration, the top edge of the card may be displaced by trimming of the card corner. Hence a more inboard column is the preferred zone for reliable edge detection. For this reason the track for edge search is shifted to the vertical position of column 2. At the other top corner of cards, even more inset was found necessary to avoid more extreme corner clipping.

Edge search begins its rightward dot-based stroke at the same horizontal coordinate as the
search for the scale bar, working from the supplied position, step size (fine), direction and reduced spot size.

3.3.8 EDGES

Scanning in edge search follows the path depicted in Figure 3-1. Signals in edge search start from low amplitudes inside the scale area until the spot reaches the card edge. Then a rapid rise takes place on crossing the edge. The true edge position is defined as that at which the signal is midway between the starting value and the transmittance just found in STRGREAD. The mean of these two establishes the edge threshold. A spot at this position would cover a low-signal area with one half while the other half would see the measured transmittance. Such exact positioning cannot be counted upon with the stepped digitized coordinates; instead an interpolation process is employed. Interpolation based on the nearest signals straddling the threshold defines the edge location.

Such a process is capable of good edge resolution with the assumption that the measured transmittance is representative of the card stock. Experience with dense cards bears out the validity of the approach. By taking into account the card stock transmittance, it provides an automatic correction for dense card images; no modification of these parameters was ever found needed.

When EDGES returns to SCAN, the extra one-column advance to column 2 is removed, leaving the half-column shift to the location of column 1. It should be noted that these advances come before any vertical sizing of the card image. At this stage the size is an estimate, feasible because the incremental distance is short. Also, vertical centering of the search track in column 2 is not critical due to the thresholding logic described above. That is, finding the true edge does not require that the edge search track be centered for best (lowest) signal because the threshold automatically adjusts itself to the initial track signal. Thus the parameters for the edge location formula are learned from the prevailing conditions. Good edge location is essential for precise access to punched hole positions.

At this time the precise location of the top of the card (card orientation) at column 1 has been established. The Fosdic coordinates are one-half column space less than the center of the first scale bar for the vertical axis and for the horizontal, the location of the card edge. These two quantities are the X and Y values in the variable known as Column1.

Return to SCAN, location of Corners 2 through 4

Using again the procedures CENTROID and EDGES with appropriate changes in the step direction, the next program sequence finds the coordinates of Corner 2 at the bottom (card orientation) edge of column 1. The transmittance measurement for thresholding is not necessary to repeat for Corner 2. After the edge search, the variable Corner2 contains the desired coordinate locations in X and Y.

The action then shifts to Corner 3 at the card top over column 80. It is similar to that for the first corner, using the same three subroutines. It is desirable to repeat Strgread at this end of the card because the illumination in the camera may not be equal transversely across the film.
Finally the program performs the same actions at Corner 4. The result is four sets of X and Y coordinate values expressed in mils. From these it is possible to derive the apparent length and width dimensions of the card as well as the slant. Calculations based upon these values then serve to direct the Crt spot for reading the 960 hole positions on the card.

3.3.9 Check for calibration failure

Before the mathematical process, the values lend themselves to checking for validity. The observed width of a card is available by subtraction of the X dimensions across the card at column 1 and again at column 80. These values should agree within acceptable limits. In this project a limit of 30 mils, about half the dimension of punched holes, was the applied criterion. Differences greater than this are liable to cause unacceptable deviations in the calculation of hole positions.

The same technique for checking the apparent width of a card applies to the Y dimensions. Here also the acceptable limit is 30 mils.

This verification process took place on every card. Those cards which showed excessive difference according to the criteria were declared failures in calibration, with the card data replaced by blank characters. During production scanning, close to one-half of the reels showed zero calibration failures. The failure rate in many decks was less than one card in a thousand; the mean for all reels was less than two in a thousand cards.

Card coordinates which successfully pass the checking process become the input to the next subroutine procedure, CALCSCAL, for calculation based upon the scale coordinates.

3.3.10 CALCSCAL

This subroutine accepts corner coordinates and computes the following:
1) Column to column (columnar) interval in terms of Fosdic vertical fine scale
2) Slant as difference between horizontal fine edge positions at columns 1 and 80
3) Table of row positions from top of card, also in horizontal fine scale
The procedure performs these actions one time on every card image, providing an automatic calibration for size and position, but only on corner data previously declared valid. The values so derived are passed on to the next subroutine, COLSCAN, for Column Scan.

3.3.10.1 Columnar interval

Columnar spacing comes from dividing the span from columns 1 to 80 by 79. Integer division in the computer yields two outputs. These are in mils for the quotient YFQuotient and the remainder YFRRemdr. Typically the former is 87 mils while the latter varies according to the exact camera reduction ratio. These values reside in a temporary working memory, available for later use in column scanning.

3.3.10.2 Slant

Calculations for slant use the corner edge locations to derive the mean of the slant at the
leading and trailing edges of the card image. Here the result is a bi-polar (can be positive or negative) value named Slant referring to the total between columns 1 and 80. Experience has shown this may range up to plus or minus 80 mils, greater than the size of a punched hole. The calculated slant for each card resides in a temporary memory for later use in COLSCAN.

3.3.10.3 RowTable

Again working with the corner coordinates, calculations extract the positional increments from the top of card images (leading edge of card images) to all 12 rows. These row positions are derived once per card to minimize the computational activity when sequencing from row to row later. The resultant of this part of the subroutine is RowTable, containing 12 distances in the horizontal fine scale from the top of the card to each row. Card geometry dictates that these values start at 1/13th and go to 12/13th of the measured card height.

Internally the calculations for RowTable use the same type of integer arithmetic involving division and summation of remainders to produce the desired proportioning of row positions. This implementation for automatic size adjustment readily accommodates the 10 percent or so variation found in a few reels.

Completion of this subroutine loads the parameters named above and returns control to SCAN to prepare for COLSCAN.

Return to SCAN, preparation for data reading, COLSCAN

This chiefly requires establishing the origin for the grid of 960 reading locations. In card orientation it is at the top of the card and one column to the left of the first, equivalent to column "0." This displacement permits the use of 80 uniform procedures for column reading. Parameters relating to the size of the grid come from the immediately prior CALCSCAL subroutine.

The parameters of threshold for hole detection and size of scanning spot are incorporated in the COLSCAN subroutine rather than being preset. This is due to their dynamic nature, meaning that these parameters are functions of signal amplitudes.

3.3.11 COLSCAN

This subroutine is responsible for executing the grid readings at the potential locations of punched holes. Its form is a sequence of 12 reads per column, starting with the first and repeating 80 times. The 12 reads in a column advance from the top row ("12" or "Y") down to the "9" row. At the end of each column, signal analysis interprets the stored information for inclusion in the 80-character string from the card.

3.3.11.1 Column advance

The initial step in reading in reading a column is an advance from the previous one, which in the Fosdic scale is a vertical retraction from the origin at column 0. This retraction is equal to a sum derived from adding YFQuot (from the CALCSCAL subroutine) for each column.
advance. YFQuot is in mils, typically 87 or 88. As each quotient adds to its sum, so does a sum of YFRemdr values. This remainder sum is compared with 79 at every column. When it reaches 79, one mil is added to the quotient sum. The remainder sum continues, with 79 subtracted. In this manner, the speed of integer arithmetic is available with no loss of precision. The mathematical process results in values accurate to one mil, not a limiting factor in scanning performance.

### 3.3.11.2 Slant correction

Next is correction for slant. Here the input, also from CALCSCAL, is total slant between end columns. It is bipolar, requiring conversion to absolute value before entering the computational process using integer arithmetic. Then with restoration of polarity it yields a correction applied to the horizontal fine scale. The resultant is XFBse, the horizontal coordinate of the top edge of a card at any column after correction for prevailing slant. The remaining task is to add positional information from RowTable to bring the spot to the 12 hole locations in a column.

Reading at each hole position and saving hole signals involves cycling through the RowTable values added to XFBse. This produces 12 amplitudes stored in memory for analysis and conversion to a final recorded character.

Character resolution in every column is complete in itself. The analysis generates a background value, calculates a threshold, compares the signals against the threshold, sorts the row identifications in order of the three strongest signals and encodes the result.

### 3.3.11.3 Calculation of background

The first step in signal evaluation is to establish a reference background in preparation for calculating the applicable threshold for the column. This background value is intended to represent signals from unpunched holes in the column. The procedure takes advantage of expectation that only one numeric punch occurs in a column. In execution, the five central rows in a column are assumed representative. The sum of these five signals, from which the lowest value is subtracted, then divided by four, is the desired value. It is independent of whether or not one in the group is punched. For interest, a typical value for good films is approximately 900 when gain calibration in clear film produces 980. Dense card images can lower the background to possibly 400.

### 3.3.11.4 Signal amplitude

Signals from scanning these film negatives reflect the fact that holes are relatively opaque. Signal strength is measured in departure downward from the background. Thus strong signals may be as low as 80. Signals considered weak may be 300. Signals from blemishes can be virtually anything in the overall range. The goal of setting a threshold in these circumstances is to generate a value for best balance between drops and pickups. The ideal algorithm here is one that offers immunity to variations in camera illumination from side to side, film development conditions, color of card stack and, almost above all, card misregistration. The adopted approach provides automatic compensation for some of these factors plus an opportunity for custom modification when indicated.

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3.3.11.5 Calculation of threshold

Technically the threshold is the level at which, in the presence of a certain amount of signal variation, half the tries would be declared above and half below. The derivation of a basic threshold level follows a formula which finds the mid point between background and assumed strong signals, the mean of the two. A numeric example would be 480. However experience demonstrates that such a level makes the system too sensitive as evidenced by a large number of pickups. It requires modification for a resonable balance of pickups and drops.

Threshold modification, or the term “fudge” in the program, is a programmed reduction of the background value before entry into the calculation. A typical modification might be 150, which changes the threshold by half this amount. The change enters via a defined parameter, requiring reassembly of the program for alternative values. Thus a specific threshold modification applies to an entire reel of film. In production processing it was not uncommon to rerun reeels with program changes in attempts to better the quality indicators.

3.3.11.6 Rescan mode

Related to threshold generation is a procedure added in the course of program evolution. Its intent is to detect signals from partial hole images caused by misregistration in filming. The best conditions for reading partial holes are to reduce the spot size and to place the spot closer to the residual image. This requires multiple readings around hole positions, an unacceptably time-consuming process if universally applied. The final version of the scanning program includes provisions for multiple reading and other desirable temporary modifications but resorts to them only when needed. The switch to five complete rescans of a card takes place whenever the normal high-speed scan shows one or more marginal signals in the entire card. Marginal here refers to hole signals which lie in the range between the threshold and the midpoint from threshold to the (possibly modified) background.

This rescanning technique reduces throughput if frequently invoked in processing the reels. Each occurrence is equivalent to approximately four cards. Commonly with films with good card registration, the additional processing time is insignificant. A count of the number of occurrences is displayed at the end of scanning as an indicator of the difficulty presented by a reel. The observed counts often were as low as 50. It should be noted here that film blemishes can also trigger the multiple scanning, setting up the conditions more favorable to reading marginal hole images.

The switch to multiple reading appears in the scanning program as a change of mode. This allows freedom to incorporate other parametric or procedural changes of potential benefit. Several items have been mentioned above, another is an increase in sensitivity. Positionally the five rescans occur at the nominal hole center, to left and right by 15 mils and above and below by 25 mils. The strongest signal of the five becomes the declared signal amplitude for the row in the column.

3.3.11.7 Mask for alphanumeric/overpunch coding

A special 80-character file for each deck, .MSK described in Section 3.2.2, provides the
information as to whether the column data should be encoded for single or multiple punching. The mask file for carrying the style information contains one character per column with the instruction for which encoding style is to be applied. The general approach for the mask file, including its ability to convert automatically from single to multiple punch, was given in Section 3.2.2. The desirability of single-punch recording style has already been mentioned for its superior performance in the presence of blemishes. For these a number such as “2” appears. For full encoding, “0” is the applicable digit. At the end of column analysis, interrogation of the mask file furnishes the indicator for the applicable encoding plan.

3.3.11.8 Character encoding

After column reading of all rows, the 12 amplitudes pass through three stages of logic to find the strongest in each pass. The logic is the same in all three, allowed by replacement of the strongest amplitude found in the first stage with a disqualifying value before executing the next stage. If none of the amplitudes passes the threshold, the sort-by-amplitude process jumps to its end for encoding as a blank column.

The encoding logic for multiple punching allows two overpunches plus one number from 0 to 9. The first step in analysis is to examine the triplet of three strongest row signals to find whether both the top two rows are punched. If so, the remaining row signal is treated as a numeric. If only one of the triplet is punched, it and the accompanying numeric become an alphabetic character. Finally the case of X over 0 carries a separate code.

To encode the described punch data, a number from 0 to 255 is developed from the row numbers 1 through 12. Special logic produces the same number regardless of which one is the stronger in an alphabetic pair. The dual overpunch condition adds an increment to this number to generate unique codes different from the ordinary numeric set. The last step in character interpretation is to pass this number through a translation table TRNSTBL1, listed in Appendix H. Unpunched columns show as the space character. Illegal punching such as two numerics results in an asterisk.

3.3.11.9 Data recording

Each card produces a string of 80 bytes in a file holding the data content of up to 640 cards, or 51,200 bytes. When this file is full, scanning pauses a fraction of a second for adding the data to the single large file called DataOut containing the total content of the reel. During the pause period, a display on the computer monitor shows the accumulated number of rescan occurrences and the number of calibration failures. These provide ongoing indicators of processing difficulty and quality. A full film reel generates approximately 20 such pause periods.

The data generated during rescans overwrite the information recorded from the original scanning by resetting the pointer in the memory section.

3.3.11.10 Return to SCAN

After the last column in a card has been recorded, control returns to SCAN to move to the next card. It is not always possible to advance the search for the next card bar by a fixed
amount; the variability in card periodicity can accumulate enough error to cause the search to miss the rightmost cards. The remedy is to shift the search origin based upon the observed position of the previous card bar.

As mentioned in Section 3.3.5 concerning determination of (horizontal) card edge positions, the distance to the next card bar is determined at the beginning of action on any card. This distance is derived using the fine scale, usually around 2180 mils. To set the origin for the next card bar search, this distance is subtracted from the fine coordinates and added to the coarse. Then a nominal card-to-card interval is also added to the coarse coordinates. Thus the origin for card bar search is based upon an assumed interval from the previous card bar rather than a multiple of the assumed interval from the stopped position of the first card. After this the next card scanning repeats the entire sequence in fine coordinates alone, beginning with a new card bar search.

The rightward scanning of card after card continues through the eighth card. Control then passes to a program section called SetXCFrame whose function is to set the horizontal position at which the FRAME subroutine is to commence. When there are less than eight cards within the scan aperture, as from empty card stacks or misfeeds, the presence or absence of a next adjacent card comes from the output of STRGREAD. This subroutine executes at the card left border. If a card is present the card stock image is clear. Absence of a card makes the film dense, generating a low signal. If comparison against a threshold after the subroutine shows that no card is present, control passes to SetXCFrame from this source as well. SetXCFrame performs the exchange of fine and coarse interval mentioned above. It furthermore adds an increment to bring the horizontal position of the Frame scan to the horizontal center of the assumed next card.

Before calling FRAME it is necessary to determine a valid threshold. In films exposed with supplemented reflected light, the card stock is relatively dense. This condition requires a correction to the threshold in FRAME for reasons which will become evident. The ideal threshold is a value midway between the card stock and averaged scale lines. Another scan procedure, named SCALREAD, determines the latter.

3.3.11.11 SCALREAD

The specific purpose of this procedure is to generate a signal amplitude which is representative of the scale lines when scanned by the defocused spot used in FRAME. Accordingly it reads at eight positions and calculates the mean, naming it ScalTransm for Scale Transmittance. The scan locations are in a vertical line stretching from column numbers 55 to 75. Horizontally the line is in the center of the scale zone immediately to the right of the last card in the group of eight or less.

Return to SCAN, preparation for FRAME

The threshold for use in FRAME is the mean of ScalTransm and Transmte, the measure of the card stock transmittance signals near column 80, from STRGREAD.

The horizontal position in preparation for FRAME has been described as approximately
half-way into the next expected card. Vertically it is around column 70. Although any vertical location inside the card images would be usable, considerations of wear distribution on the Crt screen favor this position. The leader routine LDR described in Section 3-1 also calls the FRAME procedure but places the vertical position near the lower numbered columns.

3.3.11.12  End of SCAN, return to PCSCAN

After the SCAN subroutine has completed its action to extract the punched data from eight cards, or less if fewer are available, it returns to the executive program, PCSCAN. Several indicator flags will have been set to show success or otherwise in the various search procedures. Two of these make it possible to stop the scanning process if any card in the eight has failed calibration or if illegal punching (multiple numerics in a column) has been found in any of the cards. When such a stop occurs, a complete eight-card display of detected punching appears on the computer monitor. This display is also available at any time during a process run, activated by pressing a key. This feature facilitates visual verification of reading accuracy by comparison with the projected film image on the viewing screen.

When PCSCAN has finished its disposal of information from scanning the group of eight cards, it calls for the FRAME subroutine to bring in more cards.

3.4  FRAME, detailed

This is the same subroutine as called by the leader program. Because some of the fine points in its logic are involved in the card-to-card advance here, the more detailed description is given in this section.

The scannable area to which the Crt spot can have access is equivalent to approximately eleven cards. Inside this zone the central eight cards represent the working space for the scanning program, with allowances for minor variations in positioning. It is the responsibility of the FRAME procedure to advance the film through the this scannable area despite the presence of certain anomalies.

3.4.1  Film irregularities

A brief description of film characteristics is in order here. The majority of cards appear on the films as long series of images separated by occasional breaks. Breaks arise from several causes, due to interruptions at the time of original filming. Card misfeeds, for example, usually result in leader-like sections with card and scale bars present without card images for a space. When the camera feed hopper becomes empty, the camera turns off its illumination, producing a gap of clear film. Card jams generate the least predictable images, sometimes stretching the image of a single card over the normal space of a dozen cards. In summary these are the conditions with which the film movement system must deal. One of the program goals is to prevent these interruptions from appearing in the final recorded information.

3.4.2  Framing logic

On the Crt face and the viewing screen the leftmost of the normal eight card images is
the first while the eighth is at the right. The action of the Framing subroutine is to move the film so that there is always an (apparent) card image in the first position. When scanning of eight cards has finished, the procedure finds and holds on to the left edge of the ninth card (its top edge in card orientation). Capstan rotation eventually brings this edge to the first card position, whereupon film movement stops. Scanning then begins on the new card group.

If there are fewer than eight cards, for instance three just before a misfeed, the search for the fourth card recognizes its absence and calls for FRAME. The framing procedure starts film movement and waits at a position one-half card to the right of the last card until another card (or clear film space) comes to the waiting position. It then holds on to the left edge leftward to the stop position. After film motion has ceased and a brief settling time allowance, scanning commences on the new first card. It continues with the second card in sequence up through the eighth unless there is another misfeed. Thus the system runs automatically through zones of missing cards. If the apparent next card is instead a clear zone on the film, the program halts for operator action.

The term (apparent) card image referred to above comes about because the Framing logic by itself cannot tell the difference between a true card image and a transitional break from dense film to a clear gap. The FRAME subroutine has therefore performed its function, regardless of whether or not the stopped image is a genuine card.

That discrimination is performed by other logic. If it is unable to verify that the image is a true card, the program pauses, waiting for manual advance to the next good card image. This is the operating procedure initiated by clear gaps in the films. Gaps of this nature produce no recorded data but of course have an adverse effect on throughput. On an average possibly every reel exhibited at least one such halt; a few had up to twenty.

Because of their unpredictable images, the results of card jams are difficult to define. Simple stretchouts ordinarily yield a single calibration failure, recorded as 80 space characters. More complicated distortions can give rise to multiple pseudo-cards with meaningless data.

3.4.3 Edge following

Framing begins with turning on both the capstan motor and a scanning pattern. This pattern is vertical column of 10 dots, placed horizontally in the approximate center of the ninth card at the start. The pattern is edge-seeking by acting according to the following logic. Whenever the column of dots is over the interior of a card image, it moves to the left (visual orientation of CRT screen) by an increment, before the next column actuation. After a few such shifts, the column of dots comes over the scale zone of the card. No longer in the clear, the leftward horizontal drive ceases, leaving the dot column at the horizontal position of the top edge of the card (card orientation). This edge-seeking action is rapid, possibly taking two milliseconds. A few milliseconds later the film starts moving to the left as the capstan responds to the start command. Finding itself in the clear again, the next dot column shifts to the left so as to keep up with the card movement. This is edge-following; with suitable response rates it is capable of staying with the card edge throughout the card advance period.
3.4.4 Film stop position

Cessation of film movement occurs when the horizontal location of the followed edge drops below a program-set XCFrampeStop. The desired stopping position is with the next group of eight cards nominally centered in the scanning aperture. To accomplish this requires definition of a fixed scan origin to which is added the offset allowance for film deceleration, XCFrampeStop. Altogether these combine to bring the followed card image to a position within the reach of the subsequent search for the first card bar.

Because the capstan drive is a stepper motor, the stopped position is variable over an acceptance band equivalent to about half the card period. This variability is desirable for distributing wear on the Crt screen.

Thus the framing action is to bring the new, ninth card to the first card position. The films include long continuous strings of card images, interrupted occasionally by gaps of clear film, misfeeds where the scale bars continue without card images and sometimes jammed cards. Encountering clear gaps causes the film to stop with the leading edge of the gap in the normal acceptance zone. This is also the usual case with card jams. Misfeeds, where some cards are simply missing but other parts of normal images are present, cause the film to run on until the next valid card appears, stopping it at the first card position. When there are less than eight cards available in a stopped group, a misfeed after the fifth for example, framing begins in an attempt to bring an apparent sixth card to the first card position. By starting from the last recognized card, this logic can cope with a single missing card. If there is no interruption in the scale area, framing automatically brings in the next card.

3.4.5 Manual film advance

If the image it stopped on is not recognizable as a true card, scanning pauses with a request for operator intervention. Manual film advance, by turning off power to the capstan, turning it by hand until the next valid card image is in the normal stop band, and restoring power, is the appropriate operator action.

3.4.6 FRAME threshold

This edge-following action is obviously dependent upon discrimination between signals derived from the card stock and those from the scale lines. When the cards have been filmed by reflected light, the background stock can be relatively dense, lessening its difference from the scale lines. This is the reason for introducing the SCALREAD subroutine earlier. The threshold for use in the framing procedure is the mean of ScalTransm and Transmtce, as mentioned in Section 3.3.11.11.

In the 10-dot column which constitutes the scanning pattern, not all of the dots must show signals above the threshold for the area to be declared clear. It is sufficient that at least nine meet this requirement. The Crt spot during the subroutine is enlarged so as to prevent punched holes from disqualifying the clear area. Further refinements in the Framing subroutine minimize the duty cycle of beam-on time so as to reduce Crt screen wear as much as possible. Finally the 10-dot column has an interlace of six origin displacements for the same purpose.
3.4.7 End-of-Film detection

An End-of-Film indicator appears during FRAME if the signals during execution reach the saturation value of 1023. To avoid false recognition from film blemishes, five of the ten dots in the vertical scan line must reach saturation. This condition occurs when the end of the film passes beyond the location of the Framing scan. It sets an indicator flag which later terminates the scanning program.

End of FRAME, return to PCSCAN

Upon return to PCSCAN the End of Film flag is checked. When the flag is not set, program control goes on to call SCAN for the next group of cards. If the flag has been set by termination of the reel as above, information from the cards scanned after the last 640-card pause is recorded. This marks the end of PCSCAN and action reverts to the batch file GO. The latter next calls for a wrap-up program named TLR, for Trailer.

3.4.8 End of PCSCAN

The termination of PCSCAN generates a display on the computer monitor which includes the final number of rescan occurrences on the reel. Aside from the displayed data, it loads other accumulated information about the run into the Param file.

At this time the complete card data content is available in a large file called DataOut, usually nearly one megabyte in size.

3.5 TLR program

This program provides a summary display on the computer monitor of results from scanning a reel. Among the items shown are the total number of cards scanned and number which failed calibration, both transferred from the Param file. Also displayed are the times of starting and stopping the run. These items are in addition to identification of the deck and reel.

3.6 FOSCOPY program

This is the final element in the initiating batch file GO. It has several functions, including most importantly that of adding a header to the card data file and naming the result to show deck and reel identification. Other functions are to create a logging file, allow introduction of comments and provide a summary of data on bad cards.

3.6.1 Card data file identification

Data files are labelled with eight digits for the deck, then a period for delimiter, followed by an extension of three digits for the reel number. Both fields are right-justified and zero-filled to the left. An example is 00000110.005 representing reel 5 in deck 110. This information comes from reading the Param file mentioned in Section 3.1.5 Entry.
3.6.2 Header

All card data files include an initial section of 1882 bytes containing general notes and specific information on reel processing. The latter covers deck and reel identification, date scanned, number of cards in file, number of cards failing calibration and provision for two condition codes to be added if desired by the operator at the end of the run.

Appendix K is a sample printout of a header, here for Deck 110, Reel number 5. The first 40 bytes are largely in unprintable binary form, obtained from the Param file for the run. However it is possible to note the Deck "00000110", Reel "005" and the date "05-15-1998". Next comes a description of the content of these 40 bytes. The ending alphanumeric translation table has since been supplemented with characters from overpunching according to Appendix A.

3.6.3 Card data file format

Data from reading the punched information is contained in a file called DataOut, consisting of an end-to-end string of 80 bytes from each card. Each card adds 80 bytes of punched data, or space characters in the event of calibration failure, to this file. Typically DataOut contains nearly a megabyte (from 12,000 multiplied by 80). The Foscopy program attaches this string to the header to form the final file with the identification described above. The card data begins with byte 1882 from the first column in the first card on the film. Thus each reel generates a file whose length approaches one megabytes.

3.6.4 Zip disks

The final form of output data from the project is recordings on 100-megabyte Iomega Zip disks. These disks can hold the data from slightly over one hundred reels of film. In the records from the project, whenever possible the particular group on any disk had a common hundreds digit for ease in handling. For example a disk might contain reels 100 through 199.

The first Zip disks in all decks (except Version 2 of Deck 194, where the last disk was used) contain recordings from duplicate runs to provide samples for the difference tests described in Section 4.5. At least one and usually five samples are available depending upon deck size. The duplicate files carry the identifying extension "A01" for comparison with the normal "001" for instance.

Finally there are four more files on every Zip disk, namely:

FILES.TXT, a file listing the types of files on the Zip disk
NCDCREAD.TXT, a description of the structure of the card data files
REPORT.EXE, an executable .EXE (DOS) program for displaying the data from any card
REPORT.TXT, instructions for use of REPORT.EXE

The output Zip disks are numbered as GDA-01 (for Greenough Data Associates-01) to GDA-37 in order of submission to the sponsor.
3.6.5 Replacement data files

Some of the disks have been or are to be replaced with data from rescanning with the final version of the program. The replacement disks are denoted with an "A" suffix, as "14A" replaces "14". The replacement disks better reproduce the punched data under marginal filming and punching conditions.
4.0 Performance review

Several control indicators allowed monitoring of the apparent quality of data conversion during processing runs. The most important was the count of calibration failures. Other indicators were the number of illegal characters and the number of cards with two or more illegal characters. Finally individual runs displayed the number of cards forcing rescan on account of marginal signals; this was a measure of the deviation from ideal film or card conditions in the reel.

In addition for acceptable processing on a deck, duplicate runs on sample reels must have a low count of cards with differences in recorded data in one or more columns.

In the sections which follow, the available statistics on the above indicators are summarized. Table 4-1 at the end is a listing by individual decks as well as overall figures.

4.1 Calibration failure

The overall calibration failure rate was 0.015 percent of the cards processed, equivalent to one card in 6700 or 1.8 cards per 12,000-card reel. This figure results from a sum of 5608 cards indicated as unreadable in the total of 3086 reels scanned. This overall rate includes 65 copy films, whose failure rate was more than four times that of original films.

No original films were rejected as being unsuitable for scanning. A few of the preliminary copy films were so dense as to require reprinting at less exposure. Only one reel remains outstanding on this account at the date of the report.

Many of the observed failures came about from card misfeeds in specific cameras, where misfeeds resulted in overexposure and loss of the scale lines following the last valid image. The likely cause was abrupt cessation of film movement in the camera before lamp turn-off. Another source of failure was larger-than-normal cuts at the corners of cards. Also, artificial contributions to the failure count sometimes occurred from card jams, when irregular images generated non-existent cards. The standard output from calibration failure is a string of 80 “space” characters.

There may be a few instances where the scanning program produced meaningless data. Such data may include long strings of the characters “*” or “9”. The program examines output data before recording, looking for more than 20 of these characters in a card. If so found, it declared a calibration failure and replaced the card data with space characters.

Several reels included unpunched cards, producing blank records similar to those from calibration failure but without incrementing the failure count.

To explore the reasons for calibration failures, a program switch allowed repeated scanning after pausing at detected failures. Such investigations were time-consuming and so were conducted principally on reels with high counts. This usually required a second run with the pause option turned on, then more runs with potential corrections if the causes were not simply in the punching.
4.2 Illegal character count

An illegal character, recorded as "*", arises from double punching in the numeric field of a column. The possible sources are punching, pickups from blemishes on the film or Crt screen. By far the most common was the punching. In certain decks it was so consistent that mention was included on the deck processing notes in Section 5.0. To determine whether the causes were again in the punched data, the same pause and exploration procedures as for calibration failure stops were followed. This utilized another option switch in the scanning program.

Pickups, that is, apparent punches where none exists, can be produced from blemishes or dust on either the film or the Crt screen. The source can be isolated to some extent by whether the occurrences are random in location (film) or systematic (Crt). While blemishes are usually immovable on films, preventative measures against dust include velvet pads at the entrance to the film gate with newly-cleaned surfaces at the start of reels. Normally the Crt screen was cleaned routinely every few hundred reels. Once or twice, systematic pickups, those occurring in specific columns with a periodicity of eight cards, became evident, requiring additional cleaning and reruning of affected films.

The illegal character count on one large deck, 193 with 538 reels, is probably typical. It showed 0.11 percent of cards with an illegal character, or one card in 900. Examination of several worst cases led to an estimate that three quarters of the occasions were due to punching. On this assumption perhaps 0.03 percent of the cards recorded an illegal character from blemishes. When an allowance is made for blemishes in locations other than the numeric fields of columns with punches, blemishes and dust may account for as much as 0.05 percent of cards affected by pickups.

The effect of pickups can take several forms. Blank columns appear punched. Single punches convert to either an alphabetic or illegal character. Although it is sometimes possible to extract the true punched data, the importance of minimizing errors from this source gave rise to the monitoring system for illegal characters.

4.3 Cards with two or more illegal characters

Separate monitoring of the number of cards in a reel showing multiple illegal characters resulted in a very low count in the sample above. The figure amounted to 0.0001 percent or one card in 100,000.

4.4 Rescan occurrences

The number of cards triggering the multiple-scan procedure because of marginal signals was another internally monitored performance indicator. In general it shows the "difficulty" or "stress" the particular reel is presenting to the scanning program. The occasions for rescanning are chiefly created by cards with poorly registered holes. Typically films exhibit regions of frequent rescanning mixed with sections where it is rare. If most of a reel requires rescanning the processing throughput drops significantly, even to as low as a quarter of normal.
Results for the example of deck 193 cited above indicate an average 2.1 percent of cards necessitated rescanning, equivalent to 250 times in a reel. Many reels required as few as 30, others up to several thousand. In any case, this provision for automatic rescanning allowed much greater throughput than rerunning with specific customization of the program on individual reels.

4.5 Difference tests

Difference tests are comparisons of data obtained from duplicate runs on the same reel of film. Difference tests on five reels was a requirement included in the project work statement as a measure for establishing confidence in the conversion process. The tests were later found to be of such usefulness that their application was expanded to sampling in every deck.

The overall difference rate, computed as the mean of all reels subject to the comparisons, was 0.17 percent or less than two cards per thousand card images on the films. Difference test results on the small sample available of copy films showed a nearly similar figure.

These tests are particularly sensitive indicators of marginal conditions such as card misregistration or film blemishes. This is of considerable assistance in determining the threshold level for balance between failing to detect "weak" punch images and responding to artifacts like blemishes or dust. Investigations of optimal thresholding techniques accounted for much of the time in development of the scanning program.

Initially in the project all difference tests were conducted at the Climatic Data Center. Later a comparison program was created for the project by an associate of the author which automatically identifies cards with differing data and indicates the non-matching columns. Its use greatly simplifies the otherwise laborious process of visually finding differences in 80-character record pairs. After checks on agreement between tests here and at NCDC, the resulting shortening of turn-around time expedited the exploration of thresholding. Also additions to the scanning program made it possible to stop on specified cards and examine the card images directly on the Fosdic viewing screen. Observations on this basis allowed ready follow-up of proposed thresholding approaches.

4.6 Processing summary

The results of calibration failure and difference tests on individual decks are shown in Table 4-1 on the next page. The Table also includes data on the number of reels scanned in each deck, duplicated from Section 1.0.1 at the beginning of the report.

Table 4-2 lists the records regarding shipments of films. In some cases decks which had been sent back to NCDC were requested again for rescanning. A few, initially unreadable, reels were held back from return to NCDC in anticipation of program modification. These and other details are included in the Table. An entry of "GDA" indicates reels or data files that are presently here, not yet returned. For example in Deck 116, reel 343 awaits return shipment.

Table 4-3 shows the records of output data by deck, useful for determining which Zip disks contain the data for given decks. A description of the format of these Zip disks is included
in Section 3.6 on Foscopy, the program which assembles the final data files. In this Table, "GDA" refers to temporarily recorded files which will be combined on a final disk when several more films listed in Section 5 are received.

Table 4-4 rearranges the same information for indexing by output Zip disk to show the contents of deck and reel numbers for each disk.
Table 4-1 Calibration Failure and Difference Rates by Deck

<table>
<thead>
<tr>
<th>Deck</th>
<th>Description</th>
<th>No. Reels Scanned</th>
<th>Calib Fail Rate % of cards</th>
<th>Difference Rate % of cards</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD-110</td>
<td>Navy Marine</td>
<td>66</td>
<td>0.020</td>
<td>0.36</td>
</tr>
<tr>
<td>CD-116</td>
<td>Surface Marine</td>
<td>596</td>
<td>0.009</td>
<td>0.19</td>
</tr>
<tr>
<td>CD-117</td>
<td>Navy Marine</td>
<td>244</td>
<td>0.027</td>
<td>0.07</td>
</tr>
<tr>
<td>CD-118</td>
<td>Japanese Marine</td>
<td>144</td>
<td>0.012</td>
<td>0.14</td>
</tr>
<tr>
<td>CD-119</td>
<td>Japanese Marine</td>
<td>77</td>
<td>0.009</td>
<td>0.07</td>
</tr>
<tr>
<td>CD-128</td>
<td>Surface Marine</td>
<td>229</td>
<td>0.006</td>
<td>0.09</td>
</tr>
<tr>
<td>CD-129</td>
<td>Surface Marine</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD-184</td>
<td>British Marine</td>
<td>63</td>
<td>0.017</td>
<td>0.35</td>
</tr>
<tr>
<td>CD-185</td>
<td>USSR Marine</td>
<td>10</td>
<td>0.007</td>
<td>0.07</td>
</tr>
<tr>
<td>CD-187</td>
<td>Japanese Whaling</td>
<td>2</td>
<td>0.004</td>
<td>0.07</td>
</tr>
<tr>
<td>CD-189</td>
<td>Dutch Marine</td>
<td>23</td>
<td>0.009</td>
<td>0.08</td>
</tr>
<tr>
<td>CD-190</td>
<td>CG Log Book</td>
<td>4</td>
<td>0.006</td>
<td>0.05</td>
</tr>
<tr>
<td>CD-192</td>
<td>German Marine</td>
<td>517</td>
<td>0.015</td>
<td>0.19</td>
</tr>
<tr>
<td>CD-193</td>
<td>Dutch-Netherland</td>
<td>538</td>
<td>0.016</td>
<td>0.24</td>
</tr>
<tr>
<td>CD-194</td>
<td>British Marine</td>
<td>339</td>
<td>0.019</td>
<td>0.19</td>
</tr>
<tr>
<td>CD-195</td>
<td>Navy Ship Logs</td>
<td>54</td>
<td>0.014</td>
<td>0.07</td>
</tr>
<tr>
<td>CD-196</td>
<td>German Marine</td>
<td>16</td>
<td>0.003</td>
<td>0.10</td>
</tr>
<tr>
<td>CD-197</td>
<td>Danish Marine</td>
<td>3</td>
<td>0.008</td>
<td>0.17</td>
</tr>
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<td>CD-256</td>
<td>Surface Marine</td>
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<td>0.016</td>
<td>0.12</td>
</tr>
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<td>CD-258</td>
<td>Surface Marine</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD-281</td>
<td>Navy MAR</td>
<td>97</td>
<td>0.040</td>
<td>0.24</td>
</tr>
<tr>
<td>CD-541</td>
<td>US RAOBS</td>
<td>1</td>
<td>0.025</td>
<td>0.20</td>
</tr>
<tr>
<td>CD-547</td>
<td>Payerne RAOBS</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD-608</td>
<td>Hungary RAOBS</td>
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<td>0.008</td>
<td>0.09</td>
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<tr>
<td>CD-650</td>
<td>Formosan RAOBS</td>
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<td>0.023</td>
<td>0.11</td>
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<tr>
<td>CD-690</td>
<td>Israel RAOBS</td>
<td>1</td>
<td>0.008</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Total number ............... 3061 reels scanned (10-30-98)

Average calibration failure rate ...............0.015 percent of cards

Average difference rate ................................... 0.17 percent of cards
<table>
<thead>
<tr>
<th>Deck</th>
<th>Description</th>
<th>Reels</th>
<th>Date Film Received</th>
<th>Date Film Returned</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD-110</td>
<td>Navy Marine</td>
<td>001-066</td>
<td>03-18-98</td>
<td>09-01-98</td>
<td></td>
</tr>
<tr>
<td>CD-116</td>
<td>Surface Marine</td>
<td>001-596</td>
<td>09-18-97</td>
<td>11-20-97</td>
<td>(except reel 343)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>343</td>
<td>03-18-98</td>
<td>GDA</td>
<td>(original reel 343 recvd)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>001-005</td>
<td>03-04-98</td>
<td>GDA</td>
<td></td>
</tr>
<tr>
<td>CD-117</td>
<td>Navy Marine</td>
<td>001-244</td>
<td>11-10-97</td>
<td>11-24-97</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>001-005</td>
<td>03-04-98</td>
<td>10-07-98</td>
<td>Sent again for rescanning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>006-244</td>
<td>07-30-98</td>
<td>10-07-98</td>
<td>Sent again for rescanning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>078-079</td>
<td>10-26-98</td>
<td>GDA</td>
<td>(copy reels 078,079 recvd)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>098</td>
<td>10-26-98</td>
<td>GDA</td>
<td>(copy reel 098 recvd)</td>
</tr>
<tr>
<td>CD-119</td>
<td>Japanese Marine</td>
<td>001-077</td>
<td>03-18-98</td>
<td>GDA</td>
<td></td>
</tr>
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<td>CD-128</td>
<td>Surface Marine</td>
<td>001-186</td>
<td>03-18-98</td>
<td>GDA</td>
<td>(except reel 112)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>208-210</td>
<td>03-18-98</td>
<td>GDA</td>
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<td></td>
<td>211-250</td>
<td>03-06-97</td>
<td>GDA</td>
<td>(copy reel 112 recvd)</td>
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<td></td>
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<td>10-26-98</td>
<td>GDA</td>
<td></td>
</tr>
<tr>
<td>CD-129</td>
<td>Surface Marine</td>
<td>187-311</td>
<td>03-06-97</td>
<td>07-02-98</td>
<td>Deleted from list</td>
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<tr>
<td>CD-184</td>
<td>British Marine</td>
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<td>03-18-98</td>
<td>09-01-98</td>
<td>(except reel 012)</td>
</tr>
<tr>
<td>CD-185</td>
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<td>09-01-98</td>
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<td>CD-189</td>
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<td>09-01-98</td>
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</tr>
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<td>03-18-98</td>
<td>09-01-98</td>
<td></td>
</tr>
<tr>
<td>CD-192</td>
<td>German Marine</td>
<td>001-517</td>
<td>11-19-97</td>
<td>01-28-98</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>001-517</td>
<td>07-03-98</td>
<td>10-07-98</td>
<td>Sent again for rescanning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>013</td>
<td>10-26-98</td>
<td>GDA</td>
<td>(copy reel 013 recvd)</td>
</tr>
<tr>
<td>CD-193</td>
<td>Dutch-Netherland</td>
<td>082-086</td>
<td>11-19-97</td>
<td>08-11-98</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>093</td>
<td>11-19-97</td>
<td>08-11-98</td>
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**Notes:**

(1) 18 reels were held back for scanning with modified program, then returned with deck
(2) See Section 5.0 Remnant actions, for reels not yet received.

4-7
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<th>Notes</th>
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### Table 4-3 Data Return Records by Deck, page 2 of 2
Status 10-30-98

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<th>Reels</th>
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<th>Recorded on GDA-No.</th>
<th>Notes</th>
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<td>07-22-98</td>
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<td>(except reel 002)</td>
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Notes:

1. reels 078, 079, 098 missing
2. 18 reels held back for delayed scanning, data not included on GDA-14 to 19
   New files on GDA-14A to 19A are complete.
   GDA indicates material at Greenough Data Associates, 10-30-98, to be included on GDA-37
### Table 4-4 Data Return Records by GDA Disk

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<th>Reels</th>
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<td>194</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>196</td>
<td>001-016, A01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>197</td>
<td>001-003, A01</td>
<td>(except reel 002, to be recorded on GDA-37)</td>
</tr>
<tr>
<td>29</td>
<td>07-02-98</td>
<td>118</td>
<td>001-099, A01-A05</td>
<td>(except reels 078,079,098, to be recorded on GDA-37)</td>
</tr>
<tr>
<td>30</td>
<td>07-22-98</td>
<td>118</td>
<td>100-145, A01-A05</td>
<td>(except reel 119, to be recorded when recvd)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>187</td>
<td>001-002, A01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>190</td>
<td>001-004, A01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>256</td>
<td>748-776, A48</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>650</td>
<td>001-007, A01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>690</td>
<td>001, A01</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>08-05-98</td>
<td>110</td>
<td>001-066, A01-A05</td>
<td></td>
</tr>
<tr>
<td>GDA Disk Number</td>
<td>Date Submitted</td>
<td>Deck</td>
<td>Reels</td>
<td>Notes</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------</td>
<td>------</td>
<td>-----------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>32</td>
<td>08-05-98</td>
<td>195</td>
<td>001-054</td>
<td>A01-A05</td>
</tr>
<tr>
<td>33</td>
<td>08-05-98</td>
<td>128</td>
<td>001-099</td>
<td>A01-A04</td>
</tr>
<tr>
<td>34</td>
<td>08-05-98</td>
<td>128</td>
<td>100-186</td>
<td>(except reel 112, to be recorded on GDA-37)</td>
</tr>
<tr>
<td>35</td>
<td>08-05-98</td>
<td>128</td>
<td>208-250</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>08-05-98</td>
<td>281</td>
<td>001-097</td>
<td>A01-A05</td>
</tr>
<tr>
<td>37</td>
<td>GDA</td>
<td>118</td>
<td>078,079</td>
<td>To be recorded</td>
</tr>
<tr>
<td></td>
<td></td>
<td>118</td>
<td>098</td>
<td>To be recorded</td>
</tr>
<tr>
<td></td>
<td></td>
<td>128</td>
<td>112</td>
<td>To be recorded</td>
</tr>
<tr>
<td></td>
<td></td>
<td>197</td>
<td>002</td>
<td>To be recorded</td>
</tr>
</tbody>
</table>

Notes:
GDA indicates material remaining at Greenough Data Associates, 10-30-98
5.0 Remnant actions

At the date of report preparation, certain items in the project are incomplete. Most evident is that a few reels have not yet been received, or at least, not in a form suitable for scanning.

<table>
<thead>
<tr>
<th>Deck</th>
<th>Reel Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>118</td>
<td>Reel 119 not yet received</td>
</tr>
<tr>
<td>184</td>
<td>Reel 012 not yet received</td>
</tr>
<tr>
<td>194</td>
<td>Reels not yet received in scannable form: 062, 089,</td>
</tr>
<tr>
<td>541</td>
<td>Reels 001-020 not yet received</td>
</tr>
<tr>
<td>547</td>
<td>Reel 001 not yet received</td>
</tr>
</tbody>
</table>

The total of the above yet to be scanned appears to be 25 reels. It is regarded as an obligation of the project to process these reels upon receipt. However substitutions are acceptable, even if the total number may somewhat exceed the originally specified number of 3046.

Several decks were re-scanned with a newer version of the program to enhance recovery of punched data under marginal conditions. To assure replacement of the earlier data with the new information, the following decks should be recopied:

<table>
<thead>
<tr>
<th>Deck</th>
<th>Replacement Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>117</td>
<td>Replace data files with new version on GDA-11A through -13A</td>
</tr>
<tr>
<td>192</td>
<td>Replace data files with new version on GDA-14A through -19A</td>
</tr>
<tr>
<td>193</td>
<td>Replace data files with new version on GDA-20A through -25A</td>
</tr>
<tr>
<td>194</td>
<td>Replace data files with new version on GDA-01A through -04A</td>
</tr>
</tbody>
</table>

The original files have identical Zip disk nomenclature without the suffix A.

Supplemental Notes, December 3, 1998

Notes:
1) In Deck 194, reel 062 needs to be copied with lower density
   Reel 089 has been processed and included in the data files on GDA-1A
2) In Deck 541, all 21 reels have been processed and included on GDA-37

5-1 (revised 12-03-98)
6.0 Processing notes by Deck

The following pages of Section 6 contain information on these topics below for every deck that was scanned in the project:

**Scanned:** Date the of the final submitted record. For Decks 117, 192, 193 and 194, the dates are those of the second runs, whose data files replace the first versions.

**Recorded on:** Zip disk identification on which the files are recorded. For example, GDA-31 contains the listed files for Deck 110.

**Calibration failure rates:** "Mean for deck," the total number of counted calibration failures, divided by the number of reels scanned in the deck. Failures resulted in 80 "space" characters instead of erroneous data. In some cases extra failures were created by film anomalies, leading to an apparent higher count. When causes for excessive failure counts were determined, these are noted.

"Failure rate," the total number of calibration failures in the deck, divided by the number of cards scanned. The overall rate for all scanned decks was 0.015 percent of cards failing calibration.

**Difference test data:** In the reel pairs shown, the number of cards with one or more differences in apparent punched data, divided by the number of card pairs compared, i.e. the number of cards on one reel.

"Mean for sample," the total number of cards with differences in the sample group, divided by the number of card pairs. The overall rate for cards with differences was 0.17 percent.

**Notes:** Comments on the processing

Individual data sheets follow for decks in numeric order.
Deck 110, Navy Marine, 1945-June 1951

Scanned:

001-005  04-26 & 05-15-98
A01-A05  04-26 & 05-15-98
006-066  05-26 to 05-27-98

Recorded on:

001-066  GDA-31
A01-A05  GDA-31

Calibration failure rate:

Mean for deck = 2.5  Unreadable(1)cards per reel
Failure rate = 0.020 percent Cards found unreadable

Difference test data:

001 vs A01  0.31 percent
002    A02  0.40
003    A03  0.17
004    A04  0.61
005    A05  0.31

Mean for sample 0.36 percent Data from 05-15-98, submitted on
                     /floppy disks of 05-18-98
                     Cards with differences
                     in duplicate runs

Notes:

1) Many of these cards were severely clipped at top of right
   side, causing calibration failures, a specific example is
   reel 064.
Processing Notes by Deck

Deck 116, Surface Marine, 1949-June 1963

Scanned:

001-596  10-24 to 11-08-97  Except reel 343, not received at time of first scanning
343     07-22-98           Received later
A01-A05  07-22 to 07-22-98

Recorded on:

001-099  GDA-5             Reels 001-005 to be replaced
001-005  GDA-26A           Replacement for reels 001-005
A01-A05  GDA-26A           Replacement for reels A01-A05
100-199  GDA-6             
200-299  GDA-7             
300-399  GDA-8             Reel 343 missing
343      GDA-19A            Includes reel 343
400-499  GDA-9             
500-596  GDA-10            

Calibration failure rate:

Mean for deck = 1.1  Unreadable cards found per reel
Failure rate = 0.009 percent  Cards found unreadable

Difference test data:

001 vs A01  0.20 percent
002 vs A02  0.22
003 vs A03  0.11
004 vs A04  0.25
005 vs A05  0.16

Mean for sample 0.19 percent  Cards with differences in duplicate runs

Notes:
1) Acquire reel 343 data file from GDA-19A
2) Use GDA-26A for Difference tests, contains 001-005, A01-A05
3) Reel 051: many punches of rows 2 and 9 (illegal) in col 27
4) Reel 111: many illegal characters, light streak near col. 50
5) Reel 282: column 79 often punched in X and 9 rows
6) Reels 545,546: many blank cards
Processing Notes by Deck

Deck 117, Navy Marine

Scanned:

001-244  04-21 to 09-25-98
A01-A05  04-21 to 04-22-98

Recorded on:

001-099  GDA-11A
A01-A05  "
100-199  GDA-12A
200-244  GDA-13A

Calibration failure rate:

Mean for deck = 3.2 Unreadable cards found per reel
Failure rate = 0.027 percent Cards found unreadable

Difference test data:

001 vs A01  0.12 percent
002 A02  0.07
003 A03  0.01
004 A04  0.09
005 A05  0.03

Mean for sample 0.07 percent Cards with differences in duplicate runs

Notes:

1) Card jams in filming this deck were more common than usual.
2) Data shown are from second run of entire Deck 117. GDA disks with "A" suffix replace original submissions without suffix. GDA-11A through 13A directly replace GDA-11 through 13.
Processing Notes by Deck

Deck 118, Japanese Marine, 1937-June 1953

Scanned:

006-145  05-18 to 05-20-98  Reels 078,079,098,119
001-005  04-23-98           \not received
A01-A05  04-23-98
078-079  10-27-98  Reels 078,079
098      10-27-98  Reel 098

Recorded on:

001-099  GDA-29  Except reels 078, 078, 098
100-145  GDA-30  Except reel 119, not received
078,079  GDA-37
098      GDA-37

Calibration failure rate:

Mean for deck = 1.4
Failure rate = 0.012 percent

Unreadable cards found per reel
Cards found unreadable

Difference test data:

001 vs A01  0.24 percent
002 A02    0.14
003 A03    0.06
004 A04    0.12
005 A05    0.13

Mean for sample 0.14 percent
Cards with differences in duplicate runs

Notes:

1) Column 51 often punched 0/1, illegal character
2) Reel 114, cards with heavily cut corners, causing calibration failures
3) Reel 119 not yet recvd (12-03-98)
Processing Notes by Deck

Deck 119 Japanese Marine, July 1953-1960

Scanned:

006-0077 05-20 to 05-21-98
001-005 04-28-98
A01-A05 04-28-98

Recorded on:

001-077 GDA-28
A01-A05 GDA-28

Calibration failure rate:

Mean for deck = 1.1
Failure rate = 0.009 percent

Unreadable cards found per reel
Cards found unreadable

Difference test data:

001 vs A01 0.12 percent
002 A02 0.04
003 A03 0.05
004 A04 0.08
005 A05 0.04

Mean for sample 0.07 percent
Cards with differences in duplicate runs

Notes:

1) Reel 068, cards with 0/1 punching, illegal character
Processing Notes by Deck

Deck 128 Surface Marine, July 1963-April 1968

Scanned:
001-250  06-03 to 06-08-98  Reel 112 not received
A01-A05  06-03  06-07-98  Reel 112 recvd
112      10-27-98

Recorded on:
001-099  GDA-33
100-186  GDA-34  except reel 112
208-250  GDA-35
112      GDA-37  Reel 112

Calibration failure rate:
Mean for deck = 0.8
Failure rate = 0.007 percent

Unreadable cards found per reel
Cards found unreadable

Difference test data:
001 vs A01  0.05 percent
002 A02  0.25
003 A03  0.06
004 A04  0.06
005 A05  0.04

Mean for sample 0.09 percent  Cards with differences in duplicate runs

Notes:
Processing Notes by Deck

Deck 184 British Marine, April 1953-1961

Scanned:

006-064 04-27 to 04-30-98  Reel 012 not received
001-005 04-20 05-13-98
A01-A05 04-20 05-13-98

Recorded on:

001-064 GDA-27
A01-A05 GDA-27

Calibration failure rate:

Mean for deck = 2.0  Unreadable cards found per reel
Failure rate = 0.017 percent  Cards found unreadable

Difference test data:

001 vs A01 0.41 percent  Cards with differences in duplicate runs
002 A02 0.61
003 A03 0.15
004 A04 0.34
005 A05 0.26

Mean for sample 0.35 percent

Notes:

1) Although the workflow statement listed 53 reels, 64 were received. All were scanned. Images in Reels 054 through 064 were much denser than normal, requiring program customization.
2) Reel 012 to be scanned when received.
Processing Notes by Deck

Deck 185 USSR Marine, 1957-1958

Scanned:

001-010 05-23-98
A01 05-23-98

Recorded on:

001-010 GDA-27
A01 GDA-27

Calibration failure rate:

Mean for deck = 0.9 Unreadable cards found per reel
Failure rate = 0.008 percent Cards found unreadable

Difference test data:

001 vs A01 0.07 percent

Mean for sample 0.07 percent Cards with differences in duplicate runs

Notes:

1) Deck 185 small, difference sample limited to one reel
Processing Notes by Deck

Deck 187 Japanese Whaling

Scanned:

001-002 05-28-98
A01 05-28-98

Recorded on:

001-002 GDA-30
A01 GDA-30

Calibration failure rate:

Mean for deck = 0.5 Unreadable cards found per reel
Failure rate = 0.004 percent Cards found unreadable

Difference test data:

001 vs A01 0.07 percent

Mean for sample 0.07 percent Cards with differences in duplicate runs

Notes:

1) Deck 187 small, difference sample limited to one reel
Processing Notes by Deck

Deck 189 Dutch Marine

Scanned:
001-023  05-29 to 06-01-98
A01  05-29-98

Recorded on:
001-023  GDA-27
A01  GDA-27

Calibration failure rate:
Mean for deck = 1.0   Unreadable cards found per reel
Failure rate = 0.009 percent   Cards found unreadable

Difference test data:
001 vs A01  0.14 percent
Mean for sample 0.14 percent   Cards with differences in duplicate runs

Notes:
1) Column 73 sometimes punched 0/1, illegal character
2) Deck 189 small, difference sample limited to one reel
Processing Notes by Deck

Deck 190 CG Log Book

Scanned:

001-004 05-28-98
A01 05-28-98

Recorded on:

001-004 GDA-30
A01 GDA-30

Calibration failure rate:

Mean for deck = 0.8
Failure rate = 0.006 percent
Unreadable cards found per reel
Cards found unreadable

Difference test data:

001 vs A01 0.05 percent
Mean for sample 0.05 percent
Cards with differences
in duplicate runs

Notes:

1) Deck 190 small, difference sample limited to one reel
Processing Notes by Deck

Deck 192 German Marine

Scanned:

007-517  07-06 to 07-20-98
001-006  04-24  04-25-98
A01-A05  04-24  04-25-98  A02 omitted, card jam makes card count variable

Recorded on:

001-099  GDA-14A
A01-A05  GDA-14A  A02 omitted(Note 1)
100-199  GDA-15A
200-299  GDA-16A
300-399  GDA-17A
400-499  GDA-18A
500-517  GDA-19A

Calibration failure rate:

Mean for deck = 1.8  Unreadable cards found per reel

Failure rate = 0.015 percent  Cards found unreadable

Difference test data:

001 vs A01  0.24 percent
003  A03  0.16
004  A04  0.24
005  A05  0.14

Mean for sample 0.19 percent  Cards with differences in duplicate runs

Notes:

1) A card jam caused non-reproducible card counts in multiple trials, disqualifying difference matching using A02. Meaningless or blank data may show on up to 20 cards on reel 002.
2) Many calibration failures due to image overexposure following card misfeeds
3) Reel 147 has long scratch near column 70
4) Reel 274 has long scratch near column 22
5) Reel 313 has long scratch near column 65
6) Reel 336 has high calibration failure count from cut edges of cards
7) Reels 341 and 351 may have artificially high calibration failure rate without data loss
8) Reel 378 has long streak near card 7476
9) Reel 414 has scratches near start
10) Data shown are from second run of entire Deck 192. GDA disks with "A" suffix replace original submissions without suffix. GDA-14A through 19A directly replace GDA-14 through 19.
Deck 193 Dutch-Netherland

Scanned:

001-538  06-10 to 06-24-98
A01-A05  06-10  06-12-98

Recorded on:

001-099  GDA-20A
100-199  GDA-21A
200-299  GDA-22A
300-399  GDA-23A
400-499  GDA-24A
500-538  GDA-25A

Calibration failure rate:

Mean for deck = 2.0

Failure rate = 0.016 percent

Unreadable cards found per reel*

Cards found unreadable*

Difference test data:

001 vs A01  0.26 percent
002  A02  0.21
003  A03  0.20
004  A04  0.25
005  A05  0.26

Mean for sample 0.24 percent

Cards with differences in duplicate runs

Notes:

* As a result of card jams during filming, possibly one-half of the total shown for this deck may be artificially generated, without actual loss of data from cards.
1) Column 13 with illegal character frequently punched 0/1
2) Column 19 with illegal character (sampled) punched k
3) Several reels showed narrow cards left border, required program customization.
4) Many calibration failures due to image overexposure following card misfeeds
10) Data shown are from second run of entire Deck 193. New GDA disks labeled 20A through 25A directly replace earlier numbers 20 through 25.
Processing Notes by Deck

Deck 194 British Marine, revised 12-03-98

Scanned:

001-341 08-06 to 11-30-98  Less reel 062, copy not yet received in scannable form
A11-A15  10-08-98  Sample for difference test, see Note 1

Recorded on:

001-099  GDA-1A  Except reel 062
100-199  GDA-2A
200-299  GDA-3A
300-341  GDA-4A

Calibration failure rate:

Mean for deck = 2.3  Unreadable cards found per reel
Failure rate = 0.019 percent  Cards found unreadable

Difference test data:

011 vs A11  0.15 percent
012  A12  0.32
013  A13  0.23
014  A14  0.06
015  A15  0.18

Mean of sample 0.19 percent  Cards with differences in duplicate runs

Note:

1) After multiple runs of original sample A01-A05, reels A11-A15 were adopted as a more representative sample of deck 194.
2) Copy film of reel 062 will be scanned when received
Outstanding number of reels at current date (12-03-98): 1
Processing Notes by Deck

Deck 195 Navy Ship Logs, 1945-1945

Scanned:

006-054 05-22-98
001-005 04-28-98
A01-A05 04-28-98

Recorded:

001-054 GDA-32
A01-A05 GDA-32

Calibration failure rate:

Mean for deck = 1.7 Unreadable cards found per reel

Failure rate = 0.014 percent Cards found unreadable

Difference test data:

001 vs A01 0.04 percent
002 A02 0.07
003 A03 0.06
004 A04 0.05
005 A05 0.11

Mean of sample 0.07 percent Cards with differences in duplicate runs

Notes:

1) Reel 024 has high calibration failure rate (0.09%) due to number of corner cuts at lower right edge of some cards
Processing Notes by Deck

Deck 196 German Marine, 1949-1953

Scanned:

001-016  05-27 to 05-28-98
A01       05-27-98

Recorded:

001-016  GDA-28
A01       GDA-28

Calibration failure rate:

Mean for deck = 0.4
Failure rate  = 0.003 percent

Unreadable cards found per reel
Cards found unreadable

Difference test data:

001 vs A01  0.10

Mean of sample  0.10 percent
Cards with differences in duplicate runs

Notes:

1) Deck 196 small, difference sample limited to one reel
Processing Notes by Deck

Deck 197 Danish Marine

Scanned:

<table>
<thead>
<tr>
<th>Deck</th>
<th>Reel</th>
<th>Date</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>001-003</td>
<td>05-28, 1998</td>
<td>Reel 002 omitted, not recvd</td>
<td></td>
</tr>
<tr>
<td>A01</td>
<td>05-28, 1998</td>
<td>Reel 002 recvd</td>
<td></td>
</tr>
<tr>
<td>002</td>
<td>10-26, 1998</td>
<td>Reel 002 recvd</td>
<td></td>
</tr>
</tbody>
</table>

Recorded on:

<table>
<thead>
<tr>
<th>Deck</th>
<th>Reel</th>
<th>Date</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>001-003</td>
<td>GDA-28</td>
<td>Reel 002 absent</td>
<td></td>
</tr>
<tr>
<td>A01</td>
<td>GDA-28</td>
<td>Reel 002 recvd and scanned</td>
<td></td>
</tr>
<tr>
<td>002</td>
<td>GDA-37</td>
<td>Unreadable cards found per reel</td>
<td></td>
</tr>
</tbody>
</table>

Calibration failure rate:

Mean for deck = 0.4

Failure rate = 0.003 percent

Cards found unreadable

Difference test data:

001 vs A01 0.10 percent

Mean of sample 0.10 percent

Cards with differences in duplicate runs

Notes:

1) Reel box labelled 002 contained film of Deck 159, Reel 088
2) Deck 197 small, difference sample limited to one reel
Processing Notes by Deck

Deck 256 Surface Marine, 1963-

Scanned:

<table>
<thead>
<tr>
<th>Deck</th>
<th>Date</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>748-776</td>
<td>06-02-98</td>
<td>See note (1) below</td>
</tr>
<tr>
<td>A48</td>
<td>06-02-98</td>
<td></td>
</tr>
</tbody>
</table>

Recorded on:

<table>
<thead>
<tr>
<th>Deck</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>748-776</td>
<td>GDA-30</td>
</tr>
<tr>
<td>A48</td>
<td>GDA-30</td>
</tr>
</tbody>
</table>

Calibration failure rate:

Mean for deck = 1.9
Failure rate = 0.016 percent

Unreadable cards found per reel
Cards found unreadable

Difference test data:

748 vs A48 0.12 percent

Mean of sample 0.12 percent Cards with differences in duplicate runs

Notes:

1) Original work statement specified 72 reels; 29 were received. All were scanned. Later information indicated that these may be of limited interest.

2) Deck 256 small, difference sample limited to one reel
Processing Notes by Deck

Deck 281 Navy MAR, Beg -1945

Scanned:

001-097     06-25 to 06-30-98
A01-A05     06-25      06-26-98

Recorded on:

001-097     GDA-36
A01-A05     GDA-36

Calibration failure rate:

Mean for deck = 4.8
Failure rate = 0.40 percent

Unreadable cards found per reel*
Cards found unreadable*

Difference test data:

001 vs A01   0.12 percent
002   A02    0.17
003   A03    0.49
004   A04    0.20
005   A05    0.22

Mean of sample  0.24 percent Cards with differences
                in duplicate runs

Notes:

* More numerous defects in films of Deck 281 than normal,
  overexposed at misfeeds, many card jams
Processing Notes by Deck

Deck 541 USRAOBS, 1941-1947

Scanned:

021  10-27-98
A21  10-27-98
001-020 11-30-98

Recorded on:

001-021  GDA-37
A21  GDA-37

Calibration failure rate:

Mean for deck = 5.8
Failure rate = 0.048 percent
Unreadable cards found per reel
Cards found unreadable

Difference test data:

021 vs A21  0.20 percent

Mean of sample  0.20 percent
Cards with differences in duplicate runs

Notes:

1) Deck 541 small, difference sample limited to one reel
Processing Notes by Deck

Deck 547 Payerne RAOBS, 1942-1948

This reel will be scanned when received
Processing Notes by Deck

Deck 608 Hungary RAOBS, 1954-1958

Scanned:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>10-28-98</td>
</tr>
<tr>
<td>A01</td>
<td>10-28-98</td>
</tr>
</tbody>
</table>

Recorded on:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>GDA-37</td>
</tr>
<tr>
<td>A01</td>
<td>GDA-37</td>
</tr>
</tbody>
</table>

Calibration failure rate:

Mean for deck = 1.0
Failure rate = 0.008 percent

Unreadable cards found per reel
Cards found unreadable

Difference test data:

001 vs A01 0.09 percent
Mean of sample 0.09 percent

Cards with differences in duplicate runs

Notes:

1) Deck 608 small, difference sample limited to one reel
Processing Notes by Deck

Deck 650 Formosan RAOBS

Scanned:

001-007  06-03-98
A01      06-03-98

Recorded:

001-007  GDA-30
A01      GDA-30

Calibration failure rate:

Mean for deck = 2.7
Failure rate = 0.023 percent

Unreadable cards found per reel
Cards found unreadable

Difference test data:

001 vs A01  0.11 percent

Mean of sample 0.11 percent
Cards with differences in duplicate runs

Notes:

1) Deck 650 small, difference sample limited to one reel
Processing Notes by Deck

Deck 690 Israel RAOBS

Scanned:

001 05-28-98
A01 05-28-98

Recorded on:

001 GDA-30
A01 GDA-30

Calibration failure rate:

Mean for deck = 1.0
Failure rate = 0.009 percent

Unreadable cards found per reel
Cards found unreadable

Difference test data:

001 vs A01 0.14 percent

Mean of sample 0.14 percent
Cards with differences in duplicate runs

Notes:

1) Deck 690 small, difference sample limited to one reel
### Appendix A-1  Coding Plan for Fosdic scanning of NCDC films

**CODES FOR NUMERIC AND ALPHABETIC PUNCHED DATA**

<table>
<thead>
<tr>
<th>Hollerith Rows</th>
<th>Fosdic Rows</th>
<th>Fosdic hex</th>
<th>Fosdic decimal</th>
<th>ASCII Nmbr</th>
<th>ASCII Char</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 only</td>
<td>1 only</td>
<td>10h</td>
<td>18</td>
<td>38</td>
<td>&amp;</td>
</tr>
<tr>
<td>12 + 11</td>
<td>1 + 2</td>
<td>12h</td>
<td>20</td>
<td>42</td>
<td>!</td>
</tr>
<tr>
<td>12 + 0</td>
<td>1 + 3</td>
<td>13h</td>
<td>21</td>
<td>42</td>
<td>)</td>
</tr>
<tr>
<td>12 + 1</td>
<td>1 + 4</td>
<td>14h</td>
<td>22</td>
<td>67</td>
<td>A</td>
</tr>
<tr>
<td>12 + 2</td>
<td>1 + 5</td>
<td>15h</td>
<td>23</td>
<td>68</td>
<td>B</td>
</tr>
<tr>
<td>12 + 3</td>
<td>1 + 6</td>
<td>16h</td>
<td>24</td>
<td>69</td>
<td>C</td>
</tr>
<tr>
<td>12 + 4</td>
<td>1 + 7</td>
<td>17h</td>
<td>25</td>
<td>70</td>
<td>D</td>
</tr>
<tr>
<td>12 + 5</td>
<td>1 + 8</td>
<td>18h</td>
<td>26</td>
<td>71</td>
<td>E</td>
</tr>
<tr>
<td>12 + 6</td>
<td>1 + 9</td>
<td>19h</td>
<td>27</td>
<td>72</td>
<td>F</td>
</tr>
<tr>
<td>12 + 7</td>
<td>1 + 10</td>
<td>1Ah</td>
<td>28</td>
<td>73</td>
<td>G</td>
</tr>
<tr>
<td>12 + 8</td>
<td>1 + 11</td>
<td>1Bh</td>
<td>29</td>
<td>74</td>
<td>H</td>
</tr>
<tr>
<td>12 + 9</td>
<td>1 + 12</td>
<td>1Ch</td>
<td>30</td>
<td>75</td>
<td>I</td>
</tr>
</tbody>
</table>

| 11 only        | 2 + none    | 20h       | 3             | 45         | -          |
| 11 + 0         | 2 + 3       | 23h       | 35             | 42         | (          |
| 11 + 1         | 2 + 4       | 24h       | 36             | 74         | J          |
| 11 + 2         | 2 + 5       | 25h       | 37             | 75         | K          |
| 11 + 3         | 2 + 6       | 26h       | 38             | 76         | L          |
| 11 + 4         | 2 + 7       | 27h       | 39             | 77         | M          |
| 11 + 5         | 2 + 8       | 28h       | 40             | 78         | N          |
| 11 + 6         | 2 + 9       | 29h       | 41             | 79         | O          |
| 11 + 7         | 2 + 10      | 2Ah       | 42             | 80         | P          |
| 11 + 8         | 2 + 11      | 2Bh       | 43             | 81         | Q          |
| 11 + 9         | 2 + 12      | 2Ch       | 44             | 82         | R          |

| 0 only         | 3 only      | 30h       | 3             | 48         | 0          |
| 0 + 1          | 3 + 4       | 34h       | 52             | 45         | *          |
| 0 + 2          | 3 + 5       | 35h       | 53             | 83         | S          |
| 0 + 3          | 3 + 6       | 36h       | 54             | 84         | T          |
| 0 + 4          | 3 + 7       | 37h       | 55             | 85         | U          |
| 0 + 5          | 3 + 8       | 38h       | 56             | 86         | V          |
| 0 + 6          | 3 + 9       | 39h       | 57             | 87         | W          |
| 0 + 7          | 3 + 10      | 3Ah       | 58             | 88         | X          |
| 0 + 8          | 3 + 11      | 3Bh       | 59             | 89         | Y          |
| 0 + 9          | 3 + 12      | 3Ch       | 60             | 90         | Z          |

| 1 only         | 4 only      | 40h       | 4             | 49         | 1          |
| 1 + 2          | 4 + 5       | 45h       | 69             | 42         | *          |
| 1 + 3          | 4 + 6       | 46h       | 70             | 42         | *          |
| 1 + 4          | 4 + 7       | 47h       | 71             | 42         | *          |
| 1 + 5          | 4 + 8       | 48h       | 72             | 42         | *          |
| 1 + 6          | 4 + 9       | 49h       | 73             | 42         | *          |
| 1 + 7          | 4 + 10      | 4Ah       | 74             | 42         | *          |
| 1 + 8          | 4 + 11      | 4Bh       | 75             | 42         | *          |
| 1 + 9          | 4 + 12      | 4Ch       | 76             | 42         | *          |

| 2 only         | 5 only      | 50h       | 5             | 50         | 2          |
| 2 + 3          | 5 + 6       | 56h       | 86             | 42         | *          |
| 2 + 4          | 5 + 7       | 57h       | 87             | 42         | *          |
| 2 + 5          | 5 + 8       | 58h       | 88             | 42         | *          |
| 2 + 6          | 5 + 9       | 59h       | 89             | 42         | *          |
| 2 + 7          | 5 + 10      | 5Ah       | 90             | 42         | *          |
| 2 + 8          | 5 + 11      | 5Bh       | 91             | 42         | *          |
| 2 + 9          | 5 + 12      | 5Ch       | 92             | 42         | *          |
## CODES FOR NUMERIC AND ALPHABETIC PUNCHED DATA (cont)

<table>
<thead>
<tr>
<th>Hollerith Rows</th>
<th>Fosdic Rows</th>
<th>Fosdic hex</th>
<th>Fosdic decimal</th>
<th>ASCII Nmbr</th>
<th>ASCII Char</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 only</td>
<td>6 only</td>
<td>60h</td>
<td>6</td>
<td>51</td>
<td>3</td>
</tr>
<tr>
<td>3 + 4</td>
<td>6 + 7</td>
<td>67h</td>
<td>103</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>3 + 5</td>
<td>6 + 8</td>
<td>68h</td>
<td>104</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>3 + 6</td>
<td>6 + 9</td>
<td>69h</td>
<td>105</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>3 + 7</td>
<td>6 + 10</td>
<td>6Ah</td>
<td>106</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>3 + 8</td>
<td>6 + 11</td>
<td>6Bh</td>
<td>107</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>3 + 9</td>
<td>6 + 12</td>
<td>6Ch</td>
<td>108</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>4 only</td>
<td>7 only</td>
<td>70h</td>
<td>7</td>
<td>52</td>
<td>4</td>
</tr>
<tr>
<td>4 + 5</td>
<td>7 + 8</td>
<td>78h</td>
<td>120</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>4 + 6</td>
<td>7 + 9</td>
<td>79h</td>
<td>121</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>4 + 7</td>
<td>7 + 10</td>
<td>7Ah</td>
<td>122</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>4 + 8</td>
<td>7 + 11</td>
<td>7Bh</td>
<td>123</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>4 + 9</td>
<td>7 + 12</td>
<td>7Ch</td>
<td>124</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>5 only</td>
<td>8 only</td>
<td>80h</td>
<td>8</td>
<td>53</td>
<td>5</td>
</tr>
<tr>
<td>5 + 6</td>
<td>8 + 9</td>
<td>89h</td>
<td>137</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>5 + 7</td>
<td>8 + 10</td>
<td>8Ah</td>
<td>138</td>
<td>42</td>
<td>*</td>
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<tr>
<td>5 + 8</td>
<td>8 + 11</td>
<td>8Bh</td>
<td>139</td>
<td>42</td>
<td>*</td>
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<tr>
<td>5 + 9</td>
<td>8 + 12</td>
<td>8Ch</td>
<td>140</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>6 only</td>
<td>9 only</td>
<td>90h</td>
<td>9</td>
<td>54</td>
<td>6</td>
</tr>
<tr>
<td>6 + 7</td>
<td>9 + 10</td>
<td>9Ah</td>
<td>154</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>6 + 8</td>
<td>9 + 11</td>
<td>9Bh</td>
<td>155</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>6 + 9</td>
<td>9 + 12</td>
<td>9Ch</td>
<td>156</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>7 only</td>
<td>10 only</td>
<td>A0h</td>
<td>10</td>
<td>55</td>
<td>7</td>
</tr>
<tr>
<td>7 + 8</td>
<td>10 + 11</td>
<td>ABh</td>
<td>171</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>7 + 9</td>
<td>10 + 12</td>
<td>ACh</td>
<td>172</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>8 only</td>
<td>11 only</td>
<td>B0h</td>
<td>11</td>
<td>56</td>
<td>8</td>
</tr>
<tr>
<td>8 + 9</td>
<td>11 + 12</td>
<td>BCh</td>
<td>188</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>9 only</td>
<td>12 only</td>
<td>C0h</td>
<td>12</td>
<td>57</td>
<td>9</td>
</tr>
</tbody>
</table>

### CODES FOR DOUBLE OVERPUNCH WITH SINGLE NUMERIC PUNCH

<table>
<thead>
<tr>
<th>Hollerith Rows</th>
<th>Fosdic Rows</th>
<th>Fosdic hex</th>
<th>Fosdic decimal</th>
<th>ASCII Nmbr</th>
<th>ASCII Char</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y+X only</td>
<td>1+2 only</td>
<td>EDh</td>
<td>237</td>
<td>33</td>
<td>!</td>
</tr>
<tr>
<td>Y+X + 0</td>
<td>1+2 + 3</td>
<td>F0h</td>
<td>240</td>
<td>43</td>
<td>+</td>
</tr>
<tr>
<td>&quot;</td>
<td>+ 4</td>
<td>F1h</td>
<td>241</td>
<td>94</td>
<td>^</td>
</tr>
<tr>
<td>&quot;</td>
<td>+ 5</td>
<td>F2h</td>
<td>242</td>
<td>60</td>
<td>&lt;</td>
</tr>
<tr>
<td>&quot;</td>
<td>+ 6</td>
<td>F3h</td>
<td>243</td>
<td>62</td>
<td>&gt;</td>
</tr>
<tr>
<td>&quot;</td>
<td>+ 7</td>
<td>F4h</td>
<td>244</td>
<td>36</td>
<td>$</td>
</tr>
<tr>
<td>&quot;</td>
<td>+ 8</td>
<td>F5h</td>
<td>245</td>
<td>37</td>
<td>%</td>
</tr>
<tr>
<td>&quot;</td>
<td>+ 9</td>
<td>F6h</td>
<td>246</td>
<td>61</td>
<td>=</td>
</tr>
<tr>
<td>&quot;</td>
<td>+10</td>
<td>F7h</td>
<td>247</td>
<td>91</td>
<td>[</td>
</tr>
<tr>
<td>&quot;</td>
<td>+11</td>
<td>F8h</td>
<td>248</td>
<td>93</td>
<td>)</td>
</tr>
<tr>
<td>&quot;</td>
<td>+12</td>
<td>F9h</td>
<td>249</td>
<td>92</td>
<td>\</td>
</tr>
</tbody>
</table>

### Notes:
- Sequence of rows in Hollerith code is:
  - 12-11-0-1-2-3-4-5-6-7-8-9
- Y -X -0-1-2-3-4-5-6-7-8-9

- Sequence in Fosdic scanning program is:
  - 1-2-3-4-5-6-7-8-9-1-11-12

- Remaining codes not shown above are all (42) "*"
Appendix B-1  LDR.ASM Program

The following is a printout of the source program LDR.ASM described in Sections 3.0 to 3.1.5 of the text. Written in assembler language, it requires assembly using TASM LDR to create an LDR.OBJ file. Called subroutines are similarly assembled. The group of OBJ files is then linked with the instruction TLINK @LDR0. This yields the operating program LDR.EXE. The file LDR0 is a response file containing the names of all subroutines called on in execution of LDR.EXE. Appendix E lists the contents of LDR0. This approach makes LDR0 the equivalent of a library file but one that is more easily modified for program customization than the standard type.

There are two other files referred to in the program listing below. These are called INCLUDE files, here named SCAN_VAR and SCAN_PCD, for Scan Variables and Scan Procedures. The two files are definitions of the Global variables and procedures available in common to all elements of the overall program.

;LDR.ASM Program to run leader in on NCDC films
;Calibrates Gain with called sr GAIN, displays and records Gain DAC and MaxSig
;Measures CardSig and MinSig with called sr BKGND, displays and records same
;Stores output data in <Parameters> and creates file PARAM, as listed below
;Linked via LDR0

.386
IDEAL
MODEL SMALL
STACK 128

DATASEG

XCO dw 7000  ; XC origin
YCO dw 19100 ; YC origin
XFO dw 4096  ; XF origin
YFO dw 8000  ; YF origin
Thrd0 dw 400  ; signal threshold for frame scan stroke
XC dw ?      ; working XC
YC dw ?      ; working YC
XF dw ?      ; working XF
YF dw ?      ; working YF
XCFram dw ?  ; XC when calling for Frame
YCFram dw ?  ;
XCFramStop dw ?  ; XC left threshold for turning film drive off
ParamData dw 10 dup (?)  ; ParamData +0 = Gain DAC
                        ; +2 = MaxSig
                        ; +4 = CardSig
                        ; +6 = MinSig
                        ; +8 through 18 = Spare

ParamText db 80 dup (32),0;  ',20 dup (32),0 ; this must follow
Parameters
xy dw 100 dup (20), ; (Parameter values are superimposed on above message for display purposes)
signon db 0Ah,0Dh,'Film started',0 ; sign on message
stallmsg db 13,10,'Film Drive stalled, please restart program',0
filename db 'Param',0
handle dw 5
Junk dw 100 dup (?) ; JIC
prbuf db 20 dup (?) ; JIC
Data5 dw ?

INCLUDE "Scan_var"
ParamHandle dw ?
; FlagEOF dw ?
Transmte dw 800
CODESEG
INCLUDE "Scan_Pcd"

start:
    mov ax,@data
    mov ds,ax
    mov es,ax

    mov dx,316h ;Reset
    mov ax,01
    out dx,ax
    mov ax,03 ;set deflection settling delay to minimum
    out dx,ax

    mov dx,308h ;set initial Gain DAC for advancing film
    mov ax,512
    out dx,ax
    mov dx,30Ch
    mov ax,500 ;set Tilt to null
    out dx,ax

;---------------------------------------------------------------------

;Preparation for Frame sr
    mov ax,[XCO] ;set XFrame position XCO+2000
    add ax,2000
    mov [XFrame],ax

    mov ah,2Ch ;randomize XFrame to distribute wear on CRT
    int 21h
    shr dx,5 ;divide by 32 to limit excursion to apx 500
    add [XFrame],dx ;mils
    add [XFrame],dx ;add to XFrame to shift origin

    mov ax,[XCO] ;set XFrameStop position XCO+1500
    add ax,1500
    mov [XFrameStop],ax

    mov [YFrame],12000

    mov dx,304h ;set and issue XF to initial value (center)
    mov ax,4096
    out dx,ax
    mov dx,306h
    mov ax,8000
    out dx,ax

;    mov [CardSig],650 ;dummy values to create threshold for Frame sr
;    mov [Transmtce],800
;    mov [MinSig],50

;---------------------------------------------------------------------

    call Frame ;Runs film leader to first card and stops
                ;for entry of deck and reel numbers

;---------------------------------------------------------------------

    StallCheck: ;Want to go directly to Stop if Frame stalled
        mov dx,31Ah
        in ax,dx
        test ax,4h ;bit 02 high indicates TakeUp Idler is slack
        jne StallStop

;---------------------------------------------------------------------

    call WIPE ;Activate CRT screen

;---------------------------------------------------------------------

    call GAIN ;Calibrate Gain, find Gain DAC and MaxSig

;---------------------------------------------------------------------

    call BKGND ;Calibrate CardSig and MinSig, add Spare
call CAL_DSPL ;Display calibration parameters
------------------------------------------------------------------------
call ENTRY ;Add kbd Deck, etc data
------------------------------------------------------------------------

mov [ParamData+8], 0
mov [ParamData+10], 0
mov [ParamData+12], 0
mov [ParamData+14], 0
mov [ParamData+16], 0
mov [ParamData+18], 0

mov [ParamData+43], 49
mov [ParamData+44], 57
mov [ParamData+45], 57
mov [ParamData+46], 56

CreateParamFile:
    mov dx,offset filename ;create and open PARAM file
    mov ah,03Ch
    mov cx,0
    int 21h
    mov [ParamHandle],ax

    mov bx,[ParamHandle] ;write PARAM file
    mov cx,100
    mov ah,40h
    mov dx,offset paramdata
    int 21h

stop:
    mov ah,04Ch ;close file and exit LDR program
    int 21h
------------------------------------------------------------------------

StallStop:
    mov cx,1
    mov di, offset stallmsg ;Restart msg
call strwrite
    mov cx,2
@wt1:
    mov bx,65000
@wt2:
    dec bx
    jnz @wt2
    loop @wt1
    jmp start

End start

Appendix B-1  LDR.ASM  page 3 of 3
Appendix B-2    FRAME.ASM Subroutine procedure

This procedure is assembled with the command TASM FRAME, automatically including it in LDR0 and PCSCAN0. A description of its actions is covered in Section 3.1.1 for LDR0 and in more detail for PCSCAN0, in Sections 3.4 to 3.4.7.

;-----------------------------------------------
;FRAME.ASM Procedure to frame on NCDC films

;Scan pattern makes strokes of 10 Reads, interlaced 6X, checked for
;Clear/Dense at end of strokes
;Scan follows (top) edge of card designated by XCFrame from calling program
;Film drive stops when left side threshold XCFrameStop is reached
;Vertical origin is XCFrame from calling program; XF and YF are jammed to 4096
;and 8000 in procedure and not referred to afterwards
;Horizontal origin is XCFrame loaded by calling program
;Threshold supplied by calling program

.386
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DATASEG
msg1 db 'Turn on Film Drive',0  
ClearCount dw 0
EoFCount dw ?
Interlace dw 50;100
StepF dw 300
FlagEOF dw ?
XCSStopped dw ?
FrmSig dw 800 ;default CardSig for setting threshold
YCFramedw ?
Thrd dw ?
ScalTransm dw ?

INCLUDE "Scan_Var"

CODESEG
INCLUDE "Scan_Pcd"
proc Frame
procall

    mov [FlagEOF],0               ;reset End of Film flag
    ;start capstan
    mov dx,310h
    mov ax,01h
    out dx,ax
    mov dx,30Ah
    out dx,ax
    ;set Focus for large spot
    mov dx,304h
    mov ax,4096
    out dx,ax
    mov dx,306h
    mov ax,8000
    out dx,ax
    ;set XF to origin
    cmp ax,11000
    jg @13
    mov ax,12000
    ;make XCFrame at least 12000

Appendix B-2    FRAME.ASM  page 1 of 3
@13: add ax,1000 ;advance XCFram, the initial horiz location
cmp ax,27000 ;limit deflection to 27,000
jle @13a
mov ax,27000

@13a:
mov [XCFram],ax ; of Frame Scan, 1000 above XCFram
mov [XC],ax

;Threshold calcs
mov ax,[Scalar]
add ax,[Transmit]
shr ax,1
mov [Thrld].ax
cmp [Thrld].ax,250;300 ;put floor of 250;300 in Thrld
jg @14
mov [Thrld].ax,250;300

@14:
cmp [Thrld].ax,500 ;and ceiling of 500
jl @15
mov [Thrld].ax,500

@15:

NewRaster:
mov [Interlace],0 ;reset Interlace

NewStroke:
mov cx,6 ;set for 6 vertically interlaced strokes
mov [ClearCount].ax,0 ;here at start of every stroke

mov dx,302h ;send out first YC
mov ax,[YCFram].ax;
add ax,[Interlace]
mov [YC].ax
out dx,ax

mov dx,300h ;set current XC. Limits are XCFram, max
mov ax,[XC] ;"" XCFram,Stop, min
out dx,ax ;issue XC

mov bx,1200 ;coords all loaded for first read in stroke

dly1:
dec bx
jne dly1
mov [EoFCount].ax,0

mov dx,318h ;start Read at first position in stroke
in ax,dx

push cx ;pushed from Interlace to Read counting
mov cx,10 ;No. of Reads in column

Read:
cmp cx,1 ;Skip increment below if last read in stroke
je @@1

mov dx,302h
mov ax,[YC]
add ax,[StepP] ;add YC step
mov [YC].ax ;save new YC
out dx,ax

@@1:
mov dx,318h ;Reads in loop
in ax,dx

@10:
test ax,8000h ;wait for end of Read
jne @10
and ax,1023 ;leave only useful bits
cmp ax,1023 ;check for End of Film as indicated by
jne @18 ;saturated photosignal
inc [EoFCount]
cmp [EoFCount],5
jb @18
mov [FlagEoF],1
@18:
cmp ax,[Thrld]
lsl contini ;discard low signals and skip to continue
inc [ClearCount] ;increment ClearCount if high signal
contin1:
    loop Read
    pop cx ;popped for return from Read to Interlace
    ; counting
    ;Through here at end of every stroke of 10 Reads

StallCheck:
    mov dx,31Ah
    ;Want to terminate Frame Scan when
    in ax,dx
    ; TakeUp Idler is slack (318h bit 02 high)
test ax,004h
    ; return immediately to calling program
    jne Stop
    ; to prevent sustained Frame Scan

StopCheck:
    mov ax,[XCFrameStop] ;Check edge-following XC with threshold below
cmp [XC],ax
    ; which film drive is to be turned off
    jg contin5
    ; left side at XC=XCFrameStop, then jump out
    ;through here if left side reached
    mov dx,310h ;tell film drive to stop
    mov ax,0
    out dx,ax
contin5:
    mov dx,31Ah ;want scan to continue until stopped indicated
    in ax,dx
    ; checking for Stopped Indicator (00h low)
test ax,1h
    jne contin6
    jmp Stop
    ; to Stop

DataAnalysis: ;Was this stroke in clear (card) or
dense (scale) area of image?
contin6:
    cmp [ClearCount],8 ;check Clear count at end of every stroke of 10
    jng DriveContin ;requires 9 or more high signals in stroke
    ; to be called Clear
    ;executes next instruction if Clear
    sub [XC],200 ;move XC down when in clear zone

DriveContin: ;through here until followed edge reaches left side
    add [Interlace],100 ;move stroke YC down 100 for interlace
    loop toNewStroke
    jmp toNewRaster
toNewStroke:
    jmp NewStroke

toNewRaster: ;through here at end of every raster of 6 strokes
    jmp NewRaster
    ;repeat raster of interlaced strokes

Stop: mov dx,302h ;set YC to origin
    mov ax,[YC]0
    mov [YC],ax
    out dx,ax
    popa
    ret

ENDp Frame ;Normal exits - 31Ah bit 02=0
END ;Emergency " " =1 TakeUp Idler
; is slack, need to turn off Beam
Appendix B-3  WIPE.ASM Subroutine procedure

This procedure is assembled with the command TASM WIPE, automatically including it in the linking file LDR0. A description of its action is given in Section 3.1.2.

;-----------------------------------------------------------------
;WIPE.ASM Procedure to activate CRT phosphor
.
.REAL
MODEL SMALL

DATABEG
signon db 0Ah,0Dh,'Activate CRT screen',0
space dw ',0
XCOWipe dw (5000)
YCOWipe dw (10000)
INCLUDE "Scan_Var"

CODESEG
INCLUDE "Scan_Pcd"

proc wipe
    mov dx,308h ;set Gain
    mov ax,512
    out dx,ax
    mov dx,30Ah ;set Focus to max
    mov ax,1000
    out dx,ax
    mov dx,30Ch ;set Tilt to null
    mov ax,512
    out dx,ax
    mov dx,304h ;set XF to center
    mov ax,4096
    out dx,ax
    mov dx,306h ;set YF to center
    mov ax,4096
    out dx,ax
    mov dx,316h ;reset
    mov ax,01
    out dx,ax
    mov ax,12h ;enable counter
    out dx,ax
    mov ax,03 ;Settling delay=0
    out dx,ax
    mov dx,300h ;set XC at start of raster
    mov ax,[XCOWipe]
    out dx,ax
    mov [XC],ax
    mov dx,300h ;here at start of column
    mov ax,[YCWipe]
    out dx,ax
    mov [YC],ax
    mov dx,302h
    add [XC],25
    mov ax,[XC]
    out dx,ax
    mov [XC],ax
    ;advance XC for next column

Appendix B-3  WIPE.ASM  page 1 of 2
; send out first YC
mov dx,302h
mov ax,[YC]
out dx,ax

; settling delay
mov bx,100
dly1:
  dec bx
  jne dly1

; start Read at first position in column
mov dx,318h
in ax,dx
Read:
  mov dx,302h
  add [YC],50
  mov ax,[YC]
  out dx,ax
  mov [YC],ax
  mov dx,318h
  in ax,dx
  test ax,8000h
  jne $10
  cmp [YC],23000
  jle Read
  cmp [XC],28000
  jle NewCol
  ret

$10:
  ; wait for end of Read
  jne $10

Endp   wipe
End
Appendix B-4  GAIN.ASM Subroutine procedure

This procedure is assembled with the command TASM GAIN, automatically including it in LDR0 and PCSCAN0. A description of its action is given in Section 3.3.3.

;---------------------------------------------------------------------
;GAIN.ASM Procedure to calibrate Gain
;Generates slanted stroke in clear area of film above card image on screen
;Aims for max photosignal of 980 on scale of 1023
;Finds mean of 4 highest signals in stroke of 10 Reads
;Varies Gain DAC input in successive approximations to achieve 980
;Makes 3 trials with open-end corrections
;Output is Gain (DAC) at Parameters+0, MaxSig at Parameters+2

.386
IDEAL
MODEL SMALL

DATASEG

;Fudges
GainFudge dw 0;-200;0 ;Fudge to reduce Gain from calculated value,
; may be required on dense copy films

;---------------------------------------------------------------------
;Data0  dw 10 dup (0) ;memory area for 10 Reads in slanted Gain stroke
XCGain dw 15000 ;XC origin for Gain scan
YCGain dw 65000 ;YC origin for Gain scan, also YF=8000 (-4096)

Thrld0 dw 300 ;initial threshold
Thrld1 dw 300 ;working threshold
ThrldSum dw 0 ;accumulated sum of 4 peak signals in Gain scan

Gain0 dw 512 ;initial Gain DAC setting
Gain1 dw ? ;working and final Gain DAC value
NnbrTries dw ? ;iterations in Gain calibration settling
MaxSig dw ? ;mean of 4 highest signals in Gain scan stroke
PeakPos dw ? ;location of intermediate peaks in 4 passes
;ParamData dw ? ;Storage location for parameter data as generated

INCLUDE "Scan_Var"

CODESEG
INCLUDE "Scan_Pcd"
proc Gain
    mov dx,308h ;set initial Gain value
    mov ax,[Gain0]
    mov [Gain1],ax
    out dx,ax

    mov dx,30Ah ;set Focus to max
    mov ax,1000
    out dx,ax

    mov dx,316h ;Settling delay=3
    mov ax,33
    out dx,ax

    mov dx,304h ;set initial XF
    mov ax,[XF0]
    mov [XF],ax
    out dx,ax
mov dx,306h ;set initial YF
mov ax,[YF0]
mov [YF],ax
out dx,ax

mov [NmbTrTries],0 ;initialize iteration counter

;----------------------------------------
NewStroke:
mov dx,302h ;set YC at start of stroke
mov ax,[YC0Gain]
out dx,ax
mov [YC],ax
mov di,0

mov dx,300h ;send out first XC
mov ax,[XC0Gain]
mov [XC],ax
out dx,ax ;coords all loaded for first read in stroke

mov bx,30 ;settling delay
dly1: dec bx
jne dly1

mov dx,318h ;start Read at first position in stroke
in ax,dx

mov cx,10 ;No. of Reads in stroke
Read:
cmp cx,1 ;Skip increment below if last read in stroke
je @01

mov dx,300h ;create slanted stroke of 10 Reads
add [XC],600 ;XC step
mov ax,[XC]
out dx,ax
mov dx,302h ;YC step
add [YC],100
mov ax,[YC]
out dx,ax

@01: mov dx,318h ;Read in loop
@10: in ax,dx
test ax,8000h ;wait for end of Read
jne @10
and ax,1023
mov [Data0+di],ax
inc di
inc di
loop Read

Jmp DataAnalysisRtn:
inc [NmbTrTries]
cmp [NmbTrTries],3
jge Stop ;Go out after 3 tries
jmp NewStroke ;Path to keep trying 3 times

;----------------------------------------
DataAnalysis: ;Want mean of 4 highest signals in stroke of 10
mov [ThrdSum],0 ;reset sum of 4 peaks
mov cx,4 ;set cx for repeating to find the 4 highest

@07: mov di,0 ;peaks
mov bx,[Thrd0]
mov [Thrd1],bx ;recycle to here for 4-peak search
mov bx,[Thrd1] ;reset data pointer
mov bx,[Thrd2] ;Thrd1 now has initial value for pass
mov bx,[Thrd3] ;through 10 data values

Appendix B-4  GAIN.ASM  page 2 of 3
push cx
mov cx,10
@@5:
mov ax,[Data0+di]
cmp ax,[Thrldl]
jl @@6

threshold
mov [Thrldl],ax
mov [PeakPos],di
@@6:
inc di
inc di
loop @@5
pop cx

10X
mov bx,[PeakPos]
mov [Data0+bx],0
mov ax,[Thrldl]
again
add [ThrldSum],ax
loop @@7
mov ax,[ThrldSum]
shr ax,2
mov [MaxSig],ax

; End of Data Analysis
; MaxSig has mean of 4 highest peaks,
; which is the effective gain indicator
; continue below with Set Gain

;----------------------------------------
SetGain:
; Next, want to change gain so that mean of peaks
; is approximately 980 after 3 tries
mov dx,308h
mov ax,980
sub ax,[MaxSig]
add ax,[Gain1]
mov [Gain1],ax

@1:
mov [ParamData],ax
out dx,ax

; Gain is now calibrated

;----------------------------------------
mov cx,1
cmp [NmbrTries],2
jne @@11
mov ax,[MaxSig]
mov [ParamData+2],ax
@@11:
jmp DataAnalysisRtn

;----------------------------------------
stop:
mov dx,308h
mov ax,[Gain1]
add ax,[GainFudge]
out dx,ax

ret
ENDp Gain
END
Appendix B-5  BKGND.ASM Subroutine procedure

This procedure is assembled with the command TASM BKGND, automatically including it in the linking file LDR0. A description of its action is given in Section 3.1.3.

;---------------------------------------------------------------------
;BKGND.ASM Procedure to scan widely across film card and left edge band,
; finding typical CardSig and MinSig
;Input is MaxSig at Parameters+2
;Output is CardSig at Parameters+4, MinSig at Parameters+6
;Makes a single vertical stroke of 40 Reads, beginning over card stock and
; ending below dense band (YCMargin)
;Finds CardSig as mean of 4 highest signals in first 10 Reads in stroke
;Finds MinSig as mean of 4 lowest signals in last 20 Reads
.

.386
IDEAL
MODEL SMALL

DATASEG
XC0Bkgnd dw 9000 ;fixed XC origin
YC0Bkgnd dw 13000 ;fixed YC origin
Data0 dw 40 dup (0) ;Stored amplitudes for 40 reading positions
; used for finding minimum signal mean
Data1 dw 40 dup (0) ;Duplicate of above used in moment calculations
Data2 dw 40 dup (0) ;Storage of modified amplitudes in calculations
Thrl0 dw 400 ;fixed initial value
Thrd1 dw 400 ;working threshold
ThrdSum dw 0 ;working sum of peak or valley signal values
MinSig dw (?) ;mean of 4 lowest signals in Bkgnd stroke
CardSig dw (?) ;mean of 4 highest signals over card image
Junk1 dw (?) ;JIC
ValleyPos dw (?) ;working YCs needed for clearing in 4-pass
; routines
PeakPos dw (?) ;same for developing mean CardSig
INCLUDE "Scan_Var"

include "Scan_Pcd"

proc Bkgnd

    mov dx,40Ah ;set Focus to max
    mov ax,1000
    out dx,ax

    mov dx,316h ;Settling delay=3
    mov ax,33
    out dx,ax

;---------------------------------------------------------------------

NewStroke:

    mov di,0 ;di points to YC positions in stroke

    mov dx,300h ;set XC at start of stroke
    mov ax,[XC0Bkgnd]
    out dx,ax
    mov [XC],ax

    mov dx,302h ;send out first YC
    mov ax,[YC0Bkgnd]
    mov [YC],ax
    out dx,ax

    mov bx,30 ;coords all loaded for first read in stroke
    ;settling delay

dlyl:
    dec bx
    jne dlyl

Appendix B-5  BKGND.ASM page 1 of 3
mov dx,318h ; start Read at first position in stroke
in ax,dx

Read:
mov cx,40 ; No. of Reads in stroke
cmp cx,1 ; Skip increment below if last read in stroke
je @@1
mov dx,302h
add [YC],100 ; YC step
mov ax,[YC]
out dx,ax
mov dx,300h ; XC step
mov ax,[XC]
add ax,16
out dx,ax
mov [XC],ax
@@1:
mov dx,318h ; Read in loop
@@10:
in ax,dx
test ax,8000h ; wait for end of Read
jne @@10
and ax,1023
mov [Data0+di],ax ; at termination Data0+ has 40 signal values
mov [Data1+di],ax ; Data1+ has same values
inc di
inc di
loop Read
jmp DataAnalysis ; Here at end of stroke

DataAnalysisRtn: ; Return from Data Analysis

mov [Data0+di],0 ; Want mean of 4 highest values in first 10 reading positions
mov cx,4 ; clear threshold sum
@@70:
mov di,0 ; set cx for repeating to find 4 highest peaks
mov bx,[Thrd0]
mov [Thrd1],bx ; recycle to here for 4-peak search
push cx ; clear data pointer to first of 40 Reads
mov cx,10 ; Thrd1 now has initial value for passes ; through first 10 data points
loop @@50 ; push cx from peak counting to cycling through Data0

@@50:
mov ax,[Data0+di] ; Examine 10 amplitudes
cmp ax,[Thrd1]
jl @@60 ; jump to @@60 if signals below threshold
mov [Thrd1],ax ; save new Thrd1
mov [PeakPos],di ; save di as pointer to YC where peak occurred
@@60:
inc di
inc di
loop @@50 ; pop cx from cycling data to counting peaks
pop cx
mov bx,[PeakPos] ; Thrd1 has highest in each execution of 10X
mov [Data0+bx],0 ; PeakPos has its position in terms of di
mov ax,[Thrd1]
add [ThrdSum],ax ; clear last peak amplitude to find next highest
loop @@70

; ax has threshold sum accumulated during 10X looping
; go back to peak-seeking for total of 10 times
mov ax,[ThrldSum]
shr ax,2 ;divide sum by 4 for mean
mov [CardSig],ax ;save as Card Signal
mov [ParamData+4],ax ;save for transfer and display

;---------------------------------------------------------

@@2: ;Next, want mean of 4 lowest signals in
; last 20 of 40 strokes
mov [ThrldSum],0 ;reset sum of 4 valleys
mov cx,4 ;set cx for repeating to find the 4 lowest
; valleys
@@7: ;recycle to here for 4-valley search
mov di,40 ;reset data pointer
mov bx,[Thrld0]
mov [Thrld1],bx ;Thrld1 now has initial value for pass
; through last 20 data values
push cx ;push from valley counting to cycling through
; Data0
mov cx,20 ;Examine last 20 data values
@@5: mov ax,[Data0+di]
cmp ax,[Thrld1] ;compare signal amplitude against working
; threshold
jg @@6
mov [Thrld1],ax
mov [ValleyPos],di ;save valley position in terms of di
@@6: inc di
inc di
loop @@5
pop cx ;pop cx from cycling data to counting valleys
;Thrld1 has the lowest in each execution of 20X
;ValleyPos has its position in terms of di
mov bx,[ValleyPos]
mov [Data0+bx],999 ;max out the interim valley value so next
mov ax,[Thrld1] ;valley can be found. Then go through 20 again
add [ThrldSum],ax ;ax has Thrld1 resulting from 20X looping
loop @@7 ;go back to valley-seeking 4X
mov ax,[ThrldSum]
shr ax,2 ;divide sum by 4 to derive mean (MinSig)
mov [MinSig],ax ;End of Data Analysis
mov [ParamData+6],ax ;save MinSig

Out1: ret
ENDp Bkgnd
END
Appendix B-6    CAL_DSPL.ASM Subroutine procedure

This procedure is assembled with the command TASM CAL_DSPL, automatically including it in the linking file LDR0. A description of its action is given in Section 3.1.4.

;---------------------------------------------------------------------
;CAL_DSPL.ASM Procedure to display calibration values from Parameters
;Displays Title and column headings for Gain DAC, MaxSig, CardSig,
;MinSig, Thrd and YC Margin
;Input is pre-loaded <Parameters> file
;Sole output is display

;386
IDEAL
Model small
Stack 128

DATASEG
Title2 db ',CALIBRATION DISPLAY',0
downline db 13,10,0
dash2line db 80 dup (61),0
Label1 db 13,10,' GAIN MAX CARD MIN',0
Label2 db 13,10,' DAC SIG SIG SIG',0
INCLUDE "Scan_Var"

CODESEG
INCLUDE "Scan_Pcd"
proc Cal_Dspl
    ;Display Headings
    mov di,offset dash2line
    call strwrite
    mov di,offset downline
    call strwrite
    mov di,offset Title2
    call strwrite
    mov di,offset downline
    call strwrite
    mov di,offset Label1
    call strwrite
    mov di,offset Label2
    call strwrite
    mov di,offset downline
    call strwrite
    mov di,offset downline
    call strwrite

;Display parameters
@20:
    mov ah,3
    int 10h
    ;find cursor location
    ;leave vert position (in dh) alone
    ;use horiz position (dh) to move
    ;cursor
    ; along columns
    mov cx,4
    mov si,0
    mov di,5
    @10:
    mov ah,2h
    int 10h
    mov ax,[paramdata+si]
    call prtx
    add dl,10
    add si,2
    loop @10
mov di, offset downline
    ; add blank line
call strwrite
mov di, offset downline
    ; add blank line
call strwrite

ret

ENDp Cal_Dspl
END
Appendix B-7    ENTRY.ASM Subroutine procedure

This procedure is assembled with the command TASM ENTRY, automatically including
it in the linking file LDR0. A description of its action is given in Section 3.1.5.

;--------------------------------------------------------------------------
;ENTRYX.ASM  Procedure to generate header record
;Can type in up to 11 numbers and letters for deck and reel numbers
;Format is Deck (8 char max), Period, Reel (3 char max)
;Echoes input directly but changes lower case to upper for storage
;Picks up Date and Start Time
;Displays heading information
;Displays Deck, Reel, Date and Start Time as a byte string <Parameters1>
;Output is above info saved in global string msg <Parameters1>
;SR is called by LDR program after film stop and calibration for Gain, MaxSig,
; CardSig, MinSig

.386
IDEAL
Model small

DATASEG
dashline   db   '=================================
|   ',0
dash2line db   '=================================
|   ',0
downline1 db  13,10,0

HdrTitle  db  13,10,'   |   ',13,10,0
|   |   |   |
|   FILENAME,   |   DATE   |   START   |   END   |   TOTAL   |
|   FAIL   |   CNDTN   |   ',0
|   |   |   |   |
|   DECK|REEL   |   SCANNED   |   TIME   |   TIME   |   CARDS
|   CARDs   |   CODE   |   ',0
|   |   |   |   |
|   ',13,10,0
|   |   |   |   |
|   ',13,10,0

filename   db  'PARAM',0
Prompt1    db  'Type <Deck Number> (8 char max) <Period> <Reel Number> (3
|   max) ... ',0

buffer    db  5 dup (32)  ;;
xxx       dw    0
INCLUDE "Scan_var"

CODESEG
INCLUDE "Scan_Pcd"
proc Entry
    ;display heading messages
    mov cx,1
    mov di,offset dashline
    call strwrite
    ;dash line

    mov di,offset HdrTitle
    call strwrite
    ;Title

    mov di,offset downline1
    call strwrite
    ;blank line
    mov di,offset prompt1
    call strwrite
    ;displays message "Type Deck...etc"
mov si,2 ;si places data along displayed line
mov di,2;0 ;di " " in ParamText mem
call Get_Key_Msg

mov ah,2Ah ;Get Date (Month and Day)
int 21h

mov si,17 ;insert Month
mov di,17;14
mov bl,dh
call Convert1

mov si,20 ;insert Day
mov di,20;17
mov bl,dl
call Convert1

mov ah,2Ch ;Get Start Time
int 21h

mov si,30 ;insert hours
mov di,30;27
mov bl,ch
call Convert1

mov si,33 ;insert minutes
mov di,33;30
mov bl,cl
call Convert1

mov si,36 ;insert seconds
mov di,36;33
mov bl,dh
call Convert1

display1:

mov cx,1
mov di, offset Label1 ;upper line of column headings
call strwrite

mov di, offset Label2 ;lower line of headings
call strwrite

mov di, offset Label3 ;vert lines
call strwrite

mov cx,1
mov di, offset DataLine ;contains Deck, Reel, Date, Start Time
call strwrite

mov di,offset downline1 ;blank line
call strwrite

mov di,offset dash2line ;dash line
call strwrite

ret

Get_Key_Msg: ;Routine for processing keyed data
mov ah,0Ah ;;Load keyed data
mov dx,offset buffer ;;Buffer specifies size of buffer, max char+1
int 21h ;;Buffer+1 carries number of char typed
/* Buffer+2 to Buffer+13 is typed data field, */
/* left-justified */
/* jump around G-K-M if no typed char */

cmp [Buffer+2], 13
jne @3
jmp @32

@3:
mov bx, 0
mov ch, 0
mov cl, [Buffer+1]
cmp cl, 12
jng @11
mov cl, 12

@11:
mov al, [Buffer+2+bx]
cmp al, 90
jng @15
sub al, 32

@15:
mov [DataLine+bx+si], al
mov [ParamText+bx+di], al
inc bx
loop @11

@32:
mov di, offset downline1
call strwrite

ret

; data field is left-justified

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

Convert1:
mov bh, 0

@10:
sub bl, 10
jl EndTens
inc bh
jmp @10

EndTens:
add bh, 48

Units:
add bl, 58
mov [DataLine+si], bh
mov [ParamText+di], bh

mov [DataLine+si+1], bl
mov [ParamText+1+di], bl

ee:
ret

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
Appendix B-8 UTILASM Subroutine procedure

This procedure is assembled with the command TASM UTIL, automatically including it in LDR0 and PCSCAN0. It is called by various subroutine procedures

;UTILASM Utility routines for displaying a space from "spacex", the contents of the ax register from "Prtax" and line feed from "Line"

.DEAL
MODEL small

Global Spacex:proc ;Horizontal space character
Global Line:proc ;CR and LF
Global Prtax:proc ;Print contents of ax register

DATASEG

spacex db 32,0
liney y db 13,10,0
prtbuff db 20 dup (?)
CODESEG
extn strw rite:proc,bintoascdec:proc
include "Scan_Pcd"
pro c Spacex
    push ax
    push cx
    push di
    mov cx,1
    mov di,offset spacex
    call strw rite
    pop di
    pop cx
    pop ax
    ret
ENDp spacex

pro c line
    push ax
    push cx
    push di
    mov cx,1
    mov di,offset liney y
    call strw rite
    pop di
    pop cx
    pop ax
    ret
ENDp line

pro c Prtax
    push ax
    push cx
    push di
    mov cx,1
    mov di,offset prtbuff
    call bintoascdec
    call strw rite
    pop di
    pop cx
    pop ax
    ret
ENDp Prtax
END
Appendix C-1  PCSCAN.ASM Program

The following is a printout of the source program PCSCAN.ASM described in Sections 3.2. to 3.3.11.12 and 3.4.8 of the text. Written in assembler language, it requires assembly using TASM PCSCAN to create a PCSCAN.OBJ file. Called subroutines are similarly assembled. The group of OBJ files is then linked with the instruction TLINK @PCSCAN0. This yields the operating program PCSCAN.EXE. The file PCSCAN0 is a response file containing the names of all subroutines called on in execution of PCSCAN.EXE. Appendix G-1 lists the contents of PCSCAN0. This approach makes PCSCAN0 the equivalent of a library file but one that is more easily modified for program customization than the standard type.

There are two other files referred to in the program listing below. These are called INCLUDE files, here named SCAN_VAR and SCAN_PCD, for Scan Variables and Scan Procedures. The two files are definitions of the Global variables and procedures available in common to all elements of the overall program.

;PCSCAN.ASM  Executive program for production scanning of NCDC films

;Reads in file Param to transfer parameters determined during LDR program
;Starts program in normal manner.
;Calls SCAN which in turn uses subroutines:
;   VTRACK  Finds lateral position of card images
;   CENTROID  Finds centers of lines
;   STRGREAD  Measures transmittance of card borders
;   EDGES  Finds edges of card images
;   CALCSCAL  Calculates scaling factors for 960 reading positions
;   COLSCAN  Reads 80 columns at locations calculated above
;   SPOTREAD  Measures transmittance at specified locations
;   SCALREAD  Measures average transmittance of scale zone
;SCAN returns to PCSCAN
;FRAME is second major routine; brings in new frame of 8 cards
;End of FRAME repeats SCAN. Cycle continues until:

; Keypress any key except "Enter" or "r" intercepts call to FRAME,
; goes to Display Data for 8 cards in view, waits for next keypress
; Next keypress, any key except "Enter", "r", "q", "a", or "z"
; resumes normal sequence of SCAN and FRAME
; Keypress "r" repeats scan of 8 cards in view
; Keypress "q" creates End of Film
; Keypress "z" causes stop on Fail Calibrate until toggled again
; Keypress "a" causes stop on Artifact until toggled again
; Keypress "Enter" terminates program
;Scanning pauses every 640 cards to record results of batch
;At same time, displays accumulated number of drops in Must-Have cols
;At end, the program adds Number of Cards Scanned and other data
; to PARAM file for display by Trailer file TLR
;Reads in DDDDDDDDD.msk to Maskbuf, 160 bytes, for designation of blank (No-Punch)
; required punched data (Must-Have) or single-punch columns

.386
IDEAL
MODEL small
stack 64
DATABSEG

Title1  db 13,10,25 dup (32), 'SCANNING INITIATED', 0
sign_on1  db 13,10,10, 'Press any key except Enter to display contents of 8 cards visible on screen', 0
sign_on2  db 13,10, 'Press Enter to terminate program', 0
msg1  db 'Unable to find Mask file',0
msg2  db ',' Last card number..',0
msg3  db 13,10,'Press key to resume',13,10,'Number of cards rescanned....';',0
msg4  db 13,10,10,'Program Terminated',0
msg5  db 13,10,'Program Terminated...END OF FILM',0
msg6  db 13,10,'Gain DAC..',0
msg7  db ' MaxSig..',0
msg8  db ' Number of cards scanned..',0
Tens  db 1 2 3 4 5
       6 7 8',0
Units  db '123456789012345678901234567890123456789012345678901234567890123456789012345678901234567
890',0
Ticks  db 0 ;
x; !',0
filename db 'PARAM',0
ParamData dw 10 dup (?)
ParamData1 dw 10 dup (32) ;
   ; +0 = Gain1 (Gain DAC), left in place
   ; +2 = MaxSig Near 980 by calibration
   ; +4 = CardSig
   ; +6 = MinSig
   ; +8 = NmbrCdsScnd
   ;+10 = NmbrCdsFld
   ;+12 = DirtSpot ??
   ;+16 = Spare
   ;+18 = Spare
ParamText1 db 80 dup (32) ;Must follow ParamData1
OutMsg db 8 dup (48),46,3 dup (48) ;filename for Deck.Reel
space db 32,0 ;print space
spaces db 10 dup (32),0
dash2line db 13,10,78 dup (61),0
prbbuf db 20 dup (?) ;JIC
outfile8 db 640 dup (45) ;Output data memory for 8 cards
xx    db 0 ;delimiter for ending display
FlagRep dw (?) ;Flag for selecting keyboard-controlled actions
   ; FlagRep=0 for normal SCAN/FRAME cycling
   ; FlagRep=1 or more for repeating SCAN on same
   ; frame
filename1 db 'DataOut',0
Maskfilename db 'xxxxxxx.msk',0
Maskbuf db 160 dup (45)
Buffer db 2,3 dup (32)
CndtnTitle db 28 dup (32), 'SCAN CONDITION CODES',0
CndtnCode1 db 'First....',0
CndtnCode2 db 13,10,'Second... ',0
DataHandle dw ?
ParamHandle dw ?
MaskHandle dw ?
BlockPtr dw ?
DataBlock db 52000 dup (?) ;the processed block of 51,200 may be
   ; exceeded by 639, hence the extra
   ; nmbr of designated blank columns,
BlankCols dw ?
"No-Punch"
PunchCols dw ?
"Must-Have"
TotalBlankCols dd ?
NmbrCdsScnd dw ? ;total number of cards scanned
NmbrCdsRescnd dw ? ;total number of cards with failed
NmbrCdsFld dd ? ;Total nmbr of columns with drops in
calibration
NmbrColDrops dw ? ;Total nmbr of columns with pickups in
Must-Have cols
NmbrColPickups dw ? ;Total nmbr of columns with pickups in
No-Punch cols

PrevCdsFlId dw ? ;working location
PrevCdsPicks dw ?
PrevColPicks dw ? ;working location
PrevCdsDrops dw ? ;working location
NmbrCdsDrops dw ? ;Total nmbr of cards with drop(s) in Must-Have cols
NmbrCdsPicks dw ? ;Total nmbr of cards with one or more illegal characters
NmbrCdsArtif dw ? ;total number of cards with artifacts
ResumeScan dw ? ;flag for restarting after film failure stop
AllowFailCalStop dw ? ;flag for enabling stop on Fail Calibrate
AllowArtiStop dw ? ;flag for enabling stop on Artifacts
AftrFirstFrm dw ?
Tilt dw 500 ;start Tilt at 500
TiltLeft dw ?

msg101 db 13,8 dup (10),30 dup (42),', Stop for DROP ',32 dup (42),0
dup (42),0
msg102 db 13,8 dup (10),24 dup (42),' Stop for ILLEGAL CHARACTER ',26
dup (42),0
msg103 db 13,8 dup (10),25 dup (42),' Stop for FAIL CALIBRATE ',28 dup
(42),0
msg104 db 13,10, 'XFCornerDiff.... ',0
msg105 db ' YFCornerDiff.... ',0
msg106 db 13,10, 'Thrld.... ',0
INCLUDE "Scan_Var"

CODESEG
INCLUDE "Scan_Pcd"

start:
  mov ax,8data
  mov ds,ax
  mov es,ax
  mov dx,30Ch
  ;start Tilt at 500
  mov ax,[Tilt]
  out dx,ax
  mov dx,316h
  ;reset counter
  mov ax,01h
  out dx,ax
  mov ah,3Dh
  mov dx,offset filename
  mov al,2
  int 21h
  mov [ParamHandle],ax
  mov ah,3Fh
  mov bx,[ParamHandle] ;read file PARAM of100 bytes
  mov dx,offset ParamData1
  mov cx,100
  int 21h
  mov ax,[ParamData1+2] ;load MaxSig from file
  mov [MaxSig],ax
  mov ax,[ParamData1+4] ; load CardSig
  mov [CardSig],ax
  mov ax,[ParamData1+6] ; load MinSig
  mov [MinSig],ax

;-------------------------------------------------------------
call justify ;right-justify Deck.Reel msg
  ;OutMsg has filename for specified Deck.Reel
  ;ParamTextl+2 has Deck.msk

;-------------------------------------------------------------

Appendix C-1  PCSCAN.ASM  page 3 of 12
mov ah, 3Dh ; open file DDDDDDDD.MSK for reading
mov dx, offset Maskfilename
mov al, 0
int 21h
mov [MaskHandle], ax
jc NotFind
mov [MaskBuf], 'X' ; this should be overwritten by mask
mov ah, 3Fh
mov dx, offset MaskBuf
mov cx, 80
mov bx, [MaskHandle]
int 21h
mov ah, 3Eh ; close file
int 21h

mov cx, 1
mov di, offset dash2line
call strwrite
call line
mov di, offset Title1
mov [SignOn1],
 mov cx, 0
int 21h
mov ah, 3Eh
mov [DataHandle], ax

mov [NmbrSigs], 0
mov [SigSum], 0
mov [junk], 0
mov [junk+2], 0
mov [NmbrCdsScnd], 0
mov [NmbrCdsRescnd], 0
mov [NmbrCdsFld], 0
mov [NmbrCdsArtif], 0
mov [BlockPtr], 0
mov [TotalBlankCols], 0
mov [FlagRep], 0
mov [NmbrCdsDrops], 0
mov [NmbrCdsPickups], 0
mov [AllowArtiStop], 0
mov [AllowFailCalStop], 0
mov [NmbrColDrop], 0
mov [NmbrColPickups], 0

No-Punches
mov [AfterFirst Frm], 0
mov dx, 316h
mov ax, 01h
out dx, ax

Scan1:
JMP NODISPLAY
call line
mov ax, [Card]
dec ax

; derive pointer for DataBlock from Card
; Card starts with 1, want 0

Appendix C-1  PCSCAN.ASM  page 4 of 14
mov bx, 80
mul bx
mov bx, [BlockPtr]
; ax has incremental nmbr of cols for frame
cmp bx, 0
jne @@l
add bx, 51200
@@l:
sub bx, ax
; bx has offset from DataBlock base
mov cx, 640
mov si, 0
mov ah, 2
@@30a:
mov dl, [DataBlock + bx + si]
int 21h
inc si
loop @@30a

NoDisplay:
cmp [FlagRep], 1
jne @@33
sub [BlockPtr], 640
@@33:
; mov ax, [NmbrCdsDrops]
; mov [PrevCdsDrops], ax
; save entering drop (card) count for
; comparison with exiting count

; call prtAx
mov ax, [NmbrCdsPickups]
mov ax, [PrevCdsPickups], ax
mov ax, [NmbrCdsFld]
mov ax, [PrevCdsFld], bx

-----------------------------
mov cx, 3; 2; 50; 0
wt9: mov bx, 32000; 65000
wt6: dec bx
jnz wt6
loop wt9
; call SCAN

; mov bx, 100; 0; 0
;@@5c:
im bx, 65000
;@@6a:
dec bx
jnz @@6a
loop @@5c
mov bx, 0

; Optional stops
; prepare for Stop Test

mov ax, [NmbrCdsPickups]
sub ax, [PrevCdsPickups]
mov ax, 0

; mov ax, [AllowArtiStop], 1
; is stopping on artifact allowed? (from "a")
je @@37
cmp ax, 0
je @@37
add bx, 1

; skip this if no '*'
pusha
; mov cx, 1
; mov dl, offset msg101
; call strWrite
; popa

@@37:
@@37 cont.

; mov ax,[NmbrColPickups]
; sub ax,[PrevColPickups]
;push ax
;mov ax,[AllowArtiStop]
;call line
;call prtax
;pop ax
    test [AllowArtiStop],1
    je @@37a
    cmp ax,0          ;cmp on 0 to stop for pickup(s)
    je @@37a
    add bx,1          ;skip this if no pickups
pusha
mov cx,1
mov di,offset msg102
call strwrite
popa

@@37a:
    ;Stop on frame with a fail calibrate card
    ;FailCalStop is 0 for no failure in frame of 8
    ;   1 for any fail calibration in 8

    mov ax,[NmbrCdsFlle]
    sub ax,[PrevCdsFlle]
    test [AllowFailCalStop],1 ;is stopping on fail calib allowed (from "z")
    je Stops
    cmp ax,0
    je Stops
    add bx,1          ;do only if fail calibrate cards in frame of 8
pusha
mov cx,1
mov di,offset msg103 ;announce Fail Calibrate
call strwrite
mov di,offset msg104 ;msg "XFCornerDiff...."
call strwrite
mov ax,[XFCornerDiff]
call prtax
mov di,offset msg105 ;msg "YFCornerDiff...."
call strwrite
mov ax,[YFCornerDiff]
call prtax
popa

;-------------------------------------------------------------------------------------------------

Stops:

    mov dx,31Ah        ;Unconditional stops
    in ax,dx
    cmp ax,100h
    jg continul
    jmp display1
continul:
    add bx,[Pause]    ;stops for film break or card jam
    ;film break or jam raises bx by 8
    cmp bx,0
    je NoFilmStop    ;jump if Pause not set before return from SCAN
    jmp Display1     ;through here if film problem, stop with display

NoFilmStop:
    ;through here if no film stop
    mov [ResumeScan],0 ;next keystroke resumes in SCAN with Frame

;-------------------------------------------------------------------------------------------------

    cmp [BlockPtr],51200 ;Sets data block size before transfer
    jb @16
    mov ax,[NmbrCdsRescnd] ;display current total number of cards

Appendix C-1  PCSCAN.ASM page 6 of 12
call prtax  ; with one or more unexpected drops
call spacec
mov ah,2
mov dl,','
int 21h
mov ax,[NmbrCdsFl]
call prtax
mov ah,2
mov dl,')'
int 21h
call spacec

;---------------------------------------------------------------
call FillFile  ; Record a block of 640 cards
;---------------------------------------------------------------
mov [BlockPtr],0

@16:
cmp [FlagRep],0  ; check repeat flag for cycling control
je Kpp  ; bypass display if FlagRep=0
jmp Display1

;---------------------------------------------------------------
; Test for "Display and Pause" keypress
Kpp:  mov ah,1  ; first, test for any keypress
      int 16h
je Frame1  ; no kp, continue with next frame
            ; if keypress, check character for Enter
mov ah,0   ; read kb char
int 16h    ; all may be Enter or any other char
cmp al,13   ; compare for Enter
je Stop    ; if Enter go to Stop
            ; through here if not Enter

;---------------------------------------------------------------
Display1:
call line  ; 2 blank lines
call line
mov cx,1
mov di,offset Tens  ; set up scale for labeling columns
call strwrite
call di,offset Units
call strwrite
call di, offset Ticks
call strwrite

mov ax,[Card]  ; derive pointer for DataBlock from Card
    ; Card starts with 1, want 0
dec ax
mov bx,80
mul bx  ; ax has incremental nmbr of cols for frame
mov bx,[BlockPtr]  ; show data for up to 8 cards, 640 chars
sub bx,ax

mov cx,640
mov si,0
mov ah,2

@30:  mov dl,[DataBlock+bx+si]
      int 21h
      inc si
      loop @30
mov cx,80
mov si,0
mov ah,2

@31:  mov dl,[MaskBuf+si]
      int 21h
      inc si
      loop @31

mov di,offset msg2  ; "Last card is number..."
call strwrite
mov ax,[NmbrCdsScnd] ;show card count
call prtax
mov di,offset msg3 ;msg "Press any key to Resume"
call strwrite

;@@37: ;End of display, wait for next keypress
;    ;Test for keypress to resume cycling
kpwait:
    mov ah,1 ;Wait for any keypress
    int 16h
    jz kpwait ;no kp yet, wait
    mov ah,0 ;read keypress
    int 16h
    cmp al,13 ;compare for Enter
    je Stop ;go out if Enter
    cmp al,122 ;looking for "z" to set flag allowing stop
    jne @@38 ;on fail calibrate
    inc [AllowFailCalStop] ;toggle for disabling stop when even
    jmp kpwait
@@38:
    cmp al,97 ;looking for "a" to set flag allowing stop
    jne @@38a ;on artifact
    inc [AllowArtiStop] ;toggle for disabling stop when even
    jmp kpwait
@@38a:
    cmp al,113 ;looking for "q"
    jne cont1
    mov [FlagEoF],1
    jmp Endoffilm
cont1:
    mov al,114 ;If not Enter or "a" or "q" or "z",
    jne #001 ;, resume cycling with msg1 below
    mov [FlagRep],1
    inc [FlagRep] ;if kp="r" move flag away from 0, repeat scan
    jmp @@02a
@@001:
    mov [FlagRep],0 ;if not "r" restore flag to 0
@@002a:
    cmp [FlagRep],0 ;branch according to Flagtest for Repeat mode
    je Frame1 ;continue normal scan by going to next frame
    jmp scan1 ;repeat again
Frame1:
@@001b:
    cmp [ResumeScan],1 ;switch for resuming after film stop
    je SkipFrame ;skip next Frame after manual film advance
StartDelay:
    mov dx,30Eh ;start a delay period of 40ms
    mov ax,870
    out dx,ax
    call FRAME ;moves film to next group of 8 cards

CheckDelay: ;if Frame took longer than 40ms, ;want to introduce delay of 100ms
    mov dx,318Ah
    test ax,8000h
    je SkipFrame
    mov dx,30Eh
    mov ax,1000
    out dx,ax
    mov dx,31Ah
    wait:
in ax,dx
    test ax,8000h
    jne wait
SkipFrame:
    mov [FailTrack], 0
    ; reset FailTrack
    mov [FailCardBar\1], 0
    ; reset FailCardBar
    mov [FailEdge\1], 0
    ; reset FailEdge
    mov dx, 31Ah
    ; test for TakeUp Idler slack
    test ax, 004h
    jne Stop

EndofFilm:
    cmp [FlagEOF\0], 1
    ; Test for End of Film via FlagEOF
    jne Scan\1
    ; if not EOF, continue cycling with
    ; Scan and Frame
    ; if EOF, turn off CRT beam and capstan
    ; FlagEOF is set by high signals in Frame
    ; through here only if End of Film
    call line
    mov di, offset msg5
    call strwrite
    jmp stop\1

stop:
    mov cx, 1
    mov di, offset msg4
    ; msg "Program Terminated"
    call strwrite

stop\1:
    mov cx, 1
    mov di, offset msg8
    ; msg "Number of cards scanned"
    call strwrite
    mov ax, [NmbrCdsScnd]
    ; the total number of cards
    call prt\x

; Omit Stop Time if not End-of-Film
    cmp [FlagEOF\0], 1
    jne CardsScnd
    ; Get Stop Time, insert in ParamText1+
    ; get current Time
    mov ah, 2Ch
    int 21h
    ; place hours
    mov si, 41
    mov bl, ch
    call Convert\1
    ; place minutes
    mov si, 44
    mov bl, cl
    call Convert\1
    ; place seconds
    mov si, 47
    mov bl, dh
    call Convert\1

CardsScnd:
    ; Add data on number of cards scanned, etc.
    ; to ParamData\1 for later recording in PARAM
    mov cx, 1
    mov ax, [NmbrCdsScnd]
    mov [ParamData\1+8], ax
    mov di, offset ParamText1+53
    call bintoasc\x

    mov ax, [NmbrCdsF\x]
    mov di, offset ParamText1+62
    mov [ParamData\1+10], ax
    call bintoasc\x

    cmp ax, 0
    jne CalcArtif
    ; ensure printing of 0 failed
    ; if applicable
    mov [ParamText1+62], 48
CalcArtif: ;Add keyed Condition Codes
    mov di,offset dash2line
    call strwrite
    call line
    call line
    mov di,offset CndtnTitle
    call strwrite ;display title
    call line
    mov di,offset CndtnCode1
    call strwrite ;display Cndtn1 msg
    mov di,70
    call Get_Key_Msg ;add first keyed code to output file
    mov di,offset CndtnCode2
    call strwrite ;display Cndtn2 msg
    mov di,71
    call Get_Key_Msg ;add second keyed code to output file

;Write modified PARAM file ;move pointer to 8 bytes from start of PARAM
    mov bx,[paramhandle]
    mov ah,042h
    mov cx,0
    mov dx,8
    mov al,0
    int 21h
    mov ah,40h ;Record ParamText1 in file PARAM, 92 bytes
    mov cx,92
    mov dx,offset ParamData1+8
    int 21h

;Call FillFile
    call FillFile

;mov ax, [NmbrCdsRescnd] ;display current total number of cards
    call line
    call prtax
    jmp exit1 ; with one or more unexpected drops

NotFound:
    mov cx,1
    mov di,offset msg1
    call strwrite

Exit1:
    mov ah,04Ch ;END OF PROGRAM
    int 21h

;Called internal subroutines follow
;makes 2 digits from 1 byte
Convert1:
    mov bh,0
@10:
    sub bl,10
    jl EndTens
    inc bh
    jmp @10
EndTens:
    add bh,48
;and Units:
    add bl,58
    mov [ParamText1+si],bh
    mov [ParamText1+si+1],bl
    ret ;End of Convert1 routine

;writes block of 60000 bytes or
;residual at End of Film
FillFile:
    pusha
    mov ah,40h
    mov dx,offset DataBlock
    mov cx,[BlockPtr]
    mov bx,[DataHandle]
    int 21h
mov ah, 045h
mov bx, [datahandle]
int 21h
mov bx, ax
mov ah, 03Eh
int 21h
popa
ret
;End of FillFile routine

Get_Key_Msg: ;Routine for processing keyed data
           mov ah, 0Ah
           ;Load keyed data
           mov dx, offset buffer
           ;Buffer specifies size of buffer, max char+1
           int 21h
           ;Buffer+1 carries number of char typed
           mov al, [Buffer+2]
           ;Buffer+2 is typed data field, left-justified
           cmp al, 13
           ;jump around G-K-M if no typed char
           jne @3
           jmp @Out
           ;this is shortcut if no typed char
@3:
           mov [ParamText1+di], al
           ;load typed char into file string
           @Out: ;data field is left-justified
           ret
           ;End of keyed Condition Codes routine

Justify: ;Routine to right-justify Deck and Reel message
           mov cx, 8
           ;Looking for "." in input msg for justification
           mov si, 0
@1:
           cmp [ParamText1+si+2], 46
           ;cmp for period
           je @2
           inc si
           loop @1
@2:
           mov bx, 8
           sub bx, si
           ;bx has location of period in input message
           ;bx has offset between period positions
           ; in input and output messages, 0 to 7
           mov cx, 9
           mov al, [ParamText1+si]
           cmp al, 32
           ;ASCII digits must be greater than space (32)
           jng @5
           mov [Outmsg+si+bx], al
           dec si
           loop @3a
           ;OutMsg has been loaded with Deck
           ;bx still has difference in period location
           ; in original and final msgs
           mov si, 11
           sub si, bx
           mov cx, 3
           mov al, [ParamText1+si]
           cmp al, 32
           ;Reel nmbr can include letters
           jg @5a
           dec si
           loop @6
           ;si has position of units of Reel nmbr for input
           ; Deck, 3 char to right of period in input data
@5a:
           mov bx, 11
           mov cx, 3
           ;transfer up to 3 digits to output
           mov al, [ParamText1+si]
           cmp al, 46
           je @9
           mov [OutMsg+bx], al
           dec si
           dec bx
           loop @7
@9:
; 9 cont.
    mov cx, 12 ; transfer 12-byte Deck.Reel msg to ParamText1
    mov si, 0 ; for inclusion in modified PARAM
@8:
    mov al, [OutMsg+si]
    mov [ParamText1+2+si], al
    inc si
    loop @8

    mov cx, 8 ; transfer first 8 bytes for Deck name in Mask
              ; file
@10a:
    mov al, [OutMsg+si]
    mov [Filename+si], al
    inc si
    loop @10a
    ret

    mov dx, 310h
    mov ax, 00h
    out dx, ax
    ret

End start;
Appendix C-2    SCAN.ASM Subroutine procedure

This procedure is assembled with the command TASM SCAN, automatically including it in the linking file PCSCAN0. A description of its actions is given in Section 3.3 to 3.3.11.12.

;-----------------------------------------------
;SCAN.ASM  Production procedure for scanning punch card images

;Scans up to 8 cards, returning with inset for starting Frame
;Inset is Card Bar search origin for last card
;Called by PCSCAN.
;Calls procedures VTrack, Centroid, Edges, CalcScal, ColScan, Util, MTA
;Each procedure returns to Scan
;YCMargin set by VTrack
;To customize for variable card size, changes are at lines

.386
IDEAL
MODEL small

DATASEG

;Fudges
ThrdMod12 dw 100;150 ;Working thrd is this increment above first
ThrdMod34 dw 100;150 ; signal; approx. scale factor: 200 = 1 volt
ThrdCardBar dw 300;100 ;Use 100 for thin or dense scale lines,
ThrdCardBar dw 300;100 ; 150 for normal
ThrdCardBar dw 300;100 ;Fixed value

SigSum dd 0
NmbrSigs dd 0
MeanCdSig dw 0
Card dw 1 ;Cards 1 through 8
XC0 dw 7000
YC0 dw 19100
XF0 dw 4096 ;XF origin, fixed
YF0 dw 8000 ;YF " "

Port dw 304h ;Default = XF
Step dw 40 ;Default value
MaxCnt dw 32 ;Default value
Focus dw 1000 ;Default value
ThrdI dw 300 ;default threshold, replaced by ParamData1+8
CardBar dw 16000 ;dummy value
CardPeriod dw 2000 ;dummy value
SaveXF dw ?
FrmSpan dw 2000 ;dummy value
LeftEdge dw 16000 ;dummy value
CardsSig dw 600 ;dummy
MinSig dw 50 ;dummy
Corner1 dw 1 dup (0) ;corner at top of card, col 1,
Corner2 dw 1 dup (0) ; " bottom " first word XF
Corner3 dw 1 dup (0) ; " top col 80 second " YF
Corner4 dw 1 dup (0) ; " bottom "
NoCard dw ? ;Count of signals in blank cols
XFCornerDiff dw 0 ;Non-rectangularity, size diff, cols 1 and 80
YFCornerDiff dw 0 ;Non-rectangularity, size diff, rows 12 and 9
prtbuf db 30 dup (?) ;for displaying info
junk dw 100 dup (?) ;JIC
msg2 db 32,0 ;horiz space
Flag dw 0 ;Flag for special treatments in subroutines
XC     dw  ? ; working XC
YC     dw 5000;? ; " YC
XF     dw  ? ; " XF
YF     dw  ? ; " YF
XCFrame dw  ? ; XC origin for use by Frame procedure
; YCFrame dw  ? ; YC origin for use by Frame procedure
XCFrameStop dw  ? ; default XC for stopping film movement
; NmbrCdsScnd dw 0 ; Total number of cards scanned
; NmbrCdsPlfd dw 0 ; Number of cards failing squareness check
Error dw 10 dup (0) ; JIC flag set identifying cards with errors

FailTrack dw  ? ;<1> fail flag in VTrack, for runout
FailBar dw  ? ;<8> fail flag in Centroid, for runout
FailEdge dw  ? ;<16> fail flag in Edges, for runout
FailBar1 dw  ? ;<2> fail flag in Centroid, for high first read
FailEdge1 dw  ? ;<4> fail flag in Edges, for high first read
FailCalGeom dw  ? ;<32> fail flag in GeomCheck, for non-rectangularity
FailArtifact dw  ? ;<64> fail flag for stopping on artifacts

; FailCardBar1 dw  ? ; stored fail frame flag for card bar search, hi 1st read
; FailCalCardBar dw  ? ; stored fail calib flag for card bar search, runout
; FailCalEdge dw  ? ; stored fail calib flag for edge search, runout
; FailCalScaleBar dw  ? ; stored fail calib flag for scale bar search, runout
FailCard dw  ?
FailCardinFrame dw  ?
FailCorner dw  ?
CardJam dw  ?
BarFailCount dw  ?
ThrldMod dw  ?
Want dw  ?
; SpotTransm dw  ?
; ResumeScan dw  ?
Pause dw  ?
TiltLeft dw  ?
TiltOut dw  ?
INCLUDE "Scan_Var"

CODESEG
INCLUDE "Scan_Pcd"
proc Scan
    ; Through here only at start of routine
    mov dx,316h
    ; reset
    mov ax,01h
    out dx,ax

    ; mov ax,12h ; start counter if desired
    out dx,ax

    mov ax,[XCO] ; load XC position for stopping film movement
    add ax,3300
    mov [XCFrameStop],ax
    ; mov [junk+20], 0
    ; mov [junk+22], 0
    ; mov [FailCardBar1], 0
    mov [FailTrack], 0
    mov [FailCardinFrame], 0
    ; Set calibration parameters one time per frame
    ; set Gain, may not need this
    mov dx,308h
    mov ax,[ParamData1]
    out dx,ax
    ; mov dx,30Ch ; set to Tilt null
    mov ax,500
    out dx,ax

    mov dx,3Ah
    ; set initial Focus
    mov ax,1000
    out dx,ax
mov dx, 316h ; settling delay, min.
mov ax, 03h
out dx, ax

; End of initialization, done once at start of SCAN

call Gain ; Calibrates Gain using Gain DAC, range 0 to 1023

; Preparation for VTrack; XC and YC set in VTrack
mov dx, 304h
mov ax, [XF0]
mov [XF], ax
out dx, ax ; issue XF=XF0
mov dx, 306h
mov ax, [YF0]
mov [YF], ax
out dx, ax ; issue YF=YF0

call VTrack ; finds YCMargin for vertical registration

mov ax, [YCMargin]
call prtax
call space

ErrorCheck1:

cmp [FailTrack], 0 ; check for FailTrack
je FirstCard ;
inc [Card] ; need to increment card nmbr in this shortcut
jmp FilmPause ; go back to PCSCAN for Film stop

FirstCard:

mov [Card], 1 ; search for Card Bar #1 uses this origin
mov [Card], 1 ; Initialize Card to 1

NewCard:

mov [CardJum],
mov [Pause],
mov [FailCard],

mov dx, 300h ; XC advances approx 2180 every card
mov ax, [XC]
out dx, ax

mov dx, 302h ; issue updated XC
mov ax, [YCMargin]

add ax, 100
mov [YC], ax
out dx, ax ; issue YC=YCMargin

; no delay needed here

mov dx, 304h
mov ax, [XF0]
mov [XF], ax
out dx, ax ; issue XF
mov dx, 306h
mov ax, [YF0]
mov [YF], ax
out dx, ax ; issue YF

; Initialize for each card
; XC advanced for next card at end of previous ; card
PrepCardBar:
    ; Set parameters for Centroid SR
    mov [Port], 304h    ; set for horiz movement
    mov [Step], 80      ; set step
    mov [MaxCnt], 30    ; allow 30 steps
    mov [Focus], 1000   ; set large spot
    mov ax, [ThrdCardBar]
    mov [Thrd], ax
    ; End of coordinate initialization for
    ; Centroid on Card Bar
    cmp [Card], 2
    jne $7

$7:
    ;------------------------------------------
    ; Horizontal position of Card Bar
    ;------------------------------------------
    Call Centroid
    ErrorCheck2:
        ; Returns with Center of Card Bar and
        ; XF=last Read, XC=XC0, YC=YCMargin, YF=8000
        ; FailBar1 and FailBar, 0/1
        mov ax, [FailBar1]
        ; FailBar1=0/1, failure causes film break stop
        add [FailCard], ax
        mov ax, [FailBar]
        ; check status of FailBar=0/1
        add [FailCard], ax
        ; store failure of Card Bar search
        ; for check for FailCalibrate
        mov ax, [Center]
        ; Save horizontal center of Card Bar
        mov [CardBar], ax

;jmp CardAdv
CardAdvRtn:
        ;++++++++++++++++++++++++++++++++++++++++++++++
        ; check for 9th card, skip to SetXCFrame
        cmp [Card], 9
        ; Preparing for finding (vert) center of first scale bar
        ; move to scale zone horizontally
        jg SetXCFrame
        mov dx, 304h
        mov ax, [CardBar]
        sub ax, 200
        out dx, ax
        mov [XF], ax

        mov dx, 306h
        mov ax, [YF0]
        sub ax, 350
        ; advance 400 toward scale bar to shorten scan
        mov [YF], ax
        out dx, ax

        mov [Port], 306h
        mov [Step], -8
        mov [MaxCnt], 64
        mov [Focus], 200
        mov [Thrd], 0
        mov ax, [ThrdMod12]
        mov [ThrdMod], ax;;; 100; 150
        ; Thrd becomes first amplitude +150
        ; with limits 200 to 400
        ; End of prep for first scale bar

;------------------------------------------
; Find center of first scale bar, Corner1, Col= 1/2
;------------------------------------------
ErrorCheck3:
        ; on return, XF is in scale zone, -200 from Bar
        ; YF is in Center at centroid of first scale bar
        mov ax, [FailBar]
        ; FailBar=0/1 for runout
        add [FailCard], ax
        mov ax, [FailBar1]
        ; FailBar1=0/1 for high first signal
        add [FailCard], ax
        ; enable FailCalibrate from FailBar

Appendix C-2  SCAN.ASM page 4 of 12
mov dx,306h ;jump to center of first inter-bar space, Col -½
mov ax,[Center] ;this is center of first bar as found
sub ax,43 ;move to center of column 1
mov [YF],ax
mov [Corner1+2],ax
out dx,ax ;this is YF for Col 1, Corner1
mov ax,[CardBar] ;prep for StrgRead
add ax,600
mov [XF],ax
add [YF],150 ;load XF for origin of StrgRead
mov [Focus],1000
;
;-------------------------------------------------------------
call StrgRead ;measure transmittance at card left border
;-------------------------------------------------------------
cmp ax,[Transmte] ;low transmittance indicates No-Card next
    ;use absolute thrd of 200
    ;where XF for last CardBar was converted to
    ; XC position for framing
    jb SetXCFrame
    ;Preparation for Edges SR to find top edge of card
    ;issue XF for origin of top edge search, col 1
    mov dx,304h
    mov ax,[CardBar]
    sub ax,200
    mov [XF],ax
    out dx,ax
    mov dx,306h ;use col 2 for edge search to avoid cut corner
    mov ax,[Corner1+2]
    sub ax,87
    mov [YF],ax
    out dx,ax
    mov [Port],304h ;parameters for search for edge, Corner 1
    mov [Step],16 ;direction is increasing XF
    mov [MaxCnt],50
    mov [Focus],200
    mov [ThrdMod],0 ;Thrd calculated in proc using first signal
    ;and Transmute at card left edge
;
;Call EDGES ;Top edge of card, Col 1, Corner 1
;
;-------------------------------------------------------------
mov ax,[FailEdge] ;End of prep for top edge col 1 ErrorCheck4:
add [FailCard],ax ;returns with FailEdge=0/1, FailCard=0/1
mov ax,[Edge] ;store XF for Corner1
mov ax,[Corner1] ;prep for Corner2 Centroid
mov dx,304h ;move to bottom of card
mov ax,[CardBar]
add ax,[CardPeriod];2000
sub ax,200
;
;-------------------------------------------------------------
mov dx,ax ;issue XF for scale zone
out dx,ax
mov dx,306h ;set YF origin for finding first scale bar
mov ax,[YF0] ;YF retraction=400 to shorten scan
sub ax,350
mov [YF],ax ;XF and YF now in for Centroid
out dx,ax
call SPOTREAD; reads for jam at origin of scale bar search
mov [Port], 306h ; returns with CardJam 0/1 every card
mov [Step], -8 ; check CardJam after calibration check
mov [MaxCnt], 64
mov [Focus], 200
mov [Thrd], 0
mov ax, [ThrdMod12]
mov [ThrdMod], ax
; Thrd becomes first amplitude+150
; with limits 200 to 400
; End of prep for first scale bar, Corner2

Call CENTROID; Find center of first scale bar, Corner2, Col= ½

ErrorCheck5:
; on return, XF is in scale zone between cards
; YF is in Center at centroid of first scale bar
mov ax, [FailBar]; FailBar=0/1 for runout
add [FailCard], ax ; enable FailCalibrate
mov dx, 306h ; jump to center of first inter-bar space, Col = ½
mov ax, [Center] ; this is center of first bar as found
sub ax, 43 ;
mov [YF], ax ;
mov [Corner2+2], ax ; save YF, Corner2
; XF unchanged from Centroid
sub ax, 87
out dx, ax ; YF for Col 2, bottom of card, avoid cut

; Preparation for Edges SR to find bottom edge of card
; parameters for search for edge, Corner 1
mov [Port], 304h
mov [Step], -16
mov [MaxCnt], 50
mov [Focus], 200
mov [FailEdge], 0
mov [FailEdge1], 0
mov [ThrdMod], 0
; Thrd calculated in proc using first signal
; and Transmte at card left edge
; End of prep for bottom edge col 1

Call EDGES; Bottom edge of card, Col 1, Corner2

ErrorCheck6:
; returns with FailEdge1=0/1, FailEdge=0/1
mov ax, [FailEdge] ; check for runout
add [FailCard], ax ; enable FailCalibrate
mov dx, 316h ; set for long settling delay
mov ax, 0A3h
out dx, ax
mov ax, [Edge]
mov [Corner2], ax ; save XF in Corner2+0
mov dx, 304h ; Prep for Centroid, last scale bar Corner3
mov ax, [CardBar] ; load XF with 200 retraction from Card Bar
sub ax, 200
mov [XF], ax
out dx, ax ; issue XF
mov dx, 306h ; move (up) to near col 80 at top of card
mov ax, [YFO] ; YF origin for search for scale bar at Col 80½
sub ax, 7700
mov [YF], ax
out dx, ax ; issue YF
mov [Port],306h ;parameters for Centroid, Corner3
mov [Step],8
mov [MaxCnt],64
mov [Focus],200
mov [Thrd],0
mov ax,[ThrdMod4]
mov [ThrdMod],ax,;;;100;150 ;Thrd becomes first amplitude+150 TTT
; with limits 200 to 400

;------------------------------------------------------------------
Call CENTROID ;Corner3, Col 80½
;------------------------------------------------------------------
ErrorCheck7: ;returns with FailBar=0/1, FailBar=0/1
mov ax,[FailBar]
add [FailCard],ax

mov dx,306h ;save returned center of scale bar
mov ax,[Center]
add ax,43
mov [YF],ax
mov [Corner3+2],ax
out dx,ax ;Col 80

mov ax,[CardBar]
add ax,600
mov [XF],ax
sub [YF],150
mov [Focus],1000

;------------------------------------------------------------------
call StrgRead ;measure transmittance at card right border
;------------------------------------------------------------------

;returns with Transmcte, mean signal at
; 4 positions at right side border of card
;used for thrd in Centroid next

mov dx,304h
mov ax,[CardBar]
sub ax,200
mov [XF],ax
out dx,ax ;issue XF for edge search origin

mov dx,306h
mov ax,[Corner3+2]
;;;;;;add ax,87
add ax,261 ;searches at col 79 to avoid cut corner
;search at ccol 78, avoid supercut corner

mov [YF],ax
out dx,ax ;issue YF for edge search origin

mov [Port],304h
mov [Step],16
mov [MaxCnt],50
mov [Focus],200
mov [ThrdMod],0 ;Thrd calculated in proc using first signal
; and Transmcte at card right border

;------------------------------------------------------------------
Call EDGES ;Corner3, Col 80 nominal, col 79 actual
;------------------------------------------------------------------
ErrorCheck8: ;returns with FailBar=0/1, FailBar=0/1
mov ax,[FailEdge]
add [FailCard],ax ;check for runout

mov ax,[Edge]
mov [Corner3],ax
mov [XF],ax ;save position of edge, Corner3
mov dx, 304h
mov ax, [CardBar]
add ax, [CardPeriod]; 2000
sub ax, 200
mov [XF], ax
out dx, ax
mov dx, 306h
mov ax, [YF0]; [LeftEdge]
sub ax, 7700
mov [YF], ax
out dx, ax
mov [Port], 306h
mov [Step], 8
mov [MaxCnt], 64
mov [Focus], 200
mov [Thrld], 0
mov ax, [ThrldMod34]
mov [ThrldMod], ax
; Thrld becomes first amplitude+ThrldMod34
; with limits 200 to 400

;-----------------------------------------------------
; Call CENTROID
; Corner4, Col 80½
;-----------------------------------------------------

; ErrorCheck9:
; returns with FailBar1=0/1, FailBar=0/1
mov ax, [FailBar]
add [FailCard], ax
mov dx, 306h
mov ax, [Center]
add ax, 43
mov [YF], ax
mov [Corner4+2], ax
add ax, 87
out dx, ax
; Col 80
; Col 79

mov [Port], 304h
mov [Step], -16
mov [MaxCnt], 50
mov [Focus], 200
mov [ThrldMod], 0
; Thrld calculated in proc using first signal
; and Transmce at card right edge

;-----------------------------------------------------
; Call EDGES
; Bottom edge of card, Col 80, Corner4
;-----------------------------------------------------

; ErrorCheck10:
; returns with FailEdge1=0/1, FailEdge=0/1
mov ax, [FailEdge]
add [FailCard], ax
mov ax, [Edge]
mov [Corner4], ax
mov [XF], ax
mov dx, 304h
mov ax, [YF]
out dx, ax
; All 4 corners have been located for this card

;-----------------------------------------------------
; FindTilt:
; Calibrate Tilt on first frame only
cmp [AfterFirstFrm], 0
jne continue
cmp [card], 1
jne continue0
mov ax, [Corner3+2]
save YF at Corner3 on Card1
mov [TiltLeft], ax
name it TiltLeft

Appendix C-2  SCAN.ASM page 8 of 12
continl0:
cmp [Card],8 ;select Card8
jne continl
mov ax,[Corner4+2] ;save YF at Corner4 on Card8 as
sub ax,[TiltLeft] ;ax has YF difference, (Card8-Card1)
mov dx,0
mov bx,2 ;want to divide difference by 2.5
imul bx ;start by mul by 2
mov bx,5
idiv bx
add ax,[Tilt] ;add correction to original tilt
mov [TiltOut],ax
;sub ax,15
mov dx,30Ch
out dx,ax
mov [AfterFirstFrm],1 ;this limits action to first frame
continl:
mov dx,306h ;move spot position to Corner 1
mov ax,[Corner1+2] ;for settling
out dx,ax
mov dx,304h
mov ax,[Corner1+0]
out dx,ax
mov [XF],ax

;------------------------------------------------------------------------
CalibrationCheck:
jmp CheckGeom ;Check for rectangularity, every card
CheckGeomRet:
 cmp [FlagRep],0 ;return here every card with
 jne @16
 inc [NmbrCdsScnd] ; if not in repeating mode
 mov dx,316h ;increment Panel Counter
 mov ax,22h
 out dx,ax

@16:
cmp [FailCard],0 ;check for any failure
 jne FailCal ;paths diverge:
 mov dx,306h ;if failure, go off to FailCal
 mov [YFQuot],ax
 out dx,ax

;------------------------------------------------------------------------
Fudge:
 ; sub [Corner1],15
 ; sub [Corner3],15
 ; sub [Corner4],15
 ; sub [Corner2],15
 ; add [Corner1+2],20
 ; add [Corner2+2],20
 ; add [Corner3],10
 ; add [Corner4],10

;------------------------------------------------------------------------
Call CalcScal ;for calculating:
 ; column advance
 ; base line slant correction
 ; row spacing and generation of RowTable

;------------------------------------------------------------------------
; Prep for ColScan
 mov dx,306h ;move YF to column= -1 as origin for
 mov ax,[Corner1+2] ; column incrementation
 add ax,[Corner2+2] ;use mean of Corners 1 and 2
 shr ax,1
 add ax,[YFQuot]
 mov [YF],ax
 out dx,ax
mov dx,304h ; go to top edge of card, is XF origin for
mov ax,[Corner1+0] ; column scanning
mov [XF],ax
out dx,ax
;
; Focus set earlier just after Corner4???
; Threshold set in ColScan

;--------------------------------------------------
; Call ColScan
;--------------------------------------------------

; AfterColScan: ; ColScan returns with XC for Card Bar search origin for
; last card scanned, for use by Frame procedure
; YC = YCMargin, XF = 4096, YF = 8000
; Error=1 if fail, 0 otherwise

inc [Card]
cmp [Card],8
jg SetXCFrame

; check for 9th card, skip to SetXCFrame

; +++++++++++++++++++++++++++++++++++++++++++++++++++
mov ax,[XC] ; advance XC for next card
add ax,[CardPeriod];2180
mov [XC],ax

; +++++++++++++++++++++++++++++++++++++++++++++++++++
mov dx,302h
mov ax,[YCMargin]
out dx,ax

jmp NewCard ; go back to NewCard after cards 1 through 7

; +++++++++++++++++++++++++++++++++++++++++++++++++++
mov dx,302h
mov ax,[YCo]
mov [YC],ax
out dx,ax ; issue YC

; SetXCFrame: ; Prep for ScalRead near Corner4 of last card
mov ax,[Corner4];[CardBar]
add ax,200
mov [XF],ax
mov [YF],9500
mov [Focus],1000

call ScalRead ; Measure transmittance in Scale Zone

; returns with ScalTransm for use in threshold
; calcs for Frame proc
;
; Want XF for last CardBar converted to XC
; supplement

mov ax,[CardBar]
sub ax,4096
add ax,[XC]
add ax,2180
mov [XCFrame],ax
mov [XF],4096

mov ax,[YCo]
sub ax,10000

mov [YCFrame],ax
jmpl exit1

; FailCal: ; Here after calib failure
; Record 80 "space" chars

cmp [FlagRep],0
jne Calcscale
mov cx,80
mov bx,[BlockPtr]
IncPtr: mov [DataBlock+bx],32
inc bx
loop IncPtr
add [BlockPtr],80 ; advance Block Pointer

Appendix C-2 SCAN.ASM page 10 of 12
push cx
mov cx,2

wt1:   mov bx,65000
wt3:   dec bx
      jnz wt3
      loop wt1
      pop cx

      ; could be:
      ; simple Fail Calib
      ; Card Jam

@@16:
      inc [NmbrCdsFld] ; increment failed cards count if
      ; not in Repeat mode
      ; if film failure, go back to PCSCAN via FilmPause
      ; if not card jam, continue with next card

cmp [CardJam],0
jne FilmPause
mov [FailCardInFrame],1 ; here for calib failure but not card jam
jmp AfterCalScan ; End of FailCal wrap-up, continue with next card

FilmPause:
      mov [ResumeScan],1
      mov [Pause],8
      inc [Card] ; increment Card number for unscanned cards

;-----------------------------------------------
Out1:      ret ; END OF PROCEDURE

; CheckGeom: ; a patch for checking XF and YF squareness, through here every card

mov ax,[Corner2] ; find XF size at col 1 and
add ax,[Corner3] ; sub XF size at col 80
sub ax,[Corner1] ; ; difference indicates non-rectangularity
sub ax,[Corner4] ;
cmp ax,0
jnl @@10X
neg ax
@@10X:
      cmp ax,30 ; ax has absolute XF corner difference
      jl @@2X
      mov [FailCardInFrame],1
      mov [FailCard],1
      mov [XFCornerDiff],ax
      ; save failed XFCD for display

@@2X:
      mov ax,[Corner1+2] ; find YF size at top of card
      add ax,[Corner4+2] ; sub YF size at bottom of card
      sub ax,[Corner2+2] ; ; difference indicates non-rectangularity
      sub ax,[Corner3+2] ;
cmp ax,0
      jnl @@10Y
      neg ax
@@10Y:
      ; ax has absolute YF corner difference
      cmp ax,15 ; max YF diff=20 mils
      jl @@2Y
      mov [FailCardInFrame],1
      mov [FailCard],1
      mov [YFCornerDiff],ax
      ; save failed YFCD for display

@@2Y:
      jmp CheckGeomRet ; End of GeomCheck patch

;-----------------------------------------------
CardAdv: ; Patch to determine CardPeriod, the XF advance
; for cards of variable size
; Set parameters for Centroid SR

PrepNextCardBar: ; here from line 200
      mov ax,[XF] ; save entering XF
      mov [SaveXF],ax

Appendix C-2  SCAN.ASM  page 11 of 12
mov ax,[CardBar] ;set XF origin for second stroke to find
add ax,1500 ; CardPeriod
mov [XF],ax

;mov dx,306h ;Use this to see second stroke
;mov ax,7950
;out dx,ax

mov [Port],304h ;set for horiz movement
mov [Step],80 ;set step
mov [MaxCnt],30 ;allow 30 steps
mov [Focus],1000 ;set large spot
mov ax,[ThrdCardBar]
mov [Thrd],ax ;End of coordinate initialization for
             ; Centroid on Card Bar

;-----------------------------------------------------------------
;Call Centroid ;Horizontal position of next Card Bar
;-----------------------------------------------------------------

mov ax,[Center]
sub ax,[CardBar]
mov [CardPeriod],ax

;call prtax ;Use this to display CardPeriods
;call line
mov ax,[SaveXF]
mov [XF],ax
jmp CardAdvRtn ;near line 200

;-----------------------------------------------------------------

ENDp scan
End
Appendix B   VTRACK.ASM Subroutine procedure

This procedure is assembled with the command TASM VTRACK, automatically including it in PCSCAN0. A description of its action is given in Section 3.3.4.

; VTRACK.ASM Subroutine to find vertical location of YCMargin
; Makes 12 YC strokes searching for card left edge (below card on screen)
; Strokes stop on reaching dense area at card left edge
; Mean of 4 highest YC values is declared card edge, recorded in Parameters+8
; Initial XC, XF, YF fixed positions during routine
; Final XC is at horizontal origin for Card Bar search
; Final YC is at vertical origin (YCMargin) for Card Bar search

.386
IDEAL
MODEL small

DATASEG
LeftBorder dw 300
Datal dw 20 dup (0)
ThrdSum dd 0
YCThrld dw (?)
ThrdSig dw 200;300
YCMargin dw 19000
RunoutCount dw ?
;FailTrack dw 0
INCLUDE "Scan_Var"

CODESEG
INCLUDE "Scan_Pcd"
proc vtrack
  push e
  mov ax,[XC0]
  add ax,1000
  mov [XC],ax
    ; mov bx,[MaxSig]
    ; add bx,[MinSig]
    ; shr bx,2
    ; mov [ThrdSig],bx
  mov [RunoutCount],0
  mov [FailTrack],0
  mov di,0
  NewCol:
  mov dx,300h
  mov ax,[XC]
  out dx,ax
  mov dx,302h
  mov ax,[YC0]
  sub ax,4000
  mov [YC],ax
  out dx,ax
  mov bx,30
  dec bx
  jnz @11
  mov dx,318h
  in ax,dx

; Use 300 normally or 250 for thin card left border
; storage area for peak signal from each col
; working sum for accumulating 4 peak YCs
; working peak YC threshold
; default value
; count of runout scans, 3 req'd for TrackFail

; set XC for origin of scan raster
; calculate signal threshold for edge search
; formula is (MaxSig+2*MinSig)/4
; store signal threshold
; reset FailTrack
di carries Column count
; start of column
; starts at XC0, advances 11 steps of 200
; set YC origin - YC0-4000
; issue YC origin
; settling delay
; start first read
mov cx,16  ;16 Reads in column
cmp cx,1   ;skip next if last Read in col
je @@1
mov dx,302h;advance YC by 100
add [YC],100
mov ax,[YC]
out dx,ax
@@1: mov dx,318h ;take in signal amplitude
@10: in ax,dx
test ax,8000h
jne @10
and ax,1023 ;leave only useful bits
mov ax,[ThrdSig] ;compare signal with threshold
cmp ax,[ThrdSig]
jl EdgeFound
loop Read
;finish the col of 16 Reads if Edge not found
;otherwise continue to finish 16 Reads in col
;-----------------------------------------------------------------------
inc [RunoutCount] ;through here on runout of any stroke
cmp [RunoutCount],3
jl @11a
mov [FailTrack],1 ;show Track failure, may be clear area,
; caused by runout
@11a: jmp EndCol ;-----------------------------------------------------------------------
EdgeFound: ;saves YC and starts next col for sigs<300
mov ax,[YC] ;save YC of first signal below threshold
sub ax,100 ;correction
mov [Data1+di],ax ;save YC for left edge as the data for each col
EndCol: ;through here at end of col, likely <16 max
cmp di,22 ;look for last column if no Edge found
jge EdgeCalc
inc di
inc di
add [XC],200
jmp NewCol
;Through here at end of every column of up to 16 Reads
;[Data1+di] has YCs for 12 card edge scans
;-----------------------------------------------------------------------
EdgeCalc: ;Analysis for mean of 4 highest YC values in 12 cols
mov eax,0
mov cx,4
mov [ThrdSum],0 ;clear ThrdSum
@80: mov si,0
mov ax,[YCO]
sbb ax,4700 ;displacement, nominal 15300
mov [YCThrld],ax ;YCThrld is working YC threshold
@70: mov ax,[Data1+si] ;load ax with next data (YC for edge) value
cmp ax,[YCThrld]
jl @60
inc ax
mov [YCThrld],ax ;a fudge which chooses first 4 of equal peaks
temporarily save any peak value,
save si when the peak was found
@60: inc si
inc si
cmp si,24  ;check for going through 12 iterations
jl @70     ;repeat for total of 12 times
mov [Data1+bx],0 ;zero out this peak in preparation for next
                ; pass

mov ax,[YCThrld]
add [ThrldSum],eax
loop @80

sub [ThrldSum],4 ;minor correction to remove fudge
shr [ThrldSum],2 ;divide by 4
mov eax,[ThrldSum]
add ax,[LeftBorder]
mov [YCMargin],ax
mov dx,302h
out dx,ax

@55:
    mov dx,300h
    mov ax,[XC0]
    mov [XC],ax
    out dx,ax
    popa
    ret

ENDp  vtrack
END
Appendix C-4  CENTROID.ASM Subroutine procedure

This procedure is assembled with the command TASM CENTROID, automatically including it in the linking file PCSCAN0. A description of its action is given in Sections 3.3.5 and 3.3.6.

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;CENTROID.ASM  Universal procedure to locate center of target line

.386
IDEAL
MODEL small

DATASEG
DataAmpl  dw   10
ProdSum   dd   0
AmplSum   dd   0
XYF       dw   10000 ;Default value for working position along stroke
Center    dw   5000
prbuf db   20 dup (?)
DataAmpl1 dw ? ;first signal amplitude, used in thrld calc
FirstRead dw ? ;flag, =0 before first read, =1 after
ThrldCentroid dw ? ;calculated thrld
INCLUDE "Scan_Var"

CODESEG
INCLUDE "Scan_Pcd"
proc Centroid
pusha

mov [FirstRead],0
mov [ProdSum], 0
mov [AmplSum], 0
mov [DataAmpl], 0
mov [DataAmpl1],0
mov [FailBar], 0
mov [FailBar1], 0

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;   Initialize parameters
;
mov dx,30Ah
mov ax,[Focus]
out dx,ax
mov dx,316h ;for cro sync in focus adjustment
mov ax,022h
out dx,ax

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;   Begin stroke
;
identify axis of stroke for loading XYF with initial value
;in desired axis

mov dx,[Port]
cmp [Port],304h
je @1
mov ax,[YF]
jmp @2

@1:  mov ax,[XF] ;load XF into XYF if Port=304h
    jmp @2

@2:  mov [XYF],ax ;issue XYF (XF or YF from loaded Port)
    out dx,ax
    mov dx,318h ;start Read at first position in stroke
    in ax,dx
    mov dx,316h ;shorten settling delay to minimum
    mov ax,03h
    out dx,ax

Appendix C-4  CENTROID.ASM  page 1 of 3
Read:
  mov cx,[MaxCnt] ;maximum number of reads in column
  cmp cx,1
  je @@1
  mov dx,[Port]
  mov ax,[XYF]
  add ax,[Step]
  mov [XYF],ax
  out dx,ax
@@1:   mov dx, 318h ;Reads
  in ax,dx
  test ax,8000h
  jne wtl
  and eax,1023 ;eax has signals

;Threshold determination
  cmp [FirstRead],0
  jne @@21
  mov [DataAmpl1],ax
  ;will use first amplitude in thrld calc
@@21:  cmp [Thrld],0 ;select preset or calculate threshold
  jne DataAnalysis
  ;Thrld=0 means calculate; any other, use it

;here for calculated thrld
  cmp bx,200
  add bx,[ThrldMod]
  ;ThrldMod
  ;add increment to first signal when needed
  ;for thrld calc
  cmp bx,200
  jg #001
  mov [Thrld],200
@@01:  cmp bx,300
  jl #002
  mov bx,300
@@002: mov [Thrld],bx ;save calculated thrld

;Data analysis with calculation of centroid
DataAnalysis:
  mov [FirstRead],1 ;set flag for bypassing thrld calcs
  ;on subsequent reads
  cmp ax,[Thrld]
  jge @@3
  ;Thrld brought in either from calling SCAN or
  ;calculated from first signal & ThrldMod
  mov eax,0
  ;load eax with 0 for signals below threshold
@@3:   sub ax,[Thrld]
@@4:   mov [DataAmpl],ax ;save amplitude above threshold
  add [AmplSum],eax
  ;AmplSum has cumulative sum of above
  mov ebx,0 ;clear high order bits
  mov bx,[XYF]
  ;Note: bx has (next) position
  mul ebx
  ;dx has high order 16 bits of product
  add [ProdSum],eax ;accumulate product of amplitude*distance

;Read cycling and termination check
@@5:   cmp [DataAmpl],0
  jne @@7
  cmp [AmplSum],0
  je @@7
  jmp CalcMom ;terminate reading upon finding low signal
  ;after accumulating values above threshold
@@7:
    loop toRead
    jmp OutFail

toRead:
    jmp Read

End of reading in stroke

;-------------------------------------------------------------

CalcMom:
    mov eax,[ProdSum]  ;Calculate moment
    mov ebx,[AmplSum] ;Formula:  Center=ProdSum/AmplSum
    cmp ebx,0
    je cont1

    div ebx
    sub ax,[Step]     ;eax has high order 16 bits of quotient (moment)
Out1:
    mov [Center],ax   ;Correct for current position

    mov ax,[DataAmpl]  ;Centroid position along stroke, XF or YF
    cmp ax,[Thrd]      ;Look for high first signal showing
    jl cont1
    mov [FailBar1],l

Cont1:
    mov bx,170        ;Start in clear
    10 us delay
@@10:
    dec bx
    jnz @@10
    popa

    ret                  ;END OF PROCEDURE

;==================================================================

OutFail:
    mov [FailBar1],l  ;Fail=1 indicates Card or Scale Bar
    jmp Out1         ; not seen by end of stroke

ENDp centroid

End
Appendix C-5    EDGES.ASM Subroutine procedure

This procedure is assembled with the command TASM EDGES, automatically including it in the linking file PCSCAN0. A description of its action is given in Section 3.3.8.

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;EDGES.ASM  Universal scan procedure to locate edges, opaque to clear
;     Interpolates to find location of position whose signal
;          equals threshold
;     Reports "1" in FailEdge on scan runout
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

.386
IDEAL
MODEL small

DATASEG

Edge   dw    10000       ;default
DataAmpl dw  100 dup (0) ;signal amplitudes
TempXYF dw  (?)        ;temporary XYF mem
XYF    dw  (?)         ;Fine coordinate value, XF or YF
XYF0   dw  ?           ;initial coordinate origin for Edges stroke
FirstRead dw  ?        ;identifies first signal,=0/1
zzz    dw    100 dup (0)

INCLUDE "Scan_Var"

CODESEG

INCLUDE "Scan_Pcd"

proc Edges

pusha

Initialize parameters

mov dx,30Ah
mov ax,[Focus]
out dx,ax

;-----------------------------
start1:

mov [FirstRead], 0      ;reset FirstRead
mov [FailEdge], 0       ;reset runout failure flag
mov [FailEdge1], 0      ;reset high first read flag

;Clear data memory

push di
push si
mov si,0
mov ax,SEG DataAmpl
mov es,ax
mov di,offset DataAmpl
mov ax,0
mov cx,200
cld
rep stosw
pop si
pop di

; End of memory clear
;-----------------------------

Identify axis of stroke

;mov dx,[Port]
cmp [Port],304h
je @1
mov ax,[YF]
jmp @2
@1:
mov ax,[XF]
; Begin stroke

@2: mov [XYF],ax ;ax has either XF or YF as appropriate
   out dx,ax
mov [XYF0],ax
   mov dx,318h
   in ax,dx

   mov cx,[MaxCnt] ;maximum number of reads in column
Read:
   mov bx,[XYF] ;Transfer position of current Read
   mov [TempXYF],bx ;to TempXYF leaving ax alone
   cmp cx,1 ;skip advance if last Read
   je @@1
   mov dx,[Port] ;advance XF
   mov ax,[XYF]
   add ax,[Step] ;add Step
   mov [XYF],ax
   out dx,ax ;issue advance
@@1: mov dx, 318h ;Reads
   in ax,dx
   test ax,8000h
   jne wtl
   and ax,1023

mov [DataAmpl+di],ax ;save signals in DataAmpl+
cmp [DataAmpl],300
   jle contin5
mov [FailEdge1],1
jmp Out1

contin5: ;pick out first signal amplitude for

Thrd calc:
cmp [FirstRead],0 ;Thrd is (DataAmpl + Transmtce)/2
   jne Analysis
   add ax,[Transmtce] ;ax has sum of first signal and Transmtce at
   shr ax,1 ;left or right card edge
   add ax,[ThrdldMod] ;add threshold modification if needed
   cmp ax,100;200 ;apply range limits 100 to 400
   jg @001
mov ax,100;200
@001: mov [Thrd],ax
cmp ax,400
   jl @002
mov ax,400
@002: mov [Thrd],ax
mov [FirstRead],1

@003: jmp Analysis ;Looking for position whose signal equals
threshold
AnalysisRtn: ;Come back here afterwards
   inc di
   inc di
   loop Read
mov [FailEdge],1 ;"1" indicates failure to find edge, runout
   jmp Out1

End of stroke generator
;----------------------------------------------- ;Data analysis
;ax has amplitude for position past threshold
; Search for signals immediately before and after
threshold
  cmp ax,[Thrld]
  jng AnalysisRtn
; return to scanning if signal below threshold
;-----------------------------------------------

; Interpolation, here when signal exceeds
threshold
  mov bx,[DataAmpl+di]
  sub bx,[DataAmpl+di-2]
  ; bx has amplitude difference
  mov dx,[Thrld]
  ;
  sub dx,[DataAmpl+di-2]
  ; dx:ax has Thr50 minus prior amplitude
  mov ax,0
  ; and bx has amplitude difference
  cmp dx,bx
  ; avoid divide overflow
  jae Out1
  div bx
  ; ax now has interpolated increment relative to
  mov bx,[Step]
  ; 65536
  cmp bx,0
  ; looking for neg Step
  jge @01
  ; jmp if pos Step
  neg bx
  ; if Step is neg, reverse polarity tempo
  mul bx
  ; multiply Step by fractional increment
  neg dx
  ; reverse polarity back to negative
  jmp @02
  ; go to summation with last position, the one
@01:
  ; just past threshold
  mul bx
@02:
  ; dx has interpolated increment
  ; XYF has position past threshold
  add dx,[TempXYF]
  sub dx,[Step]
  mov [Edge],dx
  ; This is Edge, interpolated to threshold
;-----------------------------------------------
Out1:
  mov bx,200
  ; minor time delay
@03:
  dec bx
  jnz @03
  ; mov ax,[DataAmpl]
  ; cmp ax,400
  ; jle contin5
  ; mov [FailEdge1],1
  ; contin5:
  popa
  ret
  ; END OF PROCEDURE
;-----------------------------------------------

ENDp Edges

END
Appendix C-6    CALCSCAL.ASM Subroutine procedure

This procedure is assembled with the command TASM CALCSCAL, automatically including it in the linking file PCSCAN0. A description of its action is given in Sections 3.3.10 through 3.3.10.3.

;-------------------------------------------------------------------------------
;CALCSCAL.asm  Procedure to calculate scaling constants
;Generates scaled constants for column spacing in YF
;   ";"  ""   slant correction in XF
;   " "  ""  row spacing in XF, creates RowTable

.386
Ideal
Model small

DATASEG
RowCorrIn dw 0        ;'0' disables RowCorr, '1' enables
Height dw ?
CardWidth dw ?
Slant dw ?
SlantNeg dw ?
YFQuot dw ?          ;Used for column positioning
YFRemdr dw ?
SlantRemdr dw ?       ;Used for slant correction
XFQuot dw ?           ;This group used in making up RowTable
XFRemdr dw ?
RowTable dw 26 dup (?)
SlantSum dw ?
SlantRemdrSum dw ?
XFRemdrSum dw ?
XFBase dw ?
RowTableSum dw ?
RowCorr dw 0,1,5,10,15,20,20,15,10,5,1,0
INCLUDE "Scan_VAR"

CODESEG
INCLUDE "Scan_Pcd"

proc CalcScal

; YF Section - 80 Column locations in YF
; Calculate quotient and remainder for Column Advance
  mov ax,[Corner1+2]    ;derive mean span between cols 1 and 80
  add ax,[Corner2+2]
  sub ax,[Corner3+2]
  sub ax,[Corner4+2]
  shr ax,1
  mov [CardWidth],ax    ;save span between cols 1 and 80
  mov dx,0
  mov bx,79
  div bx          ;ax=87 nominal
  mov [YFQuot],ax   ;Save quotient as base for col. no.
                      ;incrementation
  mov [YFRemdr],dx  ;Save remainder in YFRemdr

; YFQuot has integer quotient, YFRemdr has remainder
; End of YF section

;-------------------------------------------------------------------------------
; Slant - Calculation of XF Base correction
mov ax,[Corner3+0] ;Derive mean of card slant using cols 1 and 80
add ax,[Corner4+0]
sub ax,[Corner1+0]
sub ax,[Corner2+0]
sar ax,1 ;ax has slant in mils between cols 1 and 80
mov [Slant],ax ;save Slant, clockwise slant is positive
End of Slant section

; Calculate quotient and remainder for row intervals
mov ax,[Corner2] ;derive mean of card height from corner XFs
add ax,[Corner4]
sub ax,[Corner1]
sub ax,[Corner3]
shr ax,1
mov [Height],ax ;save card height
mov dx,0
mov bx,13 ;card height is 13 row spaces
div bx ;ax=134 nominal
mov [XFquot],ax ;Save quotient as base for col. no.
incrementation
mov [XFRemdr],dx ;Save remainder for fractional incrementation
End of Row Intervals section

; Create RowTable of 12 row positions measured
; from top of card, using above parameters
; Inputs: XFQuot, XFRemdr, scaled to height
;
mov di,0
mov [XFRemdrSum],0
mov [RowTableSum],0
mov [RowTableSum],0
mov cx,12 ;set for 12 iterations beyond row 0 (card edge)

NewRow:

mov ax,[XFRemdrSum] ;start with processing the remainder
add ax,[XFRemdr]

cmp ax,13;7 ;use half interval as breakpoint for rounding
j1 @@9 ;through below when sum exceeds breakpoint

sub ax,13 ;retract sum of remainders by whole interval
add [RowTableSum],1 ;apply 1-mil correction to position

@@9: mov [XFRemdrSum],ax ;save new remainder sum
mov ax,[RowTableSum] ;add the integer quotient
add ax,[XFQuot]
mov [RowTableSum],ax ;RowTableSum accumulates 25 half-row coords

RowTableCorrections: ;possibly add a correction to RowTable values
cmp [RowCorrIn],0 ;raises reading positions toward top of card
je @12
sub ax,[RowCorr+di]
mov [RowTable+di],ax ;Then load RowTable+di as values are generated

@12: inc di
inc di
loop NewRow ;start new row
End of RowTable calculations

Out1:
    ret

ENDp CalcScal
End
Appendix C-7  COLSCAN.ASM Subroutine procedure

This procedure is assembled with the command TASM COLSCAN, automatically including it in the linking file PCSCAN0. A description of its action is given in Sections 3.3.11 through 3.3.11.10.

;******************************************************************************;
;COLSCAN.asm  Procedure to read 80 columns
; Uses parameters from CalcScal SR
; Requires Includes "TrnsTbl1" and "Scan_Var" in DATASEG
; Requires Include "Scan_Pcd" in CODESEG
; XC = horizontal origin of search for Card Bar, fixed
; YC = vertical " YCMargin
; Initial XF = mean of Corners 1 and 2, top edge of card
; Initial YF = Col (-1) issued in proc, needed for rescans
; Final XF = 4096, origin for Card Bar search
; Final YF = 8000
; Final XF = 4096, origin for Card Bar search
; Checks for weak signals, one or more causes 5-position rescans
; of entire card, with offsets
; Weak signals are those falling between 50% and 75% of span;
; between ColBkgd and MinSig
; Weak signal check is conducted at every column
; Recognized punches have signals between 50% of span and MinSig
; Offsets from central position are 15 mils to left side of
; punched hole, at nominal center, at 15 mils to right (card
; orient) also 25 mils above and below center
; Compares signal amplitudes at the 5 positions in each row,
; picks best as signal for this row and column hole location
; Displays rescans count every 640 cards
; Spot diameter apx 30 mils

.386
IDEAL
MODEL SMALL

DATASEG

;******************************************************************************;
;Fudges

SpotSize0   dw 500  ;spot size for Mode0
SpotSize1   dw 400  ;spot size for Model
BkgnfFudge  dw ?    ;working BkgndFudge
BkgnFudge0  dw 150  ;used to lower thresholds for dense films, Mode0
BkgnFudge1  dw 100,50 ;used to set thresholds for thin holes, Model

;******************************************************************************;
;Read5   dw ?
ColResult  dw 0    ;Identification of row with strongest
;signals
CountIllegals dw ?
ColSig     dw 26 dup (1001)  ;temp storage for signals in column
WeakSigs   dw ?
ColBkgd    dw ?
Pickup     dw ?
VFRemdrSum dw (?)          ;working remainder in division for
col-col advance
SlantSum   dw (?)          ;slant from col 1 to col 80
SlantRemdrSum dw (?)  ;working remainder in division for
Slant
SlantCorr  dw ?
SlantNeg   dw ?
SlantQuot  dw ?
XFBase     dw (?)          ;XF at top edge of card at specified
; col
DATASEG continued

Min5 dw ?
Sum5 dw ?
InpA dw ?
InpB dw ?
InpC dw ?
ColThrld dw ?
ColThrldWeak dw ?
ColThrld1 dw ? ; working thrld in search for strongest signal
ColThrld2 dw ? ; working thrld in search for second strongest
ColThrld3 dw ? ; working thrld in search for third strongest
BlockPtr0 dw ? ; temp storage of blockpointer
OffsetXF dw 0,0,0,-25,25 ; XF positional offsets for reading in search
OffsetYF dw 0,15,-15,0,0 ; YF same
deltaXF dw ?
deltaYF dw ?
Mode dw ?

INCLUDE "TrnsTbl1"
INCLUDE "scan_var"

CODESEG "Scan_Pcd"

; through here at beginning of every card
; start in Mode=0
; scan all 80 columns in single-read in nominal center
; at end of data, review number of weak signals
; if any weak ssignal in single-read pass, call for
; rescanning all 80 columns in multi-read pass,
; order of hole rescan is 1)center 2)left 3)right,
; 4)above center 5)below center, card orientation
; final data is best seen in any of the 5 positions
; record the data after these passes as best in row
; report drops only after multi-read pass scan
; resume scan of next card in single read mode

mov [Mode],0 ; start card in single-read mode
mov ax,[SpotSize0] ; set initial spot size for Mode=0 in ax
mov bx,[BkgndFudge0] ; set initial background fudge for Mode=0 in bx

;-----------------------------------------------

RepeatCard:

; return here for rescanning card in Mode=1
; here to switch fudges according to Mode
cmp [Mode],0
je @@1
mov ax,[SpotSize1] ; change spot size for Mode=1
mov bx,[BkgndFudge1] ; change bkgnd fudge for Mode=1

@@1:

mov dx,30Ah ; issue spot size for reading punched holes
out dx,ax ; typically 30 mils in Mode=0, 22 mils in Mode=1
mov [BkgndFudge],bx ; issue bkgnd fudge

mov [Read5],0
mov [WeakSigs],0
mov [CountIllegals],0
mov [NmbrColPickups],0
mov dx,306h ; use mean of YFs for Corners1 and 2 for
mov ax,[Corner1+2] ; reference
shr ax,1
; derive mean
sub ax,20
add ax,[YFPquot]
mov [YF].ax
out dx,ax ; issue YF origin for card, (Column=-1)
mov dx,304h ; derive XF origin for card, (Corner1)
mov ax,[Corner1+0]
mov [XF],ax
out dx,ax

wt2:
        dec bx
        jne wt2

        mov ax,[BlockPtr]; save entering BlockPtr for this card
        mov [BlockPtr0],ax

; YF application for column position
; Inputs: YFQuot, YFRemdr
mov dx,316h ; shorten settling time to minimum
mov ax,03h
out dx,ax

mov [YFRemdrSum],0 ; initialize some variables
mov [SlantRemdrSum],0
mov [SlantCorr],0
mov [SlantNeg],0
mov si,0 ; si addresses columns, si=0 is for column 1

mov cx,80 ; set for 80 iterations starting from -01
            ; iteration starts with one-column advance

NewCol:
        mov [ColThrld],998
        cmp [Mode],1
        jne RepeatCol
        cmp [Read5],0
        jne RepeatCol
        push cx
        push di
        mov di,0
        mov cx,12

ClearCol:
        mov [ColSig+di],1002
        add di,2
        loop ClearCol
        pop di
        pop cx

RepeatCol:
        mov bx,[Read5] ; prep for deriving offsets. do this at start
        mov ax,[XF+bx] ; of every column instead of at every read
                        ; load deltaXF with next XF offset
        mov [deltaXF],ax
        mov ax,[XF+bx] ; load deltaYF with next XF offset
        mov [deltaYF],ax
        cmp [Read5],0 ; use Read5=0 for sole execution of
                        ; YFCalculation
                        ; do column advance only once per column
                        ; start with processing remainder
        jne ScanStart

YFCalculation:
        mov ax,[YFRemdrSum] ; ax now has sum of remainders
        add ax,[YFRemdr]
        cmp ax,79
                        ; when sum of remainders exceeds one mil,
                        ; remove one mil, keep on with remainder sum
        jl @@2
        sub ax,79
        sub [YF],1
                        ; retract sum of remainders by whole interval
                        ; apply 1-mil upward correction to YF position
@@2:
        mov [YFRemdrSum],ax ; remainder sum cannot exceed 158
        mov dx,306h
        mov ax,[YF]
        sub ax,[YFQuot]
        mov [YF],ax
        out dx,ax ; issue YF for column location

End of column YF application

Appendix C-7  COLSCAN  page 3 of 10
; Slant application
; Through here every column
;
; Input: Slant, Corner1
mov ax,[Slant]
; a FUDGE for biasing Slant
; reverse to positive polarity if Slant is
ADD AX,20
cmp ax,0
; processing is done in positive polarity only
neg ax
neg ax
mov [SlantNeg],1
; flag for negative slant

@5:
mov dx,0
; prep for division
mov bx,79
; want increment for each column
div bx
mov [SlantQuot],ax
; dx has remainder, ax and SlantQuot the
; quotient
mov bx,[SlantRemdrSum]
; bx has remainder Sum
add bx,dx
; add new remainder to Sum
cmp bx,79
; when sum of remainders exceeds 79, want to
jl @3
; subtract 79 and add 1 to correction
sub bx,79
inc [SlantCorr]

@3:
mov ax,[SlantCorr]
; want total of correction terms
add ax,[SlantQuot]
mov [SlantCorr],ax
; sum of terms from quotient and remainders
mov [SlantRemdrSum],bx
; save updated remainder sum

mov ax,[Corner1]
; add or subtract correction
cmp [SlantNeg],0
; slant direction
je @4
sub ax,[SlantCorr]
; through here for negative slant
jmp @5

@4:
add ax,[SlantCorr]
; through here for positive slant

@5:
mov [XFBases],ax
; XFBase is at top edge of (slanted) card,
; End of Slant application

; Start of punched data reading in column

ScanStart:

; RowTable has 12 scaled individual offsets from XFBases
; at top of card. ax has XFBases
mov di,0
mov [Sum5],0
mov bx,0
mov [InpA],0
mov [InpB],0
mov [InpC],0
mov [Min5],999
; arbitrary high initial thrld

; do while scanning and loading ColSig
XFCalculation:
mov dx,304h
mov ax,[XFBases]
add ax,[RowTable+di]

; XF fudge for offsetting top row
sub ax,95
add ax,[deltaXF]
mov [XF],ax
out ax,ax
cmp [Mode],0
; bypass deltaXF in single-read mode to save
time
je @20
mov dx,306h
mov ax,[YF]
add ax,[deltaYF]
out dx,ax

@20:

Appendix C-7  COLSCAN page 4 of 10
;@20:
    mov dx,318h          ;call for first read
    in ax,dx
    add di,2             ;offset di by 2  (di carries rows)
    push cx
    mov cx,12

    NewRow:
        cmp cx,1
        je @7
        jmp NewRow           ; here at start of column
        mov dx,304h
        mov ax,[XFBase]
        add ax,[RowTable+di]
        mov [XF],ax          ;skip the advance for last Read
        add ax,[deltaXF]
        out dx,ax
        mov [XF],ax          ;YF and XF-RowTable have current values

@7:
    mov dx,318h          ;Reads
    in ax,dx
    ;================================================================================
    ;Switch for shift between single and multi-read
    cmp [Mode],0
    je go_on             ;skip switch in single read, Mode=0
    test ax,8000h         ;here to try again for better signal in
    jne wt1               ; another offset position, want lowest value
    and ax,1023
    cmp ax,[ColSig+di-2]  ;new value is in ax
    jb go_on1             ;use new ax if lower than last best signal
    mov ax,[ColSig+di-2]  ;load ax with last best signal otherwise
    jmp BkgndCalculate    ;Switch the 2 switches

    go_on:                 ;through here in Mode 0
    test ax,8000h
    jne wt1
    and ax,1023
    ;================================================================================
    ;BkgndCalculate:
    mov [ColSig+di-2],ax  ;saves 12 amplitudes in ColSig+
    ;================================================================================
    ;here both Modes
    cmp [read5],0
    jne cont1
    cmp di,10
    ;Want min. sig in group of 4 central rows
    jb cont1
    cmp di,18
    ja cont1
    ;Take in readings on 5 rows, throw out the
    ;lowest as a possible hole signal
    jmp cont2
    ;================================================================================
    ;through here for rows 4-8
    ;is done while scanning on middle 5 rows
    mov [Min5],ax
    ;save temp min in group of 5
    ;================================================================================
    ;add all 5 sigs to Sum5
    add [Sum5],ax
    cmp di,18
    jne cont1
    ;================================================================================
    ;is calculated for every column
    mov bx,[Sum5]
    sub bx,[Min5]
    shr bx,2
    mov [ColBknd],bx
    ;================================================================================
    ;go back to cover 12 rows
    add di,2
    jmp toNewRow
    jmp @65
    ;================================================================================
    ;ColSig+ is now loaded with row signals
    ;Scanning completed in column

Appendix C-7  COLSCAN page 5 of 10
offsetswtich:
cmp [mode],0 ;switching for offset shifts
je threshold ;bypass if in single-read mode (mode=0)
add [read5],2 ;read5 can be 0 = no read offset (card orient)
cmp [read5],10 ;
jae threshold ;
4 = offset up
jmp repeatcol ;
6 = offset right
;
8 = offset down

threshold:
mov ax,[colbknd]
sub ax,[bkndfudge] ;a fudge for dense films, 100=normal
mov bx,ax
sub bx,60 ;span is in bx
shr bx,2 ;bx has 1/4 span
sub ax,bx ;ax has colbknd-1/4 span
mov [colthrdweak],ax ;save it
sub ax,bx ;ax has colbknd-1/2 span
shr bx,1 ;bx now has 1/8 span
;colthrd is 1/2 span below

(colbknd-colfudge)
mov [colthrd],ax ;is constant for column; save it
;call show
mov [colthrd1],ax ;initialize all three working thresholds
mov [colthrd2],ax
mov [colthrd3],ax

mov dx,304h ;go to top of card for next column;
mov ax,[xfbase] ;can get xf increment under way early
out dx,ax

dataanalysis:

;call show
mov bx,0
mov di,2
push cx
mov cx,12

strong1:
mov ax,[colsig+di-2] ;find row with lowest signal
mov cx,12

cmp ax,[colthrdweak] ;skip further examination if signal is too
; weak
jg @14a1

inc [weakups] ;save incidence of weak signal, to trigger
rescan of card
jmp @14a

@14a:

jmp @14a1

mov [colthrd1],ax ;try signal against standard, stiffer thrd

mov [colthrd1],ax ;save the strongest (lowest amplitude) signal

mov bx,di ;bx has di word for last row in which valley

@14a1:

add di,2 ;bx will point to row with min signal unless
; all signals are above 1000, then bx=0
add di,2 ;advance di for next row

loop strong1 ;take on next row
pop cx
mov [InpA], bx
mov [ColSig+bx-2], 1001
shr [InpA], 1

; ColSig+bx in first pass is best signal in col
; save (word) location of strongest signal
; disqualify strongest signal for next pass
; (bx-2) has 2X location of least signal in
column
; ColThrd1 has strongest signal in column
; InpA byte has position of strongest or
; 0 if blank
; End of Strong1.

BlkTest:
cmp [InpA], 0
je Encode

; Skip search for second and third strongest if

Strong2In:
mov di, 2
mov bx, 0
push cx
mov cx, 12

Strong2:
mov ax, [ColSig+di-2]
cmp ax, [ColThrd2]
jg @1b
mov [ColThrd2], ax
mov bx, di

@1b:
add di, 2
loop Strong2
pop cx
mov [InpB], bx
mov [ColSig+bx-2], 1002
shr [InpB], 1

; find location of second strongest signal
; also disqualify its amplitude

Strong3:
mov ax, [ColSig+di-2]
cmp ax, [ColThrd3]
jg @1c
mov [ColThrd3], ax
mov bx, di

@1c:
add di, 2
loop Strong3
pop cx
mov [InpC], bx
mov [ColSig+bx-2], 1003
shr [InpC], 1

; find location of third strongest signal

MaskCheck:

; Check mask file for encoding instructions

; call show

cmp [MaskBuf+si], '0'
jg on6
jmp DblOvrPunch

on6:
cmp [InpB], 0
jng DblOvrPunch
mov [InpB], 0
mov [InpC], 0

; if MaskBuf+si is 0, allow full encoding
; through here if MaskBuf greater than 0,
; indicating single read
; if 2 or more punches, dec MaskBuf
; and jam InpB & InpC=0
; means that after 2 double punches in a
column, it changes to full alpha encoding

DblOvrPunch:
; At this point, InpA has location of row with strongest signal
; InpB : first strongest
; InpC : second strongest
; third strongest

Appendix C-7  COLSCAN page 7 of 10
;call show
 ;For blank col, all three = 0 but blank cols have bypassed
 ; here
 ;Next step is to look for combination of two overpunches
 ; (YX) and a numeral (0-9)
 mov [ColResult], 0 ;initialize ColResult
 cmp [InpA], 1 ;is InpA=1?
 je @01
 cmp [InpB], 1 ;is InpB=1?
 je @02
 cmp [InpC], 1 ;is InpC=1?
 je @03
 jmp Encode ;go on to encode alpha char according to data
 ;can't be YX overpunch without a '1'

@01:
 cmp [InpB], 2 ;here if InpA=1, check for YX=AB
 je OutC
 cmp [InpC], 2 ;check for YX=AC
 je OutB

@02:
 cmp [InpA], 2 ;here if InpB=1, check for YX=BA
 je OutC
 cmp [InpC], 2 ;check for YX=BC
 je OutA

@03:
 cmp [InpA], 2 ;here if InpC=1, check for YX=CA
 je OutB
 cmp [InpB], 2 ;check for YX=CB
 je OutA
 jmp Encode ;means Y and X rows are not both punched

OutA: mov ax,[InpA] ;come to 1 of these 3 when both Y and X
 jmp OutXY
 OutB: mov ax,[InpB]; rows punched
 jmp OutYY
 OutC: mov ax,[InpC]
 jmp OutYY
 OutXY: add ax,237 ;add offset=237 for access to codes for
 numerals
 mov [ColResult], ax ; accompanying YX overpunching. YX only = 237
 jmp Translat

 Encode: ;Want to encode InpA and InpB (the two strongest)
 ; with lower value in high nibble of
 ColResult
 ;InpA has row position of strongest signal
 ;InpB has next strongest
 ;Simplifies encoding to have single entry for
 ;any alpha character
 ;swap nibbles if needed for lower ColResult
 mov ax,[InpA]
mov bx,[InpB]
cmp ax,bx
ja @003
shl ax,4
jmp @004
@003: shl bx,4
@004: add ax,bx
 mov [ColResult], ax ;al has entry for Translate table
;ColResult low byte has two nibbles:
;high nibble has lower of InpA or InpB
;low nibble has higher of InpA or InpB
;InpA or InpB=1 for top (Y) row of card
;ColResult low byte enters the translate table
;through here at end of DataAnalysis
;every column including blanks

;-----------------------------------------

Translat:
call show

    mov bx,offset TrnsTbl1 ;name of look-up table, 256 bytes "TrnsTbl1"
xlatb
    ;al has converted value from look-up table
    ;through here every col

    mov bx,[BlockPtr]
    ;Block Ptr is column pointer from start of
    mov [DataBlock+bx],al  ; DataBlock (51200 cols, 640 cards)
    inc [BlockPtr]

------------------------------------------

    cmp al,'*
    jne @@8;next1
    ;want to declare FailCal if more than 8 '**
    inc [NmbrColPickups]

@@8:
    cmp al,'9'
    jne next1
    ;same for '9' or combined total of 8
    inc [NmbrColPickups]

next1:    inc si
    loop toNewCol
    jmp ModeSwitch

    toNewCol:
    mov [Read5],0
    ;call show
    jmp NewCol

;-----------------------------------------

ModeSwitch:

    mov [WeakSigs],0
    ;use this to disable rescanning
    cmp [WeakSigs],0
    ;check for indication of weak signal
    je Exit1
    ;go out to scan next card if strong signals
    cmp [Mode],0
    jne Model

    mov ax,[BlockPtr0]
    ;through here if WeakSigs not equal 0 in Mode=0
    mov [BlockPtr],ax
    ;retract BlockPtr
    mov [Mode],1

    cmp [FlagRep],1
    je @@21
    ;increment nmbrr of cards rescanned if not
    inc [NmbrCdsRescnd]

@@21:
    jmp RepeatCard

    Model:
    mov [Mode],0
    ;go back to initiate card Mode=1 for repeat 5X

    Exit1:
    cmp [NmbrColPickups],0
    je on3
    cmp [FlagRep],1
    je on3
    inc [NmbrCdsPickups]

on3:
    cmp [NmbrColPickups],20
    jle RestoreCoords
    ;through here when 5 or more '*' in card,
    mov ax,[BlockPtr0]
    ; make it record 80 spaces instead
    mov [BlockPtr],ax
mov cx, 80 ; record 80 spaces
mov bx, [BlockPtr]

IncPtr: mov [DataBlock+bx], 32
inc bx
loop IncPtr
add [BlockPtr], 80
cmp [FlagRep], 1
je RestoreCoords
inc [NmbrCdsFld]

;-------------------------------------------------------------------------------

RestoreCoords:
mov dx, 304h ; move XF and YF back to origin of Card Bar search for this card
mov ax, 4096
mov [XF], ax
out dx, ax
mov dx, 306h
mov ax, 8000
out dx, ax

;call show ; through here after every card
ret ; END OF PROCEDURE
;-------------------------------------------------------------------------------

show:
cmp [Card], 8
jne out2
cmp si, 1
jne out2
call line
push si
mov si, 0
push cx
mov cx, 12
con: mov ax, [colsig+si]
    ; mov ax, [junk+10+si]; [ColThrdWeak]
call prtax
call space
inc si
inc si
loop con
pop cx
pop si
call line
out2:
ret

ENDp colscan
End
call show at line 298
Appendix C-8  STRGREAD.ASM Subroutine procedure

This procedure is assembled with the command TASM STRGREAD, automatically including it in the linking file PCSCAN0. A description of its action is given in Section 3.3.7.

;------------------------------------------------------------------
;STRGREAD.ASM Procedure to measure transmittance in specified location
;Output is mean transmittance signal from four reads with defocused spot
;Reads four positions spaced 200 mils horizontally
;Returns with entrance coordinates and variable named Transmtce for
; Transmittance

.386
IDEAL
MODEL small
stack 128

DATASEG

Transmtce dw ?
XF1 dw ?
YF1 dw ?
Include "Scan_var"

CODESEG

Include "Scan_Pcd"
proc StrgRead
procv
mov dx,30Ah
mov ax,[Focus]
out dx,ax

;mov bx,65000
;wtila:  dec bx
;jnz wtila

mov ax,[XF]
mov [XF1],ax
mov ax,[YF]
mov [YF1],ax

mov dx,304h
mov ax,[XF]
out dx,ax
mov dx,306h
mov ax,[YF]
out dx,ax

mov dx,318h
in ax,dx

mov [Transmtce],0 ;Transmtce begins as a sum, then divided by 4
Read:

mov cx,4
cmp cx,1
je @@1

mov dx,304h
mov ax,[XF]
add ax,200
mov [XF],ax
out dx,ax

Appendix C-8  STRGREAD.ASM  page 1 of 2
@@1:       mov dx, 318h
w1:        in ax, dx
          test ax, 8000h
          jne w1
          and ax, 1023

;---------------------------------------------------------------
;          add [Transmte], ax ; when loop is left, sum is 4x typical signal
;          loop Read          ; at specified location
;          shr [Transmte], 2 ; final transmittance signal
;---------------------------------------------------------------

mov ax, [XF1] ; restore but not issue entrance coords
mov [XF], ax
mov ax, [YF1]
mov [YF], ax
ret
Endp strgread
End
This procedure is assembled with the command TASM SPOTREAD, automatically including it in the linking file PCSCAN0. This procedure serves as part of the logic to detect card jams.

;----------------------------------------------------------------------------------------------------------------------------------
;SPOTREAD.ASM Procedure to measure transmittance in specified location
;Output is transmittance signal from one read with defocused spot
;Returns with entrance coordinates and variable SpotTransm
;A high signal amplitude at its location below column 1 sets CardJam=1

.386
IDEAL
MODEL small
stack 128

DASEG

ThrIdJam dw 200
SpotTransm dw ?
XF1 dw ?
YF1 dw ?
INCLUDE "Scan_var"

CODESEG
Include "Scan_Pcd"
proc SpotRead
    mov dx,30Ah    ;set Focus
    mov ax,[Focus]
    out dx,ax
    mov [CardJam],0 ;reset CardJam

    ; mov ax,[XF]     ;save entrance coords
    ; mov [XF1],ax
    ; mov ax,[YF]
    ; mov [YF1],ax

    mov dx,304h    ;set read position
    mov ax,[XF]
    out dx,ax
    mov dx,306h
    mov ax,[YF]
    out dx,ax

    mov dx,318h    ;read
    in ax,dx
    @@1:
    mov dx,318h
    in ax,dx
    test ax,8000h
    jne wtl
    and ax,1023

    mov [SpotTransm],ax
    cmp ax,[ThrldJam]
    jl @@2
    mov [CardJam],1 ;Card jam sets CJ=1

@@2:
    ; mov ax,[XF1]   ;restore but not issue entrance coords
    ; mov [XF],ax
    ; mov ax,[YF1]
    ; mov [YF],ax

ret
Endp SpotRead
End
Appendix C-10  SCALREAD.ASM Subroutine procedure

This procedure is assembled with the command TASM SCALREAD, automatically including it in PCSCAN0. A description of its action is given in Section 3.3.11.11 in the text.

;------------------------------------------------------------
;SCALREAD.ASM Procedure to measure transmittance in Scale Zone
;Output is mean transmittance signal from four reads with defocused spot
;Reads 8 positions spaced 500 mils vertically
;Returns with entrance coordinates and the variable named ScaleTransm

.386
IDEAL
MODEL small

DATASEG
;ScalTransm dw ?
XF1 dw ?
YF1 dw ?
Include "Scan_var"

CODESEG
Include "Scan_Pcd"
proc ScalRead
mov dx,30Ah ;set Focus
mov ax,[Focus]
out dx,ax

mov ax,[XF]
mov [XF1],ax
mov ax,[YF]
mov [YF1],ax

mov dx,304h ;set first read position
mov ax,[XF]
out dx,ax
mov ax,306h
mov ax,[YF]
out dx,ax

mov dx,318h ;first read
in ax,dx

mov [ScalTransm],0 ;ScalTransm begins as a sum then divided by 8
                   ; for output value
mov cx,8
Read:
    cmp cx,1
    je @@1

    mov dx,306h
    mov ax,[YF]
    add ax,250
    mov [YF],ax
    out dx,ax

@@1:
    mov dx,318h
    wtl:
    in ax,dx
test ax,8000h
    jne wtl
    and ax,1023

    add [ScalTransm],ax ;when loop is exited, sum is 8x typical signal
loop Read
    shr [ScalTransm],3 ;final Scale transmittance signal, mean of 8
    ; reads
; cmp [ScalTransm],300 ;apply range limits 300 to 900
; jg @@10
; mov [ScalTransm],300
@@10:
; cmp [ScalTransm],900
; jl @@11
; mov [ScalTransm],900
@@11:
;---------------------------------------------------------------
    mov ax,[XF1] ;restore but not issue entrance coords
    mov [XF],ax
    mov ax,[YF1]
    mov [YF],ax
    ret

Endp scalread
End
Appendix D-1  TLR.ASM Subroutine procedure

This procedure is assembled with the command ASM TLR. A description of its actions is given in Section 3.5.

;---------------------------------------------------------------------
;TLR.ASM, Program to read the file PARAM after end of FCSCAN

.386
IDEAL
MODEL small
Stack 128

DATASEG
filename db 'PARAM',0 ;file size is 100 bytes
ParamData dw 10 dup (32) ;first 10 words are decimal values
ParamText db 80 dup (32) ;remainder is text from Entry
downline1 db 13,10,0
dash2line db 13,10,78 dup (61),0

HdrTitle db 13,10, 'FOSDIC SCAN TRAILER DISPLAY',0

Label1 db 13,10,10,'FILENAME, | DATE | START | END |
TOTAL | FAIL | CNDTN |
Label2 db 13,10, 'DECK,REEL | SCANNED | TIME | TIME |
CARDS | CARDS | CODES |
Label3 db 13,10, |

DataLine db 13,10, ' | - - | : : | : : |
room db 20 dup (32)

Buffer db 2,3 dup (32)
CndtnCode1 db 'First Condition Code... ',0
CndtnCode2 db 13,10,'Second Condition Code... ',0
space db 0,0,0,0
prtbuf db 20 dup (?)

CODESEG
INCLUDE "Scan_Pcd"

start:
    mov ax,@data
    mov ds,ax
    mov es,ax

    mov ah,03Hh ;open file PARAM
    mov al,0
    mov dx,offset filename
    int 21H

    mov ah,3FH ;read contents of PARAM
    mov bx,5 ; to ParamData1, passing through
    mov cx,100 ; ParamText1
    mov dx,offset ParamData
    int 21H

    ;---------------------------------------------------------------------
    mov cx,1
    mov di,offset CndtnCode1
call strwrite
    mov si,73
call Get_Key_Msg
    mov di,offset CndtnCode2
call strwrite

Appendix D-1  TLR.ASM  page 1 of 3
mov si, 75
call Get Key_Msg

mov cx, 1
mov di, offset dash2line
call strwrite
mov di, offset downline1
call strwrite

mov cx, 1
mov di, offset Hdr_title
call strwrite

mov cx, 80
mov si, 0
mov ah, 2
@30:  mov dl, [Label1+si]
       int 21h
       inc si
       loop @30

mov cx, 80
mov si, 0
mov ah, 2
@30a: mov dl, [Label2+si]
       int 21h
       inc si
       loop @30a

mov cx, 80
mov si, 0
mov ah, 2
@30b: mov dl, [Label3+si]
       int 21h
       inc si
       loop @30b

mov cx, 80
mov si, 0
mov ah, 2
@30c: mov dl, [Label3+si]
       int 21h
       inc si
       loop @30c

mov cx, 80
mov si, 0
@32:   cmp [ParamText+si], 32
        jne @31
        cmp [DataLine+si+2], 32
        je @31

        ; here if ParamText1 is 32
        ; if DataLine is also 32, jump to out
        32

mov al, [DataLine+si+2]
mov [ParamText+si], al
@31:   inc si
       loop @32

mov cx, 80
mov si, 0
mov ah, 2
@30d: mov dl, [ParamText+si]
       int 21h
       inc si
       loop @30d

; display top line of boundaries
; display upper line of headings
; display lower line of headings
; display row with boundary extenders
; display row with boundary extenders
; OR ParamText1 and DataLine+2
; (DataLine begins with cr,lf)
; here if ParamText1 is 32
; if DataLine is also 32, jump to out
; here if DataLine has something other
; display DataLine combined with
; ParamText
mov ah,2
mov dl,13
int 21h
mov dl,179
int 21h
mov cx,1
mov di,offset downlinel
call strwrite
mov di,offset dash2line
call strwrite
mov di,offset downlinel
call strwrite

mov ah,4Ch
int 21h

;===================================================================
Get_Key_Msg:       ;Routine for processing keyed data

mov ah,0Ah
mov dx,offset buffer
int 21h
mov al,[Buffer+2]
cmp al,13
jne @3
jmp @Out

@3:
mov [DataLine+si],al  ;load typed char into DataLine msg
;mov [ParamText+bx+di],al  ;load typed char into file string

@Out:
ret

;data field is left-justified

END start
Appendix E-1  SCAN_VAR  List of global variables included in all programs and subroutines of LDR and PCSCAN

;SCAN_VAR  A list of variables used with LDR and PCSCAN

global  XC:word, YC:word ;Working Coarse coordinate values
global  XF:word, YF:word ;Same for Fine
global  XC0:word, YC0:word ;Scan Origin in scan aperture, Coarse coordinates
global  XF0:word, YF0:word ;Same for Fine coords
global  YCMargin:word ;Vertical position for finding Card Bar
global  Port:word ;Axis indicator - 304h=XF, 306h=YF
global  Step:word ;Increment in search strokes
global  MaxCnt:word ;Number of reading positions allowed for strokes
global  Focus:word ;Focus count value
global  Card:word ;Card number of 8 in frame
global  CardExam:word ;Card no. selected for printout
global  Gain0:word ;Default initial value
global  Gain1:word ;Final Gain DAC input for MaxSig=980
global  MaxSig:word ;Determined highest signal
global  MinSig:word ;Determined lowest signal
global  CardSig:word ;Determined card stock signal
global  Thrld:word ;Threshold value
global  BandCenter:word ;Center of left edge band
global  CardBar:word ;Determined center of target line in Centroid, SR
 ; expressed in XF
global  Cal_Data:word:5 ;part of data conveyed by file PARAM
global  Center:word ;Output data from Centroid SR in XF or YF
 ; in XF or YF according to axis of stroke
global  Edge:word ;Output data from Edges SR in XF or YF
global  LeftEdge:word ;Determined position of left edge in Centroid SR in YF
global  Corner1:word:2 ;XF and YF at lower left of card image
global  Corner2:word:2 ;XF and YF at lower right of card image
global  Corner3:word:2 ;XF and YF at upper left of card image
global  Corner4:word:2 ;XF and YF at lower right of card image
;global  DirtSpot:word ;Count of corner-restores and sigs in blank cols
global  NextCard:word

global  XFCornerDiff:word ;Non-rectangularity, XF size difference, cols 1 & 80

global  YFCornerDiff:word ;Non-rectangularity, YF size difference,
global  NoCard:word ;Card absence indicator

global  YFQuot:word
global  YFRehdr:word
global  YFRehdrSum:word
global  Slant:word
global  XFQuot:word
global  XFRrehdr:word
global  XFRrehdrSum:word
global  RowTable:word:26
global  xx:byte
global  ParamData:word:10
global  ParamText:byte:86

global  Blob:word ;Failure indicator for blob removal, fail=1
;global  CardinError:word ;flag showing card failed geometry check
global  Report:word:4 ;vehicle for displaying parameters
global  Status:word ;Working status word
global  Tilt0:word ;Initial Tilt, scale 0 to 1023
global  Thrld:word ;Threshold
global  Flag:word
global  FlagEOF:word ;End of Film=1
global  FlagRep:word ;Flag for repeating mode, =1 for repeat
global  junk:word:100 ;Notepad
global  PrtTbl:word:100 ;Vehicle for printout

global  NmbrCdsScnd:word ;Total number of cards scanned
global  NmbrCdsFld:word ;Total number of cards that failed
global  NmbrCdsRescd:word ;Total number of cards rescanned
global  NmbrColDrops:word ;Total number of column with drops in Must-Haves
global  NmbrColPickups:word ;Total number of columns with pickups in No-Punches
global  NmbrCdsDrops:word ;Total number of cards with drops in Must-Have cols
global  NmbrCdsPickups:word ;Total number of cards with pickups in No-Punch cols
global  PrevColDrops:word ;tempo storage for NmbrColDrops
global  PrevCdsDrops:word ;tempo storage for NmbrCdsDrops
global  PrevColPickups:word ;tempo storage for NmbrColPickups

global  XCFrameStop:word ;Leftside location for stopping film drive
global  XCFrame:word ;XC for start of Frame routine
global  YCFram:word ;YC for start of Frame routine
global  ParamData1:word:10
global  ParamText1:byte:80
global  BlockPtr:word
global  ParamHandle:word
global  DataHandle:word
global  DataBlock:byte:52000
global  Maskbuf:byte:160
global  CardError:word
global  XCStopped:word

global  FailTrack:word ;FT=1 indicates clear area after Frame, not card
global  FailEdge:word ;runout Failure indicator for Edges proc
global  FailEdge1:word ;hi-sig Failure indicator for Edges proc
global  FailBar:word ;Failure indicator for Centroid proc
global  FailBar1:word ;high first sig failure in Centroid proc
global  FailCalCardBar:word ;stored calib failure indicator for Card Bar
global  FailCardBar1:word ;stored frame failure indicator for Card Bar
global FailCalEdge:word ; stored calib failure indicator for Edges
global FailCalScaleBar:word ; stored calib failure indicator for Scale Bar
global FailCalGeom:word

global Cease:word ; for emergency stopping and display
global SigSum:dword
global NmbrSigs:dword
global ThrdMod:word
global Want:word
global Transmtce:word
global FrmSig:word
global PunchCols:word
global StopOnArti:word
global ScalTransm:word
global MeanBlank:word
global ThrdFrame:word
global CardJam:word
global SpotTransm:word
global ThrdJam1:word
global ThrdJam:word
global ResumeScan:word
global Pause:word
global FailCardinFrame:word
global AftrFirstFrm:word
global Tilt:word
global Pickup:word
Appendix F-1  SCAN_PCD  List of global procedures included in all programs and subroutines of LDR, PCSCAN and TLR

;SCAN_PCD  A list of procedures used with LDR and PCSCAN

global  Scan:proc  ;central program procedure for handling scan subroutines
global  Centroid:proc  ;Finds center of target line
global  Edges:proc  ;Finds position of edge, opaque to clear transition
global  CalcScal:proc  ;Generates scaling factors for Width, Slant and Height
global  ColScan:proc  ;Scans all 960 punch positions in 8 card images
global  Gainpc1:proc  ;Calibrates Gain, sets MaxSig near 980
global  VTrack:proc  ;Finds YCMargin
global  Spacex:proc  ;Horizontal space  Located in Util.asm
global  Line:proc  ;LF and CR  "
global  Prtax:proc  ;Prints contents of ax  

global  Print0:proc  ;Prints messages at end of scanning

global  Frame:proc  ;Film drive

global  Strwrite:proc  ;in MTA

global  Bintoascdec:proc  ;in MTA

global  FrmScan:proc  ;Scan pattern and film drive for leader

global  Gain:proc  ;calibrates Gain DAC and MaxSig

global  Bkgnd:proc  ;calibrates CardSig and MinSig

global  VTrack:proc  ;calibrates YCMargin

global  Cal_Dspl:proc  ;displays calibration parameters

global  Entry:proc  ;enters and displays keyboard data

global  Framex:proc

global  BlobRemv:proc  ;attempts to remove blobs

global  Wipe:proc

global  Movon:proc

global  colscan:proc

global  scan:proc

global  strgread:proc

global  scalread:proc

global  spotread:proc
Appendix G-1  Linking files  LDR0, PCSCAN0, MTA

LDR0 and PCSCAN0 are files listing the subroutines used in the programs LDR.EXE and PCSCAN.EXE respectively. Linking is accomplished with these instructions:

    tlink @LDR0 generates LDR.EXE
    tlink @PCSCAN0 generates PCSCAN.EXE

Listings:

---------------------------------------------------------------
LDR0:  LDR  FRAME  WIPE  GAIN  BKGNDS  CAL_DSPL  ENTRY  UTIL  „„ MTA
---------------------------------------------------------------
where:
LDR      Calls for leader film movement
FRAME    Runs film in to Reel ID (first) card
WIPE     Activates Crt phosphor screen
GAIN     Adjusts sensitivity of optical system
BKGNDS   Measures density of card images
CAL_DSPL Displays calibration parameters
ENTRY    Calls for deck and reel identification via keyboard
UTIL     Facilitates displays
MTA      Library routines for displays, described below

---------------------------------------------------------------
PCSCAN0: PCSCAN  SCAN  GAIN  VTRACK  CENTROID  EDGES  STRGREAD
         SPOTREAD  CALCSCL  COLSCAN  SCALREAD  FRAME  UTIL  „„ MTA
---------------------------------------------------------------
PCSCAN      Executive program for scanning
SCAN        Calls subroutines for scanning
GAIN        Adjusts optical sensitivity for card images
VTRACK      Finds transverse location of card images on film
CENTROID    Finds centers of Card and Scale bars
EDGES       Finds edges of card images
STRGREAD    Measures average film transmittance at designated zones in card images
SPOTREAD    Measures transmittance at designated positions in card images
CALCSCL     Calculates movement scale factors from card corner locations
COLSCAN     Controls scanned positions at 960 hole locations on card images
SCALREAD    Finds average transmittance in scale zone
FRAME       Controls film movement
UTIL        Facilitates displays
MTA         Library routines for displays, described below

MTA:

This is a library of routines to facilitate the display of numeric values in a register and strings of text from sections of memory. From the collection in the library, BINTOASCDEC and STRWRITE have been utilized extensively. The source for MTA-LIB is "Mastering Turbo Assembler" by Tom Swann, pages 208 and 182 respectively, published 1989 by Hayden Books.
Appendix H-1  TRNSTBL1  Translation table

This table is referred to in COLSCAN.ASM to translate Fosdic row data identification to final recorded characters.

; TRNSTBL1 An INCLUDE file for the output data translation table ;

<table>
<thead>
<tr>
<th>TrnsTbl1</th>
<th>Ext1</th>
<th>Ext2</th>
<th>Ext3</th>
<th>Ext4</th>
<th>Ext5</th>
</tr>
</thead>
<tbody>
<tr>
<td>' &amp;-0123456789*****!'ABCDEFGHI*****'(JKLMNOPQR*****'</td>
<td>'<em><strong>STU VWXYZ</strong></em>************************************************************************'</td>
<td>'***************************************************************************'</td>
<td>'***************************************************************************!'</td>
<td>'***************************************************************************!'</td>
<td>'*****!'</td>
</tr>
</tbody>
</table>

Appendix H-1  TRNSTBL1  page 1 of 1
Appendix J-1 GO.BAT Executive batch file

This small batch program enables the sequence of programs comprising the overall scanning system.

; Contents of GO.BAT

smartdrv c-/q ; disables SMARTDRV delays scanning of new data until old is recorded on hard disk
ldr ; starts LDR.EXE runs in film leader and acquires keyed reel identification
pcscan ; starts PCSCAN.EXE scans entire reel
tlr ; starts TLR.EXE adds timing and quality control data
foscapy c: ; starts FOSCOPY combines card data and header to create final file for reel
Appendix J-2  List of .MSK Mask files

Mask files are called by PCSCAN.ASM to convey information regarding selection of numeric or alphanumeric/overpunching in specific columns, as obtained from Reference Manuals for individual decks. The action of these files is described in Section 3.3.11.7.

------------------------------------------------------------------------------------------------------------------
The contents of sample file 00000110.MSK are as listed below:

2222222222222222222222202222222222222222222222222222222

Notes:
Columns with "2" indicate expected single punch i.e. numeric, Y or X.
After 2 double punches these convert to "0" for full alphanumeric/overpunch encoding.
Columns with "0" indicate expected possible double or triple punches, alphanumeric/overpunch.
The above example (Deck 110) shows expected possible multiple punches in columns 19 36 39 40 41 45 48 64.

------------------------------------------------------------------------------------------------------------------
The contents of all DDDDDDDDD.MSK files are as listed below. Except as noted, columns not listed are filled with "2".

Columns with "0"
for alphanumeric/
overpunch data

<table>
<thead>
<tr>
<th>Deck</th>
<th>19</th>
<th>36</th>
<th>39-41</th>
<th>45</th>
<th>48</th>
<th>64</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>1</td>
<td>25</td>
<td>27</td>
<td>37</td>
<td>50</td>
<td>57</td>
</tr>
<tr>
<td>116</td>
<td>36</td>
<td>37</td>
<td>39-41</td>
<td>45</td>
<td>47</td>
<td>51</td>
</tr>
<tr>
<td>117</td>
<td>29</td>
<td>32</td>
<td>34</td>
<td>41</td>
<td>44</td>
<td>58</td>
</tr>
<tr>
<td>118</td>
<td>59</td>
<td>64</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>119</td>
<td>2</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>23</td>
<td>32</td>
</tr>
<tr>
<td>128</td>
<td>1</td>
<td>33</td>
<td>34</td>
<td>36</td>
<td>37</td>
<td>46</td>
</tr>
<tr>
<td>184</td>
<td>1</td>
<td>57</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>185</td>
<td>20</td>
<td>32</td>
<td>35</td>
<td>43</td>
<td>46</td>
<td>50-52</td>
</tr>
<tr>
<td>189</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>14-18</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>190</td>
<td>3</td>
<td>10</td>
<td>13</td>
<td>30</td>
<td>56</td>
<td>57</td>
</tr>
<tr>
<td>192</td>
<td>3</td>
<td>6</td>
<td>8</td>
<td>18</td>
<td>39</td>
<td>42</td>
</tr>
<tr>
<td>193</td>
<td>3</td>
<td>6</td>
<td>8</td>
<td>18</td>
<td>39</td>
<td>42</td>
</tr>
<tr>
<td>194</td>
<td>58</td>
<td>60</td>
<td>61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>195</td>
<td>18</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>196</td>
<td>1</td>
<td>39</td>
<td>50</td>
<td>56</td>
<td>58</td>
<td>65</td>
</tr>
<tr>
<td>256</td>
<td>1</td>
<td>48</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>281</td>
<td>none</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>541</td>
<td>reel not recvd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>608</td>
<td>24</td>
<td>40</td>
<td>56</td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>650</td>
<td>38</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>690</td>
<td>15</td>
<td>18</td>
<td>32</td>
<td>35</td>
<td>49</td>
<td>52</td>
</tr>
</tbody>
</table>

Appendix J-2  List of .MSK files  page 1 of 1
Appendix K-1  HEADER.TXT  Header file

This is the Header record attached to all card data files by FOSCOPY after the end of scanning on a reel. It contains identification information and data on the results of the processing for the specific run. The encoding table given in this record has since been augmented with additional codes to handle overpunching with numerics; the most complete table is located in Appendix A.

Byte offset
0-1  Offset from start of file to start of data  2-byte unsigned integer
2-10 Deck number <nos.,letters,()>  8 ASCII chars plus NULL terminator
11-14 Reel number  3 ASCII digits plus NULL terminator
15-25 Date scanned <mm-dd-yyyy>  10 ASCII digits plus NULL terminator
26-27 Number of card images in file  2-byte unsigned integer
28-29 Number of cards failing scan validity check 2-byte unsigned integer
30  Condition Code 1  1-byte unsigned character
31  Condition Code 2  1-byte unsigned character
32-33 Integer constant '42', byte-order indicator 2-byte unsigned integer
34-38 Spares, initially space characters
39  NULL, end of parameter section of header

All integers are in low-byte, high-byte format.
80 characters per card, fixed-length records, no delimiters

Character translation:

<table>
<thead>
<tr>
<th>Row</th>
<th>ASCII</th>
<th>Char</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>space</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>&amp;</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>12,1</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>12,2</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>12,3</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>12,4</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>12,5</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>12,6</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>12,7</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>12,8</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>12,9</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>11,1</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>11,2</td>
<td>K</td>
<td></td>
</tr>
<tr>
<td>11,3</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>11,4</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>11,5</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>11,6</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>11,7</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>11,8</td>
<td>Q</td>
<td></td>
</tr>
<tr>
<td>11,9</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>
0,2  S
0,3  T
0,4  U
0,5  V
0,6  W
0,7  X
0,8  Y
0,9  Z

Note: Any combination not listed above translates to an "**" character.

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Data follows after CR-LF

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