CENTRAL BIBLIOGRAPHIC SYSTEM TERMINAL REQUIREMENTS STUDY

TASK II REPORT TERMINAL STATE-OF-THE-ART SURVEY

BY
HOBBS ASSOCIATES, INC.
CORONA DEL MAR, CALIF.

SUBMITTED TO
INFORMATION SYSTEMS OFFICE
LIBRARY OF CONGRESS
WASHINGTON, D.C. 20540
NOVEMBER 1969
CENTRAL BIBLIOGRAPHIC SYSTEM
TERMINAL REQUIREMENTS STUDY

TASK II REPORT
TERMINAL STATE-OF-THE-ART SURVEY

BY
HOBBS ASSOCIATES, INC.
CORONA DEL MAR, CALIF.

L. C. HOBBS
H. R. LUXENBERG
D. J. THEIS
W. GROSS

SUBMITTED TO
INFORMATION SYSTEMS OFFICE
LIBRARY OF CONGRESS
WASHINGTON, D.C. 20540

NOVEMBER 1969
# TABLE OF CONTENTS

1. INTRODUCTION AND SUMMARY .................................................. 1

2. HARDWARE DEVICES AND TECHNOLOGIES RELATED TO TASK I ANALYSIS OF REQUIREMENTS FOR TERMINAL MODULES AND TERMINAL CATEGORIES (STATIONS) ........................................... 4

   2.1 General .................................................................................... 4
   2.2 Implementation of Terminal Stations From Terminal Modules ...... 4
   2.3 Module Requirements Implemented with Separate Hardware .... 5
   2.4 Module Requirements Implemented with Either Logic or Software in the Terminal Station or in a Controller 6
   2.5 Further Considerations for the Task III Trade-off Analyses .... 7
   2.6 Correlation of Technology Survey in Task II With Terminal Module List Derived in Task I 8


   3.1 General .................................................................................... 11
   3.2 Pin Labelers and Pin Readers ................................................ 13
      3.2.1 General .............................................................................. 13
      3.2.2 Techniques or Technologies ............................................. 14
      3.2.3 Present State-of-the-Art ................................................... 17
      3.2.4 Problem Areas .................................................................. 17
      3.2.5 Projected State-of-the-Art for 1970 and 1972 .................... 18
   3.3 Keyboards and Keyboard/Printers .......................................... 20
      3.3.1 General .............................................................................. 20
      3.3.2 Techniques or Technologies ............................................. 21
      3.3.3 Present State-of-the-Art ................................................... 24
      3.3.4 Problem Areas .................................................................. 24
      3.3.5 Projected State-of-the-Art for 1970 and 1972 .................... 25
   3.4 Entry Devices for Special Symbols ........................................ 26
      3.4.1 General .............................................................................. 26
      3.4.2 Techniques or Technologies ............................................. 26
      3.4.3 Present state-of-the-Art ................................................... 28
      3.4.4 Problem Areas .................................................................. 29
      3.4.5 Projected State-of-the-Art for 1970 and 1972 .................... 29
   3.5 Badge Readers ......................................................................... 30
      3.5.1 General .............................................................................. 30
      3.5.2 Techniques or Technologies ............................................. 30
      3.5.3 Present State-of-the-Art ................................................... 31
      3.5.4 Problem Areas .................................................................. 32
      3.5.5 Projected State-of-the-Art for 1970 and 1972 .................... 32
TABLE OF CONTENTS (CONTINUED)

3.6 Alphanumeric and Symbol Displays
   3.6.1 General 34
   3.6.2 Techniques or Technologies 35
   3.6.3 Present State-of-the-Art 38
   3.6.4 Problem Areas 39
   3.6.5 Projected State-of-the-Art for 1970 and 1972 40

3.7 Hard Copy Devices (Printers)
   3.7.1 General 41
   3.7.2 Techniques or Technologies 41
   3.7.3 Present State-of-the-Art 44
   3.7.4 Problem Areas 45
   3.7.5 Projected State-of-the-Art for 1970 and 1972 45

3.8 Machine Readable Unit Document Generator and Reader 46
   3.8.1 General 46
   3.8.2 Techniques or Technologies 46
   3.8.3 Present State-of-the-Art 48
   3.8.4 Problem Areas 49
   3.8.5 Projected State-of-the-Art for 1970 and 1972 50

3.9 Machine Readable Media Generator 51
   3.9.1 General 51
   3.9.2 Techniques or Technologies 51
   3.9.3 Present State-of-the-Art 54
   3.9.4 Problem Areas 54
   3.9.5 Projected State-of-the-Art for 1970 and 1972 55

3.10 Calculating Unit (Small Computers)
   3.10.1 General 56
   3.10.2 Techniques or Technologies 56
   3.10.3 Present State-of-the-Art 60
   3.10.4 Problem Areas 62
   3.10.5 Projected State-of-the-Art for 1970 and 1972 62

3.11 Oriental Language Devices
   3.11.1 General 63
   3.11.2 Entry Devices for Oriental Languages 64
   3.11.3 Display Devices for Oriental Languages 67
   3.11.4 Hard Copy Devices for Oriental Languages 73
   3.11.5 Machine Readable Code for Oriental Languages 73
   3.11.6 Projected State-of-the-Art for 1970 and 1972 74

4. POTENTIAL PROBLEM AREAS 78

5. CONCLUSIONS AND RECOMMENDATIONS 80
<table>
<thead>
<tr>
<th>APPENDIX</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPENDIX A</td>
<td>SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE KEYBOARDS &amp; KEYBOARD/PRINTERS</td>
<td>A-1</td>
</tr>
<tr>
<td>APPENDIX B</td>
<td>SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE BADGE READERS</td>
<td>B-1</td>
</tr>
<tr>
<td>APPENDIX C</td>
<td>SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE ALPHANUMERIC AND SYMBOL DISPLAYS</td>
<td>C-1</td>
</tr>
<tr>
<td>APPENDIX D</td>
<td>SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE REMOTE PRINTERS</td>
<td>D-1</td>
</tr>
<tr>
<td>APPENDIX E</td>
<td>SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE MACHINE READABLE UNIT DOCUMENT DEVICES</td>
<td>E-1</td>
</tr>
<tr>
<td>APPENDIX F</td>
<td>SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE TAPE DEVICES FOR MACHINE READABLE MEDIA</td>
<td>F-1</td>
</tr>
<tr>
<td>APPENDIX G</td>
<td>SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE SMALL COMPUTERS</td>
<td>G-1</td>
</tr>
<tr>
<td>APPENDIX H</td>
<td>SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE DEVICES FOR ENTRY, DISPLAY, AND PRINTING OF ORIENTAL LANGUAGES</td>
<td>H-1</td>
</tr>
<tr>
<td>APPENDIX I</td>
<td>MANUFACTURERS CONTACTED DURING THE STUDY</td>
<td>I-1</td>
</tr>
</tbody>
</table>
1. INTRODUCTION AND SUMMARY

This report presents the results of Task II of the study of terminal requirements for the Central Bibliographic System for the Library of Congress. Task I covered a study of the functional requirements and establishment of performance specifications. This report on Task II presents the results of a survey of the state-of-the-art related to the requirements for the Central Bibliographic System for the present, for mid-1970 and for mid-1972. Task III of this study will consist of analyses and evaluations including the identification of performance specifications that cannot be met with the anticipated state-of-the-art, developments that will be required to meet the Library's needs, and cost and trade-off studies of alternative configurations.

The requirements analyses in Task I identified categories of terminal stations that will be required, the terminal modules needed to configure these terminal stations, and the performance requirements for the terminal modules. The investigations in Task II surveyed the present state-of-the-art in the types of equipments required to implement the terminal modules and stations specified in Task I, identified problem areas, and projected the state-of-the-art into 1972. Manufacturers claims for performance, performance specifications that cannot be met, and new developments needed are to be identified in Task III. However, since it was convenient to do part of this work during Task II, this report identifies problem areas and some performance requirements that cannot be met with existing or anticipated state-of-the-art. These questions will be considered further during Task III.

Approximately fifteen different kinds of equipment have been covered in this survey. Since there are many versions and variations of each of these kinds of equipments, as well as many manufacturers for most of them, the correspondence, number of people interviewed, and material studied during this survey has been extensive. Letters requesting information have been sent to over 500 companies; replies have been received and analyzed from
over 200; personal discussions and interviews have been held with representatives of 72 companies; and 44 technical articles, comparisons, and documents, in addition to many sales brochures, have been reviewed. A serious attempt has been made to contact or consider material from all of the manufacturers supplying the different types of equipment covered in this survey (see Appendix I). However, despite the intention of covering all applicable manufacturers, some have undoubtedly been missed. Any such omissions are unintentional. The possibility of omissions has been increased by the fact that for some kinds of equipments, such as displays and small computers, new devices and new companies are announced almost weekly. This is an indication of rapid technological progress and proliferation of equipment in this field which makes an equipment survey transitory in nature. Hence, the comparison of specific equipments has been presented in Appendices. The body of the report presents trends and performance characteristics that are considered typical of the field, and hence more lasting.

Keyboards and other entry devices, badge readers, alphanumeric and symbol displays, hard copy devices, devices for generating and reading machine readable unit documents, devices for generating machine readable media, and small computers (calculating units) are highly developed at this time. For such equipment there is a considerable depth of technology and ready availability of off-the-shelf equipment. However, the Library's requirements for the 176 character extended Roman alphabet and for handling subsets of Roman alphabet along with alphabets of other languages imposes requirements for displays and hard copy devices that cannot be met with commercially available equipment. The requirements for keyboards for this large character set cannot be met with standard commercially available keyboard assemblies, but the configuration of larger character set keyboards is not difficult and does not require development funds because of the availability of modular key assemblies which permit configuring a keyboard to meet the Library's needs using commercially available key modules. Technology is available to meet the Library's requirements for displays and hard copy devices, but some development
funds and customized equipment will likely be required since no commercially available devices handle such a large character set.

The devices required for the preparation and reading of PIN labels are also feasible from the technology standpoint, but there is no existing equipment that meets the Library's requirements -- particularly for the portable PIN reader.

Handling of special symbols and the oriental languages are the most serious problem from the terminal standpoint. Of these two, the oriental languages are considered to be the most serious problem because of the large amount of bibliographic material of this type that is handled by the Library.

The problems discussed above, as well as trade-offs and alternative configurations, will be considered further in Task III of this study.
2. THE RELATION OF HARDWARE DEVICES AND TECHNOLOGIES TO TASK I ANALYSES OF REQUIREMENTS FOR TERMINAL CATEGORIES AND MODULES

2.1 General

In Task I of this study, which covered the analysis of Library of Congress terminal requirements and the development of quantitative performance specifications, functional requirements were determined for eleven categories of terminals. The terms "terminal categories" and "terminal stations" are used somewhat interchangeably in this report. A category of terminals includes a number of terminal stations with similar characteristics and performance requirements. A terminal station is essentially a work station for one or more persons, such as catalogers, reference librarians, etc. A terminal station includes a number of terminal modules which together provide the capabilities and performance characteristics required for the user. For example, a preliminary cataloging station includes a PIN reader, a keyboard, a badge reader, a hard copy device, and an alphanumeric display module. All of the terminals in a given category have similar requirements and include similar modules, although some of the modules may operate in different languages for different terminal stations in that category. For example, one preliminary cataloging terminal station would be equipped with modules for handling the extended Roman alphabet while another would be equipped with modules for handling a set of non-Roman alphabets, as well as the Roman alphabet. The Task I report also derives the modules required to implement the terminal stations in each category.

2.2 Implementation of Terminal Stations from Terminal Modules

The Task I report includes a matrix which identifies the terminal modules necessary to implement each category of terminal stations. Although most of these modules represent separate hardware equipments (e.g., keyboards, printers, CRT displays, etc.), some of them may be implemented by logical arrays or programmed subroutines. Hence, the terminal modules derived in Task I for implementing the terminal stations in the eleven categories may be considered in a broad sense as
functional modules rather than necessarily equipment modules. Section 3 and the Appendices to this report discuss the state-of-the-art and available equipments for those terminal modules which are physically distinct hardware or equipment modules. The remainder of Section 2 identifies those module requirements which can best be implemented with logic, and those which can best be implemented with software in the terminal station or controller. The last part of Section 2 identifies some of the considerations which must be analyzed as part of the trade-off analyses in Task III. For example, the Time and Date Clock could be implemented with logical hardware in the terminal station, with a programmed subroutine if the terminal station includes a small computer, or with a programmed subroutine in a controller which handles several terminals.

2.3 Module Requirements Implemented With Separate Hardware
The requirements that can best be implemented with separate hardware modules are those which require special purpose electronic, mechanical, and electromechanical parts and which cannot be easily implemented with logical arrays alone or with programmed subroutines. The following terminal modules should be implemented with separate hardware or equipment modules:

- PIN labelers and PIN readers
- Keyboards
- Entry devices for special symbols
- Badge readers
- Alphanumeric and symbol displays
- Hard copy devices
- Machine readable unit document generators and readers
- Machine readable media generators
- Calculating units
- Oriental language, input, display, and printing devices

Equipment applicable to these modules have been surveyed in Task II of this study. The current and projected state-of-the-art for these devices is discussed in Section 3 of this report, and presently available devices of
these types are summarized in the Appendices at the end of this report. For the terminal stations in any terminal category, these modules represent almost the entire cost of the terminal and the major cost of any controller associated with the terminal. As used in this report the term "controller" refers to a local logic, storage, and control unit which works with several terminals. A controller is used in those cases where several terminals in reasonably close proximity to one another can share the capabilities of a common controller for some functions more economically than would be the case if these functions were included separately in each of the terminal stations. For example, a controller might provide the computing, stored program, buffer storage, and communication capabilities for several cataloger terminal stations which are physically located within a few hundred feet of one another.

2.4 Module Requirements Implemented With Logic or Software in a Terminal Station or in a Controller

Several of the functional modules identified in the Task I report can best be implemented with either logic or software in the terminal station, or perhaps in a controller associated with several terminal stations. The calculating unit function can be provided by logic or software in the terminal or controller. The ID Code Generator can be an array of logic gates wired to generate the code, a small read-only memory, or the contents of several storage locations in the memory of a small computer in the terminal station or in a controller. The generation of the ID Code could be accomplished in either the terminal itself or in a controller which is associated with that terminal. The generation of any record of data from the terminal would automatically cause the ID Code to be generated and inserted in the data record.

Similarly, the Time and Date Clock can be implemented logically with a controller or with a short programmed subroutine in a small computer in the terminal station or in a controller associated with the terminal. The Preprogrammed Data Entry Device will require selection keys on the keyboard to identify the particular preprogrammed message to be
entered. This can be accomplished either by a set of keys each calling for the entry of a different preprogrammed message or by a single function key to indicate the entry of a preprogrammed message and the use of several of the regular keys on the keyboard to identify the particular preprogrammed message. For example, the depression of the function key indicating the use of a preprogrammed message followed by the depression of three particular numeric keys could select one of a thousand preprogrammed messages. The preprogrammed messages can be implemented internally in the terminal or in a controller with an array of logic gates, a read-only memory, or storage locations in the memory of a computer in the terminal or controller or can be stored in the central computer. The choice between these three alternatives depends upon the number of preprogrammed messages required and upon whether the small computer is available. If a very limited number of preprogrammed messages are required a logic array may be satisfactory. However, if many messages of this type are required, the read-only memory or the use of part of the main memory in a small computer would be a better approach.

2.5 Further Considerations for the Task III Trade-Off Analyses

The trade-off analyses to be made in Task III will include consideration of logic arrays, read-only memories, and stored data or subroutines in the small computer's main memory as alternative ways of accomplishing the module functions of ID Code Generation, Time and Date Clock, and Preprogrammed Data Entry. These trade-off analyses will also explore whether each terminal station should be a stand-alone system or whether in some cases several terminal stations should operate with and share the capabilities of a controller. In those cases where the controller is desirable, the trade-off analyses in Task III must then consider which functions should be performed in the individual terminal station and which should be performed in the shared controller.

In those cases where the terminal requirements and performance specifications developed in Task I for the Central Bibliographic system
cannot be met with existing state-of-the-art equipment or with equipment or technologies expected to be available in 1972, the trade-off analyses in Task III will consider the compromises that can be made and the implications of making these compromises. In such cases, this will also involve the consideration of alternative modules or approaches.

These trade-off analyses may also indicate that some functions presently planned for the terminals can best be implemented in the central computer of the Central Bibliographic System, but there is no indication to date that will be the case.

2.6 Correlation of Technology Survey in Task II With Terminal Module List Derived in Task I

A list of the terminal modules derived during the Task I study was presented in Section 5.3 of the Task I report. This list included the following modules:

1. Full printer - standard Roman character set
2. Full printer - extended Roman character set
3. Full printer - combined sets (extended Roman and selected Non-Roman)
4. Full printer - combined sets (extended Roman and selected set for Oriental language or special symbols)
5. Full printer - combined sets (extended Roman, Non-Roman, Oriental language set, and special symbols)
6. Machine readable media generator - standard Roman character sets
7. Machine readable media generator - extended Roman character set
8. Machine readable media generator - combined sets (extended Roman and selected Non-Roman)
9. Machine readable media generator - combined sets (extended Roman and selected set for Oriental language or special symbols)
10. Machine readable media generator - combined sets (extended Roman, Non-Roman, Oriental language set, and special symbols)
11. Marking device - numeric character set
13. PIN labeler - standard Roman character set
14. Full visual display - extended Roman character set
15. Full visual display - combined sets (extended Roman and set
16. Full visual display - combined sets (extended Roman and selected set for Oriental language or special symbols)
17. Full visual display - combined sets (extended Roman, Non-Roman, Oriental language set, and special symbols)
18. Keyboard - standard Roman character set
19. Keyboard - extended Roman character set
20. Keyboard - combined sets (extended Roman and selected Non-Roman)
21. Entry device - Oriental language character set
22. Entry device - special symbols
23. Preprogrammed data entry device - numeric character set
25. PIN Reader - standard Roman character set
26. Badge reader - numeric character set
27. ID code generator - numeric character set
28. Time/date code generator - numeric character set
29. Calculating unit - numeric character set

The above list of modules from the Task I report are correlated in Table 2-1 with the devices and equipment modules discussed in this Task II report.

Table 2-1 serves as a cross reference between particular modules identified in Task I and the Sections and Appendices of this report which present information on devices and technologies applicable to those modules. A list of the names and addresses of the manufacturers of each type of equipment contacted during this study is presented in Appendix I.
<table>
<thead>
<tr>
<th>Modules Identified in Task I (See list on pages 8 and 9 of this report)</th>
<th>Sections of This Task II Report Which Cover Devices and Technologies for Those Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 3, 4, 5, and 11</td>
<td>3.3, 3.4, 3.7, Appendices A &amp; D</td>
</tr>
<tr>
<td>4, 5, 16, 17, and 21</td>
<td>3.11, Appendix H</td>
</tr>
<tr>
<td>6, 7, 8, 9, and 10</td>
<td>3.9, Appendix F</td>
</tr>
<tr>
<td>12, and 24</td>
<td>3.8, Appendices B and E</td>
</tr>
<tr>
<td>13, and 25</td>
<td>3.2, Appendices B and E</td>
</tr>
<tr>
<td>14, 15, 16, and 17</td>
<td>3.6, Appendix C</td>
</tr>
<tr>
<td>18, 19, 20, 21, and 22</td>
<td>3.3, Appendix A</td>
</tr>
<tr>
<td>22</td>
<td>3.4</td>
</tr>
<tr>
<td>23, 27, 28</td>
<td>2.4</td>
</tr>
<tr>
<td>26</td>
<td>3.5, Appendix B</td>
</tr>
<tr>
<td>29</td>
<td>3.10, Appendix G</td>
</tr>
</tbody>
</table>

**CORRELATION OF TECHNOLOGY SURVEY IN TASK II WITH TERMINAL MODULE LIST DERIVED IN TASK I**

**TABLE 2-1**

3.1 General
This section presents the present state-of-the-art for each of the terminal modules that will be implemented by physically distinct hardware or equipment modules. The techniques or technologies used in implementing these modules, the state-of-the-art at present, problems encountered, and the improvements in performance and cost anticipated for the 1970 and 1972 time frames are discussed for these types of equipment.

In general, discussion is centered on equipment modules which perform the specific functions of individual modules derived in Task I from the functional requirements. Presently available systems which include several of these modules are usually not discussed as systems. For example, complete data entry systems, which include keyboards, printers, magnetic tape units, buffer memories, and controllers for controlling the operation of a number of such input stations, are available but they are not discussed as systems. The individual components, such as keyboards, printers, and magnetic tape units are discussed separately.

There are three partial exceptions and one major exception to this approach to the discussion of terminal modules. Keyboard/printers (e.g. an electric typewriter, teletype, etc.) which include both the keyboard and a serial character printer, are compared and discussed in the same subsection as keyboards. Since most CRT visual displays include a keyboard and a refresh memory, these are discussed as a unit under alphanumeric and symbol displays. All small computers include some complement of peripheral equipments (e.g. punched paper tape, magnetic tape, printers, etc.); hence, the peripheral equipment offered with each small computer is summarized in the Appendix on small computers. The major exception is found in the case of oriental language devices. Because of the scarcity of suitable devices for handling the oriental languages and the close
interrelationship between the way data is entered, the way it is displayed, and the way hard copy is generated, all oriental language devices are discussed together in Section 3.11. That section also considers the encoding of the oriental language characters in machine readable code. The discussion of presently available devices for oriental languages in Appendix H also treats data entry, display, and printing together.
3.2 PIN Labelers and PIN Readers

3.2.1 General

The PIN, or Piece Identification Number, is on a small unobtrusive label attached to the outside cover of a book or other document to uniquely identify a physical item. The PIN label must be prepared by a terminal station and later read automatically by either a reader in a fixed terminal station or a portable PIN reader. The portable PIN reader may be connected to a terminal station or it may record on a machine readable media which is later read by a terminal station. The decoded Piece Identification Number is used automatically to retrieve the corresponding bibliographic record for processing by a terminal. The PIN must also be human readable.

When a new piece of bibliographic material is received, an identification number must be assigned to it. The process of adding a call number to a PIN label can be accomplished either by employment of a "temporary" label which is replaced after shelf-listing by a "permanent" one or a label to which call number data can be added in some relatively simple manner after it is attached to an item. When the label is read at any terminal station, the PIN information is recorded, decoded and used to carry out identification, processing and retrieval functions.

The operational requirements necessary to effect a PIN Assignment category are: generating next available PIN to be assigned, linking PIN to machine readable record, creating label with coded PIN, attaching label to item, and verifying that proper record is linked to item.

In some cases, such as individual titles ordered via the Library's Order Division's system, a computer record will already exist and entering the assigned identification number into that record will link the material to its computer record. In other cases, where no computer record exists when the identification number is assigned, the number on the label affixed to the material can later be entered into the computer at the time the first computer record is generated for that document (e.g. at the accessioning station). After the assignment and linkage of the PIN has been completed a PIN label is generated. The PIN may be either the call number and copy number of the item
or some numeric code which can be uniquely derived from the call number and copy number. If the handling of alphabetic characters by the PIN reader is not overly difficult, the call number could be used directly, otherwise some transliteration would be required.

There is a significant difference between PIN labelers and readers and the other equipments discussed in this section. There are no off-the-shelf PIN labelers and readers to survey. Existing keyboards, badge readers, displays, printers, unit document devices, machine readable media devices, and small computers can be surveyed by requesting information on existing devices and analyzing this information and comparing the devices. A request to manufacturers for information on PIN labelers and PIN readers would, of course, bring no response. Hence, PIN labelers and PIN readers must be analyzed in terms of devices designed for other purposes which may be adapted to meet the PIN requirements and in terms of techniques and technologies which may be used as a basis for developing PIN labelers and PIN readers. There are no PIN labelers and PIN readers at present. If devices developed for other purposes can be adapted to meet PIN requirements, the solution will be quicker and less expensive than if it becomes necessary to develop new devices for this purpose. Hence, the Task III trade-off analyses may indicate that the ideal or optimum PIN modules must be compromised to permit a solution that is timely, economic, and technically feasible.

The consideration of PIN labelers in this report is limited to the techniques and technologies that may be used to generate the PIN label and to read the PIN label. Consideration of the actual labeling device itself (i.e., the device that prints and dispenses the label, and the physical method of affixing the label) will be considered in Task III when the more appropriate technique or technology for PIN identification has been determined. Consideration of the physical characteristics of the label and the physical labeling device are heavily dependent upon the PIN identification and reading technique to be used.

3.2.2 Techniques or Technologies
The techniques and technologies that are suitable for adaptation to the PIN modules are also possible candidates for the badge reader and machine
readable unit document modules. Hence, approaches to the PIN problem are discussed here but the presently available equipments that embody these techniques and technologies are covered in Appendix B on Badge Readers and Appendix E on Machine Readable Unit Document Devices.

The technique chosen to implement the PIN must have the following characteristics:

1. human readable
2. machine readable
3. both alphabetic and numeric
4. readable when affixed to a book or soft covered item (e.g. magazine, single page, etc.)
5. readable by both a fixed and a portable device
6. printed from computer selected and generated data
7. either readable with poor alignment and registration or includes an automatic or easy manual alignment method
8. readable with high signal to noise ratio (e.g. when dirty)
9. long life

Reading speed and capacity are not significant requirements since only 10 to 12 characters are involved in the PIN.

The techniques and technologies that can be considered for meeting the requirements listed above include:

- Optical Character Recognition
- Magnetic Ink Character Recognition
- Optical Bar Codes
- Optical Circular Codes
- Magnetic Bar Codes
- Magnetic Circular Codes
- Other Optical Materials, e.g. reflective, fluorescent, etc.

A number of conventional techniques, such as those involving punched holes or embossed characters or bars, cannot be considered because of the requirement for affixing the label to the front of the book. Several other possible techniques, such as the magnetic recording strip now being placed on the back of credit cards, must be discarded because of the alignment and registration problem.
Of the techniques listed above, presently available equipment for optical character recognition and magnetic ink character recognition are discussed in Appendix E on Machine Readable Unit Document Devices. Presently available equipment for optical and magnetic bar codes and magnetic circular codes are discussed in Appendix B on badge readers. As far as can be determined, there are no equipments commercially available at this time for optical circular codes nor for other optical material such as fluorescent markings.

If character recognition techniques are used to permit direct machine reading of the Call Number, alphabetic as well as numeric capability will be required because of the use of alphabetic characters in a few positions of a conventional book call number. However, both optical character recognition and magnetic ink character recognition techniques are considered unsuitable for the PIN label, primarily because of alignment problems and secondarily because of the relative cost of the equipment required compared to other techniques described below—particularly if alphabetic characters are to be read. Another objection to magnetic ink character recognition is the highly stylized font required which makes human readability more difficult.

The techniques that are most suitable for the PIN problem are those which involve the simultaneous printing of human readable characters and a corresponding bar or circular code. A circular code consists of concentric circles each representing a coded character. The bar code approach has the advantage that each code can be printed above or below the human readable character and thus directly correlated with it. Hence, a bar code can be printed character by character by the same print mechanism that prints the human readable character. This character by character correlation is not possible if a circular code is used. The circular code on the other hand offers some advantage with respect to alignment and registration since registration must be made on only a single point—the center of the circle. Thus the book or label could be skewed in the reader in any way as long as this one point is registered. The bar code on the other hand would require a linear registration, but if a bar code is used which is reasonably large physically, the alignment and registration need not be extremely accurate.
Alignment and registration for a bar code could be accomplished on 2 points compared to the single point for a circular code.

The use of magnetic or optical retro-reflective material (see Appendix B) for the bar or circular code would improve the signal to noise ratio when the label is old or dirty. However, insufficient information is available about the life and wear of these materials under the type of use that will be incurred in the Library over a period of years. For example, the magnetic ink characters on bank checks are required to have only a short life span. The check is written and processing is usually completed within a period of a few days. It is uncertain how this magnetic ink technique would stand up after several years of the wear and tear involved in handling of books and putting them in and out of stacks. The use of printed bar or circular codes that can be scanned optically is believed to represent the best approach for the PIN labeler. If the label is damaged or becomes excessively dirty, it can be easily replaced by affixing a new label with the same number, either on top of the old label or after removing the old label.

3.2.3 Present State-of-the-Art

As pointed out in the preceding discussion, there is no present state-of-the-art for PIN labelers and PIN readers per se at this time. The present state-of-the-art for optical and magnetic ink character recognition is discussed in Section 3.8.3 under "Machine Readable Unit Document Generator and Reader". The present state-of-the-art for bar codes and circular codes is also covered to some extent in Section 3.8.3 and in Section 3.5.3 under "badge readers". There is of course a considerable state-of-the-art at present in labels and labeling machines--i.e., the equipment for actually fabricating the labeling. However, the consideration of the label and the device that actually fabricates and dispenses the label is being postponed to Task III because of the possible effect that the selection of a particular PIN technology will have on the physical characteristics of the label and labeling device.

3.2.4 Problem Areas

The major problem areas for PIN labelers and readers are:
the alignment and registration problem;
the signal-to-noise problem that may be caused by dirt and wear;
the requirement for reading the label when it is affixed to a book
or soft covered item rather than as a separate slip of paper;
the requirement for a hand-held portable PIN reader.

The requirement that the label be both human readable and machine readable
is not considered a problem since it is permissible to have two types of
printed information on the same label—the human readable PIN number
and a coded machine readable version of that number. The alignment
and registration problem is relatively easy to handle if manual positioning of
the document or the read head is permitted. This problem is further mitigated
if a bar code or circular code is used and the coded characters are made
relatively large—e.g. 3/8" to 1/2" in height for a bar code or 3/4" to 1"
in diameter for a circular code. The signal-to-noise problem is not
considered a serious one because in the worst case the PIN label can be
replaced if it becomes damaged or excessively dirty. The requirement for
reading the label when it is affixed to a thick book is not technically difficult
but is a serious problem at present because the available equipment is almost
universally designed to handle a slip of paper, card stock, or a plastic card
(e.g., credit card). The requirement for a hand-held portable reader is a
serious one at present because there is no known equipment of this type
available—probably because of the lack of demand or application for such
a device. However, several companies are known to be working on portable
hand-held readers for bar codes and circular codes. Future commercial
needs for devices of this type are seen in applications such as inventory
control, warehousing, shipping, grocery and retail store check-out, etc.

3.2.5 Projected State-of-the-Art for 1970 and 1972
Although it is technologically feasible, there are no known developments
underway that will provide a portable PIN reader nor a fixed station reader
capable of reading a PIN affixed to a thick book during 1970. However, at
least two companies are known to be working on hand-held portable devices
for reading bar or circular codes (one is optical and one is magnetic) that
may lead to available equipment by the end of 1972. Unfortunately, one of
the companies insisted that nothing be written about their device in this report, although we have permission to discuss it verbally with Library of Congress personnel. Hence, both of the devices that offer promise for a possible solution to the PIN problem by the end of 1972 will be discussed verbally with Library of Congress personnel. The solution to the PIN problem is considered technically feasible within the next two years. Whether equipment actually becomes available within that time span is a function of industry's view of commercial demand and marketability and of funding, either within a company or from external sources such as the Library of Congress.
3.3 Keyboards and Keyboard/Printers

3.3.1 General

The functional requirements and performance specifications call for keyboards in most of the terminal stations for the manual entry of catalog and other data. Delete, shift, space, backspace, carriage return, shift-lock, shift-release, tab, and interlock features are required. The ability to enter 176 characters from a keyboard is required for the extended Roman alphabet. This section discusses keyboards and keyboard/printers for the extended Roman alphabet and non-Roman alphabets. The input equipment requirements for oriental languages are discussed separately in Section 3.11.2 and entry devices for special symbols are discussed separately in Section 3.4.

The keyboards are used to permit input of data by operators in most categories of terminal stations as itemized in the Task I report. Since there are over 100 companies in this country that make different types of keyboards, the discussion here and in Appendix A is limited to the technologies involved in the major types of keyboards rather than attempting to discuss 100 individual keyboard devices. The highest volume production of keyboards in this country today are those which are directly associated with a serial character printer. Examples of this are electric typewriters and Teletype machines. Hence, Appendix A discusses different types of keyboards and compares the characteristics of presently available keyboard/printers.

Some of the companies that make complete keyboard/printers offer the keyboard as an item that can be purchased separately. Many of the smaller companies making keyboard/printers buy the keyboard as a unit from one company and the printing mechanism from another company and then assemble them to make the complete keyboard/printer. Keyboards are also purchased as separate items by many of the companies that make cathode-ray tube terminals where the keyboard is used for the manual entry of data and the CRT for visual display of data for the operator.

One important consideration for the Library of Congress application is whether the keyboard is fabricated as a complete assembly by the manufacturer or whether the keyboard can be purchased as individual key devices which are then assembled into the keyboard. Some of the techniques, particularly electromechanical ones, that are used to make complete keyboard assemblies
are very difficult to modularize or vary in terms of the number or placement of the keys. On the other hand, those types of keyboard devices which are sold by the manufacturer as individual key devices for assembly into complete keyboards permit great flexibility in the physical arrangement of the keyboard and in the number of keys involved.

3.3.2 Techniques or Technologies

Keyboard technologies are discussed here in terms of the way in which the characters are generated by the keyboard and linked to the printing mechanism or encoded for transmission to other part of the system. The major keyboard technologies are:

- Mechanical
- Electro-mechanical (switch or relay closures)
- Photo-electric (optical)
- Magnetic/electronic
- Fluidic (pneumatic)

Since the terminals for the central bibliographic system interface with either a controller or directly with a central computer, it is desirable that the keyboards be physically decoupled from the printer mechanism to permit full-duplex operation. Full-duplex operation means that when the key is depressed by the operator it does not directly activate the printer or CRT, but rather the character is transmitted to the controller or computer and then back to the printer or CRT. Full-duplex operation assures that the printed or displayed character is the same one received by the computer. In half-duplex operation the key depression activates the printer or CRT directly with a consequent possibility of the operator visually verifying the character which he thinks has been entered into the computer, whereas the computer has actually received a different character. For this reason, strictly mechanical keyboards are not considered suitable for implementing terminal modules.

Electro-mechanical keyboards are the most widely used at present. This is the type of keyboard used in most electric typewriters and Teletype equipment. In an electro-mechanical keyboard the key depression causes contact closures in a switch or relay. This may be either a single contact closure which activates the line to a particular logic network that generates the coded character, or it may be several contact closures which generate the coded character directly. The former requires logical circuitry for
encoding while the latter requires more contact closures. Electro-mechanical keyboards of this type permit full-duplex operation, but they are usually noisy and less reliable than some of the other techniques such as optical and magnetic ones. If the noise is within reasonable limits it may be an advantage rather than a disadvantage, because operators who are accustomed to typewriters or similar devices expect to hear some sound that indicates that the key has been activated. Completely quiet keyboards have been found to be very distracting to operators.

In photo-electric or optical keyboards the depression of the key interrupts a particular combination of several light paths. There may be a single light source but a separate photo cell for each light path. The key depression blocks a set of light paths corresponding to the particular character represented by the key. Hence, the photo cells pick up the coded character. For example, when using a seven-level code the output of 7 photo-detectors would be the coded representation of a character corresponding to the key depressed. This type of keyboard involves a minimum of moving parts and a minimum of encoding electronics. The only sources of failure are the light source and the 7 photo-detectors.

Magnetic/electronic keyboards are a relatively recent development in which a depression of the key changes the magnetic field around another element. In one such device a magnetic shunt containing two barium-ferite filled PVC magnets is attached to the switch plunger. Depressing the key causes this magnetic element to move over a solid-state Hall effect circuit. The depression of the key causes the magnetic field through the Hall element to increase thus raising the voltage to a level that operates the circuit. A trigger circuit then provides a signal which is amplified and sent to the encoding circuitry for the code generation. Another device uses capacitive effects.

Of the keyboard types discussed above, the magnetic/electronic keyboard and one form of electro-mechanical keyboards are most suitable for the Library of Congress terminal application because of their flexibility. The particular type of electro-mechanical keyboard that is attractive is one in which each key is completely self-contained, including the top cap, the housing, the plunger or stem, and the electrical contact or relay. This type of modular key assembly may either encode the character directly
within the key assembly or may provide a single output signal which is sent to an encoding matrix.

The advantage of these two types of keyboards is that they can be assembled as individual key modules in any desired configuration or number of keys. This flexibility and expandability is essential to provide the capability for the 176 character extended Roman alphabet and to facilitate handling a subset of extended Roman alphabet plus character sets for other languages. A modular keyboard arrangement of this type with an adequate number of shift keys can meet all of the keyboard requirements using commercially available key elements but arranged in a different configuration than commercially available keyboard assemblies. For example a 4 x 17 keyboard key array with 3 shift levels would provide a 204 character capability or a 4 x 13 key array with 4 shift levels would provide a 208 character set. This would permit handling the extended Roman character set. For combined character sets using a subset of the extended Roman character set in conjunction with the character set for another language, additional shift levels may be required. The 44 key plus 4 shift level MARC keyboard could be implemented easily.

**Character Serial Printers**

Character serial printers are used in combination with different types of keyboards to make conventional keyboard/printer terminals. The type of printer mechanism used for this purpose is one in which characters are printed serially across a line in contrast to the line printer operation in which all of the characters in one line are printed during one rotation of the print drum. The character serial printer used with keyboards is an incremental printer in which a single character is printed for each depression of the key. The character serial printer can also print characters individually upon receipt of character codes from the computer or controller as well as from the keyboard. Hence, the character serial printer can operate in a full-duplex mode with the keyboard or can operate directly from a computer or controller without a keyboard.

Four major techniques are currently in use for character serial printers:

- Impact printers
- Electrostatic printers
- Thermal printers
- Ink spray printers
The print mechanisms in keyboard/printers are discussed in greater detail along with other types of printers in Section 3.7 on Hard Copy Devices and in Appendices A and D.

### 3.3.3 Present State-of-the-Art

Keyboards are highly developed but new and improved technologies are still being developed as evidenced by the magnetic and electrostatic keyboards discussed previously. Typical characteristics for the major types of keyboards available today are compared below:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mechanical (i.e. typewriter)</th>
<th>Elect-Mech. (i.e. Reed)</th>
<th>Solid-State (i.e. HallEffect)</th>
<th>Optical (PhotoElectric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Immunity</td>
<td>Not applicable</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Expandability</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Reliability</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Maintainability</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

Conventional keyboards range from 50 to 96 character keys but special keyboard configurations with a larger number of keys can now be made relatively easily with some of the new modular keys in which each key is a self-contained assembly including the top caps, the plunger, the contact or magnetic/electronic elements, and the encoder. With modular keys of this type the full extended Roman alphabet, or a subset of the extended Roman alphabet plus the character set of another language, can be implemented in several ways. For example four rows of 17 keys plus three shift levels or four rows of 13 keys with four shift levels could be used to generate over 200 character types, or the 44 key 4 level MARC keyboard could be implemented.

### 3.3.4 Problem Areas

There are no significant technical problems in implementing the keyboard requirements for the Library of Congress Central Bibliographic System. The only significant problem is that there are no standard commercially available keyboards that exactly meet the Library's requirements. However, the modular keyboards of the type discussed above permit configuring keyboard assemblies to meet the Library's needs with relative ease.
3.3.5 Projected State-of-the-Art for 1970 and 1972

Improvements in the state-of-the-art for keyboards are anticipated by 1972, but none of these are expected to be of major significance. One advance expected in state-of-the-art for keyboard capabilities is the use of MOS circuitry to provide complete encoding flexibility. This technique makes a four mode (4 way shift) operation easier, which would facilitate the 176 character set required by the Library. Expanded use of modular key assemblies is anticipated which should lead to cost reductions in special keyboards of this type.
3.4 Entry Devices for Special Symbols

3.4.1 General

In the Task I report, Appendix A on "Languages and Character Sets" defines "special symbols" as all those alphabets and character sets for which encoding by keyboard devices is considered for one reason or another to be impractical. This includes the following:

a. Non-Roman keyable alphabets which are of relatively infrequent occurrence amongst Library of Congress acquisitions.

b. Archaic writing systems in which, presumably, nobody is currently publishing but for which materials may conceivably turn up and require cataloging.

c. Idiosyncratic productions of authors who sometimes produce books with titles such as an ampersand or a pointing finger (a very small percentage of the materials acquired by the Library of Congress).

The keyboard devices discussed in Section 3.3 of this report are applicable to the non-Roman keyable alphabets of infrequent occurrence, but if their occurrence is sufficiently infrequent it may not be practical to provide separate keyboards for all such languages. The types of character sets listed above present the same problem -- the need for inputting any arbitrary symbol configuration that can be drawn. These arbitrary symbols have one important point in common with the oriental languages with respect to the Library catalog card -- they are not used for machine searching or automatic identification of the bibliographic material. The material is identified and searches are made on a transliterated Romanized title. Hence, in the record stored in the computer the symbols that make up the title for such material may be represented by a stored digital image, or by an index identification number that would provide a reference to some other media (e.g., microfilm) where the symbols and possibly complete catalog cards are stored in image form.

3.4.2 Techniques or Technologies

If any arbitrary symbol configuration is to be permitted, the only methods of input that can be considered are ones which permit hand drawing of the symbol by the terminal user. The technique or technology used must provide
some form of digital encoding of the hand drawing. Several approaches can accomplish this including:

- A light pen with a CRT display
- A RAND tablet
- A ball or joy stick cursor with a CRT
- Optical or photo-electric scanning and encoding
- Curve followers - manual or automatic

With any of these techniques, the symbol can be considered as being overlayed on a dot matrix where the coordinates of the points on the matrix intersected by the symbol are used to encode it. Hence, the encoding is a description of the symbol which would permit it to be redrawn, but it is not a dense code nor one which would permit easy machine identification of the symbol.

A light pen is a device used with cathode-ray-tube display terminals which permit the user to identify positions on the face of the tube or draw lines by moving the pen across the face of the tube. As the electron beam passes the point on the face of the cathode-ray-tube on which the light pen is placed the beam is capacitively coupled into the light pen and a signal is sent to the computer or controller driving the display to identify the particular point. A line or symbol drawn by a light pen consists of a stored sequence of such identified points.

A RAND tablet consists of a matrix of X and Y lines embedded in a large print circuit card or plastic sheet where each line corresponds to a particular code. As the stylus is moved across the tablet the codes for the X and Y lines over which it passes are picked up capacitively and transmitted to the computer where they are stored to form a description of the path followed by the stylus and, hence, of the shape of the character.

Ball and joy stick cursors are standard techniques for permitting an operator to identify points or draw lines on a CRT display. As the operator moves the ball or joy stick, its position is converted to a digital code which causes the electron beam to be positioned at the corresponding location on the face of the tube. A sequence of these digital codes can be stored in the computer or controller to provide a description of the symbol.
With an optical or photo-electric scan technique a hand drawn symbol can be scanned and a digital code generated each time the scan intersects a line of the symbol. A stored sequence of such point identifications provides a stored description of the symbol. In a somewhat different photo-electric approach a digitizer or curve follower can be made to follow the lines of the symbol generating a coded description. This can run into ambiguities for symbols which consist of several non-contiguous lines.

It is important to note that all these techniques permit entering and storing a digital image of the symbol, but they require a relatively large amount of storage and do not produce high quality images. These disadvantages are discussed also in connection with the oriental languages in Section 3.11. The microfilm approach for oriental languages discussed in Section 3.11.6 represents a possibly attractive approach for handling special symbols. The special symbols could be identified in the computer record by means of an index number which references the microfilm file. Either the complete catalog card or the special symbols making up the title could be stored in the microfilm file and reproduced from there. This permits a significant advantage in terms of the reproduction quality. If a digital image is stored in the computer using any of the techniques discussed above, the quality of the catalog card generated on request would be significantly poorer than that which could be achieved from a microfilm record.

Another possibility for handling these special symbols, if the occurrences are sufficiently infrequent and they represent a sufficiently small percentage of the total bibliographic material handled by the Library, is to continue using the present manual techniques.

3.4.3 Present State-of-the Art

Present state-of-the-art cannot be considered in a meaningful way until further trade-off analyses in Task III indicate the preferred approach for handling special symbols. Light pens, RAND tablets, cursors, curve followers and photo-electric scanners are all available today. The feasibility of using any of these devices is also heavily dependent upon the other characteristics of the terminal in which they are used. For example, a light pen could not be used without a cathode-ray-tube display.
3.4.4 Problem Areas
The problems encountered for special symbols are significant. They include:

- An almost unlimited number of possible symbol configurations
- Slow speed and poor quality for hand drawn symbols
- Appreciable computer storage required to store a digital image of the symbol
- Requirement for a plotter, CRT, or other special device to recreate the stored image from computer output
- Poor print quality of output generated from computer stored digital image.

Problems cited above appear to favor a microfilm system or manual handling of special symbols, but this will be considered in greater detail in the trade-off analysis in Task III.

3.4.5 Projected State-of-the Art for 1970 and 1972
The state-of-the-art for entry of special symbols cannot be projected into the future until the trade-off analyses in Task III indicate the method which should be used for handling special symbols.
3.5 **Badge Readers**

3.5.1 General

A badge reader, an identification card reader, or some similar device is required to control access to and use of certain types of terminals, such as some processing and cataloging terminal and circulation control terminals. The use of the badge reader permits the use of terminals by authorized persons and/or provides an automatic identification of attendants, users, and borrowers. Each expected user of a certain type of terminal will be provided with a badge, a card, or a key-like device which can be inserted into the reader in the terminal. The reader will then permit access, when such access is requested, if the identification code of the user is authorized for that terminal. The reader can automatically insert the user's identification in any messages sent to the central processor. The badge reader uses numeric characters only.

Some of the techniques used in badge preparation and badge reading devices may also be applicable to the PIN Labeler and PIN Reader requirement discussed in Section 3.2. However, none of the presently available badge preparation and badge reader devices are directly applicable to the PIN problem.

3.5.2 Techniques or Technology

Techniques in use and under development for badge readers and other identification devices include large or small round or rectangular punched holes, several magnetic techniques, optical coding, machine readable embossing,
3.4.4 Problem Areas
The problems encountered for special symbols are significant. They include:

- An almost unlimited number of possible symbol configurations
- Slow speed and poor quality for hand drawn symbols
- Appreciable computer storage required to store a digital image of the symbol
- Requirement for a plotter, CRT, or other special device to recreate the stored image from computer output
- Poor print quality of output generated from computer stored digital image.

Problems cited above appear to favor a microfilm system or manual handling of special symbols, but this will be considered in greater detail in the trade-off analysis in Task III.

3.4.5 Projected State-of-the Art for 1970 and 1972
The state-of-the-art for entry of special symbols cannot be projected into the future until the trade-off analyses in Task III indicate the method which should be used for handling special symbols.
3.5 Badge Readers
3.5.1 General
A badge reader, an identification card reader, or some similar device is required to control access to and use of certain types of terminals, such as some processing and cataloging terminal and circulation control terminals. The use of the badge reader permits the use of terminals by authorized persons and/or provides an automatic identification of attendants, users, and borrowers. Each expected user of a certain type of terminal will be provided with a badge, a card, or a key-like device which can be inserted into the reader in the terminal. The reader will then permit access, when such access is requested, if the identification code of the user is authorized for that terminal. The reader can automatically insert the user's identification in any messages sent to the central processor. The badge reader uses numeric characters only.

Some of the techniques used in badge preparation and badge reading devices may also be applicable to the PIN Labeler and PIN Reader requirement discussed in Section 3.2. However, none of the presently available badge preparation and badge reader devices are directly applicable to the PIN problem.

3.5.2 Techniques or Technology
Techniques in use and under development for badge readers and other identification devices include large or small round or rectangular punched holes, several magnetic techniques, optical coding, machine readable embossing,
printed optical codes, and key-like devices. A wide range of materials are used. Cards are made of paper, polyvinyl chloride mylar, and other types of durable plastics.

The oldest encoding technique used is punched holes with the conventional Hollerith code using rectangular holes being the most common. Large round holes are also used widely in industrial and outdoor applications because of the wider tolerances they permit. Another device uses small round holes. Recently, several types of magnetic encoding techniques have been developed which offer advantages of higher character packing density and greater difficulty in copying. Printed optical code patterns are also used with a significant advantage in the ease of preparation. Machine readable embossing is widely used, largely because of the low preparation cost and the ability to use the embossed card as a printing device in applications such as gasoline station credit cards. Other techniques include a notched key which offers low preparation and reading cost and the use of a key type device which includes an integrated circuit to provide a binary encoding scheme. Circular tracks are used in some optical devices and in some magnetic devices because of the greater ease of registering on a single spot in the center of the card.

3.5.3 Present State-of-the-Art
Badge preparation devices, badge readers, and other identification devices that are commercially available at present are discussed and summarized in Appendix B. The maximum number of characters that can be encoded on one badge or card varies from 6 for key like units to 75 for magnetic stripe units. The size of the character set ranges from straight numeric to full ASCII. Typically, card sizes are similar to the standard 2-1/8 x 3-3/8 inch credit card.

The Air Transport Association has adopted the IATA magnetic stripe technique as an interim standard with ability to record 75 8-bit characters at a density of 210 bits per inch in 2.7 inches. One manufacturer uses a
different recording technique based on the use of a four track magnetic stripe and lower character packing density to improve reading reliability, while another uses magnetic materials in grooves where only the presence or absence of the magnetic material is sensed.

One company uses an optical code pattern made up of four types of bars which permits recording 61 characters in a 3 inch space. In punched Hollerith code and similar techniques, 22 characters can be punched on a standard 2-1/2 by 3-3/8 inch credit card type plastic card. Other punched card approaches permit from 12 to 24 characters.

A system using circular magnetic tracks permit 40 characters to be recorded. This particular system uses a single hole in the center for registering the reader and records circular tracks on a magnetic media where the tracks are accurately registered to that hole. One hand-held optical reader under development also uses circular tracks recorded optically and registered on a center hole.

3.5.4. Problem Areas
No significant problem areas are foreseen in the use of any one of several currently available badge techniques for identifying terminal users in the Central Bibliographic System.

3.5.5 Projected State-of-the-Art for 1970 and 1972
The state-of-the-art in badge readers in 1970 is expected to be the same as that discussed in Section 3.2.3 and as indicated in the comparison of presently available devices in Appendix B. By 1972, magnetic encoding techniques are expected to dominate for most applications because of the wide impetus given this technology by credit card applications. Both magnetic stripe and circular magnetic track techniques appear to be gaining in favor. The ability of the magnetic stripe and circular magnetic track techniques to provide a relatively large number of characters may be of importance in Library applications because of the ability to enter more than a simple identification number from the card.

32
If only a simple identification number is required, consideration could be given to entering this from the keyboard, thus eliminating the need for a badge reader but increasing the chance of errors.
3.6 Alphanumeric and Symbol Displays

3.6.1 General

The requirements analysis in Task I indicated the need for visual display devices in a number of types of terminal stations (e.g., cataloging, accessing, reference, etc.) to permit the user to view data being entered and data stored in the computer, to edit and rearrange messages, and to verify messages which have been modified before their transmission to the central computer. The visual displays must handle extended Roman, selected non-Roman, and selected oriental language and special symbol character sets. Display devices for oriental languages are discussed in Section 3.11.3. Those techniques are also applicable to special symbols. This section discusses visual displays for Roman and non-Roman alphabet languages.

A few simple devices, such as TV monitors, are available as display only devices, but most of the CRT displays offered on the market for viewing data to be entered into a computer, or data retrieved from the computer or a central storage system, are offered as complete terminals including a keyboard, buffer storage, control logic, character generation circuitry, communications interfaces, and in some cases a hard copy device. Hence, the CRT display terminals for displaying alphanumeric and symbol data discussed in Appendix C are complete terminals -- not a display module alone.

For purposes of this study, the buffer storage, control logic, character generation circuitry, and communications interface can be considered part of the visual display module, although some of these functions may reside in a controller which is shared by a number of display modules in different terminal stations. Keyboard and hard copy devices are considered as different modules and discussed in Subsection 3.3 and 3.7, respectively. However, in comparing presently available equipment, the keyboard is included with the available CRT display terminals compared in Appendix C.

Logic and control functions frequently offered with commercially available alphanumeric CRT display terminals include formatting, editing, selective erasure and insertion of characters and words, entry of preprogrammed data or messages, and cursor or point-of-type indicators which indicate the position at which the next character will be entered.
3.6.2 Techniques or Technologies

Cathode-ray-tube technology completely dominates the alphanumeric display field at this time and will continue to do so for the foreseeable future. A number of new display technologies are in various stages of research and development including the following:

- Crossed-grid electroluminescent matrix displays
- Magneto-optic displays
- Plasma panel displays
- Laser displays
- Injection electroluminescence or light emitting diode displays

None of these are expected to have an impact on the market for small screen (single operator size) alphanumeric display terminals within the time frame covered by this study. Of the new display technologies listed above, magneto-optic, plasma panel, and injection electroluminescence diode technologies are most likely to provide commercially feasible alphanumeric displays in the future. However, it is extremely unlikely that any of these will be used in commercially available alphanumeric display terminals until after 1972 -- probably closer to 1975. Some of the new display technologies offer promise for characteristics which are superior to those of conventional CRT displays, but even when their feasibility and reliability are proven, it will be a number of years before their cost is competitive with that of CRT displays. These new display technologies will probably find their earliest application in military systems where cost is a secondary consideration to factors such as size, power, reliability, ruggedness, and so forth. Hence, within the time frame and scope covered by this study, CRT display terminals are the only ones that can realistically be considered for terminals requiring the display of more than 50 to 100 characters on the screen.

The most common and widely used type of CRT terminal uses a conventional cathode-ray-tube in which the image must be scanned forty to sixty times per second to refresh the phosphor to avoid noticeable flicker to the user. This refresh requirement necessitates the use of some type of storage device to store the alphanumeric and symbol
information displayed on the screen so that it can be repeatedly scanned to refresh the image on the screen. In some cases the image is refreshed from the computer's main internal storage, but this is an excessive load on the computer's input/output capabilities and is completely impractical for remote terminals because of the transmission speeds that can be achieved over conventional telephone lines.

Hence, in most CRT display terminals and particularly those used in a remote mode, some type of buffer storage must be provided in the terminal itself to permit refreshing the image on the screen. Magnetic core and magnetostrictive delay line memories have been widely used for this buffer storage function in the past. Several new display terminals are now using MOS (metal-oxide-semiconductor) storage for refreshing the screen. This is particularly advantageous in display terminals with smaller screen capacities (e.g., a few hundred characters) since magnetic core storage becomes increasingly uneconomic for smaller numbers of characters. MOS buffer storage is expected to play an increasingly significant role in CRT display terminals in the future.

In addition to the essential but rather mundane function of refreshing the image on the screen forty to sixty times per second, the buffer storage in the terminal plays several other important roles in most alphanumeric CRT display terminals. One of these is the storage of a complete message as it is being entered by the user to permit transmitting it to the computer as a complete message rather than on a character by character basis as it is entered. This facilitates communication with the computer and provides the entire message to the computer at one time. More importantly, it permits the user to visually verify the message and make any corrections prior to the transmission of the message to the computer. Another important function provided by the buffer storage in remote terminals is in making possible the selective editing and changing of characters and words in a message that has been entered by the user or that has been transmitted from the computer and displayed to the user. When a message is retrieved from the computer's central storage system which the user wishes to edit or rearrange, the use of the buffer storage permits the message to be
edited on a purely local basis, and then sent back to the computer or central storage system. Only a single transmission of the message from the computer is required.

The use of some type of storage tube is an alternative to the use of the conventional CRT which eliminates the need for the buffer storage from the standpoint of refreshing the image on the screen. Several types of storage cathode-ray-tubes are available which permit the storage of the image within the tube itself thus eliminating the need for externally refreshing the image in the phosphor on the face plate of the tube. The use of a storage tube in remote display terminals permits the displayed information to be transmitted from the computer at rates that can be handled by a conventional telephone line without the requirement for buffer storage in the terminal itself. However, as buffer storage costs continue to drop as a result of improvements in memory technology, the potential economic advantage of the storage tube becomes less. Storage tube displays available today do not offer the ability to selectively erase individual characters or words. Most of these require the erasure of the complete screen. Hence, if the user wishes to change something in a message, it is necessary to send the change to the computer, erase the entire screen, and then have the computer rewrite the message on the screen including the change. This problem makes the use of a storage tube unattractive for applications, such as cataloging stations in the Library of Congress Central Bibliographic System, which involve extensive editing. Storage tube terminals may be more advantageous in graphic applications which are more complex and which involve different requirements for changing displayed information than is the case for straight alphanumeric and symbol terminals. Storage tube terminals may also be attractive for alphanumeric terminals which involve only the displaying of data retrieved from the computer without the need for changing or editing that data.

Another difference found among CRT terminals offered by different manufacturers is the technique used for generating the image or displayed characters from the coded characters received from the computer. The character
generation techniques currently in use include:

- Dot matrix
- Stroke
- Monoscope
- Charactron tube

Each of these character generation techniques has its own advantages and disadvantages and it is difficult to generalize in the sense of saying that one is better than another. The dot matrix approach is the most widely used, but some manufacturers have valid reasons for offering different types of character generation techniques related to their specified equipments. Since the dot matrix approach is the most common, it is used as a basis for discussions in subsequent parts of this section dealing with the problem of the large character set requirement in the Library of Congress applications. However, if other manufacturers prefer to meet these requirements by using other character generation techniques, there should be no objection to this.

In the dot matrix character generation approach a 5 x 7 dot matrix is the most commonly used for the 64 characters in the most commonly used character sets offered today. Many manufacturers are moving toward the use of a 96 character set as an optional capability which will require at least a 6 x 8 and probably a 7 x 9 matrix for satisfactory character legibility with the larger character set. The 176 character set required for the Library of Congress application will necessitate the use of a 9 x 11 matrix or the equivalent using one or the other character generation techniques.

3.6.3 Present State-of-the-Art

Many alphanumeric CRT display terminals are available today offering 64 character sets. A few are available which offer 96 character sets. The presently available CRT display terminals of the type required for the Library of Congress application (except for the size of the character set) are discussed and compared in Appendix C. Typical characteristics for alphanumeric CRT terminals available are shown below:

<table>
<thead>
<tr>
<th>Number of Displayable Characters</th>
<th>500 - 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Character Set Size</td>
<td>64 - 96</td>
</tr>
<tr>
<td>Lines per Screen</td>
<td>15 - 30</td>
</tr>
</tbody>
</table>
Characters per Line | 40 - 80
Cursor Controls | 3 - 8
Number of Character Positions | 1000 - 4000

**Stand-Alone Terminal**

| Price | $4K - $15K
| Monthly Lease | $88 - $380

**Multi-Station/Terminal**

| Price (average per terminal) | $3.5K - $6K
| Monthly Lease | $83 - $200

**Typical Range of Characteristics for Alphanumeric CRT Terminals**

The wide price range of $4,000 to $15,000 results from the wide variation in characteristics that are available. The price is heavily influenced by the number of characters displayed on the screen, the editing and formatting features offered, and the quality and legibility of the image. The price for each individual display terminal is also affected significantly by whether the terminal operates in a completely stand-alone mode or whether it is one terminal in a multi-terminal system in which much of the storage and logic required for such terminal is centralized in a central station which operates with and controls several terminals. A number of CRT terminal manufacturers offer both stand-alone and multi-station versions of their terminals. If a controller is used for several terminal stations in the Library of Congress application, the CRT display portion of these terminals will be operated in a manner similar to that for multi-station CRT terminal systems.

**3.6.4 Problem Areas**

The only significant technical problem in implementing the requirements for alphanumeric and symbol displays in the Library of Congress Central Bibliographic System is that of generating a large character set or a large number of special symbols. The number of characters to be displayed on a screen at one time, the formatting capabilities, and the editing capabilities required are all readily available in commercial CRT
terminals. However, no commercially available CRT terminal offers a character set greater than 96 characters and most are limited to 64 characters. The 176 character set required for the extended Roman alphabet, or for characters of other languages plus a subset of the extended Roman alphabet will require significantly larger size matrices for dot matrix character generation or corresponding changes in other character generation techniques. In this regard, it is important to note that the differences required in the terminal to handle a larger dot matrix are much greater than a mere change in the character generator itself. If the number of characters to be displayed on the screen at one time is held constant, a 9 x 11 dot matrix would require almost three times as many dot positions on the screen as a 5 x 7 dot matrix. This is reflected in requirements for greater resolution, faster sweep times with correspondingly more expensive deflection amplifiers, and faster blanking and unblanking rates and consequently more expensive blanking circuits. These factors will be reflected in higher costs for the terminal even on a production basis. This plus the fact that such a terminal would be a non-standard, hence requiring development engineering, and the fact that these would be produced in smaller quantities than a manufacturer's standard product line will result in significantly higher costs for CRT alphanumeric display terminals for use in the Central Bibliographic System.

3.6.5 Projected State-of-the-Art for 1970 and 1972
The state-of-the-art in alphanumeric CRT display terminals in 1970 is expected to be essentially the same as that for the more advanced terminals today shown in the comparisons in Appendix C. Cost improvements in the order of one-fourth to one-third are anticipated by 1972. Most of the CRT terminal characteristics that will be available in 1972 are available in some terminals today, but the major change by 1972 will be availability of given characteristics and a given performance at a lower cost. None of the new display technologies are expected to have a significant impact nor to replace CRT terminals for small screen alphanumeric applications by 1972. However, the use of MOS techniques for buffer storage in terminals will be widespread by that time. Character sets of 96 characters will be readily available by 1972, but it is unlikely that a 176 character set will be commercially available.
3.7 Hard Copy Devices (Printers)

3.7.1 General

Printers are required for preparing hard copy of catalog and other data in almost all of the terminal categories. The format and positioning of the hard copy must be controlled by the operator, the terminal station or controller, and the central computer. Speed requirements for printers in terminal stations are limited by the rate at which the operator can use the data and by telephone line transmission speeds. Typical printer speeds required are in the 10 to 40 characters per second range; hence, character serial printers, which can be obtained at lower cost, will suffice in most cases.

The printers must handle Roman, extended Roman, selected non-Roman, and selected oriental language and special symbol character sets. Printers for oriental languages are discussed in section 3.11.4. Those techniques are also applicable to special symbols. This section discusses printers for Roman and non-Roman alphabet languages.

One of the terminal modules identified in the Task I analysis was called a marking device which prints numeric only information in a single column. In the survey of the state-of-the-art printer technology this marking device is considered a printer since the requirement can be met by most of the equipments surveyed in the printer category. However, a simpler device may be used - e.g., a one character print wheel.

3.7.2 Techniques and Technologies

Remote printers can be considered in two categories -- character serial printers and line printers. Character serial printers, which are also discussed in Section 3.3 under "Keyboard/Printers," print characters serially across a line one at a time. In the operation of a drum printer all of the characters in one line are printed during one rotation of the print drum. Printer techniques such as bar printers, chain printers, electrostatic, and others not classified as character serial printers are included in the general category of line printers. Character serial printers are well suited to most terminal applications where data is entered at a relatively slow rate by keyboard and data is received from the computer over a telephone line. Four major techniques presently in use for character serial printers are impact, electrostatic, thermal, and ink spray. Impact printers are those in which a print hammer or ball forces the ribbon into the paper to generate the
character imprint. Because of the mechanical impact involved, this type of print can easily produce carbon copies. However, the speed and reliability are limited by the electromechanical movement and the noise level is usually quite high. This is the lowest cost type of serial character printer available. Electrostatic printers and thermal printers generate characters by using a dot matrix format. In an electrostatic printer a dot matrix (5 x 7 matrix) is energized in the proper combination for the particular character and the electrical signals on the energized wires in the matrix transfer the character image to the sensitized paper. Thermal printers work in a similar manner except that the dot matrix in the print head is thermal rather than electrical. The combination of heating elements in the matrix transfers the character image to a heat sensitive paper.

Ink spray printers direct a fine spray of fast drying ink toward the paper and deflect the ink spray electrostatically to generate the characters. In one ink jet printer the ink jet is deflected electrostatically to actually draw the characters as the ink nozzle is moved horizontally across the paper in a manner similar to drawing characters of an electron beam on the face of a cathode-ray-tube. Another type of ink spray printer uses a dot matrix.

Impact printers have the advantage of providing multiple copies through the use of carbons but are usually slower and less reliable than the other types because of the mechanical motions and parts involved. Electrostatic printers and thermal printers provide higher speeds and higher reliability because of fewer moving parts, but they usually cannot print multiple copies and they require special sensitized paper. Ink jet printers have the same advantages and disadvantages as electrostatic and thermal printers except that they do not require a special treated paper. However, at present, ink jet printers are more expensive than electrostatic or thermal printers.

Line printers, which are both faster and more expensive than character serial printers, are of two major types -- drum printers and chain printers. In a drum printer the print font for each column to be printed is placed around the circumference of the continuously rotating drum. The ink ribbon and paper, which are interposed between the hammers and the print drum,
are impacted by the hammers for each column at the proper time to imprint the particular character called for. The selection of the character to be printed is by the timing of the firing of the hammer at the proper point in the rotation of the drum.

In chain printers, the entire character set is placed longitudinally on a chain which rotates past the hammers parallel to the print line. This is in contrast to the drum printer which rotates perpendicular to the print line. Hence, in the chain printers a separate character set is not required for each column to be printed but multiple character sets are usually used to increase the printing speed. Again the selection of the character to be printed is by means of the timing of the firing of the hammers in each print position to coincide with the desired character passing under that hammer. In general, chain printers have larger character sets but are slower than drum printers.

It is easier to expand or change the character set on a chain printer by increasing or modifying the characters affixed to the chain. Since the character set is usually repeated several times around the chain for higher speed, a larger character set can be achieved at a slower speed. It is more difficult to change the character set on a drum printer since this would require fabricating a new drum and a larger character set would require a larger diameter drum and possibly a major redesign of the printer.
3.7.3 Present State-of-the-Art

Electromechanical character serial and line printers have been in use for many years and are highly developed. Non-impact printers are a relatively recent development, but have been perfected to a commercially feasible state. Impact techniques are more widely used at present in character serial printers. Because of the ready availability of copying machines, the requirement for multiple copies is less important now than in the past. Presently available remote printers are discussed and compared in Appendix D. The characteristics of presently available keyboard printer terminals which utilize character serial printers are presented in Table A-1 in Appendix A.

Typical characteristics available for the four different types of character serial printers are shown below:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Impact</th>
<th>Electrostatic</th>
<th>Thermal</th>
<th>Ink Jet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print Quality</td>
<td>Excellent</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>Special Paper Required</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Speed-Char/Sec</td>
<td>10-30</td>
<td>20-40</td>
<td>20-40</td>
<td>120-250</td>
</tr>
<tr>
<td>Type Font - No/Char (at present)</td>
<td>64/96</td>
<td>64/96</td>
<td>64/96</td>
<td>96</td>
</tr>
<tr>
<td>Changeable Type Font</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Reliability</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Mechanical Complexity</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Cost (complete Keyboard/Printer Term.)</td>
<td>$1,000 to $3,000</td>
<td>$2,500 to $4,000</td>
<td>$2,500 to $4,000</td>
<td>$5,000 to $7,000</td>
</tr>
</tbody>
</table>

Typical characteristics available today for serial printers as a class are compared with those for remote line printers of both the drum and chain variety in the table below:

<table>
<thead>
<tr>
<th>Character</th>
<th>Character Serial Printers</th>
<th>Drum Line Printers</th>
<th>Chain Line Printers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Character Set Size</td>
<td>62-94</td>
<td>64-128</td>
<td>192-288</td>
</tr>
<tr>
<td>Number of Columns</td>
<td>80-132</td>
<td>80-160</td>
<td>132</td>
</tr>
<tr>
<td>Printer Speed</td>
<td>10-250cps</td>
<td>60-600lpm</td>
<td>140-245lpm</td>
</tr>
<tr>
<td>Price Range of Printers with Buffer but not Interface to the Communications link</td>
<td>$1,600 to $6,000</td>
<td>$8,000 to $21,000</td>
<td>$12,000 to $50,000</td>
</tr>
<tr>
<td>Price Range of Printers Complete with Interface to the Communications link</td>
<td>$2,000 to $5,000</td>
<td>$14,000 to $56,000</td>
<td>$20,000 to $120,000</td>
</tr>
</tbody>
</table>
Most character serial and drum printers are limited to character sets in the 64 - 96 character range while chain printers may have larger character sets. The character set and speed shown in the preceding table for Chain Printers were chosen for the maximum character sets. Using a smaller character set would permit a higher printing speed.

3.7.4 Problem Areas
The only significant problem in implementing the hard copy and printing requirements for terminals for the Central Bibliographic System is the large character set required. The requirement for 176 characters is a major problem for most types of character serial printers and for line printers of the drum type. The large character set for a drum printer is not strictly speaking a technical problem in the sense that the solution is relatively straightforward. It is an economic problem in that it would require a significant redesign of a drum printer to provide a larger character set around the drum and sacrifice printing speed to accomplish this.

Two or three companies are believed to be considering the problem of a larger character set for impact character serial printers, either by using a larger print ball on a selectric type mechanism or by using two print mechanisms. However, no assurance could be obtained that appreciable development work is underway on this and there is no indication at this time that such a device would be marketed without government support of a development effort. The most attractive approach to obtaining a larger character set in a character serial printer probably lies in one of the non-impact technologies. For an electrostatic, a thermal, or an ink jet printer which uses a dot matrix (e.g., 5 x 7 at present) the printable character set could be expanded by expanding the size of the matrix to 9 x 11. This would require an increase of almost three times in the number of elements in the matrix, but it should not require a significant change in the mechanical portion of the printer. If a 7 x 9 print matrix could be used as a compromise, the increase in the number of elements would be slightly less than a factor of two.

3.7.5 Projected State-of-the-Art for 1970 and 1972
No significant improvements are expected in electromechanical impact
printers by 1972 although some cost improvements can be anticipated. Chain printers, and possibly drum printers, with 176 character sets, are feasible within this time span but it is not certain whether any company will consider the market potential sufficient to justify the development and production of printers with larger character sets. This is an area in which encouragement from the Library of Congress could affect the availability of the necessary equipment.

Continued improvement in non-impact character serial printers is anticipated in both printing speed, equipment cost, and paper cost. The larger character set required by the Library of Congress is technically feasible within this time span with the three major non-impact technologies - electrostatic, thermal, and ink jet. However, since there is no commercial demand for that large a character set, it is unlikely that equipment with a 176 character set capability will be available during this time frame unless development efforts are funded by some government agency or the Library community can convince some company of a sufficiently large demand in the Library market to justify the development and production cost.

Non-impact line printers with a full 132 character line width may be available by 1972 because of the higher speed permitted by these techniques and the availability of alternative methods of obtaining multiple copies. However, the development of such a printer would not be important for terminal applications. Such a printer would be pointed toward the high speed generation of large volumes of computer output.
3.8 Machine Readable Unit Document Generator and Reader

3.8.1 General

The Task I requirements analysis indicated requirements in the PIN Assignment and Charging terminals to generate unit documents which are both human readable and machine readable. Requirements for reading these unit documents are found in a number of other terminal categories, such as Reference, Reading room control, Material Request, Discharging, and Invoice Clearing. The function of the generator is to prepare documents that can be read into a terminal or other parts of the CBS later, while the function of the reader is to permit reading these documents.

The requirement for a document that is both machine readable and human readable can be met by using stylized characters that can be read by optical character recognition or magnetic ink character recognition equipment. This requirement can also be met by using any style or font of printed characters in conjunction with encoded information (e.g., dots, bars, punched holes) which is machine readable. In other words, the machine readable and human readable characters may be the same or they may be two different types of characters which are printed at the same time. The requirements call for a fixed number of fields which are relatively limited in length totalling between 40 and 160 standard Roman alphabet characters per unit record.

3.8.3 Techniques or Technologies

There are basically five approaches that can be considered for generating and reading unit documents which are both human readable and machine readable. These are:

1. Optical character recognition
2. Magnetic ink character recognition
3. Printed characters with optically readable codes
4. Printed characters with magnetic readable codes
5. Printed punched cards

The first two approaches, which involve the machine reading of the same character font as that read by the human, usually require that the character font be stylized. The next two approaches above involve reading a code which is printed at the same time as the human readable character. With the last three approaches any type font can be used for the human readable characters. The machine reader only looks at the coded information.
Optical character recognition equipment permits either numeric or alphanumeric characters to be read by one of several scanning techniques, such as circular scan curving tracing and matching against stored patterns, dot matrix scanning and matching against stored patterns, and stroke recognition. Optical character recognition techniques permit type fonts which are more easily human readable than the standards that have been accepted for magnetic ink character readers.

Magnetic ink characters readers, which are widely used in the banking industry, use a special font style defined by the American Banking Association. These characters are read by a serial scan technique and appear to the reader as a magnetic code. The standard character set is limited at ten numerals and four special symbols with no alphabetic characters.

Either optical or magnetic techniques can be used to read coded marks if they are printed above or below the human readable character. A modified typewriter or printer may be used to print the characters in which the coded information is on the same type bar as the human readable character. For example, in a keyboard input device such as a modified electric typewriter, depressing the key for the character "G" would cause the corresponding type bar to hit the ribbon thus printing on the paper both the character "G" and the code for the character "G". If an ordinary ribbon is used the code can be read optically by a photoelectric technique. If a magnetic ink ribbon is used the code can be read by a magnetic reading head. In the latter case the magnetic reading head senses only the presence or absence of magnetic material and does not require that the material be recorded in the sense of magnetic tape recording. Hence, the readability of the code is not affected by magnetic fields or environmental factors. Excessive wear is the only thing that could seriously affect accurate reading of the magnetic ink code.

Magnetic techniques have an advantage over optical techniques in that dirt, pencil, and ink marks do not affect the machine readability of the
characters. Magnetic approaches which only sense the presence or absence of the magnetic material should provide long life and good shelf wear. For terminal applications in the Library of Congress there is no apparent reason that the techniques which involve printed codes as well as human readable characters should not be acceptable. These techniques will permit less expensive reading equipment. They will also provide characters which are more legible to the human than the conventional magnetic ink character set in use in the banking industry. Present optical character recognition equipment and punched card equipment that both punches and prints on the card are more expensive than those discussed above and offer no significant advantage. However, lower cost remote terminal optical readers are being developed for optical character recognition applications.

Optical character recognition equipment is usually classed by whether it reads full pages, documents less than one page in size (usually with only one to three lines being read on the document) or journal tapes (i.e., roll type tapes from cash registers or adding machines). For the Library of Congress terminal applications only a few lines are to be read so that a document reader would be adequate if the optical character recognition approach is chosen.

3.8.3 Present State-of-the-Art
The present state-of-the-art in optical character recognition equipments, magnetic ink character readers, and optical mark sense readers is discussed and compared in Appendix E. Some other bar code approaches that may be applicable are considered under Badge Readers in Appendix B. Equipment for generating and reading unit documents that are both machine readable and human readable are readily available today, but many of them are not well suited to terminal applications. Several companies are now developing remote terminal optical character recognition equipment. One device of this type scans the document in a facsimile manner at the remote terminal and transmits and recreates the image at a central station where the character recognition is accomplished by a computer program. Typical characteristics for presently available optical character recognition equipment is summarized in the following table:

48
The magnetic ink character readers which are available are designed primarily for the requirements of the banking industry. The devices for printing and reading both human readable and machine readable characters in the same document are so diverse that no "typical" characteristics can be cited. Available devices of this type are included in Appendices D and E.

3.8.4 Problem Areas
There are no significant problem areas from a technology standpoint, but the specific devices required for the Library of Congress applications do not exist at this time. It will be necessary to adapt techniques used in other devices. If optical character recognition equipment is used, the unit document generation can be handled by a straightforward character serial or line printer with the proper type font. If the approach of using both machine readable and human readable characters on the same document is used, conventional printers are again applicable with modifications in the type font to include the coded as well as the human readable characters. If magnetic ink character reading approach is chosen, the device used for recording magnetic ink numbers on bank checks might be applicable, but magnetic ink character reading equipment designed for banks which is primarily designed for high speed handling of large volumes of checks, would not be suitable to remote terminal applications. Conventional optical character recognition page readers and document readers are also
designed for high volume applications. However, the remote terminal readers which have been introduced recently and are under development by several companies may provide an adequate solution to the requirement for a low cost reader in terminals. One of the devices which prints the coded character and human readable character at the same time is designed to print and read a strip or paper tape rather than a document or page.

3.8.5 Projected State-of-the-Art for 1970 and 1972
The state-of-the-art in 1970 for this type of equipment is expected to be essentially the same as that today presented in Appendices B and E. However, by 1972 remote terminal readers are expected to be readily available and in widespread use for optical character recognition applications. The development of devices in which both human readable and coded machine readable characters are used is also expected to provide more commercially available equipment of this type by 1972, including readers that can read documents or pages in which several of the lines are machine readable as well as human readable.
3.9 Machine Readable Media Generator

3.9.1 General
The functional requirements and performance specifications call for generating some type of machine readable media for off-line data capture, PIN assignment, material status recording, and cataloging terminals. This media will be used to store data temporarily after it is captured before it is entered into the computer system and to serve as a buffer and permanent storage media. The media may be physically carried to a central location to be read into the computer, or the media may be read remotely and the data transmitted to the central computer over telephone lines. Although the functional requirements call for a generator only at the terminal, a reader will also be required at the central computer, and possibly at the terminal. In some cases, it may be advantageous to use the machine readable media for temporary storage only at the terminal - i.e., data recorded on the media and later read back into the terminal for further editing. Machine readable media generators are needed for recording coded characters for Roman, non-Roman, oriental, and special symbol languages.

3.9.2 Techniques or Technologies
Potential technology candidates for this function include punched paper tape, magnetic tape, punched cards, and disc pack devices. Of these possibilities some form of magnetic tape device offers the best approach. The reasons for rejecting the other candidates are shown below:

<table>
<thead>
<tr>
<th>Media</th>
<th>Reasons for Rejection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punched Paper Tape</td>
<td>Noisy, lower reliability, higher maintenance, low density, media not erasable</td>
</tr>
<tr>
<td>Punched Cards</td>
<td>Slows the input operation, physically bulky, noisy, lower reliability, higher maintenance, low density, media not erasable</td>
</tr>
<tr>
<td>Disc Packs</td>
<td>Expensive, physically bulky, much higher speed than required</td>
</tr>
</tbody>
</table>
For the reasons cited above, the detailed analysis and survey of devices for Machine Readable Media Generation has been limited to magnetic tape devices. Conventional computer tape units are not included because they are expensive and provide higher speed than required. For direct compatibility with a keyboard terminal, either a buffer must be included in the terminal or a tape unit which can be stopped and started on individual characters must be used. Three types of magnetic tape devices are presently available that meet the requirements for generating machine readable data--cassette tape units, cartridge tape units, and compatible incremental tape units. The first two would require a small buffer (e.g., 80 characters) in the terminal while the latter would record character-by-character incrementally.

Magnetic tape cassette units use a small bi-directional magnetic tape cassette physically similar to those used in small audio record and playback units. However, the tape is specially selected computer quality tape and closer quality controls are placed on the manufacturer of the cassette itself. These units have the advantage of being low-cost, very compact, and using parts which are made in high volume production for commercial applications (but not at the same quality level). Most, but not all, of these devices record two tracks redundantly for greater reliability. They have the disadvantage of being slow speed (e.g., 1-7/8 ips), but the speed is more than adequate for the input operation since input is limited by the operator's keyboard speed. In reading the data from the cassette into the computer, either a special slow speed channel would be required or a special device would be required to transcribe data from cassette tape units onto conventional computer tape, which could then be read into the computer at high speed.

Magnetic tape cartridge units are similar in most respects to the magnetic tape cassette units except that they do not use a cassette that is physically compatible with those used in commercial audio cassette recorders. The cartridge unit, which is somewhat larger than the cassette and may use a wider tape, is usually designed specially for the handling device for which it is intended. There is no "standard" cartridge. One form of cartridge
tape unit uses an endless loop of tape from a single reel while other cartridge units are more similar to the cassette units in that they use two reels and move the tape from one to another. The use of two reels either requires rewinding the tape or running it backwards and recording in the opposite direction. In other respects the advantages and disadvantages of the magnetic tape cartridge are very similar to those of the magnetic tape cassette. Magnetic tape cassette and magnetic tape cartridge handling units include both read and write capability so that the same device can either read or record the tape. Hence, the machine readable media generator at the terminal could also be used as a reader for a very minor increase in cost—essentially the cost of the read amplifier.

In incremental magnetic tape units, the bits of a character are normally stored in parallel tracks across the width of the tape and the tape starts and stops between successive characters—hence, the term incremental. For example, when used with a keyboard device the incremental tape unit records a character in seven to nine parallel tracks as the operator depresses a key and then steps into position to record the next character and stops until the operator depresses the next key. In general, incremental magnetic tape units are physically larger and more expensive than magnetic tape cassette or magnetic tape cartridge units. However, they have the advantage of producing a tape which is compatible with the high speed tape handlers used by the computer. Hence, a tape recorded on an incremental tape recorder in compatible format can be read by a conventional high speed tape handler on the computer. In contrast to the tape cassette and tape cartridge units, which normally read and write by switching different electronics to the same heads, incremental magnetic tape units usually use different heads for reading and writing. In fact, incremental magnetic tape recorders and incremental magnetic tape readers are frequently fabricated and sold as separate units.

The relative economics of converting magnetic tape cassettes or magnetic tape cartridges to a compatible tape by using a special purpose device, of reading magnetic tape cassettes or magnetic tape cartridges directly into the computer, and of using a compatible incremental magnetic tape will be considered further in the cost and trade-off analysis during Task III.
However, at this time it appears that the cost and physical size of incremental magnetic tape units does not favor their use in this application.

3.9.3 Present State-of-the-Art
Magnetic tape cassette units, tape cartridge units, and compatible incremental magnetic tape units that are presently available are summarized and compared in Appendix F. The characteristics representative of the present state-of-the-art for these three types of magnetic tape devices are shown below:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Magnetic Tape Cassette typical</th>
<th>Magnetic Tape Cartridge typical</th>
<th>Incremental Magnetic Tape typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of tapes per unit</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Transfer rate in (char/second)</td>
<td>300 to 625</td>
<td>636</td>
<td>200 to 1500</td>
</tr>
<tr>
<td>Tape transport speed in inches/second</td>
<td>1-7/8 to 10</td>
<td>10 to 20</td>
<td>Incremental</td>
</tr>
<tr>
<td>Recording density in bits/inch</td>
<td>550 to 1200</td>
<td>600</td>
<td>200/556/800</td>
</tr>
<tr>
<td>Price (incl. Electronics)</td>
<td>$2,000</td>
<td>$5,000</td>
<td>$13,700</td>
</tr>
</tbody>
</table>

3.9.4 Problem Areas
The major problems that have been encountered to date in using magnetic tape cassettes have resulted from the attempt to use commercially available audio tape cassettes. By this time most manufacturers have found that the quality control on commercial cassettes is inadequate for computer usage. Hence, most manufacturers now load the cassettes with tested computer quality tape and place higher quality-control standards on the physical cassette fabrication and assembly. The same problem has been encountered to some extent in magnetic tape cartridge units although most of the cartridge units offered now are physically different from audio cartridge units and, hence, must be specially made.
In selecting a tape cassette or tape cartridge unit for use in the terminal, careful attention must be given to the design characteristics of the specific tape handling mechanism, and care must be taken to assure that only computer quality cassettes or cartridges are used. The major problems with incremental tape units for terminal applications are the cost and physical size.

3.9.5 Projected State-of-the-Art for 1970 and 1972
Most of the magnetic tape cartridge and cassette devices available today have been developed within the last two years; hence no significant improvements in the tape drive units are anticipated during 1970. Significant improvements in the mechanical tape handling within the cassette or cartridge will be necessary and fully tested digital quality tape will be used. This should occur during 1970. The major improvements that can be expected by 1972 are in quality and reliability. Evolutionary improvements will be made in speed and density by mid-1972—in the order of 1,000 to 1,500 bytes per second and 800 to 1600 bits per inch. Price per tape drive is expected to drop below $1,000 by mid-1972.

Incremental magnetic tape recorders have been available for several years and appear to have passed the knee of the development curve and are improving at a relatively slow and gradual rate at this time. Hence, no noticeable improvement is anticipated during 1970, and improvements in performance and cost will most likely be no more than 10% to 20% by mid-1972.
3.10 Calculating Unit and Controllers (Small Computers)

3.10.1 General

Functional requirements developed in Task I indicate the need for a calculating unit in terminal stations used for invoice clearing. This functional requirement can be met by including a small computer as a module in that terminal station. However, the most significant application for small computers in the terminals for the Central Bibliographic System is as controllers providing functions which are common to and shared between several terminals in relatively close physical proximity to one another. It is also very likely that some of the individual terminal stations which are not connected to a controller can best be implemented by including a very small low cost computer in the terminal station. The function of the small computer in this case would be to provide the necessary buffer storage, control logic, and timing functions required in the terminal. Also, Section 2.4 of this report discussed some of the functions and module requirements (e.g., the time and date clock and the storage of preprogrammed messages to permit entry of preprogrammed data) that might best be implemented with logic or software in a small computer in the terminal station or in the controller.

3.10.2 Techniques or Technologies

The main memory in most small computers today are implemented with magnetic core technology. In the future magnetic core memories will be threatened by competition from plated wire memories and semi-conductor memories as discussed in the preceding paragraph. Magnetic core memories enjoy a significant advantage in terms of existing technology and large production facilities. For larger capacity memories, plated wire technology is the most likely to supplant magnetic core technology within the next two to three years. However, for very small computers the memory requirements tend to be more limited; hence, semi-conductor technologies may have an advantage over plated wire technology. An important characteristic of semi-conductor memories is that for capacities larger than a few hundred bits the cost per bit is not significantly dependent upon the capacity of the memory. For plated wire and magnetic core memories the cost per bit decreases significantly as the capacity of the memory increases. Hence, plated wire and magnetic core memories tend to be less economic for very small capacities, in the order of a few hundred words. For this reason, as well as the speed advantage,
semi-conductor memories are being used more and more for small capacity memories of a few hundred words, which provide storage for control functions (e.g., micro-programs or firmware) and frequently used data and subroutines. Larger capacity magnetic core memory or plated wire memories are used for the bulk of the data and program storage.

A few very small computers have been announced recently in which the entire program may be stored in a read-only memory. In the future, semi-conductor memories may be used for this function, which would permit electrical alterability of the memory, and hence greater ease in adapting the machine to a specific application. MOS read-only memories are available now with 256 words being a typical capacity for this type of memory. If micro-programs are stored in this type of memory they must be preprogrammed at the manufacturer's facility and cannot be easily changed in the field without replacing the memory. In the future, as an extension of this technique, an alterable semi-conductor memory could be used for storing micro-programs and other control functions in the same way that read-only memories are used in a few machines at present. This would permit the easy extension of memory capacity using the same kind of memory technology, with the possibility of storing micro-program operations as well as data and the main program in the same memory. Although there is a definite trend toward the use of micro program operations in a number of small computers at present, it is not clear at this time whether this trend will continue in the future toward the use of read-only memories or whether programmed operations will be stored in an electrically alterable memory thus permitting greater flexibility for field changes.

Most of the small computers available today are implemented with magnetic core matrix memories and bipolar integrated circuit logic. A number of companies are actively working on small computers using MOS semi-conductor memory arrays and MOS logic arrays. MOS is an acronym for "metal oxide semi-conductor" which is a type of semi-conductor element that utilizes the surface effects in semi-conductors and is fabricated by growing oxide layers and depositing metal layers on a semi-conductor surface rather than by the diffusion processes used in fabricating conventional bi-polar LSI arrays. However, many people in the semi-conductor and computer
industry believe that MOS devices, which provide a higher component density in a given area of silicone chip and which require fewer processing steps, will offer a lower cost approach to implementing computer memory and logic functions in LSI (large scale integrated) arrays.

In general, MOS devices are significantly slower than bi-polar devices by a factor of between two-to-one and five-to-one. On the other hand, many people in the field expect MOS devices to enjoy a significant cost advantage over bi-polar devices. For large scale high speed computers, bi-polar LSI arrays are more attractive because of their speed; but for small computers, such as those required in terminal applications, speed is not as important a factor and cost is the more important factor. Hence, if present development on MOS arrays proves the technical and economic feasibility of this type of device, they may be more attractive for use in small computers.

At this time, it appears that the present state of development permits larger MOS memory arrays than bi-polar LSI memory arrays. The trade-off made for this higher density and lower cost is one of speed. MOS memory arrays offer potential for memories in the 500 nanosecond cycle time range within the next year or two and perhaps as low as 150 to 250 nanoseconds by 1975. This is in contrast to bi-polar LSI memory arrays where the cycle time is expected to be in the 150 to 250 nanosecond range within the next year and in the 100 nanosecond or faster range by 1975. A cost differential of approximately two to one is anticipated between these two types of memories. Since speed is not the primary consideration for small computers, many people expect MOS technology to dominate the small computer field, if satisfactory yields, reliabilities, and stability over long life periods can be proven. However, bi-polar LSI technology has a significant potential advantage because of the extensive development of bi-polar LSI devices for other applications. It is likely that bi-polar LSI technology will benefit from more extensive research and development efforts; hence, the two technologies may not compete on a completely equal basis.

In general, the memory speed is a limiting factor on the basic operation speed of a computer. It is expected that logic circuits will be readily available that are more than capable of matching any available memory speed in small computers. Hence, the future capability of small computers will be
heavily dependent upon the memory technology used. It is important to note, however, that for a given circuit and memory speed the performance and capability of a small computer is significantly affected by the organization or architecture of the computer and the instructions and functions implemented in the machine. There are many cases where a small computer with a memory speed significantly slower than that of another outperforms the second because of the greater capability in the architecture and logic implementation of functions such as arithmetic operations, interrupt operations, and input/output control functions. Hence, a small computer cannot be selected on the basis of memory speed or basic operation speeds alone. The machine must be selected in terms of the requirements of the particular application on an overall basis giving adequate consideration to the types of interrupt and input/output control functions required. This is particularly important for terminal and control applications. Interrupts may occur from the human operator, the display, the printer, the communication line or other terminal modules. The communication capabilities of the small computer are particularly important if it is to be used in a controller application since the controller must communicate over a telephone line or other type of long distance communication line with the central computer on one side and with a number of local (and probably hard wired) stations on the other side.

Other important considerations in the selection of a small computer are the software and peripheral equipments available with the computer. For some types of applications the availability of extensive system software, such as Fortran compilers, is a major consideration; but this is not as important in a real time application such as a terminal controller because of the strong likelihood that the controller will be programmed in assembly language in order to achieve maximum efficiency and real-time speed. The major software requirements for a computer to be used in a terminal or controller are the assembly language, the real-time operating system, and diagnostic routines.

The availability of a wide range of peripheral equipments is generally an important consideration in selecting a small computer, but again this may not be as important for the terminal and controller application. More important for this application is the ease with which different types of
Peripheral equipment can be interfaced with the computer. It is very likely that the terminal modules with which the small computer will be required to interface will not be standard peripheral equipments offered by any computer manufacturer. Hence, the complement of peripheral equipment already interfaced to the computer by the manufacturer is less important than the ease with which new kinds of equipments can be interfaced to the computer by those designing the terminal station.

3.10.3 Present State-of-the-Art
The technology for small low cost computers is highly developed at this time and there are a large number of equipments offered in this category with new companies and new equipments entering the field at a rapid rate. The characteristics of the small computers available at the time this report was written are summarized and discussed in Appendix G. The tables in Appendix G indicate the availability of a large number of small computers offering wide range of characteristics and prices. Typical characteristics for small computers available today are summarized below:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Cycle Time (us)</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td>Memory Capacity</td>
<td>4K - 32K</td>
</tr>
<tr>
<td>Instruction Word Length</td>
<td>8 - 16</td>
</tr>
<tr>
<td>No. of Hardware Registers</td>
<td>4 - 8</td>
</tr>
<tr>
<td>Indirect Addressing</td>
<td>Multi-level</td>
</tr>
<tr>
<td>I/O Data Path Width</td>
<td>8 - 16</td>
</tr>
<tr>
<td>DMA Word Transfer Rate</td>
<td>200 KHZ - 1.2 MHZ</td>
</tr>
<tr>
<td>No. of External Interrupt Levels</td>
<td>2 - 32</td>
</tr>
<tr>
<td>Relocatable Assembler Core Reg.</td>
<td>4K</td>
</tr>
<tr>
<td>Price of 4K Memory and TTY-33</td>
<td>$5K - $16K</td>
</tr>
<tr>
<td>Price of 8K Memory and TTY-33</td>
<td>$10K - $22K</td>
</tr>
</tbody>
</table>

**Typical Range of Small Computer Characteristics**
Almost all types of peripheral equipments are offered with small computers, although some manufacturers offer a wide variety of peripheral equipments than others. The ASR-33 Teletype is typically used as a computer console and punched paper tape equipment, magnetic tape equipment, magnetic discs and drums, punched card equipments, and external interrupt lines are usually offered. Many of these machines also offer some type of communication interface and modem.

Words sizes of 8 and 16 bits are most common with the 8 bit machines being in the lower end of the price range and the 16 bit machines in the upper end. Some of these machines offer memory expansion capability only to 8,000 or 16,000 words, while others offer expansion capability up to 32,000 words.

3.10.4 Problem Areas
There are no significant problems in implementing small computer requirements for terminals for the Library of Congress Central Bibliographic System. Very small computers in the below $5,000 price range are available which could be used in the terminal itself and somewhat larger small computers in the $10,000 to $15,000 price range are available which could be used as controllers for a number of terminals. The availability of low cost peripheral equipments is a problem in some small computer applications, but this is not a factor in the Library of Congress application.

3.10.5 Projected State-of-the-Art for 1970 and 1972
The state-of-the-art in small computers is advancing very rapidly and will continue to do so for a number of years. However, the major improvements will be in cost rather than in performance. That is, any performance level required is available today, but the price for a given level of performance is continually declining. This also implies that for a given price greater capability will be available in the future. A
number of the small computers shown in the tables in Appendix G have only recently been announced, and in some cases none have been delivered. Hence, the state-of-the-art for small computers in 1970 is represented by several of the machines shown in Appendix G. By 1972 price decreases in the small computer field should provide cost improvements in the order of one-fourth to one-third over those available today for a given level of performance. Small computers for use in an individual terminal should be available in the $2,500 to $3,000 price range, while small computers capable of serving as controllers for a number of terminals should be available for under $10,000 by 1972. These prices, which are for the central processor and minimum memory capacity, will be increased to the extent that additional memory capacity, additional features, or peripheral equipments are added to the central processor.
3.11 Oriental Language Devices
3.11.1 General

This section is concerned with the written form of the three ideographic oriental languages. These are in order of increasing complexity of "mechanization" Japanese, Korean, and Chinese.

Japanese

Japanese is considered the simplest of the three because of its more limited repertoire of Chinese derived characters. The number of these characters, referred to as Kanji, in current use is limited (by edict) to 1850, plus a few special characters used only for proper names. The Kanji are supplemented by two syllabic alphabets, the Katakana and Hiragana. Words of foreign origin are transliterated (as closely as possible considering the fact that certain sounds, most notably "L", are not present) into Katakana. Words of native origin for which Kanji are not available are phonetically spelled out in Hiragana syllables. Hiragana syllables are also used for special word endings.

The Katakana and Hiragana syllabaries consist of approximately 49 basic symbols each. The basic syllabaries are extended by the use of two diacritical marks, " and " to indicate consonantal changes, e.g.

/\ is HA
\"/ is BA
\/\ is PA

The Japanese also use arabic numerals and the roman ("Romanji") characters as well. The maximum number of symbols, Kanji, Katakana, Hiragana, and Romanji is, however, well under 2000.

Korean

Korean has only a limited alphabet (not as versatile as the Japanese Katakana) and hence must depend more heavily on the Chinese derived characters, referred to as Hancha. Some attempts have been made to reduce the number of Hancha characters to less than 600, but somewhere between 1300-2000 are considered "indispensable". If the number of sanctioned characters can be reduced to the lower limit, mechanization of Korean will be simpler than Japanese, as of now Korean is somewhat more complex to mechanize than Japanese.
Chinese

Chinese has no phonetic alphabet and depends exclusively on the traditional characters. Whereas the Japanese form complex words by placing two or more Kanji characters side by side, the Chinese have tended to construct new words by combining the essential parts (radicals) of simpler characters to form new characters. The number of "essential" characters is estimated as between 6000 and 10,000 (depending on the estimates) but older works contain upwards of 20,000 characters. The standard Chinese Telegraph Code (CTC), originally devised during the last century, provided for some 799 characters, but it has been continuously augmented and modified ever since.

Because the more complex characters can be considered as made up of one or more radicals plus additional strokes, dictionary look up is feasible on the basis of first looking up the basic radical and then counting the number of additional strokes to find the desired character.

3.11.2 Entry Devices for Oriental Languages

While simple keyboard devices are practical for entry of the Japanese syllabaries and the Korean alphabet, the use of a one-to-one correspondence between key and character is impractical for the ideographic symbols.

Two distinct approaches have been found at least partly successful. These are discussed below. Analog drawing has been suggested also and is discussed later. A new method which has not been found in the literature will also be presented.

The oriental characters are made up of combinations of vertical, horizontal and diagonal linear strokes. Curvilinear strokes are used also, but the curvature is slight and not truly essential to recognition. The "hooks" at the ends of some of the strokes are analogous to serifs and are also not essential to recognition. The characters are stroked in a rigidly prescribed sequence, generally left to right, top to bottom.

The RCA photocomposition machine (see Appendix H) uses a keyboard with 21 basic strokes, plus punctuation and "entity" keys (entities are the most frequently used radicals). The keys are struck in the traditional
stroke sequence. When enough keys have been struck to define a unique character beginning with the selected sequence of strokes, that character is displayed for acceptance or rejection by the operator. Certain combinations of strokes lead to ambiguous patterns. In these cases the ambiguous characters are displayed simultaneously for operator selection. The number of such ambiguities is surprisingly low. Shashoua\textsuperscript{1} states that in a vocabulary of some 2500 characters only 20 pairs and 4 triads of ambiguous characters were found. The RCA photo-composition machine has a repertoire of up to 10,000 characters.

A second approach is based not on strokes but on "features". Lin Yutang is credited with pointing out that the top and bottom halves of the characters can be categorized separately into a limited number of "features" or patterns. All characters can be reasonably well categorized to within small families in terms of only 36 top and 32 bottom features. The ITEK Chicoder is based on the Yutang principle and requires three keystrokes per character. A pair of top and bottom feature keys is struck and all ideographs containing these features are displayed. The third key stroke identifies the individual character by its position in the display. The Chicoder has a repertoire of over 10,518 characters.

It has been suggested that characters be entered by essentially tracing the strokes on a RAND tablet or some other analog-to-digital conversion device. The problems connected with this approach will be discussed below in connection with the inverse problem (digital-to-analog) of display. Such a means of input is not recommended for the oriental languages although it may have some merit for special symbols.

A fourth approach which appears to have some merit but does not seem to have been discussed in the literature is the use of a digital input matrix.

The matrix could contain \(32 \times 32 = 1024\) squares each \(1/2''\) on a side with the most frequently used characters arranged in a systematic (e.g. dictionary order) fashion.

A stylus is used to enter a 10 bit code by "pointing" the stylus to the desired character. A \(64 \times 64\) matrix would be 32 inches square and provide a 12 bit code. A single matrix of this size would be complete in itself for Japanese. Either the larger or smaller matrix could be extended to cover Korean, Chinese, or all three languages by providing keyed overlays with additional groups of characters. For example sixteen \(32 \times 32\) overlays or four \(64 \times 64\) overlays could provide a \(2^{14}\) \((16,384)\) character font. The selection of a particular overlay would, by self-keying, introduce the additional 4 or 2 bits into the encoding and a three position switch could be used to select the desired language. Because of the lack of ambiguities, a feedback display would not be required and "checking" could be provided by double entering such as is now done to verify punched cards.

Further study of matrix devices of this type from a human usage standpoint would be required to evaluate the input speeds which may be achieved, particularly as compared with the RCA and ITEK devices which require multiple keystrokes and near instantaneous display to resolve ambiguities. The digital input matrix could be quite inexpensive, especially since feedback display is not required. Such a matrix could be implemented in many ways, e.g. mechanically, electrically, optically, etc.

Since the Chinese characters have been assigned 4 decimal digit numbers for purposes of telegraphy (see Section 3.11.5 on Machine Readable Codes for Oriental Languages), a 10 key keyboard may be of limited use particularly in entering corrections. Such a device may prove slow since it would require four keystrokes per character and prolonged experience to memorize the digital codes. The codes are not as easy to memorize as the meanings of the characters because of the meaning mnemonics inherent in the characters.

An additional set of four digit codes, which is well accepted, is the Mathews number assigned to each character in the Mathews Chinese-English dictionary.
3.11.3 Display Devices for Oriental Languages
An electronic display operating on line with the input keyboard or other entry device will permit "instant" verification of the input data, will permit more rapid proof reading and correction (more of the errors may be caught by the input operator) and will permit editing.

While displays need not be of typographic quality, the characters should be legible and unambiguous. Variable line widths and graceful curves are not required. Some stylization is permissible from a cost/effectiveness standpoint.

The cathode-ray-tube (CRT), which is the most widely used individual display device, is the only such device to be considered here. A number of methods for generating characters on the face of a CRT are described in the literature. Many of these methods are immediately seen to be impractical for the oriental languages. The electron beam stencil used in the Charactron R for example is practically limited to around 128 symbols. The Monoscope R and similar techniques are also limited in repertoire for the same reasons.

The limitations of these devices are due to the necessity for generation of the symbols within a CRT itself. If the symbol generation is performed externally to the tube envelope much larger repertoires are possible. Optical means, as used in typographical systems can be used, but the film must be replaced by a storage tube. This method will be discussed below. The immediately following paragraphs will describe the advantages and disadvantages of two all electronic methods for symbol generation. These are the well known dot matrix and stroke methods. Of the two, the stroke method presents better appearing characters and requires less memory. However, an optical/electronic method using a video pickup of an optically projected character and a storage tube on which sequentially generated string of characters may be displayed offers certain advantages over all electronic systems. A single optical generator could be time shared for both hard copy generation and a number of simultaneous displays because both

---

the recording material and the individual storage tubes provide the required self storage.

**Dot Generators**

While a 5 x 7 matrix can provide just marginal legibility for Roman characters, at least a 16 x 24 matrix is required for the more complicated oriental characters. See, for example, Figure 1 which is a reproduction of an electrostatic printer output using a 16 x 24 dot matrix. Even this is definitely marginal in appearance. A larger matrix would be desirable from the appearance standpoint, but that could be prohibitive from a cost standpoint. The 16 x 24 matrix contains 384 bits and the storage of the dot structure for 10,000 characters on this format would require $3.84 \times 10^6$ bits. Larger matrices would of course require proportionately more memory.

**Stroke Generators**

Stroke Generators provide better appearing characters than dot matrix characters. The most complicated Kanji characters, Shū and Kan shown in Figure 2 consist of 23 strokes each. If these strokes are created by joining points of a matrix as large as 32 x 32 only 20 bits are required to designate the starting and ending points of each stroke. A 23 stroke character would thus require 460 bits of storage. This is more than required for a 16 x 24 bit dot matrix character, but simpler characters would require less storage as will be shown.

### Storage Required for the Most Complex Kanji Characters

<table>
<thead>
<tr>
<th>No. of Strokes</th>
<th>No. of Characters</th>
<th>Bits/Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>2</td>
<td>460</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>440</td>
</tr>
<tr>
<td>21</td>
<td>5</td>
<td>420</td>
</tr>
<tr>
<td>20</td>
<td>11</td>
<td>400</td>
</tr>
<tr>
<td>19</td>
<td>17</td>
<td>380</td>
</tr>
<tr>
<td>18</td>
<td>32</td>
<td>360</td>
</tr>
<tr>
<td>17</td>
<td>31</td>
<td>340</td>
</tr>
<tr>
<td>16</td>
<td>67</td>
<td>320</td>
</tr>
<tr>
<td>15</td>
<td>98</td>
<td>300</td>
</tr>
</tbody>
</table>

The table has not been extended to include all of the 1850 Kanji characters, but it shows that only 19 of the Kanji characters built up of strokes on a 32 x 32 matrix require more data storage than do all of the characters built up of dots on a 16 x 24 matrix. The simpler stroke characters require, of course, far less storage, even if additional storage requirements are introduced to permit curvatures to be generated either by segments or curved stroke generation techniques. This implies that a stroke generation method is more economical of storage and provides better appearing characters than does a dot generation technique, if all electronic methods are required.

### Mechanization of the Display

Character generation which involves a translation from the storage code to the display code that drives the digital-to-analog converters may be done either through hardware or software. For limited fonts, hardware has proven more cost effective; for large fonts, such as Kanji, software conversion will be more cost effective.

The number of characters which may be simultaneously displayed at a flicker-free rate, depends on numerous parameters, e.g., number of
Note that these characters consist of groups of strokes.

THE 23 STROKE KANJI CHARACTERS SHŪ AND KAN

FIGURE 2
stations in simultaneous use, time per character, etc. 3

The number of oriental characters which may be simultaneously displayed will be less than the number of Roman characters because in general more writing time will be required per character because of the greater complexity. These problems of number of characters versus refresh rates may be resolved by using a storage tube. For an all electronic system the combination of a software stroke generator and a storage type CRT appears to be an optimum solution.

Optical/Electronic Method
The use of a storage tube, with the absence of a refresh requirement opens the way for slower (i.e., non-electronic) character generation techniques. A film stencil, which is the optical analog of the electron beam stencil in the Charactron R and the pattern plate in the Monoscope R can store far more information than its electronic analogs. The film stencil is properly positioned in a projection path and the image of the projected character is scanned with a video pick-up system. A synchronized recording beam in the storage tube will then generate the image of the character in its specified position where it will remain until erased.

Optically shaped characters will be far more attractive than either stroke or dot matrix characters. Because the optical stencils are easily interchangeable, all three of the languages under consideration may be handled with the same hardware.

Because of the existence (although not in quantities) of devices for generating hard copy (ITEK and RCA), and the state-of-the-art in video and storage tube technology, no extensive development is required for this photo-optical/storage tube display approach. However, the equipments themselves are relatively expensive.

3.11.4 Hard Copy Devices for Oriental Languages

Hard copy devices are required to produce characters of graphic arts quality. While all electronic photo composition devices have been developed for Roman (and italic, bold face, and gothic) characters, the large repertoire of Chinese characters is most easily generated by optical means. At least two United States manufacturers, RCA and ITEK, have produced photo-composition machines for the oriental languages. The specifications for these existing machines are given in Appendix H.

The means of entry into these two devices is by keyboards which have already been described. They may be operated either "on-line" or from a keyboard prepared tape.

Output is to a film which is then used to prepare the reproducible master, by the usual graphic arts methods.

The optical technique used in the RCA photo-compositor is unique in that selection of the desired individual character is done by illuminating only a single block (of 16 characters) on the matrix plate, which remains stationary. A system of mirrors and beam splitter superimposes the images of all the blocks into a single aperture, but only the illuminated block is visible. This approach permits rapid selection of the characters since no mechanical motion is required.

The original RCA photo-compositor used conventional photo imagery in the matrix plate. It is understood that a newer version of the RCA photo-compositor will use a holographic image in the photo-matrix plate to reduce size and weight.

3.11.5 Machine Readable Media Code for Oriental Languages

Each of the input devices discussed above (except the RAND tablet used as a drawing tablet) is capable of directly generating a simple unique digital code for each character. For the ITEK and RCA machines these are only indirectly related to the combination of keys struck. In those machines the desired characters are recovered from the photographic
image memory for immediate verification on a Kinescope, and the binary location of the stored image is available for direct encoding. Since the same machine is used for both input and output machine readable media (e.g., a magnetic tape or a punched paper tape) can be prepared simultaneously with the hard copy. As an alternative, the machine readable media can be generated instead of the hard copy for future hard copy preparation. The digital tape thus prepared is in proper form for computer entry.

The Japanese Kanji Teletypewriter, described in Appendix H, operates on a 12 bit code and is designed to prepare a punched paper tape.

The Chinese Teleprinter described in Appendix H also prepares a punched paper tape.

For some purposes, the use of a "code book" which assigns an arbitrary identification number to each character may be feasible, particularly if several systems using different bit patterns are combined. In this case a "dictionary" converting each systems bit patterns into the common code could provide the commonality. Examples of such codes are:

1. The serial arrangement of the Kanji characters in a standard Japanese dictionary
2. The four digit serial numbers of the Standard Chinese Telegraph Code (STC)

Either of these codes may be generated on a standard keyboard at rates dependent on the operator's memory and proficiency in converting characters into their equivalent digital codes.

3.11.6 Projected State-of-the-Art for 1970 and 1972

The keyboard devices and the character serial printers (e.g., Chinese Teleprinter and the Kanji Teletypewriter) discussed in this section and in Appendix H are available now but they are limited to under 2,000 characters and symbols. The Fujitsu electrostatic printer, which uses a 16 x 24 dot matrix, is also available. The other devices discussed in this section and Appendix H are in a developmental stage. None of
these capable of handling oriental language character sets will be available by 1970 except in developmental models with a consequent high price. It is very doubtful that any of them can be considered off-the-shelf or commercially available equipment by 1972 for oriental language character sets. It is difficult to predict the availability of devices of this type, which are presently in the experimental stage, because their development and availability depends very heavily on the funding available for the completion of research and development efforts and the conversion to production status. There is no strong indication at this time that demand is sufficient or that funding is available to assure production status for these equipments by the end of 1972.
4. POTENTIAL PROBLEM AREAS

Four major problem areas exist with respect to the availability of devices for implementing terminal requirements for the Central Bibliographic System.

The first of these is the PIN Labeler and PIN Reader. Several techniques and technologies used in Badge Readers and Optical Character Recognition Equipment are applicable to the PIN problem but specific devices do not exist that can handle the PIN reading requirements. The two major bars to the use of existing equipment are the size (thickness) of the book in fixed stations and the need for a hand-held reader in the portable stations. Two hand-held devices currently under development may offer a solution to both of these problems by 1972.

The second problem area results from the requirement to handle character sets of 176 characters for the Extended Roman alphabet and combined character sets for other alphabets plus a subset of the Extended Roman alphabet. This does not present a serious problem for keyboards, but it is quite serious for printers and displays.

The larger character set can be handled in line printers of the "chain" type by expanding the character set on the chain at the expense of printing fewer lines per minute and the cost involved in customized equipment. It can also be handled in character serial printers of the matrix type (e.g., thermal, electrostatic, ink jet) by using a 9 by 11 matrix instead of a 5 by 7 matrix, at a consequently higher cost. The cost could be substantially higher because of the higher number of dots in the matrix, the development costs required, and the fact that the equipment is not a standard production item.

The same considerations are true for CRT displays. A display using a dot matrix character generator would require a 9 by 11 matrix instead of a 5 by 7 matrix, one using a stroke character generator would require more strokes, and one using a monoscope or a charactron tube would require a larger character mask.
The third and most serious problem area is in the handling of Oriental languages. This problem, which is discussed in detail in Section 3.11, is so difficult and equipment so expensive that an alternate approach that does not require terminal entry and computer storage and print-out of the oriental languages may be required.

The fourth problem area is in the handling of special symbols. A limited number that are frequently used can be handled in the same way that non-Roman character sets are handled with special keyboards, printers, and displays. However, the use of unlimited special symbols presents the same problem as the Oriental languages.
5. CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations from this study depend heavily on the other two tasks of the study and will be presented in the Final Report. However, some of the hardware and equipment problems discussed in the preceding sections require consideration by Library of Congress personnel while the work on Task III is underway.

It is recommended that the Library give consideration to partially supporting development work in the following areas:

1. A portable PIN Reader
2. A character serial printer and a line printer capable of handling a character set of 176 characters
3. A CRT display with a 9 by 11 matrix for handling a character set of 176 characters.

It is further recommended that the Library seriously consider the use of a microfilm storage and retrieval system for the Oriental languages and many special symbols. In such a system the microfilm file could be accessed by an index number stored in the computer record. The cataloging could be done at a semi-automated terminal station, but with the Oriental language characters or special symbols originally added by hand and then printed on the card by a photocompositor as it is done now. The complete card could then be stored in microfilm form for accessing and reproduction under computer control.
APPENDIX A
SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE KEYBOARDS AND KEYBOARD/PRINTERS

The characteristics of the more prominent keyboard/printer terminals available today and the major technologies for implementing keyboards are presented in this Appendix. Keyboard/printer terminal requirements are primarily for on-line use where individuals are interacting with a computer system and for off-line data preparation where data is recorded on some machine readable media. Quite often these devices are used in conjunction with other types of terminal equipment modules and, hence, these equipments might also be included as modules in other types of equipments. Most of the products of this type include a keyboard and a serial character printer that produces hardcopy but which at the same time generates electrical signals to the computer over communication lines or to a machine readable media generator (e.g., a paper tape punch). There are also some applications of keyboard-only units where the printed copy is not required or where visual copy is generated by some other device. Such units have applications as transaction input units, as portable input units, and as input for CRT terminals.

Keyboards
Since there are upwards of 100 manufacturers making keyboard equipments of one kind or another, this study did not compare all of the specific keyboard products from various manufacturers. Instead, different technologies or techniques for implementing keyboards were analyzed. A few selected keyboard units that are representative of the different technologies are shown in Table A-1.

Keyboards are designed to enter alphanumeric and symbolic information. These numbers and letters are usually supplemented with other non-spoken symbology -- special characters such as %, and punctuation marks. Keyboards may be numeric, alphabetic, symbolic or any combination thereof. They can be designed to meet many special needs. Most typewriters have 44 keys which provide 26 alphabetic numbers and some punctuation marks with upper case and more punctuation marks available in a shift position. The MARC Pilot Project Keyboard designed by the Library of Congress uses
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>No. of Keys</th>
<th>Keyboard Technique</th>
<th>Encoding in Key Module</th>
<th>Special Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clare-Pendar</td>
<td>88</td>
<td>Solid State (reed switch &amp; MOS)</td>
<td>No</td>
<td>Encoding flexibility up to four levels, Modular</td>
</tr>
<tr>
<td>Controls Research Corp.</td>
<td>58</td>
<td>Electronic (reed switch &amp; diodes)</td>
<td>Yes</td>
<td>Modular</td>
</tr>
<tr>
<td>Digitronics PK-275</td>
<td>75</td>
<td>Photo-electric</td>
<td>No</td>
<td>Maximum of 75 keys</td>
</tr>
<tr>
<td>George Risk Industries -573</td>
<td>73</td>
<td>Electronic (reed switch &amp; diodes)</td>
<td>No</td>
<td>--</td>
</tr>
<tr>
<td>IKOR</td>
<td>66</td>
<td>Capacitive</td>
<td>Yes</td>
<td>No mechanical switching</td>
</tr>
<tr>
<td>Licon-550</td>
<td>73</td>
<td>Electronic (magnetic cores)</td>
<td>Yes</td>
<td>Modular</td>
</tr>
<tr>
<td>Mechanical Enterprises Inc.</td>
<td>55</td>
<td>Electromechanical (mercury switch &amp; diodes)</td>
<td>Yes</td>
<td>--</td>
</tr>
<tr>
<td>Microswitch</td>
<td>63</td>
<td>Solid State (Hall effect &amp; MOS)</td>
<td>No</td>
<td>Encoding flexibility up to four levels, Modular</td>
</tr>
<tr>
<td>NAVCOR-1050</td>
<td>50</td>
<td>Electronic (reed switches &amp; diodes)</td>
<td>No</td>
<td>Buffered outputs</td>
</tr>
<tr>
<td>Synergistics</td>
<td>65</td>
<td>Electromechanical</td>
<td>Yes</td>
<td>Maximum of 160 keys</td>
</tr>
</tbody>
</table>

Clarification of Terms Used in Table A-1

- **Keyboard Technique** - whether the technique used to implement the keyboard is solid state, electronic, photo electric, capacitive, or electromechanical.

- **Encoding in Key Module** - whether the encoding is accomplished in the key assembly itself or in some external encoding equipment.

**SELECTED KEYBOARD UNITS**

**TABLE A-1**
44 keys and 2 shift keys (4 shift levels) to input 176 characters for the extended Roman alphabet.

Although many non-standard keyboards are available for special purposes, there are three standard keyboards that are accepted in this country: they are the alphanumeric or typewriter keyboard, the numeric ten-key keyboard, and the numeric bank or columnar keyboard. Many variations occur within each of these standards. However, there is enough standardization to allow the training of personnel in their operation.

Alphanumeric keyboards are designed to operate at a peak repetition rate for a single character of ten or fifteen times per second. As most alphanumeric keyboards are not interlocked to prevent the simultaneous depression of characters, it is possible to operate such keyboards at speeds up to 20 characters per second providing that the same character is not repeated in sequence. Typical operator rates are about five characters per second when copying from legible data.

Ten-key numeric keyboards are designed to be operated by one hand. A trained operator can produce output at the rate of ten to twenty characters per second for reasonably long periods of time.

The bank or columnar keyboard provides a column for each digit position. Each column contains all of the digits which may be entered in that position, usually one through nine. This keyboard can be used as a fixed format forced entry device as all zeros or all blanks are automatically entered in each column when no key is depressed.

Currently available technology is adequate to provide for the construction of any desired configuration or speed of keyboard. Although most of the keyboards now in use are electromechanical in nature and involve the use of several moving parts, it is possible today to get a keyboard which senses key depression electronically or magnetically and uses solid state logic to generate coded output. These keyboards have the advantage of eliminating the wear problems associated with moving parts and have high reliability. Another common keyboard technique used today is a reed
switch module which is also actuated by a magnet when the key is depressed. These types of keyboard and some other types of contact keyboards also offer an advantage in providing modular key assemblies that can be assembled into keyboards with larger numbers of keys and greater flexibility.

Microswitch offers a solid-state keyboard using the concept of triggering integrated circuits with plunger mounted magnets. The magnetic field created by the plunger being depressed causes a Hall effect voltage to be generated and this is amplified to a usable level which is fed into the encoding matrix of the keyboard. This technique eliminates the need for discrete diodes, thus reducing the cost of encoding.

Ikor uses a different solid-state approach employing capacitive coupling in which each key generates its own code. There are no switch contact closures and the key can be placed anywhere on the keyboard layout. In other words, each key contains its own function code. The depression of the key establishes an AC signal between the transmit and selected receive bars thus generating the specific code for that key. Any code up to 12 bits can be handled with the restriction that one and only one binary code be assigned to each character.

**Keyboard/Printers**

Impact keyboard/printer terminals provide hard copy, which is essential in most applications, but these types of terminals are slow, have high maintenance costs, and are usually quite noisy. The most common and widespread example of keyboard/printer terminals using impact printing are the hundreds of thousands of Model 33 Teletypes presently in use which operate at 10 characters per second. Other keyboard/printer terminals are designed around electric typewriters, with the IBM Selectric being the most commonly used. Such terminals typically operate at 15 characters per second but some go up to 20 characters per second. The characteristics of these and other keyboard printer terminals are presented in Table A-2. Manufacturers of other types of keyboard/printer terminals are attempting to either serve specialized applications or to overcome some of the present
<table>
<thead>
<tr>
<th>Manufacturer Model Number</th>
<th>No. of Keys</th>
<th>Printer Char. Set Size</th>
<th>Keyboard Technique</th>
<th>Printing Technique</th>
<th>Keyboard/Printer Mfr. (if bought out)</th>
<th>Transmission Rate (char/sec)</th>
<th>Transmission Code</th>
<th>Special Comments (options available, etc.)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson Jacobson ADT 233</td>
<td>54</td>
<td>63</td>
<td>E-M Impact</td>
<td>TTY</td>
<td>10 ASCII</td>
<td>Coupler incl.</td>
<td>$2,085</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Transceiver Systems Execuport 300</td>
<td>80</td>
<td>96</td>
<td>E Thermal</td>
<td>NCR</td>
<td>30 ASCII</td>
<td>PTR/P, CRT Cassette</td>
<td>$3,800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connecticut Technical Corporation (Stelma) 8110</td>
<td>55</td>
<td>90</td>
<td>E Impact</td>
<td>Underwood</td>
<td>14.5 ASCII</td>
<td>Coupler incl.</td>
<td>$4,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Datel Thirty 57 88</td>
<td>57</td>
<td>88</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 BCD</td>
<td>Coupler incl.</td>
<td>$5,430</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dura-Model 1021</td>
<td>68</td>
<td>88</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 BCD</td>
<td>PTR/P &amp; Card I/O</td>
<td>$4,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friden-7100</td>
<td>56</td>
<td>91</td>
<td>E Impact</td>
<td>--</td>
<td>12.7 ASCII</td>
<td>Coupler incl.</td>
<td>$3,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GE Terminet 300</td>
<td>74</td>
<td>94</td>
<td>E Impact</td>
<td>--</td>
<td>10, 15, 30 ASCII</td>
<td>PTR/P</td>
<td>$3,400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IBM 1050</td>
<td>54</td>
<td>88</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 BCD</td>
<td></td>
<td>$3,100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IBM 2740/2741</td>
<td>54</td>
<td>88</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 BCD</td>
<td></td>
<td>$6,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kleinschmidt-311</td>
<td>51</td>
<td>64</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 BCD</td>
<td>PTR/P</td>
<td>$4,800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microdyne</td>
<td>56</td>
<td>88</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 BCD</td>
<td>Incr. MT</td>
<td>$5,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teletype Model 33</td>
<td>54</td>
<td>63</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 BCD</td>
<td>PTR/P</td>
<td>$750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teletype Model 35</td>
<td>56</td>
<td>63</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 BCD</td>
<td>PTR/P</td>
<td>$2,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teletype Model 37</td>
<td>54</td>
<td>126</td>
<td>E-M Impact</td>
<td>Selectric (IBM)</td>
<td>15 ASCII</td>
<td>PTR/P</td>
<td>$3,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal Equipment Corp. Tycom 20/20</td>
<td>55</td>
<td>63</td>
<td>E Impact</td>
<td>Selectric (IBM)</td>
<td>15 ASCII</td>
<td>PTR/P</td>
<td>$4,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texas Instruments 720</td>
<td>102</td>
<td>95</td>
<td>E Thermal</td>
<td>--</td>
<td>40 ASCII</td>
<td>Coupler incl.</td>
<td>$4,950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MITE Model 123</td>
<td>50</td>
<td>64</td>
<td>E-M Impact</td>
<td>--</td>
<td>10 ASCII</td>
<td>Coupler Reg</td>
<td>$600</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KEYBOARD PRINTER TERMINALS
Table A-2
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>No. of Keys</th>
<th>Printer Char. Set Size</th>
<th>Keyboard Technique</th>
<th>Printing Technique</th>
<th>Keyboard/Printer Mfgr. (if bought out)</th>
<th>Transmission Rate (char/sec)</th>
<th>Transmission Code</th>
<th>Special Comments (options available, etc.)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MITE Model 123</td>
<td>50</td>
<td>64</td>
<td>E-M</td>
<td>Impact</td>
<td>--</td>
<td>10</td>
<td>ASCII</td>
<td>Coupler req.</td>
<td>$600</td>
</tr>
<tr>
<td>INVAC (Digitronics) TR-200</td>
<td>54</td>
<td>88</td>
<td>E-M</td>
<td>Impact</td>
<td>Selectric (IBM)</td>
<td>15</td>
<td>BCD</td>
<td>Coupler req.</td>
<td>$1,800</td>
</tr>
<tr>
<td>ECCO 1656</td>
<td>54</td>
<td>88</td>
<td>E-M</td>
<td>Impact</td>
<td>Selectric (IBM)</td>
<td>15</td>
<td>ASCII</td>
<td>Coupler req.</td>
<td>$2,500</td>
</tr>
<tr>
<td>NOVAR 5-50</td>
<td>54</td>
<td>88</td>
<td>E-M</td>
<td>Impact</td>
<td>Selectric (IBM)</td>
<td>15</td>
<td>ASCII</td>
<td>Modem incl. MT opt.</td>
<td>$6,000</td>
</tr>
<tr>
<td>OMINTEC 800</td>
<td>50</td>
<td>63</td>
<td>1</td>
<td>Impact</td>
<td>--</td>
<td>10</td>
<td>ASCII</td>
<td>Coupler incl.</td>
<td>$1,490</td>
</tr>
</tbody>
</table>

Clarification of Terms Used in Table A-2

Keyboard Technique - whether the technique used to implement the keyboard is electronic (E) or electromechanical (E-M).

Printing Technique - the technique used to implement the printer.

Keyboard Printer Mfgr. - identification of the company that manufactures the keyboard printer if it is not manufactured by the terminal manufacturer. (A dash indicates that the terminal manufacturer also manufactures the keyboard printer used in the terminal).

Transmission Rate - the number of characters transmitted per second.

Transmission Code - the code in which data is transmitted to and from the terminal.

KEYBOARD PRINTER TERMINALS (continued)
disadvantages of teletype or electric typewriter terminals. These kinds of keyboard/printers usually offer higher speeds at higher costs.

Most users consider trade-offs on keyboard/printers in order of importance as:

1. Cost
2. Reliability
3. Speed

It is likely that 20 to 50 characters per second will be available with impact printers in the near future, but non-impact techniques will be required to achieve significant improvements in speed and reliability.

Non-impact thermal and electrostatic printers are higher in cost, form characters from a dot matrix, require special paper, and do not provide multiple copies; but they provide higher speed, are more reliable, and are quieter. They are presently suited to applications where quietness and higher speed are important, but use of these techniques in terminals is expected to become widespread as their cost drops with further development.

Computer Transceiver uses the NCR thermal printer (see Appendix D on Printers) in its terminal. This non-impact technique permits faster printing rates with fewer mechanical difficulties than in impact printers.

The price of the special paper needed with thermal non-impact printers is quoted between 1¢ and 5¢ per 8-1/2 x 11 inch page.

Texas Instruments offers a Model 720 remote keyboard printer using a 5 x 7 dot matrix thermal printer. This terminal can handle data rates up to 40 characters per second. Incorporated in this terminal is an internal buffer memory (using LSI and MOS circuitry) which stores the keyboard data input by the operator until the CPU polls that terminal. This buffer also allows the user to erase the last character or line entered if desired. The thermal printer in this unit uses a 3M paper that now costs $3 for a 100 foot roll.
APPENDIX B

SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE
BADGE READERS

The characteristics of presently available badge readers and badge preparation units are presented in this Appendix.

During the past year many new companies have entered this field because of the urgent need for low cost, pocketable, machine readable cards, badges and tickets. The companies listed in Table B-1 manufacture either reading units or card preparation equipment. Major applications include personal identification for credit, ticketing and retailing. Some of the badge reader techniques (but not equipments) discussed in this Appendix are also possible candidates for use in PIN labeling and reading.

The primary characteristics of the products offered by these companies are listed and compared in Table B-1.

Encoding techniques in use and under development include large or small, round or rectangular punched holes, several types of magnetic techniques, optical coding, and machine readable embossing. In addition, two companies, Addo-X and Digital Identification Systems, make key-like devices. The maximum number of characters that can be encoded on one unit varies from 6 for the key-like units to 75 for magnetic stripe units. The size of the character set ranges from full ASCII to straight numeric.

A wide range of materials are used. Cards are made of paper, polyvinyl chloride, mylar and other types of durable plastics. Typically, the card size will be similar to the 2-1/8 x 3-3/8 inch credit card. The Addo-X plastic key is made from DuPont Delvin. Digital Identification Systems uses a small integrated circuit. Card prices vary with quantity and the technique used but are in the order of 10¢ to 20¢ per card.

Some companies such as Dasher Business Machines specialize in making
<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Encoding Method</th>
<th>Number of Char or Bits on One Card</th>
<th>Badge or Card Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addo-X Inc.</td>
<td>CPI-3100 Key</td>
<td>Notched Key</td>
<td>Max. 7 numeric</td>
<td>Delrin</td>
</tr>
<tr>
<td>American Computer and Communications</td>
<td>7090-A-210-1</td>
<td>IATA Magnetic Stripe</td>
<td>Max. 75 alphanumeric 8-bit ASCII</td>
<td>Plastic, 2 1/8 x 3 3/8&quot; with Magnetic Stripe</td>
</tr>
<tr>
<td></td>
<td>Docutel Reader</td>
<td>4-Track Magnetic</td>
<td>Max. 50 bits/inch</td>
<td>Plastic, 2 1/8 x 3 3/8&quot; with Magnetic Stripe</td>
</tr>
<tr>
<td></td>
<td>Accounting Terminal</td>
<td>2-Track Magnetic</td>
<td>Max. 40 bits/inch</td>
<td>2 1/8 x 3 3/8&quot; with Magnetic Stripe</td>
</tr>
<tr>
<td>Amp Inc.</td>
<td>360 Series</td>
<td>Rectangular Holes</td>
<td>Max. 12 rows 22 columns, Hollerith</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>Audac Corp.</td>
<td>Telephone Terminal</td>
<td>Optical Bar Code</td>
<td>Max. 61 4-bit Characters</td>
<td>Plastic, Laminated 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>Control Data</td>
<td>0107</td>
<td>Rectangular Holes</td>
<td>Max. 12 rows 22 columns, Hollerith</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td></td>
<td>1020 Series</td>
<td>Rectangular Holes</td>
<td>Max. 12 rows - 15, 22, or 80 columns Hollerith</td>
<td>Plastic, 2 1/8 x 3 3/8&quot; and Full Tab Card Size</td>
</tr>
<tr>
<td>Credit Systems</td>
<td>440</td>
<td>Rectangular Holes Hollerith</td>
<td>Max. 12 rows 22 columns</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>Data Pathing</td>
<td>1101</td>
<td>Rectangular Holes</td>
<td>Max. 12 Rows 22 columns, Hollerith</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>Digital Identification Systems</td>
<td>Digi-Lock</td>
<td>Integrated Circuit</td>
<td>Max. 60 bits</td>
<td>&quot;Key-type&quot; Device Integrated Circuit mounted on 1-1/4&quot; x 1-1/2&quot; Etched Circuit Board</td>
</tr>
<tr>
<td>Company</td>
<td>Type of Preparation Equipment</td>
<td>Reader Physical Characteristics</td>
<td>Interface</td>
<td>Price of Reader</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>-------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Addo-X Inc.</td>
<td>Encoding (key cutter) Rental - $85/month Blank keys - $.05 Pre-cut-$ .25</td>
<td>2-1/2&quot; x 3/4&quot; x 4&quot;</td>
<td>Parallel Binary Output</td>
<td>$ 750</td>
</tr>
<tr>
<td>American Computer</td>
<td>IATA Credit Card Encoder (Service Bureau) Encoder available ($8,500 est.)</td>
<td>Approx. 4.75&quot; x 5&quot; x 4&quot;</td>
<td>Char. Serial Bit Parallel</td>
<td>$2,650</td>
</tr>
<tr>
<td>and Communications</td>
<td>Encoder available ($8,500 est.)</td>
<td>Approx. 12&quot; x 4&quot; x 5&quot;</td>
<td>Char. Serial Bit Parallel</td>
<td>$2,650</td>
</tr>
<tr>
<td>Amp Inc.</td>
<td>Service Bureau</td>
<td>Approx. 5.3&quot; x 4.2&quot; x 4.5&quot;</td>
<td>Bit Parallel</td>
<td>Slightly Larger than Direct Telephone Line Connection</td>
</tr>
<tr>
<td>Audac Corporation</td>
<td>Standard Embossing Machine &amp; Audac Optical Code Generator</td>
<td>Slightly Larger than an Ordinary Telephone</td>
<td>Direct Telephone Line Connection</td>
<td>$2,650</td>
</tr>
<tr>
<td>Control Data</td>
<td>Service Bureau</td>
<td>18&quot; x 12-3/4&quot; x 6-5/8&quot;</td>
<td>Designed for Specific System</td>
<td>$1,590</td>
</tr>
<tr>
<td>Data Pathing</td>
<td>Service Bureau</td>
<td>18&quot; x 12-3/4&quot; x 6-5/8&quot;</td>
<td>Designed for Specific System</td>
<td>$3,340</td>
</tr>
<tr>
<td>Credit Systems</td>
<td>Service Bureau</td>
<td>-----</td>
<td>Designed for Specific System</td>
<td>-----</td>
</tr>
<tr>
<td>Digital Identification</td>
<td>$300 for Unit that Encodes Key Blanks (Approx. $2 for blanks)</td>
<td>Approx. 3&quot; x 1-1/2&quot; x 5&quot;</td>
<td>Serial Pulse Train or Bit Parallel</td>
<td>$100</td>
</tr>
</tbody>
</table>

BADGE AND CARD READERS
Table B-1 (continued)
<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Encoding Method</th>
<th>Number of Char or Bits on One Card</th>
<th>Badge or Card Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friden (1)</td>
<td>30 - Data Collection System</td>
<td>Rectangular Holes</td>
<td>Max. 10 columns</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>General Electric Oklahoma City</td>
<td>MRA 001</td>
<td>2 Circular Magnetic Tracks</td>
<td>22 7-bit ASCII Char per Track</td>
<td>3/4&quot; Diameter Magnetic Patch</td>
</tr>
<tr>
<td>Hickok Electrical Instrument Co.</td>
<td>50</td>
<td>Round Holes</td>
<td>5 x 10, 8 x 10 matrix</td>
<td>Plastic, 1-1/2&quot; x 3-3/4&quot;</td>
</tr>
<tr>
<td></td>
<td>264</td>
<td>Rectangular Holes</td>
<td>12 rows, 22 columns</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>IBM (1)</td>
<td>1035</td>
<td>Rectangular Holes</td>
<td>Max. 12 rows 22 columns (Max. of 10 columns can be read, numeric only)</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>Key Data Machines</td>
<td>Badge Reader</td>
<td>Rectangular Holes</td>
<td>Max. 12 rows 96 columns (using new IBM card standard)</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>Kimball Systems Div.</td>
<td>KR-20</td>
<td>Small Round Hole</td>
<td>Special 1-2-4-7 Code Max. 24 bits</td>
<td>Plastic, 1 1/2 x 3 3/4&quot;</td>
</tr>
<tr>
<td>Sealectro Corporation</td>
<td>SCR-1012</td>
<td>Rectangular Holes</td>
<td>Max. 12 rows 22 columns</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
<tr>
<td>Synergistics</td>
<td></td>
<td>Magnetic (presence or absence, not conventional recording)</td>
<td>35 7-Bit Characters per inch, Max. 50</td>
<td>Plastic, 2 1/8 x 3 3/8&quot;</td>
</tr>
</tbody>
</table>

(1) Normally furnished as part of a complete system

BADGE AND CARD READERS

Table B-1 (continued)
<table>
<thead>
<tr>
<th>Company</th>
<th>Type of Preparation Equipment</th>
<th>Reader Physical Characteristics</th>
<th>Interface</th>
<th>Price of Reader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friden</td>
<td>Service Bureau</td>
<td>18&quot; x 18&quot; x 18&quot;</td>
<td>Char. Serial Bit Parallel</td>
<td>$1,800</td>
</tr>
<tr>
<td>General Electric</td>
<td>Reader available</td>
<td>4-1/2&quot; x 3-3/4&quot; x 6&quot;</td>
<td>Printed Circuit Connector</td>
<td>Approx. $525 in</td>
</tr>
<tr>
<td>Oklahoma City</td>
<td>(Dashew Business Machines will</td>
<td></td>
<td>Serial Pulse Train</td>
<td>small quantities</td>
</tr>
<tr>
<td>Hickok Electrical</td>
<td>provide units on order)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrument Co.</td>
<td>Service Bureau</td>
<td>4&quot; x 4&quot; x 5&quot;</td>
<td>Bit Parallel</td>
<td>Approx. $195</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(50 contact)</td>
</tr>
<tr>
<td></td>
<td>Service</td>
<td>3&quot; x 5&quot; x 4&quot;</td>
<td>Char. Serial Bit Parallel</td>
<td>$250 est. ($100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>for quantity)</td>
</tr>
<tr>
<td>IBM</td>
<td>Service Bureau</td>
<td>8&quot; x 14&quot; x 9-3/4&quot;</td>
<td>Char. Serial Bit Parallel</td>
<td>$1,090</td>
</tr>
<tr>
<td>Key Data Machines</td>
<td>Service Bureau</td>
<td>Approx. 5&quot; x 8&quot; x 3&quot;</td>
<td>Char. Serial Bit Parallel</td>
<td>$100 (1 - 10)</td>
</tr>
<tr>
<td>Kimball Systems</td>
<td>Service Bureau</td>
<td>Approx. 8&quot; x 6&quot; x 9&quot;</td>
<td>Bit Serial</td>
<td>$350 (Small</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Quantities)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$150 (1,000)</td>
</tr>
<tr>
<td>Sealectro Corporation</td>
<td>Service Bureau</td>
<td>Approx. 5-7/16&quot; x 6-1/16&quot; x 9&quot;</td>
<td>Char. Serial Bit Parallel</td>
<td>$424</td>
</tr>
<tr>
<td>Synergistics</td>
<td>Service Bureau or Buy Equipment</td>
<td></td>
<td>Serial pulse Train</td>
<td>Approx. $350 (small quantities) Under $100 for 1000 units in 1971</td>
</tr>
</tbody>
</table>

BADGE AND CARD READERS

Table B-1 (continued)
Clarification of Terms Used in Table B-1

Encoding Method - the method used to encode the identification number or other data on the badge or card.

Type of Preparation Equipment - the type of equipment or other method used for preparing the badge or card--i.e., recording or encoding the data on the badge or card.

Physical Characteristics - the physical size of the reader.

Interface - the type of interface provided by the badge or card reader as seen from external equipment.

BADGE AND CARD READERS

TABLE B-1 (continued)
the equipment used to prepare the cards or badges. This equipment is sold or leased to large users. In addition, Dasher Business Machines will prepare cards to order for customers who do not own preparation equipment, offering nearly every encoding technique.

A wide variety of interfacing techniques are available. Many manufacturers are willing to build "specials" because their readers are frequently built into other equipment.

The oldest encoding technique is punched holes. The Hollerith code using rectangular holes is the most common. Large round holes are commonly used for industrial and outdoor applications. They have the advantages of wider environmental tolerance, more wear resistance and wider dimensional tolerance but the disadvantage of fewer characters per square inch. Kimball, who makes the familiar merchandise tickets uses small round holes.

Recently, several types of magnetic encoding techniques have been developed. Manufacturers claim the advantages of higher character packing density and greater difficulty in illegal copying.

The Air Transport Association has adopted the IATA magnetic stripe technique as their standard. In 2.7 inches, 75 eight-bit characters can be recorded at a density of 210 bits per inch. Companies manufacturing equipment to use this technique are actively encouraging other industries and users to adopt it. However, no information is available about wear, life, or reliability in an application like that for the Library of Congress. The possibility of intentionally or unintentionally damaging or destroying the recorded information with a strong magnetic field would pose problems also for the Library's application.

American Computer and Communications Company uses a four track magnetic stripe recording system differing from the IATA standard by having four tracks instead of one and a lower character packing density.
These changes substantially improve the reading reliability.

An optical code pattern made up of four types of bars is used by Audac Corporation. With this technique they can record 61 characters in a 3-inch space. The main advantages claimed are inexpensive preparation and reading equipment, great tolerance for wear, dirt, and mutilation.

Machine readable embossing is a widely used technique. Low encoding cost is one of the main advantages. The embossed card is frequently used to print the code on a sales slip which is then read optically.

An interesting encoding technique is used by Addo-X. A key made of DuPont Delvin is encoded with notices which can handle seven numeric digits. Extremely low encoding and terminal costs are claimed. Another "key-type" device is manufactured by Digital Identification Systems. The unit uses an integrated circuit. A binary encoding scheme is used presumably in the form of the layout of electrical conductors on the integrated circuit.

Optical character recognition techniques are also used now in some credit card readers, replacing bar codes in many applications. OCR techniques and equipments are discussed in Appendix E.

With the Hollerith and similar rectangular hole encoding schemes, the maximum number of characters on a 2-1/8" x 3-3/8" (standard sized credit card) is 22. Up to 24 characters can be handled by the Kimball Systems small round hole cards. The present Bell System Touch-Tone dialing cards can handle fourteen characters.

The IATA magnetic stripe technique allows up to 75 eight-bit ASCII characters. Forty characters can be handled by General Electric's Tradar System cards. Approximately 60 characters can be handled on a standard sized credit card using the optical bar technique.
The standard eight bit ASCII character set can be handled with the IATA magnetic stripe technique. Using the Hollerith encoding technique, a full alphanumeric set of 64 characters can be defined. Kimball Systems, with their small round hold encoding technique uses a modified binary code to handle a numeric character set. Both alphabetic and numeric characters can be provided by the optical encoding technique. The key device recently introduced by Addo-X handles only numeric information. Digital Identification Systems "integrated circuit key" uses a binary code which could encode alphabetic or numeric characters in a binary number.

Dasher Business Machines provides card preparation service to handle most types of encoding techniques. They are widely used by companies requiring small quantities of cards, a few thousand or less. Large users (e.g., credit card companies), will buy or lease the card preparation equipment from Dasher and other manufacturers.

If some less commonly used technique, such as optical or magnetic bar coding is selected, purchasing or leasing card preparation equipment would be required. Potter Instruments offers a system in which the magnetic bar code card or sheet can be prepared on a modified typewriter (see Appendix E). In this system each alphanumeric character typed has a code of dots typed above and below it by the same typewriter key and hammer using a magnetic ink ribbon. The reader then senses the presence or absence of the dots. The magnetic material is not "recorded"; it is merely present or absent.

Synergistics Inc. offers a magnetic system which depends only on the presence or absence of magnetic material. Groves are cut in a plastic card and then filled with magnetic material corresponding to the desired code. This approach is said to be less expensive and more durable than other approaches which rely on recording patterns on the magnetic material.

Another approach under development by Monarch Marking Systems uses either a pressure sensitive label or a pin-on ticket which is round and has a
hole in the middle. The hole is used to register a hand-held optical scanner that can read 18 characters of data encoded in radial bars. This approach using pressure sensitive labels may be applicable in the future to PIN labeling and reading, but the requirement for achieving registration by inserting a "centering" pin in the hole in the center of the label may preclude its use on the cover of the book. Also, nothing is known at this time about the wear or long-life qualities of a label of this type. For these reasons, and because it is not available at this time, this device is not included in Table B-1.

Minnesota Mining and Manufacturing Company makes a retroreflective material that will be used by Identicon Corporation to place a bar code on labels to be read by a device presently under development. This device is not included in Table B-1 since it is not available at this time.
APPENDIX C

SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE ALPHANUMERIC AND SYMBOL DISPLAYS

The display terminals included in this Appendix are alphanumeric low-cost remote CRT terminals selling for less than $20,000. The costs used for these terminals and equipments are restricted to an operational unit on the remote end of a communications voice grade telephone line not including the modem. Since these devices all have to meet a standard interface requirement, namely the 232B, for operation over telephone lines there are a large number of independent companies offering these products in addition to the computer companies one would expect to offer display peripheral devices.

This Appendix includes all the alphanumeric displays offered at the time this report was written where the display characters are alphabetic, numeric, and special. These characters can be presented in any fashion on the CRT in a text format or, in some cases, in a random format. These types of CRT display terminals can be one way or two way in that information can be displayed only or the operator can employ some means of modifying, editing or changing the information displayed. This changing of information occurs via a keyboard associated with the CRT display terminal. Characteristics of available displays are shown on the next 15 pages (Table C-1).

Remote alphanumeric display terminals can be categorized in basically two ways: stand-alone and multi-station configurations. "Stand-alone" refers to one terminal at a remote location tied to a computer via a communication link whereas "multi-station" refers to more than one terminal at a particular location sharing storage and control logic. In the multi-station configuration a large controller is usually shared between the terminals at a site, but the stand-alone terminal includes its dedicated
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Displayable Char. Set Size</th>
<th>Max. No. of Display. Char.</th>
<th>Lines/Screen</th>
<th>Char/Line</th>
<th>Screen Size</th>
<th>Char Size</th>
<th>Char. Gen Technique</th>
<th>Cursor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. B. Dick Videograph 990</td>
<td>64</td>
<td>768</td>
<td>16</td>
<td>48</td>
<td>Any TV Char.</td>
<td></td>
<td>5 x 7 dot</td>
<td>Std.</td>
</tr>
<tr>
<td>Atlantic Tech. ATC 2000</td>
<td>64/96</td>
<td>1920</td>
<td>24</td>
<td>80</td>
<td>8 1/2 x 11 .12 x .18</td>
<td>Stroke Blinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolt Beranek &amp; Newman Teleputer</td>
<td>64</td>
<td>500</td>
<td>25</td>
<td>20</td>
<td>3.1 x 3.1 .13 x .10</td>
<td>Stroke no</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunker Ramo 2206</td>
<td>62/92</td>
<td>960</td>
<td>12/24</td>
<td>80/80</td>
<td>8.75 x 6.25 .125 x .125</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Bunker Ramo 2223</td>
<td>62/92</td>
<td>960</td>
<td>12/24</td>
<td>80/80</td>
<td>8.75 x 6.25 .125 x .125</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Burroughs 9351/9352</td>
<td>64</td>
<td>960</td>
<td>25</td>
<td>80</td>
<td>12 x 9 .15 x .115</td>
<td>Stroke</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Computer Comm. Inc. CC30</td>
<td>64/96</td>
<td>960</td>
<td>24</td>
<td>40</td>
<td>Any TV Adj.</td>
<td></td>
<td>5 x 7 dot</td>
<td>Std.</td>
</tr>
<tr>
<td>Computer Terminal Corp. 3300</td>
<td>64</td>
<td>1800</td>
<td>25</td>
<td>72</td>
<td>9 x 6.25 .16 x .11</td>
<td>Mod TV Scan</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Conrac Corp. 201</td>
<td>64</td>
<td>888</td>
<td>24</td>
<td>37</td>
<td>7.5 x 8.5 Adj.</td>
<td></td>
<td>5 x 7 dot</td>
<td>Std.</td>
</tr>
<tr>
<td>Control Data Corp 216</td>
<td>63</td>
<td>1000</td>
<td>20</td>
<td>50</td>
<td>8 x 6 .25 x .125</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Control Data Corp 217</td>
<td>63</td>
<td>1000</td>
<td>20</td>
<td>50</td>
<td>8 x 6 .25 x .125</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Courier Executerm I</td>
<td>64</td>
<td>512</td>
<td>15</td>
<td>40</td>
<td>6.4 x 4.8 .11 x .14</td>
<td>7 x 8 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Data Disc Inc. 6200</td>
<td>64/96</td>
<td>4080</td>
<td>48</td>
<td>85</td>
<td>Any TV Adj.</td>
<td></td>
<td>5 x 7 dot</td>
<td>Std.</td>
</tr>
<tr>
<td>Delta Data Systems Corp. 1</td>
<td>64</td>
<td>960</td>
<td>24</td>
<td>40</td>
<td>Any TV Adj.</td>
<td></td>
<td>5 x 7 dot</td>
<td>Std.</td>
</tr>
<tr>
<td>General Electric 760</td>
<td>64</td>
<td>1196</td>
<td>26</td>
<td>46</td>
<td>8 x 6.3 .16 x .12</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>IBM Corp. 2260</td>
<td>64</td>
<td>960</td>
<td>6</td>
<td>40</td>
<td>10.5 x 9.5 .14 x .094</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>IBM Corp. 2265</td>
<td>64</td>
<td>960</td>
<td>15</td>
<td>64</td>
<td>9 x 7.5 .178 x .126</td>
<td>Stroke</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Spira Systems Inc. IRASCOPE</td>
<td>63/96</td>
<td>1000</td>
<td>32</td>
<td>64</td>
<td>7.5 x 9.5 .13 x .10</td>
<td>Monoscope Std.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Cash Register 795</td>
<td>64</td>
<td>768</td>
<td>12</td>
<td>64</td>
<td>7.5 x 9.5 .12 x .09</td>
<td>Stroke</td>
<td>Std.</td>
<td></td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS  TABLE C-1
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Cursor Controls (back, up, down, etc.)</th>
<th>Brightness</th>
<th>Contrast</th>
<th>Type of Memory</th>
<th>Memory Buffer Size (No. Char.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. B. Dick Videograph 990</td>
<td>3</td>
<td>Adj.</td>
<td>Adj.</td>
<td>core</td>
<td>1024</td>
</tr>
<tr>
<td>Atlantic Tech. ATC 2000</td>
<td>7</td>
<td>75</td>
<td>Adj.</td>
<td>delay line</td>
<td>1920</td>
</tr>
<tr>
<td>Bolt Beranek &amp; Newman Teleputer</td>
<td>--</td>
<td>7</td>
<td>4:1</td>
<td>storage tube</td>
<td>--</td>
</tr>
<tr>
<td>Bunker Ramo 2206</td>
<td>5</td>
<td>Adj.</td>
<td>Adj.</td>
<td>delay line</td>
<td>1024</td>
</tr>
<tr>
<td>Bunker Ramo 2223</td>
<td>5</td>
<td>Adj.</td>
<td>Adj.</td>
<td>delay line</td>
<td>1024</td>
</tr>
<tr>
<td>Burroughs 9352</td>
<td>5</td>
<td>50</td>
<td>10:1</td>
<td>delay line</td>
<td>960</td>
</tr>
<tr>
<td>Computer Comm. Inc. CC30</td>
<td>6</td>
<td>Adj</td>
<td>Adj</td>
<td>core</td>
<td>1024</td>
</tr>
<tr>
<td>Computer Terminal Corp. 3300</td>
<td>6</td>
<td>75</td>
<td>12:1</td>
<td>MOS</td>
<td>1800</td>
</tr>
<tr>
<td>Conrac Corp. 201</td>
<td>6</td>
<td>50</td>
<td>Adj</td>
<td>delay line</td>
<td>1000</td>
</tr>
<tr>
<td>Control Data Corp. 216</td>
<td>5</td>
<td>75</td>
<td>8:1</td>
<td>delay line</td>
<td>1000</td>
</tr>
<tr>
<td>Control Data Corp. 217</td>
<td>5</td>
<td>75</td>
<td>8:1</td>
<td>delay line</td>
<td>1000</td>
</tr>
<tr>
<td>Courier</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Executerm I</td>
<td>3</td>
<td>Adj</td>
<td>Adj</td>
<td>MOS</td>
<td>600</td>
</tr>
<tr>
<td>Data Disc Inc. 6200</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>disc</td>
<td>250K</td>
</tr>
<tr>
<td>Delta Data Systems Corp. 1</td>
<td>6</td>
<td>Adj</td>
<td>Adj</td>
<td>core</td>
<td>960</td>
</tr>
<tr>
<td>General Electric 760</td>
<td>6</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>2012</td>
</tr>
<tr>
<td>IBM Corp. 2260</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>960</td>
</tr>
<tr>
<td>IBM Corp. 2265</td>
<td>5</td>
<td>Adj</td>
<td>7:1</td>
<td>delay line</td>
<td>960</td>
</tr>
<tr>
<td>SpirasSystems Inc. IRASCOPE</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>1200</td>
</tr>
<tr>
<td>National Cash Register 795</td>
<td>8</td>
<td>30</td>
<td>Adj</td>
<td>delay line</td>
<td>1024</td>
</tr>
<tr>
<td>Manufacturer/Model No.</td>
<td>Refresh Rate (frames/sec)</td>
<td>Character And/or Line Editing</td>
<td>Tab Feature</td>
<td>Split Screen Capability</td>
<td>Partial Transmit Capability</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------</td>
<td>------------------------------</td>
<td>-------------</td>
<td>-------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>A. B. Dick Videograp 990</td>
<td>60</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Atlantic Tech. ATC 2000</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Bolt, Beranek &amp; Newman Teleputer</td>
<td>-</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Bunker Ramo 2206</td>
<td>54</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Bunker Ramo 2223</td>
<td>54</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Burroughs 9352</td>
<td>60</td>
<td>Partially</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Computer Comm. Inc. CC30</td>
<td>60</td>
<td>Partially</td>
<td>Opt</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Computer Terminal Corp. 3300</td>
<td>60</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Conrac Corp. 201</td>
<td>60</td>
<td>Partially</td>
<td>Opt</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Control Data Corp. 216</td>
<td>50</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Control Data Corp. 217</td>
<td>50</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Courier Executerm I</td>
<td>66</td>
<td>Partially</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Data Disc Inc. 6200</td>
<td>30</td>
<td>Full</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Delta Data Systems Corp. 1</td>
<td>60</td>
<td>Partially</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>General Electric 760</td>
<td>30</td>
<td>Partially</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>IBM Corp. 2260</td>
<td>30</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>IBM Corp. 2265</td>
<td>54</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Spiras Systems Inc. IRASCOPE</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>National Cash Register 795</td>
<td>46.5</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS TABLE C-1 (continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Transmission Code</th>
<th>Modem Interface</th>
<th>Hard Copy Capability</th>
<th>Price Lease</th>
<th>Monthly Rental</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. B. Dick Videograph 990</td>
<td>ASCII</td>
<td>201A</td>
<td>Opt.</td>
<td>$8,300</td>
<td></td>
</tr>
<tr>
<td>Atlantic Tech. ATC 2000</td>
<td>ASCII</td>
<td>201/202</td>
<td>No</td>
<td>$10,000</td>
<td>$365</td>
</tr>
<tr>
<td>Bolt, Beranek &amp; Newman Teleputer</td>
<td>ASCII</td>
<td>201B</td>
<td>Opt.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Bunker Ramo 2206</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$8,600</td>
<td>$235</td>
</tr>
<tr>
<td>Bunker Ramo 2223</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$8,600</td>
<td>$235</td>
</tr>
<tr>
<td>Burroughs 9352</td>
<td>ASCII</td>
<td>201/202</td>
<td>Opt.</td>
<td>$8,775</td>
<td>$200</td>
</tr>
<tr>
<td>Computer Comm. Inc. CC30</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$6,845</td>
<td>$215</td>
</tr>
<tr>
<td>Computer Terminal Corp. 3300</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$4,500</td>
<td>$147</td>
</tr>
<tr>
<td>Conrac Corp. 201</td>
<td>ASCII</td>
<td>201A</td>
<td>No</td>
<td>$7,500</td>
<td></td>
</tr>
<tr>
<td>Control Data Corp. 216</td>
<td>BCD</td>
<td>200 Series</td>
<td>Opt.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Control Data Corp. 217</td>
<td>BCD</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$12,000</td>
<td>$330</td>
</tr>
<tr>
<td>Courier Executerm I</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$3,800</td>
<td>$150</td>
</tr>
<tr>
<td>Data Disc Inc. 6200</td>
<td>ASCII</td>
<td>201/202</td>
<td>Opt.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Delta Data Systems Corp. 1</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$6,600</td>
<td>$85</td>
</tr>
<tr>
<td>General Electric 760</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$24,820</td>
<td>$620</td>
</tr>
<tr>
<td>IBM Corp. 2260</td>
<td>ASCII</td>
<td>201/202</td>
<td>Opt.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>IBM Corp. 2265</td>
<td>ASCII</td>
<td>201/202</td>
<td>Opt.</td>
<td>$15,050</td>
<td>$380</td>
</tr>
<tr>
<td>Spiras Systems Inc. IRASCOPE</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>$5,995</td>
<td>$150</td>
</tr>
<tr>
<td>National Cash Register 795</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Multi-Station Terminals (Max. No. Terminals Per Controller)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. B. Dick</td>
<td></td>
</tr>
<tr>
<td>Videograph 990</td>
<td></td>
</tr>
<tr>
<td>Atlantic Tech.</td>
<td></td>
</tr>
<tr>
<td>ATC 2000</td>
<td>4</td>
</tr>
<tr>
<td>Bolt, Beranek &amp; Newman</td>
<td>32</td>
</tr>
<tr>
<td>Teleputer</td>
<td>9</td>
</tr>
<tr>
<td>Bunker Ramo 2206</td>
<td>16</td>
</tr>
<tr>
<td>Bunker Ramo 2223</td>
<td>--</td>
</tr>
<tr>
<td>Burroughs 9351/9352</td>
<td>12</td>
</tr>
<tr>
<td>Computer Comm. Inc.</td>
<td></td>
</tr>
<tr>
<td>CC30</td>
<td>--</td>
</tr>
<tr>
<td>Computer Terminal Corp.</td>
<td></td>
</tr>
<tr>
<td>3300</td>
<td></td>
</tr>
<tr>
<td>Conrac Corp.</td>
<td></td>
</tr>
<tr>
<td>201</td>
<td></td>
</tr>
<tr>
<td>Control Data Corp.</td>
<td></td>
</tr>
<tr>
<td>216</td>
<td>12</td>
</tr>
<tr>
<td>Control Data Corp.</td>
<td></td>
</tr>
<tr>
<td>217</td>
<td></td>
</tr>
<tr>
<td>Courier</td>
<td></td>
</tr>
<tr>
<td>Executerm I</td>
<td></td>
</tr>
<tr>
<td>Data Disc Inc.</td>
<td></td>
</tr>
<tr>
<td>6200</td>
<td>32</td>
</tr>
<tr>
<td>Delta Data Systems</td>
<td></td>
</tr>
<tr>
<td>Corp. 1</td>
<td></td>
</tr>
<tr>
<td>General Electric</td>
<td></td>
</tr>
<tr>
<td>760</td>
<td>32</td>
</tr>
<tr>
<td>IBM Corp.</td>
<td></td>
</tr>
<tr>
<td>2260</td>
<td>24</td>
</tr>
<tr>
<td>IBM Corp.</td>
<td></td>
</tr>
<tr>
<td>2265</td>
<td></td>
</tr>
<tr>
<td>Spiras Systems Inc.</td>
<td></td>
</tr>
<tr>
<td>IRASCOPE</td>
<td></td>
</tr>
<tr>
<td>National Cash Register</td>
<td></td>
</tr>
<tr>
<td>795</td>
<td>12</td>
</tr>
</tbody>
</table>

Display Terminal Characteristics Table C-1 (continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Displayable Char. Set Size</th>
<th>Max. No. of Display Char.</th>
<th>Lines/Screen</th>
<th>Char/Line</th>
<th>Screen Size</th>
<th>Char Size</th>
<th>Char. Gen Technique</th>
<th>Cursor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philco D22</td>
<td>64</td>
<td>512</td>
<td>16</td>
<td>32</td>
<td>18.4 x 13.8</td>
<td>.517 x .359</td>
<td>5 x 7 dot</td>
<td>Std.</td>
</tr>
<tr>
<td>Radiation 6603</td>
<td>63</td>
<td>1520</td>
<td>32</td>
<td>134</td>
<td>19&quot; TV</td>
<td>.125 x .25</td>
<td>Stroke</td>
<td>Std.</td>
</tr>
<tr>
<td>Raytheon 402</td>
<td>64/96</td>
<td>1040</td>
<td>13</td>
<td>80</td>
<td>8.5 x 6.5</td>
<td>.17 x .14</td>
<td>Monoscope</td>
<td>Std.</td>
</tr>
<tr>
<td>RCA 70/750</td>
<td>64</td>
<td>1080</td>
<td>20</td>
<td>54</td>
<td>8 x 6</td>
<td>.14 x .10</td>
<td>Monoscope</td>
<td>Std.</td>
</tr>
<tr>
<td>RCA 70/752</td>
<td>64</td>
<td>1080</td>
<td>20</td>
<td>54</td>
<td>8 x 6</td>
<td>.14 x .10</td>
<td>Monoscope</td>
<td>Std.</td>
</tr>
<tr>
<td>Sanders 620</td>
<td>64</td>
<td>768</td>
<td>12</td>
<td>64</td>
<td>7.5 x 9.5</td>
<td>.13 x .08</td>
<td>Stroke</td>
<td>Std.</td>
</tr>
<tr>
<td>Sanders 720</td>
<td>64</td>
<td>1024</td>
<td>12</td>
<td>64</td>
<td>7.5 x 8.5</td>
<td>.13 x .08</td>
<td>Stroke</td>
<td>Std.</td>
</tr>
<tr>
<td>Stromberg Carlson 1110</td>
<td>64</td>
<td>1066</td>
<td>13</td>
<td>80</td>
<td>10 x 10</td>
<td>.13 x .07</td>
<td>Charactron</td>
<td>Std.</td>
</tr>
<tr>
<td>Trans Elect. Corp 560/565</td>
<td>64</td>
<td>1000</td>
<td>20</td>
<td>50</td>
<td>9 x 6.25</td>
<td>.15 x .115</td>
<td>Stroke</td>
<td>Std.</td>
</tr>
<tr>
<td>Ultronic 7000</td>
<td>64</td>
<td>960</td>
<td>12</td>
<td>80</td>
<td>7.4 x 10</td>
<td>.12 x .08</td>
<td>5 x 7 dot</td>
<td>Std.</td>
</tr>
<tr>
<td>Univac 100</td>
<td>64/96</td>
<td>960</td>
<td>16</td>
<td>64</td>
<td>5 x 10</td>
<td>.15 x .113</td>
<td>Stroke</td>
<td>Std.</td>
</tr>
<tr>
<td>Univac 300</td>
<td>56/61</td>
<td>1024</td>
<td>16</td>
<td>64</td>
<td>5 x 10</td>
<td>.15 x .113</td>
<td>Stroke</td>
<td>Std.</td>
</tr>
<tr>
<td>Wyle Laboratories Model 600</td>
<td>64</td>
<td>256</td>
<td>8</td>
<td>32</td>
<td>6 x 4.5</td>
<td>.28 x .14</td>
<td>Stroke</td>
<td>Std.</td>
</tr>
<tr>
<td>Xerox Data Systems 7550/7555</td>
<td>96</td>
<td>2048</td>
<td>32</td>
<td>86</td>
<td>10 x 7</td>
<td>.125 x .125</td>
<td>Monoscope</td>
<td>Std.</td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS
TABLE C-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Cursor Controls (back, up, down, etc.)</th>
<th>Brightness</th>
<th>Contrast</th>
<th>Type of Memory</th>
<th>Memory Buffer Size (No. Char.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philco D22 Radiation</td>
<td>4</td>
<td>75</td>
<td>15:1</td>
<td>core</td>
<td>2048</td>
</tr>
<tr>
<td>Philco 5603 Raytheon</td>
<td>3</td>
<td>50</td>
<td>10:1</td>
<td>core</td>
<td>4096</td>
</tr>
<tr>
<td>Raytheon 402 RCA</td>
<td>7</td>
<td>50</td>
<td>Adj</td>
<td>delay line</td>
<td>1040</td>
</tr>
<tr>
<td>RCA 70/750 RCA</td>
<td>5</td>
<td>50</td>
<td>6:1</td>
<td>delay line</td>
<td>1080</td>
</tr>
<tr>
<td>RCA 70/752 Sanders</td>
<td>5</td>
<td>50</td>
<td>6:1</td>
<td>delay line</td>
<td>1080</td>
</tr>
<tr>
<td>Sanders 620 Sanders</td>
<td>5</td>
<td>30</td>
<td>Adj</td>
<td>delay line</td>
<td>768</td>
</tr>
<tr>
<td>Sanders 720</td>
<td>8</td>
<td>30</td>
<td>Adj</td>
<td>delay line</td>
<td>1024</td>
</tr>
<tr>
<td>Stromberg Carlson 1110</td>
<td>5</td>
<td>50</td>
<td>200:1</td>
<td>delay line</td>
<td>1111</td>
</tr>
<tr>
<td>Trans Elect. Corp. 560</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>core</td>
<td>1000</td>
</tr>
<tr>
<td>Ultron 7000</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>960</td>
</tr>
<tr>
<td>Univac 100</td>
<td>7</td>
<td>50</td>
<td>10:1</td>
<td>core</td>
<td>1024</td>
</tr>
<tr>
<td>Univac 300</td>
<td>8</td>
<td>50</td>
<td>10:1</td>
<td>core</td>
<td>1024</td>
</tr>
<tr>
<td>Wyle Laboratories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 600</td>
<td>1</td>
<td>Adj</td>
<td>Adj</td>
<td>core</td>
<td>1024</td>
</tr>
<tr>
<td>Xerox Data Systems</td>
<td>6</td>
<td>20</td>
<td>5:1</td>
<td>delay line</td>
<td>2048</td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Refresh Rate (frames/sec)</th>
<th>Character And/or Line Editing</th>
<th>Tab Feature</th>
<th>Split Screen Capability</th>
<th>Partial Transmit Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philco D22</td>
<td>60</td>
<td>Partially</td>
<td>Opt</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Radiation 6603</td>
<td>60</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Raytheon 402</td>
<td>67</td>
<td>Partially</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>RCA 70/750</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>RCA 70/752</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sanders 620</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sanders 720</td>
<td>46.5</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Stromberg Carlson 1110</td>
<td>50</td>
<td>Full</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trans. Elect. Corp. 560/565</td>
<td>60</td>
<td>Full</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ultronic 7000</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Univac 100</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Univac 300</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Wyle Laboratories Model 600</td>
<td>40</td>
<td>Partially</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Xerox Data Systems 7550/7555</td>
<td>50</td>
<td>Full</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Transmission Code</th>
<th>Modem Interface</th>
<th>Hard Copy Capability</th>
<th>Stand-Alone Terminals Price</th>
<th>Monthly Rental &quot;</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Philco D22</td>
<td>ASCII</td>
<td>201/202</td>
<td>No</td>
<td>--</td>
<td>--</td>
<td>C-10</td>
</tr>
<tr>
<td>Radiation 6603</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Raytheon 402</td>
<td>ASCII</td>
<td>201/202</td>
<td>Std</td>
<td>$6,000</td>
<td>$167</td>
<td></td>
</tr>
<tr>
<td>RCA 70/750</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>RCA 70/752</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$8,325</td>
<td>$190</td>
<td></td>
</tr>
<tr>
<td>Sanders 620</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$5,400</td>
<td>$180</td>
<td></td>
</tr>
<tr>
<td>Sanders 720</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Stromberg Carlson 1110</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$8,500</td>
<td>$250</td>
<td></td>
</tr>
<tr>
<td>Ultronic 7000</td>
<td>ASCII</td>
<td>201/202</td>
<td>Opt</td>
<td>$4,980</td>
<td>$156</td>
<td></td>
</tr>
<tr>
<td>Univac 100</td>
<td>ASCII</td>
<td>200 Series</td>
<td>No</td>
<td>$4,000</td>
<td>$88</td>
<td></td>
</tr>
<tr>
<td>Univac 300</td>
<td>ASCII</td>
<td>201A</td>
<td>No</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Wyle Laboratories Model 600</td>
<td>ASCII</td>
<td>202D</td>
<td>Opt</td>
<td>$5,000</td>
<td>N.A.</td>
<td></td>
</tr>
<tr>
<td>Xerox Data Systems 7550/7555</td>
<td>ASCII</td>
<td>202</td>
<td>Opt</td>
<td>$10,000/$12,500</td>
<td>$225/$285</td>
<td></td>
</tr>
</tbody>
</table>

N. A. - Not Announced/Not Available

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (Continued)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Philco D22</td>
<td>7</td>
<td>N.A.</td>
<td>N.A.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Radiation 6603</td>
<td>16</td>
<td>$250,000</td>
<td>N.A.</td>
<td>$15,625</td>
<td>--</td>
</tr>
<tr>
<td>Raytheon 402</td>
<td>64</td>
<td>$307,840</td>
<td>N.A.</td>
<td>$4,800</td>
<td>--</td>
</tr>
<tr>
<td>RCA 70/750</td>
<td>48</td>
<td>$274,950</td>
<td>$5,850</td>
<td>$5,749</td>
<td>$122</td>
</tr>
<tr>
<td>RCA 70/752</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Sanders 620</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Sanders 720</td>
<td>12</td>
<td>$45,050</td>
<td>$1,330</td>
<td>$3,800</td>
<td>$120</td>
</tr>
<tr>
<td>Stromberg Carlson 1110</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Trans. Elect. Corp. 560/565</td>
<td>16</td>
<td>$62,000</td>
<td>N.A.</td>
<td>$3,875</td>
<td>--</td>
</tr>
<tr>
<td>Ultronic 7000</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Univac 100</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Univac 300</td>
<td>48</td>
<td>$267,865</td>
<td>$8,330</td>
<td>$5,600</td>
<td>$173</td>
</tr>
<tr>
<td>Wyle Laboratories Model 600</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Xerox Data Systems 7550/7555</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

N.A. - Not Announced/Not Available

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1(Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Displayable Char. Set Size</th>
<th>Max. No. of Display Char.</th>
<th>Lines/Screen</th>
<th>Char/Line</th>
<th>Screen Size</th>
<th>Char Size</th>
<th>Char. Gen</th>
<th>Technique</th>
<th>Cursor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infoton KDT-1D</td>
<td>64</td>
<td>1,280</td>
<td>20</td>
<td>64</td>
<td>12&quot;</td>
<td>.45 x .40</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Infoton KDT-2D</td>
<td>64</td>
<td>1,280</td>
<td>20</td>
<td>64</td>
<td>12&quot;</td>
<td>.45 x .4</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Computer Terminals Inc. TK-360</td>
<td>64</td>
<td>448</td>
<td>7</td>
<td>64</td>
<td>11&quot;</td>
<td>.5 x .5</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Courier Executerm 60</td>
<td>64</td>
<td>240/480</td>
<td>12</td>
<td>40</td>
<td>6.4 x 4.8</td>
<td>.11 x .14</td>
<td>7 x 9 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Video Systems Corp. VST-1000</td>
<td>64</td>
<td>1,296</td>
<td>18</td>
<td>72</td>
<td>12&quot;</td>
<td>.25 x .17</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Alphameric Data Corp. DW-33</td>
<td>64</td>
<td>1,800</td>
<td>25</td>
<td>72</td>
<td>11&quot;</td>
<td>.14 x .09</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Sugarman Laboratories Video T6</td>
<td>96</td>
<td>1,600</td>
<td>20</td>
<td>80</td>
<td>14&quot;</td>
<td>Adj.</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Beehive Electrotech Alpha 101</td>
<td>64</td>
<td>800</td>
<td>20</td>
<td>40</td>
<td>11&quot;</td>
<td>Adj.</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Lear Siegler, Inc. Model 810</td>
<td>64</td>
<td>640</td>
<td>20</td>
<td>32</td>
<td>12 x 9</td>
<td>.25 x .18</td>
<td>Stroke</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Honeywell 2323</td>
<td>64</td>
<td>960</td>
<td>24</td>
<td>80</td>
<td>9 x 6.25</td>
<td>.25 x .125</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Honeywell 2322</td>
<td>64</td>
<td>960</td>
<td>24</td>
<td>80</td>
<td>9 x 6.25</td>
<td>.25 x .125</td>
<td>5 x 7 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>RCA Digital Video</td>
<td>117</td>
<td>512</td>
<td>16</td>
<td>32</td>
<td>5, 1 x 6, 8</td>
<td>16 x 14</td>
<td>Scan</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Computer Displays, Inc. ARDS-100A</td>
<td>96</td>
<td>4,000</td>
<td>50</td>
<td>80</td>
<td>8.25 x 6.5</td>
<td>Adj.</td>
<td>7 x 9 dot</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Computek Model 100</td>
<td>64</td>
<td>1,000</td>
<td>20</td>
<td>50</td>
<td>7 x 9.3</td>
<td>.14 x .19</td>
<td>7 x 9 dot</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Computer Optics CO-70</td>
<td>88</td>
<td>3,000</td>
<td>30</td>
<td>100</td>
<td>9.5 x 7.5</td>
<td>.09 x .18</td>
<td>TV Mod.</td>
<td>Std.</td>
<td></td>
</tr>
<tr>
<td>Computer Optics CO-75</td>
<td>88</td>
<td>3,000</td>
<td>30</td>
<td>100</td>
<td>9.5 x 7.5</td>
<td>.09 x .18</td>
<td>TV Mod.</td>
<td>Scan</td>
<td></td>
</tr>
<tr>
<td>Computek Model 400/12</td>
<td>96</td>
<td>3,400</td>
<td>40</td>
<td>85</td>
<td>6.5 x 8.5</td>
<td>.06 x .11</td>
<td>Stroke</td>
<td>Std.</td>
<td></td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Cursor Control (back, up, down, via CPU, etc.)</th>
<th>Brightness</th>
<th>Contrast</th>
<th>Type of Memory</th>
<th>Memory Buffer Size (No. Char.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infoton KDT-ID</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>MOS</td>
<td>1,280</td>
</tr>
<tr>
<td>Infoton KDT-2D</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>MOS</td>
<td>1,280</td>
</tr>
<tr>
<td>Computer Terminals Inc. TK-360</td>
<td>6</td>
<td>Adj</td>
<td>Adj</td>
<td>Core</td>
<td>896</td>
</tr>
<tr>
<td>Courier Executerm 60</td>
<td>7</td>
<td>Adj</td>
<td>Adj</td>
<td>MOS</td>
<td>600</td>
</tr>
<tr>
<td>Video Systems Corp. VST-1000</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>1,296</td>
</tr>
<tr>
<td>Alphameric Data Corp. DW-33</td>
<td>3</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>2,000</td>
</tr>
<tr>
<td>Sugarman Laboratories Video T6</td>
<td>7</td>
<td>Adj</td>
<td>Adj</td>
<td>MOS</td>
<td>1,750</td>
</tr>
<tr>
<td>Beehive Electrotech Alpha 101</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>MOS</td>
<td>800</td>
</tr>
<tr>
<td>Lear Siegler, Inc. Model 810</td>
<td>--</td>
<td>Adj</td>
<td>Adj</td>
<td>core</td>
<td>1,024</td>
</tr>
<tr>
<td>Honeywell 2323</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>960</td>
</tr>
<tr>
<td>Honeywell 2322</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>960</td>
</tr>
<tr>
<td>RCA Digital Video</td>
<td>5</td>
<td>Adj</td>
<td>4:1</td>
<td>delay line</td>
<td>1,080</td>
</tr>
<tr>
<td>Computer Displays, Inc. ARDS-100A</td>
<td>--</td>
<td>3</td>
<td>3:1</td>
<td>Storage tube</td>
<td>--</td>
</tr>
<tr>
<td>Computek Model 100</td>
<td>5</td>
<td>30</td>
<td>Adj</td>
<td>delay line</td>
<td>1,080</td>
</tr>
<tr>
<td>Computer Optics CO-70</td>
<td>4</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>3,000</td>
</tr>
<tr>
<td>Computer Optics CO-75</td>
<td>4</td>
<td>Adj</td>
<td>Adj</td>
<td>delay line</td>
<td>3,000</td>
</tr>
<tr>
<td>Computek Model 400/12</td>
<td>5</td>
<td>Adj</td>
<td>Adj</td>
<td>Storage tube</td>
<td>--</td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Refresh Rate (frames/sec)</th>
<th>Character and/or Line Editing</th>
<th>Tab Feature</th>
<th>Split Screen Capability</th>
<th>Partial Transmit Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infoton KDT-1D</td>
<td>60</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Infoton KDT-2D</td>
<td>60</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Computer Terminals Inc. TK-360</td>
<td>60</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Courier Executerm 60</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Video Systems Corp. VST-1000</td>
<td>60</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Alphameric Data Corp. DW-33</td>
<td>60</td>
<td>Partially</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Sugarman Laboratories Video T6</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Beehive Electrotech Alpha 101</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Lear Siegler, Inc. Model 810</td>
<td>60</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Honeywell 2323</td>
<td>54</td>
<td>Full</td>
<td>Std.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Honeywell 2322</td>
<td>54</td>
<td>Full</td>
<td>Std.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>RCA Digital Video</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Computer Displays, Inc. ARDS-100A</td>
<td>--</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Computek Model 100</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Computer Optics CO-70</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Computer Optics CO-75</td>
<td>60</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Computek Model 400/12</td>
<td>--</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (Continued)
## Display Terminal Characteristics

<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Transmission Code</th>
<th>Modem Interface</th>
<th>Hard Copy Capability</th>
<th>Stand-Alone Terminals Price</th>
<th>Monthly Rental Lease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infoton KDT-1D</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$2,495</td>
<td>N.A.</td>
</tr>
<tr>
<td>Infoton KDT-2D</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$2,995</td>
<td>N.A.</td>
</tr>
<tr>
<td>Computer Terminals Inc. TK - 360</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Courier Executerm 60</td>
<td>ASCII</td>
<td><strong>200 Series</strong></td>
<td>Opt</td>
<td><strong>$5,500</strong></td>
<td>N.A.</td>
</tr>
<tr>
<td>Video Systems Corp. VST - 1000</td>
<td>ASCII</td>
<td>201A</td>
<td>Opt</td>
<td>$3,990</td>
<td>N.A.</td>
</tr>
<tr>
<td>Alphameric Data Corp. DW - 33</td>
<td>ASCII</td>
<td>201/202</td>
<td>Opt</td>
<td>$3,500</td>
<td>N.A.</td>
</tr>
<tr>
<td>Sugarman Laboratories Video T6</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$5,500</td>
<td>N.A.</td>
</tr>
<tr>
<td>Beehive Electrotech Alpha 101</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$3,495</td>
<td>N.A.</td>
</tr>
<tr>
<td>Lear Siegler, Inc. Model 810</td>
<td>ASCII</td>
<td>200 Series</td>
<td>No</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Honeywell 2323</td>
<td>ASCII</td>
<td>201/202</td>
<td>Opt</td>
<td>$10,500</td>
<td>$230</td>
</tr>
<tr>
<td>Honeywell 2322</td>
<td>ASCII</td>
<td>201/202</td>
<td>Opt</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>RCA Digital Video</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Computer Displays, Inc. ARDS -100A</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td><strong>$8,485</strong></td>
<td>N.A.</td>
</tr>
<tr>
<td>Computek Model 100</td>
<td>ASCII</td>
<td>Yes</td>
<td>Opt</td>
<td>$5,700</td>
<td>N.A.</td>
</tr>
<tr>
<td>Computer Optics CO-70</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$8,000</td>
<td>$200</td>
</tr>
<tr>
<td>Computer Optics CO-75</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Computek Model 400/12</td>
<td>ASCII</td>
<td>200 Series</td>
<td>Opt</td>
<td>$7,400</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

N.A. = Not announced or Not available

**DISPLAY TERMINAL CHARACTERISTICS**

**TABLE C-1** (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Maximum Number Terminals</th>
<th>Price of Full Complement</th>
<th>Mo. Rental/Lease Full Complement</th>
<th>Price/Terminal in Max. Config.</th>
<th>Rent/Lease Ter. in Max. Config.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infoton KDT-1D</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Infoton KDT-2D</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Computer Terminals, Inc. TK-360</td>
<td>6</td>
<td>$20,000</td>
<td>$828</td>
<td>$3,340</td>
<td>$138</td>
</tr>
<tr>
<td>Courier Executerm 60</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Video Systems Corp. VST - 1000</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Alphameric Data Corp. DW - 33</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Sugarman Laboratories Video T6</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Beehive Electrotech Alpha 101</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Lear Siegler, Inc. Model 810</td>
<td>12</td>
<td>N.A.</td>
<td>N.A.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Honeywell 2323</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Honeywell 2322</td>
<td>18</td>
<td>N.A.</td>
<td>$1,692</td>
<td>--</td>
<td>$94</td>
</tr>
<tr>
<td>RCA Digital Video</td>
<td>14</td>
<td>$58,000</td>
<td>N.A.</td>
<td>$4,143</td>
<td>--</td>
</tr>
<tr>
<td>Computer Displays, Inc. ARDS -100A</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Computek Model 100</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Computer Optics CO-70</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Computer Optics CO-75</td>
<td>32</td>
<td>$194,500</td>
<td>$4,870</td>
<td>$6,078</td>
<td>$152</td>
</tr>
<tr>
<td>Computeck Model 400/12</td>
<td>8</td>
<td>$36,400</td>
<td>N.A.</td>
<td>$4,550</td>
<td>--</td>
</tr>
</tbody>
</table>

N. A. = Not announced or Not available

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (Continued)
Clarification of Terms Used in Table C-1

Displayable Char. Set Size - the size of the character set or number of different characters that can be displayed.

Max. No. of Display. Char. - the maximum number of characters that can be displayed on the screen at one time.

Lines/Screen - the number of lines of characters displayed on the screen.

Char/Line - the number of characters displayed in each line.

Screen Size - the physical size of the viewing screen.

Char Size - the physical size of each individual character.

Char. Gen Technique - the technique used to generate the characters displayed on the screen.

Cursor - whether a cursor is available as a standard or optional item in the display terminal.

Cursor Control - the number of different controls provided for moving the cursor.

Brightness - whether the brightness is adjustable or fixed and if it is fixed, the number of ft' lumens.

Contrast - whether the contrast is adjustable or fixed and if it is fixed, the contrast ratio.

Type of Memory - the type of memory used for storing the displayed characters and refreshing the CRT screen.

Memory Buffer Size - the number of characters stored in the buffer or refresh memory.

Refresh Rate - the rate in frames per second at which the information displayed on the CRT screen is refreshed from the buffer memory.

Character and/or Line Editing - whether means are provided for editing individual characters and lines.

Tab Feature - whether the ability is provided to move the character position to certain tab locations.

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (continued)
Clarification of Terms Used in Table C-1 (continued)

Split Screen Capability - whether the ability is provided to display two different sets of information in different parts of the screen with the ability to control each set independently of the other.

Partial Transmit Capability - whether the ability to transmit only a portion of the displayed information is provided.

Transmission Code - the code in which data is transmitted to and from the terminal.

Modem Interface - the type of Bell system modem to which the terminal interfaces.

Hard Copy Capability - whether hard copy capability is available as an option.

Stand-Alone Terminals - a terminal that is capable of operating independently as a self-contained unit.

Multi-Station Terminals - terminals which cannot function independently as self-contained units but which require a controller that provides certain functions common to all of the terminals connected to it.

Maximum Number Terminals - the maximum number of terminals that can be connected to a single controller.

Price of Full Complement - the price of a full system including the controller and the maximum number of terminals that can be connected to the controller.

Mo. Rental/Lease Full Complement - the monthly rental or lease price including the controller and the maximum number of terminals that can be connected to the controller.

Price/Terminal in Max. Config. - the average price of a terminal in the maximum configuration including a prorated share of the controller costs.

Rent/Lease Ter. in Max. Config. - the average monthly rental or lease price per terminal including a prorated share of the controller costs.

DISPLAY TERMINAL CHARACTERISTICS

TABLE C-1 (continued)
buffer storage and controller. One should note however that some of these units can be configured either way with some equipment modifications. Both types of alphanumerical terminal configurations are included in the survey. Graphic CRT display terminals are not included in the survey.

The equipment characteristics presented in Table C-1 fall into the following five basic categories:

1. General Characteristics
2. Memory Specifications
3. Editing Features
4. Optional Features
5. Equipment Pricing

The table shows the purchase price and lease price both for stand-alone terminals and for multi-station configurations where one terminal price includes its prorated share of a controller in the maximum multi-station configuration prices. These prices supplied by the manufacturers are intended to include all the necessary equipment on the remote end of the communications link except the modem itself to make the display terminal operational. A reasonable effort was made to verify these figures but in all cases this cannot be guaranteed and they are subject to change without notice.

The general characteristics include the character set size, display size, characters per line, lines per display, maximum number of displayable characters, character size, brightness and contrast ratio. These are self-explanatory and well established specifications. The typical character set available today is 64 characters with 4 or 5 manufacturers offering the full 96 character ASCII set. These manufacturers are offering the 96 character set to provide upper and lower case capability since some users seem to want this additional feature, but usually at little or no additional expense. Hence, in order to be more competitive, a few manufacturers have offered that capability. By the latter part of 1970 most CRT display manufacturers will probably offer this 96 character set as a standard optional capability. Typically, 1000 is the maximum number of displayable characters on the viewing screen, but some CRT terminals are available.
with up to 4000 character screens. By mid-1971 most manufacturers foresee screen capacities up to and including 2000 displayable characters as the trend in alphanumeric CRT displays.

Ease in formatting the display is dependent upon the maximum number of characters that can be stored and displayed in relation to the maximum number of character positions on the screen. One of the basic limitations of larger screen sizes is an electronic circuitry problem arising because of the larger currents or voltages required to deflect the electronic beam across the screen at high speed. This results in higher costs and thus puts limits on screen size. Display size is given in inches for heighth and width respectively and character size is given in inches for the heighth and width respectively.

The character generator techniques used with these types of terminals is one of the following: a 5 x 7 dot matrix, a stroke method, or monoscope. Many trade-offs are involved in the selection of the appropriate technique to meet the overall specifications. The important considerations include character generation rate, number of character types, the complexity and quality of characters, and the number of displays being driven by the character generator. In the 5 x 7 dot matrix method characters are written by brightening the proper combination of spots within the 5 x 7 dot matrix. Character generation rates can be increased in this method by limiting the number of dots used to make up these characters but the character quality will not be as clear as with other techniques. A unique approach which overcomes this limitation typical of dot matrix implementations was developed at MIT on the Intrex Project. Instead of incrementing the beam to each position before intensification, the new Intrex generator selectively intensifies a 750 KHZ sinusoidal signal. This method uses a phased-locked signal to provide a nine (column) by thirteen (row) element array which gives excellent character definition. In this technique a 5 x 7 dot matrix of information is stored and is expanded to the 9 x 13 matrix according to a set of rules.
By going to a larger dot matrix, for example 7 x 10 or 9 x 13, one can generate a satisfactory character representation for the extended Roman alphabet 176 character set. This might be better done by using the stroke method which allows even more freedom in implementing each character. In the stroke method, each stroke is generated from a voltage matrix network which provides a time variable voltage to drive the appropriate deflection circuitry. This method is usually better than the matrix method for generating complex symbols, although the character generation rate is slower.

The monoscope generates each character via an image drawn in ink on a target anode. This technique also produces quality characters but at a slower character generation rate. The CHARACTRON tube made by Stromberg Carlson uses a special technique whereby the characters are generated through a metal electrode in which the 64 character set is etched by a shaped electron beam. This method produces a very legible and distinct print like image on the CRT.

The refresh rate used to maintain a flicker-free viewing screen for all of the CRT displays is included in the characteristics. The type of refresh memory, either magnetic core, MOS or delay lines, is also shown. The size of the memory relates directly to the maximum number of displayable characters and how the memory is organized internally. One efficient method called non-spacial organization requires memory capacity only for the displayed characters plus some control characters.
This eliminates the need for memory to store all blank character positions which can be more efficiently stored by just using the proper control characters. One alternative method for storage in a CRT terminal not using core or delay line memory is the use of a storage tube CRT. A storage tube retains the image on the face plate for several minutes and this saves the cost of an internal memory, but editing of alphanumeric data is cumbersome. It requires special software programs for identifying, deleting, and inserting characters displayed on the screen. Whenever the user wishes to make a correction, he does so through a special function key. The non-storing cursor is used to identify the characters to be edited by a directional control on the keyboard.

Editing capability is a very important feature on any interactive user oriented display terminal. For some requirements the display terminal will be used by the Library of Congress as an information inquiry device but in other situations a large amount of text or data manipulation will be required. Most units in this survey were rated as having either partial or full edit capability for doing operations related to correction, modification, and deletion of certain portions of material presented on the CRT. Each device incorporates a cursor of one type or another which indicates the character position which an operator is editing. Control keys are usually included on the keyboard layout to allow the operator to position the cursor for data manipulation at various positions or locations on the screen. In addition to providing full editing capabilities several of these terminals provide horizontal and vertical tabulation which allows the operator to set specified stops. Some units also provide a line erase feature and a line insertion feature which allows the operator to selectively insert characters in a line of data.

Other features sometimes useful in various applications are partial transmit which allows transmission of a selected portion of the total display screen in contrast to having the whole display screen transmitted. Split screen capability allows retention of previously displayed information while new information is being entered or received. With this means one can be prevented from modifying formatted data as such.
Probably the most important option available on a CRT display terminal in terms of the Library of Congress needs is that of some type of hard copy capability for information and data displayed on the CRT. In many instances an auxiliary printer can be added to provide this permanent method of recording data. Such units typically are low speed teleprinters or typewriters. Hard copy capability is not necessary for all the information displayed on the CRT, but usually only for that generated after several editing steps—i.e., the final copy. This hard copy capability extends the flexibility of the display system and permits other conventional data communications tasks to be performed concurrently.

Since remote terminals imply transmission of information, the units included in this survey are all available with standard telephone line communications interface either to a telephone company or other manufacturer's modem. Practically all the terminals surveyed in this Appendix use the ASCII character code format for data communication. The ASCII code is considered to be the accepted standard throughout the industry now, particularly in government installations.

Human factors considerations are important in display design, including factors such as eye fatigue, legibility, screen background color, size of characters and size of screen. The latter two characteristics are determined largely by the number of characters that must be displayed and the viewing distance from the operator to the screen.

Eye fatigue can be considered a function of parameters such as flicker, brightness, contrast and visual acuity. There is little definitive experience with alphanumeric CRTs in this regard and no published information could be found on eye fatigue while viewing alphanumeric displays. Since brightness and contrast are usually controllable by the operator, there is little difference in eye fatigue between different commercial displays which are flicker free. A light green-yellow screen background is somewhat easier on the eye, but this can be adjusted by filters in front of the screen.
Legibility of displayed characters is difficult to evaluate because the term "legibility" has a wide latitude of meaning to different people. The character font that gives the best reading performance by the operator is usually said to be the most legible. Studies have been made to investigate how operator performance depends on brightness, contrast ratio, character size and style, character spacing and other qualities. The results relate "legibility" to reading ease, reading time and reading error, but no definition or specification of legibility is given—only the claim that certain character fonts are better than others. Even this varies with different operators. In general, more "legible" characters can be generated with TV raster scan, charactron, and monoscope techniques than with dot matrix or stroke techniques.
APPENDIX D

SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE REMOTE PRINTERS

In this Appendix a survey of remote printer terminals including both line and character printers is presented. Table D-1 summarizes the more important characteristics of available remote printers for generating hard copy. The line printers, which are much faster than character serial printers, print one line of data at a time. The printing speed is independent of the number of characters printed on each line but is dependent on the number of columns (or printable character positions per line) and the total number of character types that can be printed. Character printers are designed to print one character at a time horizontally across the paper. Printing speed for character serial printers is in direct proportion to the number of characters printed and control actions that must be taken by the printing device. Typical of the control actions used are the space, back space, upper and lower case, etc. Character serial printers are also discussed to some extent in Appendix A under "Keyboard/Printers".

In general, printing techniques consist of impact printing and non-impact printing. Impact techniques are used in the majority of digital printers today. The impact printer mechanism must selectively present a character type face from a character set to the desired position on the paper. This is done character at a time in the character printer and line at a time in the line printer. The way in which the character set is made selective usually determines the speed and printing technique limitations. In general, impact printers easily make multiple copies while non-impact printers do not.

Impact printers are usually electromechanical while non-impact printers use a variety of technologies, such as electrostatic, thermal, inkjet, etc. Within these categories there are several subdivisions according to the printing and operating principles and technologies involved.

D-1
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>Type of Printer (Char/line)</th>
<th>Printable Character Set Size</th>
<th>Printer Speed (lines/min, char/sec)</th>
<th>Printing Technique</th>
<th>Number of Columns</th>
<th>Physical Size (width, depth, height)</th>
<th>Communications Interface (std., opt.)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SERIAL PRINTERS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Codamite 771</td>
<td>char</td>
<td>63</td>
<td>10 cps</td>
<td>special</td>
<td>80</td>
<td>20.375x19.875</td>
<td>opt.</td>
<td>$1,800</td>
</tr>
<tr>
<td>Gulton Industries LG 10/30</td>
<td>char</td>
<td>64</td>
<td>30 cps</td>
<td>wheel</td>
<td></td>
<td>28x29.2x35</td>
<td>opt.</td>
<td>$5,500</td>
</tr>
<tr>
<td>IBM 2770</td>
<td>char</td>
<td>63</td>
<td>66 cps</td>
<td>7x9 wire matrix</td>
<td>132</td>
<td>23.75x26.5x17</td>
<td>opt.</td>
<td>$4,600</td>
</tr>
<tr>
<td>AB Dick Videojet 960</td>
<td>char</td>
<td>64</td>
<td>250 cps</td>
<td>ink jet</td>
<td>136</td>
<td>24.5x16.375</td>
<td>std.</td>
<td>$7,000</td>
</tr>
<tr>
<td>NCR EM-TI</td>
<td>char</td>
<td>96</td>
<td>30 cps</td>
<td>thermal</td>
<td></td>
<td>12.5x7.25x4.88</td>
<td>opt.</td>
<td>$1,650</td>
</tr>
<tr>
<td>Tally</td>
<td>char</td>
<td>64</td>
<td>60 cps</td>
<td>special</td>
<td>120</td>
<td>34x24x46</td>
<td>opt.</td>
<td>$6,000</td>
</tr>
<tr>
<td>Teletype Inktronic</td>
<td>char</td>
<td>62</td>
<td>120 cps</td>
<td>ink jet</td>
<td>8x10 matrix</td>
<td>18x27x47.75</td>
<td>std.</td>
<td>$5,500</td>
</tr>
<tr>
<td>Univac 0769</td>
<td>char</td>
<td>63</td>
<td>30 cps</td>
<td>wheel</td>
<td>132</td>
<td>27.25x18x9</td>
<td>opt.</td>
<td>$2,800</td>
</tr>
<tr>
<td>Computer Terminals Inc. LP-210</td>
<td>char</td>
<td>64</td>
<td>250 cps</td>
<td>ink jet</td>
<td>136</td>
<td>24.5x29.75x36.75</td>
<td>std.</td>
<td>$7,500</td>
</tr>
<tr>
<td>Motorola MTP-6000</td>
<td>char</td>
<td>63</td>
<td>320 cps</td>
<td>electrostatic</td>
<td>80</td>
<td>17x18x10.125</td>
<td>opt.</td>
<td>$3,850</td>
</tr>
<tr>
<td><strong>DRUM PRINTERS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CDC 9340</td>
<td>line</td>
<td>64</td>
<td>300 lpm</td>
<td>drum</td>
<td>132</td>
<td>46x25x44</td>
<td>opt.</td>
<td>$15,000</td>
</tr>
<tr>
<td>Data Printer Corp. F-80</td>
<td>line</td>
<td>64</td>
<td>600 lpm</td>
<td>drum</td>
<td>80</td>
<td>18.125x16.25</td>
<td>opt.</td>
<td>$8,250</td>
</tr>
<tr>
<td>Data Printer Corp. F-132</td>
<td>line</td>
<td>64</td>
<td>600 lpm</td>
<td>drum</td>
<td>132</td>
<td>23.75x16.25x12</td>
<td>opt.</td>
<td>$9,860</td>
</tr>
<tr>
<td>Data Products DT-8280</td>
<td>line</td>
<td>64</td>
<td>356 lpm</td>
<td>drum</td>
<td>80</td>
<td>24x22x24</td>
<td>std.</td>
<td>$17,100</td>
</tr>
<tr>
<td>Data Products 2410</td>
<td>line</td>
<td>64</td>
<td>245 lpm</td>
<td>drum</td>
<td>132</td>
<td>48.5x24x46</td>
<td>opt.</td>
<td>$11,900</td>
</tr>
</tbody>
</table>

**HARD COPY DEVICES (REMOTE PRINTERS)**

**TABLE D-1**
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>Type of Printer (Chars/line)</th>
<th>Printable Character Set Size</th>
<th>Printer Speed (lines/min char/sec)</th>
<th>Printing Technique</th>
<th>Number of Columns</th>
<th>Physical Size (width, depth height)</th>
<th>Communications Interface (std., opt.)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCR 740-501</td>
<td>line</td>
<td>64</td>
<td>250 lpm</td>
<td>drum</td>
<td>132</td>
<td>39x24.5x48</td>
<td>opt.</td>
<td>$20,000</td>
</tr>
<tr>
<td>Digitronics 4021</td>
<td>line</td>
<td>64</td>
<td>292 lpm</td>
<td>drum</td>
<td>120</td>
<td>44x30x48</td>
<td>std.</td>
<td>$42,420</td>
</tr>
<tr>
<td>G.E. 1-541</td>
<td>line</td>
<td>64</td>
<td>100 lpm</td>
<td>drum</td>
<td>136</td>
<td>26.5x14x28.25</td>
<td>opt.</td>
<td>$ 8,000</td>
</tr>
<tr>
<td>G.E. 105 RTS</td>
<td>line</td>
<td>64</td>
<td>250 lpm</td>
<td>drum</td>
<td>120</td>
<td>46.5x26.5x51.5</td>
<td>std.</td>
<td>$56,670</td>
</tr>
<tr>
<td>Honeywell MBP-12</td>
<td>line</td>
<td>64</td>
<td>300 lpm</td>
<td>drum</td>
<td>132</td>
<td>45x30x45.5</td>
<td>opt.</td>
<td>$12,000</td>
</tr>
<tr>
<td>Mohawk Data Sciences 4013</td>
<td>line</td>
<td>64</td>
<td>300 lpm</td>
<td>drum</td>
<td>120</td>
<td>39x24.5x48</td>
<td>opt.</td>
<td>$11,500</td>
</tr>
<tr>
<td>Vogue Shepard 400A</td>
<td>line</td>
<td>128</td>
<td>600 lpm</td>
<td>drum</td>
<td>80</td>
<td>41x29x47.5</td>
<td>opt.</td>
<td>$14,250</td>
</tr>
<tr>
<td>Vogue Shepard 400B</td>
<td>line</td>
<td>128</td>
<td>600 lpm</td>
<td>drum</td>
<td>132</td>
<td>46x29x47.5</td>
<td>opt.</td>
<td>$17,850</td>
</tr>
<tr>
<td>Vogue Shepard 880C</td>
<td>line</td>
<td>64</td>
<td>600 lpm</td>
<td>drum</td>
<td>80</td>
<td>20.5x16x36.5</td>
<td>opt.</td>
<td>$10,500</td>
</tr>
</tbody>
</table>

**OTHER TYPE PRINTERS:**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Type of Printer</th>
<th>Printable Character Set Size</th>
<th>Printer Speed (lines/min)</th>
<th>Printing Technique</th>
<th>Number of Columns</th>
<th>Physical Size (width, depth height)</th>
<th>Communications Interface (std., opt.)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datamark, Inc. Series 700</td>
<td>line</td>
<td>64</td>
<td>300 lpm</td>
<td>oscillating bar</td>
<td>132</td>
<td>45.5x22.5x43</td>
<td>std.</td>
<td>$14,500</td>
</tr>
<tr>
<td>IBM 2780</td>
<td>line</td>
<td>63</td>
<td>200 lpm</td>
<td>type bar</td>
<td>80</td>
<td>42x26.75x47.5</td>
<td>std.</td>
<td>$32,010</td>
</tr>
<tr>
<td>Clevite 4800</td>
<td>line</td>
<td>64</td>
<td>4800 lpm</td>
<td>electrostatic</td>
<td>75</td>
<td>21x14x39</td>
<td>opt.</td>
<td>$19,000</td>
</tr>
<tr>
<td>Nortec</td>
<td>line</td>
<td>128</td>
<td>100 lpm</td>
<td>belt</td>
<td>132</td>
<td>22.5x20x9.5</td>
<td>opt.</td>
<td>$ 9,800</td>
</tr>
</tbody>
</table>

**CHAIN PRINTERS:**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Type of Printer</th>
<th>Printable Character Set Size</th>
<th>Printer Speed (lines/min)</th>
<th>Printing Technique</th>
<th>Number of Columns</th>
<th>Physical Size (width, depth height)</th>
<th>Communications Interface (std., opt.)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mohawk Data Sciences 4330</td>
<td>line</td>
<td>128</td>
<td>162 lpm</td>
<td>chain</td>
<td>136</td>
<td>40.5x29.25x48</td>
<td>opt.</td>
<td>$ 9,500</td>
</tr>
<tr>
<td>CDC 9360</td>
<td>line</td>
<td>288</td>
<td>245 lpm</td>
<td>chain (train)</td>
<td>132</td>
<td>62x28x50</td>
<td>std.</td>
<td>$75,000</td>
</tr>
<tr>
<td>IBM 1403</td>
<td>line</td>
<td>240</td>
<td>140 lpm</td>
<td>chain</td>
<td>132</td>
<td>46x28x50</td>
<td>std.</td>
<td>$126,000</td>
</tr>
<tr>
<td>Potter HSP-3502</td>
<td>line</td>
<td>192</td>
<td>170 lpm</td>
<td>chain</td>
<td>132</td>
<td>45.125x30.875x</td>
<td>opt.</td>
<td>$11,220</td>
</tr>
</tbody>
</table>

**HARD COPY DEVICES (REMOTE PRINTERS) TABLE D-1 (continued)**
Clarification of Terms Used in Table D-1

Type of Printer - whether the printer is character serial or line printer.

Printable Character Set Size - the size of the character set or the number of different types of characters that can be printed.

Printer Speed - the speed of the printer in characters per second or lines per minute.

Printing Technique - the technique used for printing.

Number of Columns - the maximum number of columns that can be printed across the width of the page.

Physical Size - the physical dimensions of the printer.

Communications Interface - whether a communications interface is provided as standard equipment or is optional.
Typical non-impact types include dot matrix printers (both electrograph and thermograph) and ink jet printers. The NCR EM-T1 printer is typical of this approach. A single print head is used to print one character at a time over an 80 column print line. The print head contains a 5 x 7 dot matrix and the characters are formed by heating selected elements of the matrix and bringing the head into contact with the heat sensitive paper.

Motorola uses an electrographic technique in which an electric pulse applied to a stylus in contact with the paper causes a change to take place on the paper's surface in the form of a dark dot. Electrical pulses from the printing heads instantly mark the dry current sensitive paper. As the print head is moved across the paper, it receives five sequential sets of seven parallel pulses to form a 5 x 7 dot matrix.

Line printers available today are capable of printing line lengths (i.e., columns) of 80 to 160 characters with type fonts of 64 characters or more. These units and their important characteristics are included in Table D-1. Strip and half page (i.e., 32 columns or less) printers are not included in this survey because these types of printers are primarily used in data logging or monitoring functions.

The printer characteristics used in this survey related to the use of printers in a data entry or communication terminal. Any trade-off analyses with respect to printer characteristics must include the printer line speed which is a function of the number of columns (or character positions) per line and the number of characters in the character set. The size of the character set determines the speed because it takes a finite amount of time to present each character in the set to the print position when moving font techniques are involved, thus the larger the character set the slower the speed. Typically the speed of line printers range from 100 to 1200 lines per minute although even higher speed line printers are available. Within the next few years speeds will probably be pushed up to 2000 lines per minute.
The interface between the printer and the data source is another very important consideration. Input data formatting, timing, and device control must be examined along with the electrical and mechanical interface problems. For example, a serial printer receiving parallel data requires a buffer interface. The timing considerations must include the formatting and conversion of data to synchronize with the print cycle.

Line printers that are commercially available today are of the electromechanical impact type. There are two major types of impact line printers—drum printers and chain printers.

In drum printers the print font is on a continuously revolving drum with one or more hammers impacting it "on the fly" while the drum moves. An inked ribbon and the paper are interposed between the hammers and the print drum. In this type all the characters in the set are available to each print position so that a properly timed firing of a hammer will print the selected character. Recent research in electromechanical drum printers has been directed toward time-sharing hammers to reduce hammer and hammer driver cost. This is done by separating the type used for odd and even columns in a manner such that a hammer with a head two columns wide is first fired to print the odd columns and then to print the even columns. This technique allows 60 hammers and hammer drives to print 120 columns.

Chain printers are much like drum printers in that an inked ribbon is interposed between the type font and the face of the paper, and the character to be printed is selected by firing a hammer against the back of the paper or the ribbon when the selected character reaches that hammer position. Chain printers require characters to be carried on a flexible band, which must be routed around pulleys of fairly large diameter to avoid excessive stresses in the band.

Research on chain printers has been directed toward reducing the cost of type font and allowing field changes in the type font. Mohawk Data Sciences (Analex) recently announced a new low cost chain printer (Model 4330) which has both a 136 column line and a 128 character set.
It sells for $9,500 with buffer.

Table D-1 also includes other printers that do not fit in the drum and chain categories—e.g., oscillating bars or belts for font and hammer selection, dot matrix designs where the character is made dot at a time by either multiple impacts of a single hammer or by impacts of multiple hammers, and electrostatic techniques.

A recent announcement in this field is the Model 2213 matrix printer which is part of the IBM 2770 modular remote terminal. This character serial matrix printer, which is capable of 66 characters per second, utilizes a mechanism for impressing a 9 x 7 dot matrix to form characters. The dots are formed by the ends of wires which are moved forward by energy supplied from an actuator. The printing occurs when the wires forming the character are fired against the paper through an inked ribbon.

A Philips subsidiary in West Germany announced it has developed a 90 character per second character serial print-out device. This high speed typeless print technique uses a vertical line of magnet-actuated printing pins to form alphanumeric characters as patterns of dots on a raster field. One significant advantage of this printing technique is that it can produce all kinds of characters, including Roman hieroglyphs or Chinese ideograms provided the character generating circuitry is programmed accordingly. Sufficient information is not available to include this in Table D-1.

Codamite offers a low cost remote receive only impact printer terminal which uses digital step motors for type font and hammer indexing. The font is behind the paper and the hammer impacts a ribbon in front of the font. The font translates and rotates simultaneously but is stationary at the instant of printing. This unit is said to require very little maintenance and no lubrication.
The Teletype Inktronic utilizes a fine spray of fast-drying ink directed against a roll or sheet or ordinary paper to achieve a 120 characters per second speed. In present technology, the ink source is moved horizontally across the paper to determine character position and the ink is electrostatically deflected in order to "draw" characters. The principle used is much the same as that achieved in a cathode-ray-tube by the electron beam being deflected to draw characters on the face of the tube. The number of moving parts required for a spray printer is reduced to a minimum and includes only the paper transport, which is required for all printing devices, and the spray positioner.

A.B. Dick offers an ink-stream communication terminal printer which has a speed of 250 cps. In contrast to Teletype's Inktronic keyboard/printer terminal (which employs 40 stationary nozzles each printing two characters) the Videojet 960 uses one nozzle driven in a horizontal plane. The movement of the nozzle provides horizontal deflection of the ink droplets and high voltage plates provide vertical deflection.

Conventional electromechanical character serial printers are also discussed further in Appendix A under "Keyboard/Printers".
APPENDIX E

SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE
MACHINE READABLE UNIT DOCUMENT DEVICES

This Appendix on Machine Readable Unit Document Devices covers the characteristics of the three major types of devices available today for this function -- Optical and Magnetic Character Recognition Equipment and Optical Mark Sense Readers. The characteristics of presently available devices of these types are presented in Table E-1. Some of the techniques discussed here may be applicable to PIN Labels as well as Machine Readable Unit Documents. Since Section 3.8 points out that punched card equipment that both punches and prints on the card are more expensive than devices using other techniques discussed here and offer no significant advantage, conventional card punches and readers are not included in this Appendix.

The first technique to be widely used commercially was Magnetic Ink Character Readers (MICR). They are extensively used in the banking industry. A special font style, defined by the American Bankers Association, is used. The character set consists of ten numerals and four special symbols. No alpha characters are allowed. Disadvantages of MICR are lack of alpha characters and difficulty of human readability.

Optical character Recognition Equipment (OCR) is in use and is being actively developed for many commercial applications. It has the advantages that a full alphanumeric character set can be handled (although numeric only sets are frequently used for lower cost) and the font style is more easily human readable. The main disadvantage is high cost; although recent development of remote terminal readers will greatly reduce the cost by sharing central control and recognition logic and circuitry among a number of remote readers. The major present commercial application of OCR is in handling documents such as credit card receipts. However, applications also extend to full size pages. In fact, OCR is being used in some applications for reading full pages of typed information as a way of generating computer input data in lieu of conventional keypunching.
<table>
<thead>
<tr>
<th>Name of Company</th>
<th>Equipment Model</th>
<th>Document Feed Type</th>
<th>Document Transport Type</th>
<th>Document Size (Inches)</th>
<th>Documents Per Minute</th>
<th>Reader Scanner Type</th>
<th>Recognition Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burroughs</td>
<td>B102 &amp; B103</td>
<td>Friction</td>
<td>Conveyor Belt</td>
<td>Length: 5.94-9.06</td>
<td>1,000 to 1,565</td>
<td>Magnetic</td>
<td>Analog Waveform Matching</td>
</tr>
<tr>
<td></td>
<td>B9134-1</td>
<td>Friction</td>
<td>Conveyor Belt and Roller</td>
<td>Length: 5.94-9.06</td>
<td>1,625</td>
<td>Magnetic or Optical</td>
<td>Matrix Matching</td>
</tr>
<tr>
<td>Control Data Corporation, Rabinow Div.</td>
<td>915 Page Reader</td>
<td>Vacuum</td>
<td>Belt</td>
<td>Length: 2.5 to 14</td>
<td>Max. 180 for 8.5 x 11&quot;</td>
<td>Optical Matrix</td>
<td>Matrix Matching</td>
</tr>
<tr>
<td>Remote Terminal Reader</td>
<td></td>
<td></td>
<td></td>
<td>Paper: Length: 4.87-11.12</td>
<td>Approx. 400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cards: Length: 4.87-8.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Optional) Width: 3.25-5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Journal)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Single Line Document</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farrington Electronics, Inc.</td>
<td>3010 Document Reader</td>
<td>Vacuum</td>
<td>Drive Rollers</td>
<td>Card Stock: From 2.2 x 2.75 to: 8.5 x 6.0</td>
<td>Max. 440</td>
<td>Optical Mechanical Disc</td>
<td>Stroke Analysis</td>
</tr>
<tr>
<td></td>
<td>3020 Self-Punch</td>
<td>Vacuum</td>
<td>Drive Rollers</td>
<td>Standard Tab Cards: 51 or 80 Columns</td>
<td>Max. 500</td>
<td>Optical Mechanical Disc</td>
<td>Stroke Analysis</td>
</tr>
<tr>
<td></td>
<td>3630 Pa..c Reader</td>
<td>Vacuum</td>
<td>Drive Rollers</td>
<td>From: 4.5 x 5.5 (1) to: 8.5 x 14</td>
<td></td>
<td>Optical Mechanical Disc</td>
<td>Stroke Analysis</td>
</tr>
</tbody>
</table>

(1) Dependent upon number of lines and fields within lines to be read

OPTICAL AND MAGNETIC CHARACTER RECOGNITION EQUIPMENT AND MARK SENSE READERS

TABLE E-1
<table>
<thead>
<tr>
<th>Name of Company</th>
<th>Equipment Model</th>
<th>Type Font</th>
<th>Character Set</th>
<th>Reading Speed (ch./sec.)</th>
<th>First Installation</th>
<th>Approximate Base Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burroughs</td>
<td>B102 &amp; B103 Sorter-Reader</td>
<td>E-13B, CMC-7</td>
<td>Numerals, Four Special Characters</td>
<td>Max. 3,200</td>
<td>1960</td>
<td>$91,000</td>
</tr>
<tr>
<td></td>
<td>B9134-1</td>
<td>E-13B, CMC-7, USASC, OCR-B</td>
<td>Numerals, Four Symbols (Five Symbols OCR-B)</td>
<td>2,400 (MICR), 3,000 (OCR)</td>
<td>Late 1969, 1970</td>
<td>$96,000, $80,400</td>
</tr>
<tr>
<td>Control Data Corporation, Rabinow Div.</td>
<td>915 Page Reader</td>
<td>USASC</td>
<td>Alphanumeric, Punctuation</td>
<td>Max. 370</td>
<td>1965</td>
<td>$110,000</td>
</tr>
<tr>
<td>Farrington Electronics, Inc.</td>
<td>3010 Document Reader</td>
<td>Selfchek 7B, 12F and/or Selfchek 12L, IBM 407, IBM1428 USASC</td>
<td>Alphanumeric, Punctuation Marks, Special Symbols</td>
<td>Max. 400</td>
<td>1967</td>
<td>$2,920 R(rental)</td>
</tr>
<tr>
<td></td>
<td>3020 Self-Punch</td>
<td>Selfchek 7B, 7BR, 12F and 12L, IBM 1428 USASC</td>
<td>Numerals Special Symbols Punctuation</td>
<td>Max. 600</td>
<td>1969</td>
<td>$2,635 R(rental)</td>
</tr>
<tr>
<td></td>
<td>3030 Page Reader</td>
<td>Selfchek 12F and/or Selfchek 12L, USASC</td>
<td>Alphanumeric, Punctuation Marks Special Symbols</td>
<td>Max. 400</td>
<td>1967</td>
<td>$3,625 R(rental)</td>
</tr>
<tr>
<td>Name of Company</td>
<td>Equipment Model</td>
<td>Feed Type</td>
<td>Transport Type</td>
<td>Size (Inches)</td>
<td>Documents Per Minute</td>
<td>Reader Type</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------</td>
<td>-----------</td>
<td>----------------</td>
<td>--------------</td>
<td>----------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Farrington Page Reader Inc. (Cont'd.)</td>
<td>3050</td>
<td>Vacuum</td>
<td>Drive Rollers</td>
<td>From: 4.5 x 5.5 to: 8.5 x 13.5</td>
<td>(1)</td>
<td>Optical</td>
</tr>
<tr>
<td></td>
<td>4040</td>
<td>Tape Spool</td>
<td>Vacuum Conveyor</td>
<td>Length: to 350 ft. Width: 1.31-4.5</td>
<td>6,000 lpm</td>
<td>Flying</td>
</tr>
<tr>
<td>General Electric MRS-200/205</td>
<td>Friction Vacuum</td>
<td>Conveyor Belt</td>
<td>Length: 5.25-9.0 Width: 2.5-4.15</td>
<td>Max. 1,200</td>
<td>Magnetic or Optical</td>
<td>Analog Waveform Analysis (MICR) Inbuilt Code (OCR)</td>
</tr>
<tr>
<td>GE/Bull DRD-200</td>
<td>Friction Vacuum</td>
<td>Conveyor Belt</td>
<td>Length: 3.5-8.5 Width: 2.5-4.19</td>
<td>1,200</td>
<td>Optical</td>
<td>Inbuilt Code</td>
</tr>
<tr>
<td></td>
<td>MDR-100</td>
<td>Friction</td>
<td>Belt</td>
<td>Length: 2.35-8.75 Width: 2.75-4.5</td>
<td>300-650</td>
<td>Magnetic</td>
</tr>
<tr>
<td>Honeywell H-243</td>
<td>Vacuum</td>
<td>Conveyor Belt</td>
<td>Length: 3 x 3.5 Width: 4 x 8</td>
<td>1,100</td>
<td>Optical</td>
<td>Photo Cells Matrix Matching</td>
</tr>
<tr>
<td>IBM IBM 1412</td>
<td>Friction</td>
<td>Conveyor Belt</td>
<td>Length: 6-8.75 Width: 2.75-3.66</td>
<td>Max. 950</td>
<td>Magnetic</td>
<td>Matrix Matching</td>
</tr>
<tr>
<td></td>
<td>IBM 1418</td>
<td>Friction</td>
<td>Vacuum Drum and Conveyor Belt</td>
<td>Length: 5.875-8.75 Width: 2.75-3.67</td>
<td>Max. 420</td>
<td>Optical Mechanical</td>
</tr>
<tr>
<td></td>
<td>IBM 1419</td>
<td>Friction</td>
<td>Conveyor Belt</td>
<td>Length: 6-8.75 Width: 2.75-3.67</td>
<td>Max. 1,600</td>
<td>Magnetic</td>
</tr>
<tr>
<td></td>
<td>IBM 1428 I, II, &amp; III</td>
<td>Friction</td>
<td>Vacuum Drum and Conveyor Belt</td>
<td>From: 3.5 x 2.25 to: 8.75 x 4.25</td>
<td>Max. 400</td>
<td>Optical Mechanical</td>
</tr>
<tr>
<td></td>
<td>IBM 1282</td>
<td>Friction</td>
<td>Card</td>
<td>51 or 80 Column Cards</td>
<td>Max. 200</td>
<td>Optical</td>
</tr>
<tr>
<td></td>
<td>IBM 1285</td>
<td>Tape Spool</td>
<td>Journals Rolls Width: 1.31-3.5 Length: 36&quot; to 200'</td>
<td>Max. 2,000 lpm</td>
<td>CRT Scanner</td>
<td>Matrix Matching</td>
</tr>
</tbody>
</table>

(1) Dependent upon number of lines and fields within lines to be read

OPTICAL AND MAGNETIC CHARACTER RECOGNITION EQUIPMENT AND MARK SENSE READERS

TABLE E-1 (Continued)
<table>
<thead>
<tr>
<th>Name of Company</th>
<th>Equipment Model</th>
<th>Type Font</th>
<th>Character Set</th>
<th>Reading Speed (ch./sec.)</th>
<th>First Installation</th>
<th>Approximate Base Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farrington Electronics, Inc. (Cont'd.)</td>
<td>3050 Page Reader</td>
<td>Selfcheck 12L or OCR-A Only</td>
<td>Alphanumeric, Special Symbols</td>
<td>Max. 400</td>
<td>1969</td>
<td>$2,345 R (rental)</td>
</tr>
<tr>
<td></td>
<td>4040 Journal Tape Reader</td>
<td>Selfcheck 7B or 12FIBM 1428, NOF, USASC</td>
<td>Numerals, Special Symbols</td>
<td>Max. 2,000</td>
<td>1969</td>
<td>$3,150 R (rental)</td>
</tr>
<tr>
<td>General Electric</td>
<td>MRS-200/205</td>
<td>E13B, CMC-7, COC-5</td>
<td>Numerals, Limited Symbols</td>
<td>Max. 2,400</td>
<td></td>
<td>$2,080 R (rental)</td>
</tr>
<tr>
<td>IBM</td>
<td>IBM 1412</td>
<td>E-13B</td>
<td>Numerals, Four Special Symbols</td>
<td>Max. 1,600</td>
<td>1960</td>
<td>$91,400</td>
</tr>
<tr>
<td></td>
<td>IBM 1418</td>
<td>IBM 407-1 Font or 407-E-1</td>
<td>Numerals, Special Symbols</td>
<td>Max. 500</td>
<td>1962</td>
<td>$120,300</td>
</tr>
<tr>
<td></td>
<td>IBM 1419 Model I</td>
<td>E-13B</td>
<td>Numerals, Four Special Symbols</td>
<td>Max. 2,112</td>
<td>1962</td>
<td>$110,500</td>
</tr>
<tr>
<td></td>
<td>IBM 1428</td>
<td>IBM 1428</td>
<td>Alphanumeric, Special Symbols</td>
<td>Max. 480</td>
<td>1963</td>
<td>$138,600</td>
</tr>
<tr>
<td></td>
<td>IBM 1282</td>
<td>1428E, Farrington Selfcheck</td>
<td>Numerals Three Symbols</td>
<td>N/O</td>
<td>1964</td>
<td>$72,000</td>
</tr>
<tr>
<td></td>
<td>IBM 1285</td>
<td>1428-NOF</td>
<td>Numerals Seven Symbols</td>
<td>Max. 365</td>
<td>1966</td>
<td>$84,000</td>
</tr>
<tr>
<td>Name of Company</td>
<td>Equipment Model</td>
<td>Document Feed Type</td>
<td>Document Transport Type</td>
<td>Document Size (Inches)</td>
<td>Documents Per Minute (1)</td>
<td>Reader Scanner Type</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>--------------------</td>
<td>-------------------------</td>
<td>------------------------</td>
<td>--------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>IBM (Cont'd)</td>
<td>IBM 1287</td>
<td>Friction + Tape</td>
<td>Belt and Roller</td>
<td>Max. 5.91 x 9.00 Min. 2.25 x 3.00</td>
<td>Max. 750 (Doc.) Max. 3,400 lpm (J. T.)</td>
<td>Optical CRT Scanner</td>
</tr>
<tr>
<td></td>
<td>IBM 1288</td>
<td>Friction</td>
<td>Belt and Roller</td>
<td>3&quot; x 6.5&quot; to 9&quot; x 14&quot;</td>
<td>Max. 444</td>
<td>Optical CRT Scanner</td>
</tr>
<tr>
<td>National Cash Register Co.</td>
<td>420-2</td>
<td>Automatic Tape Spooling Device</td>
<td>Tape</td>
<td>Journal Rolls Width: 1.31 x 3.25 Length:10 to 1560&quot;</td>
<td>52 lines per sec.</td>
<td>Optical Mechanical Disc</td>
</tr>
<tr>
<td>670-101 Sorter-Reader</td>
<td>Friction Belt</td>
<td>Conveyor Belt</td>
<td>Length: 5.8 to 8.75 Max. 600 Width: 2.5 to 3.85</td>
<td>Magnetic Waveform Matching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>671-101 Sorter-Reader</td>
<td>Friction Belt</td>
<td>Conveyor Belt</td>
<td>Length: 4 to 8.75 Width: 2.75 to 4.5</td>
<td>Magnetic Matrix Matching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optical Scanning Corporation</td>
<td>Opscan 288</td>
<td>Vacuum Belt</td>
<td>Conveyor Belt</td>
<td>Length: 3.5 to 8.5 Width: 2.5 to 4.5</td>
<td>Optical, Parallel Feature Matching</td>
<td></td>
</tr>
<tr>
<td>Philco</td>
<td>General Purpose Print Reader</td>
<td>Vacuum Belt</td>
<td>Conveyor Belt</td>
<td>From 5 x 7 to 8.5 x 11</td>
<td>180</td>
<td>Optical, Flying Spot Scanner</td>
</tr>
<tr>
<td>P6600</td>
<td>Customer Supplied</td>
<td>Customer Supplied</td>
<td>Customer Supplied</td>
<td>-------</td>
<td>600</td>
<td>Multiple Remote Vidicon (Max. 30)</td>
</tr>
<tr>
<td>P6700</td>
<td>Microfilm</td>
<td>Film Reel</td>
<td>35 mm. x 100'</td>
<td>N.A.</td>
<td>Flying Spot Scanner</td>
<td>Matrix Matching</td>
</tr>
</tbody>
</table>

(1) Dependent upon number of lines and fields within lines to be read

OPTICAL AND MAGNETIC CHARACTER RECOGNITION EQUIPMENT AND MARK SENSE READERS

TABLE E-1 (continued)
<table>
<thead>
<tr>
<th>Name of Company</th>
<th>Equipment Model</th>
<th>Type Font</th>
<th>Character Set</th>
<th>Reading Speed (ch./sec.)</th>
<th>First Installation</th>
<th>Approximate Base Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM (Cont'd)</td>
<td>IBM 1287</td>
<td>Handprinted Numerals, 1428, Selfchek 7B, USASC, NOF, 3/16&quot;</td>
<td>Alphabets, Mark Sense, Upper Case Alphabets</td>
<td>Max. 2,000</td>
<td>1968</td>
<td>$126,000</td>
</tr>
<tr>
<td></td>
<td>IBM 1288</td>
<td>Handprinted Numerals, 1428, Selfchek 7B, USASC, NOF, 3/16&quot;</td>
<td>Upper Case Alphabets, Special Symbols</td>
<td>Max. 1,800</td>
<td>1970</td>
<td>$230,000</td>
</tr>
<tr>
<td>National Cash</td>
<td>420-2</td>
<td>NOF</td>
<td>Numerals, Special Symbols</td>
<td>Max. 1,664</td>
<td></td>
<td>$80,000</td>
</tr>
<tr>
<td>Register Company</td>
<td>670-101</td>
<td>E13B</td>
<td>Numerals, Four Special Symbols</td>
<td>Max. 1,200</td>
<td></td>
<td>$45,000</td>
</tr>
<tr>
<td></td>
<td>671-101</td>
<td>E13B, CMC-7</td>
<td>Numerals, Special Symbols</td>
<td>Max. 3,200</td>
<td></td>
<td>$117,500</td>
</tr>
<tr>
<td>Optical Scanning</td>
<td>Opscan</td>
<td>Handprinted Characters USASC, Mark Sense, 1428</td>
<td>Numerals + 6 Alpha, Special Symbols</td>
<td>Max. 800</td>
<td>1969</td>
<td>$100,000</td>
</tr>
<tr>
<td>Corporation</td>
<td>General Purpose</td>
<td>Multiple Type Fonts</td>
<td>Alphanumeric, Punctuation, Special Symbols</td>
<td>Max. 1,000</td>
<td>1965</td>
<td>$300,000</td>
</tr>
<tr>
<td>Print Reader</td>
<td>P6600</td>
<td>Futura, 1403</td>
<td>Numerals, Dash and Slash</td>
<td>Max. 1,000</td>
<td>1969</td>
<td>$80,000 Base</td>
</tr>
<tr>
<td></td>
<td>P6700</td>
<td>Customer Selected</td>
<td>Alphanumeric</td>
<td>Max. 300</td>
<td>1969</td>
<td></td>
</tr>
<tr>
<td>Name of Company</td>
<td>Equipment Model</td>
<td>Document Feed Type</td>
<td>Document Transport Type</td>
<td>Document Size (Inches)</td>
<td>Documents Per Minute</td>
<td>Reader Scanner Type</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------</td>
<td>--------------------</td>
<td>-------------------------</td>
<td>------------------------</td>
<td>----------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Recognition</td>
<td>Electronic Retina</td>
<td>Vacuum</td>
<td>Conveyor</td>
<td>Length: 3.25 to 8.75</td>
<td>1,200</td>
<td>Optical</td>
</tr>
<tr>
<td>Equipment,</td>
<td>Document Reader</td>
<td></td>
<td>Belt</td>
<td>Width: 3.25 to 4.75</td>
<td></td>
<td>Photocell</td>
</tr>
<tr>
<td>Incorporated</td>
<td>Electronic Retina</td>
<td>Vacuum</td>
<td>Belt and Roller</td>
<td>Length: 3.25 to 14</td>
<td>Max. 30</td>
<td>Optical</td>
</tr>
<tr>
<td></td>
<td>Rapid Index Page</td>
<td></td>
<td></td>
<td>Width: 4.88 to 14</td>
<td></td>
<td>Photocell</td>
</tr>
<tr>
<td></td>
<td>Reader</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Matrix</td>
</tr>
<tr>
<td>Scan Data</td>
<td>100/300 Page Reader</td>
<td>Vacuum</td>
<td>Conveyor</td>
<td>8.5 x 11</td>
<td>(1)</td>
<td>Optical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Belt</td>
<td></td>
<td></td>
<td>Flying</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spot</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Scanner</td>
</tr>
<tr>
<td></td>
<td>200 Page Reader</td>
<td>Vacuum</td>
<td>Conveyor</td>
<td>8.5 x 11</td>
<td>(1)</td>
<td>Optical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Belt</td>
<td></td>
<td></td>
<td>Flying</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spot</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Scanner</td>
</tr>
<tr>
<td>Hewlett-Packard</td>
<td>2760A/2761A</td>
<td>Friction</td>
<td>Drive Rollers</td>
<td>3.25&quot;x 7.375&quot;</td>
<td>Max. 250</td>
<td>Optical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Parallel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Photocells</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorola</td>
<td>MDR Series</td>
<td>Friction</td>
<td>Drive Rollers</td>
<td>Min. 4.875&quot; in Reading</td>
<td>Max. 16</td>
<td>Optical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Area - No limit on</td>
<td></td>
<td>Parallel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>length Will transport</td>
<td></td>
<td>Photocells</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>full 8.5&quot; wide pages</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potter Instruments</td>
<td>MCR 8000</td>
<td>Mechanical Roller</td>
<td>3.25 x 7.375&quot;</td>
<td>300</td>
<td></td>
<td>Magnetic</td>
</tr>
<tr>
<td>Company</td>
<td></td>
<td></td>
<td>3.3 x 2.65</td>
<td>1,500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Dependent upon number of lines and fields within lines to be read

OPTICAL AND MAGNETIC CHARACTER RECOGNITION EQUIPMENT AND MARK SENSE READERS

TABLE E-1 (continued)
<table>
<thead>
<tr>
<th>Name of Company</th>
<th>Equipment Model</th>
<th>Type Font</th>
<th>Character Set</th>
<th>Reading Speed (ch./sec.)</th>
<th>First Installation</th>
<th>Approximate Base Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognition Equipment, Incorporated</td>
<td>Electronic Retina Document Reader</td>
<td>Handprint, Multiple Type Fonts, Mark Sense</td>
<td>Alphanumeric, Punctuation, Special Symbols</td>
<td>Max. 2,400</td>
<td>1964</td>
<td>$730,000</td>
</tr>
<tr>
<td></td>
<td>Electronic Retina Rapid Index Page Reader</td>
<td>Handprint, Multiple Type Fonts, Mark Sense</td>
<td>Alphanumeric, Punctuation, Special Symbols</td>
<td>Max. 2,400</td>
<td>1964</td>
<td>$740,000</td>
</tr>
<tr>
<td>Scan Data</td>
<td>100/300 Page Reader</td>
<td>Handprint, Multiple Type Fonts</td>
<td>Alphanumeric, Punctuation, Special Symbols</td>
<td>Max. 600</td>
<td>1968</td>
<td>$400,000</td>
</tr>
<tr>
<td></td>
<td>200 Page Reader</td>
<td>USASC, OCR-B, 1403, Selected Typewriter Handprint</td>
<td>Alphanumeric, Punctuation, Special Symbols</td>
<td>Max. 600</td>
<td>1969</td>
<td>$175,000</td>
</tr>
<tr>
<td>Hewlett-Packard</td>
<td>2760A/2761A</td>
<td>Mark Sense Pencil or Punched Holes</td>
<td>64 Char. Hollerith 64 Char. Dial Codes Available</td>
<td>Max. 105</td>
<td>1967</td>
<td>$3,000</td>
</tr>
<tr>
<td>Motorola</td>
<td>MDR Series</td>
<td>Mark Sense Pencil or Punched Holes</td>
<td>EBCDIC USASCII PIIC/BCD</td>
<td>Max. 105</td>
<td>1968</td>
<td>$4,890</td>
</tr>
<tr>
<td>Potter Instruments Company</td>
<td>MGR 8000</td>
<td>Any</td>
<td>Up to 256</td>
<td>3,500</td>
<td>6,000</td>
<td>-----</td>
</tr>
</tbody>
</table>

OPTICAL AND MAGNETIC CHARACTER RECOGNITION EQUIPMENT AND MARK SENSE READERS
TABLE E-1 (continued)

Note: Much of the material in the above tables was taken from: "Optical Character Recognition - A Survey," by P. L. Andersson, Datamation, July 1969, pp.43-48.
Clarification of Terms Used in Table E-1

Document Feed Type - the method used for feeding documents into the reader.

Document Transport Type - the method used for transporting documents through the reader.

Document Size - the size in inches of documents that can be handled by the reader.

Documents Per Minute - the rate at which documents are handled by the reader.

Scanner Type - the method and technique used for scanning the characters or marks to be read.

Recognition Type - the method or technique used for identifying and recognizing the characters.

Type Font - the type font which can be read or recognized.

Character Set - the character set which can be read or recognized.

Reading Speed - the speed at which characters are read.

First Installation - the year in which the equipment was first installed in field use.
The third technique covered here involves readers that can detect ordinary pencil marks (or in some cases printed marks or bar codes) made in specific locations on pre-printed forms. The most common application is where fixed data is to be stored on the same form as manually entered data. Some readers of this type mark sense data as well as punched data. The best applications are those which involve a relatively small amount of data. One of the main advantages of the Optical Mark Sense Reader is that it can be used as a Computer Terminal at a cost that is low compared to conventional OCR and MICR equipment.

MICR

Most MICR equipment in use today reads the highly stylized font specified for the banking industry by the American Bankers Association. The characters are printed with magnetic ink. The pick-up or reading device is a magnetic head. This technique is not sensitive to overprinting by pen or pencil. The size of the American Bankers Association character set is limited to ten numerals and four special symbols. A 41 character set defined by the CMC-7 Magnetic Font is used in Europe but very little in the United States. CMC-7 characters are made up of bars.

Another approach is used by Potter Instruments for MICR. It consists of a special bar code that is printed simultaneously with conventional human readable characters. Since each character has eight bars or bits up to 256 characters can be defined. However, when error detecting techniques are added the more practical limit appears to be 81 characters. Preparation equipment for the Potter approach may be either a printer or a typewriter in which the print slugs contain the bar code above and below each human readable character. Potter feels this technique will allow production of readers in the $10,000 price range. Another advantage is that document preparation equipment costs will be much lower.
than for American Bankers Association MICR font since more conventional equipment can be used.

**OCR**

OCR equipment is usually classed by the type of paper handling, document or page, and by the font or fonts that can be read. Three types of documents can be handled:

1. **Document Readers**
   
   Size is typically less than normal 8-1/2" by 11". The number of lines that can be read are usually small - i.e., 1, 2, or 3. The transport is designed to handle high document rates (up to 30/second).

2. **Page Readers**
   
   Size is typically 8-1/2" by 11" or legal size, 8-1/2" by 14". All lines on the page can be read. Although the character reading rate may be as high as for document readers, the average paper handling rate is usually much lower.

3. **Journal Tape Readers**
   
   These handle the normal roll-type tapes from cash register or adding machines.

Some machines incorporate more than one type of document transport.

The most common type font for OCR is the USASI font proposed by the Bureau of Standards and adopted by the American Standards Association. It includes the upper case English alphabet, ten numerals and twenty special symbols. Most machines in use today can read the USASI-OCR font. Another commonly used font is the Farrington self-check font.

Machines that can handle only one of the stylized fonts are called single
font machines. Those that can handle more than one are called multifont machines. One well known pioneer in the OCR field, Jacob C. Rabinow, classifies OCR equipment by font and by application as follows:

1. **Fixed-Font** -- "Turn-around" documents printed by or for the OCR user himself, such as bank checks, subscription blanks, bills, credit card slips, notices, documents generated by card imprinters, typewriters, high speed printers and other printing equipment. In addition to turn-around documents, fixed-font applications include the reading of journal tapes, message forms, and "internally" generated records of business and government.

2. **Multifont** -- Documents generated in a large enterprise that has more than one type of printing equipment, documents with several fonts selected from a large multitude of fonts, situations where the reading machine can have its fonts changed to fit the documents.

3. **Handprint Readers** -- Unconstrained printing such as found on mail envelopes (for example, the Toshiba machine in Japan, which reads a form of zip code) and semi-constrained readers such as built by IBM, CDC, Recognition Equipment, and others. In semi-constrained hand printing, the characters have to be printed in "boxes" and can be well formed. Such machines generally read only numerals and perhaps three or four alphabetic characters. At the present time there are no machines that can read unconstrained script.

Many companies are developing or have announced machines that will read handprinted characters. The most commercially successful unit is the
IBM 1287 document reader. It employs the technique of small circular scan curve tracing. If the stored pattern fits, within the prescribed tolerance, the machine will identify the character correctly. Cost of these machines appears to be directly related to the constraints that are placed on the "quality" of the handprinting.

Due to the high cost of OCR equipment, there is a strong movement to develop remote time-shared readers. Recognition Equipment Incorporated has announced the Remote Time-Sharing Retina. Control Data is discussing their model X with potential large users. It will sell for approximately $3,000 in large quantities. One company, Cognitronics Corporation, which is very active in remote optical character recognition, is not included in Table E-1 because they do not sell their equipment except under special conditions. They are in the "service bureau" business. Cognitronics quotes the rental of their remote scanner at $250/month plus $175/month for a bandwidth saving device plus a service charge proportional to the amount and type of data converted to computer language. A facsimile type remote scanner is used to transmit the document to the central "service bureau" where it is reproduced and read optically.

Optical Mark Sense Readers

The earliest optical readers were mark sense readers that detected the presence or absence of a pencil or "special pencil" mark in a prescribed box. Early applications concentrated on test scoring. IBM was a pioneer in this field.

Recently two companies, Hewlett Packard and Motorola, have concentrated on marketing terminal devices that handle pencil marked pre-printed forms. The equipment offered reads the cards or documents, encodes the information and transmits it over voice grade telephone lines to a central computer.
The real benefits offered by the Hewlett Packard and Motorola units depend on the ingenuity of form design. Both units will handle "IBM card size" documents. The Motorola unit will also handle normal page-sized paper with a 4.875 inch edge reserved for optical marking.

The best application for Optical Mark Sense documents are where pre-printed or pre-punched fixed information must be handled in addition to some quantity of variable information. For example, the fixed information could be printed for human use or in Hollerith punched code for machine reading or a combination of both. The variable information is entered as pencil marks on the prescribed area of the particular form. Purchase prices of this type of equipment range from approximately $3,000 to $5,000. Lease plans are also available. The interface can be through ordinary telephone lines to the central computer.

Printed bar codes can also be read with optical mark sense techniques. This approach is discussed in Appendix B also.

A relatively new line of equipment offer by INTERMEC is not included in the Table E-1 because it cannot be directly compared with the other devices in that Table. This line of equipment called "Dual Image Recording" appears to have been designed originally as a replacement for punched paper tape but has wider applications. In this equipment as each human readable character is printed a coded character consisting of dots and bars is printed vertically below it. These characters are printed on a strip of paper somewhat similar in appearance to conventional punched paper tape before it is punched. This equipment can record up to 128 character types at a rate of up to 75 characters per second. The equipment for reading these strips of paper tape can read at rates of up to 100 characters per second or 120 characters per second asynchronously. The equipment can run the tape in either direction and can record 50,000 characters on a 5" reel of paper tape. A simple keyboard and printer combination costs between $1,750 and $2,700 while a reader cost between $1,000 and $1,500. Because of the paper strip approach this equipment may not be directly applicable to terminal requirements for the Library of Congress but the same technique applied to pages could be appropriate.
APPENDIX  F
SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE
TAPE DEVICES FOR MACHINE READABLE MEDIA

Because of the very wide application areas in which remote terminals are now being used, the demand for inexpensive data storage and entry over telephone lines is increasing. The need for lower cost storage to be used with minicomputers has also become very apparent in the last year or two. Costs of presently used paper tape punch/reader units are well below $1,000, but these are limited in performance. When the cost of intermediate magnetic tape storage drops to become competitive with punched paper tape, applications which were previously not practical suddenly become very promising.

Tables F-1 and F-2 compare the characteristics of available magnetic tape devices of types suitable for the Library's applications. The equipments included in this survey of magnetic tape storage devices are divided into three classifications:

1. Magnetic tape cassette
2. Magnetic tape cartridge
3. Incremental magnetic tape

The IBM MTST unit which provides magnetic tape storage in conjunction with a selectric typewriter was reviewed but not included because it does not meet the performance capabilities or cost objectives needed in these terminal applications. This device has had wide business acceptance and it is typically an off-line text editing and reproducing device for a typist.

The other type of equipment not included in this survey is the keyboard to computer compatible magnetic tape units which are primarily used as key-punch replacements. One keyboard to magnetic tape unit, however, deserves serious consideration because it offers a 256 character set. In addition to the standard selectric keyboard, they offer a function panel and auxiliary keyboard which allows the user to select characters from this large character set. The standard typewriter keyboard provides 102 input codes with the auxiliary keyboard capable of 94 more input codes for a total of 196 codes.
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>Type of Unit</th>
<th>Number of Tape Units</th>
<th>Number of Read/Write Heads</th>
<th>Buffer Size (No. of Char.)</th>
<th>Transfer Rate (bytes Per Second)</th>
<th>Tape Transport Speed (ips)</th>
<th>Recording Density (bpi)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tri-Data 4096</td>
<td>cartridge</td>
<td>4</td>
<td>4</td>
<td>Variable</td>
<td>636</td>
<td>10</td>
<td>600</td>
<td>$5,000*</td>
</tr>
<tr>
<td>International Computer Products</td>
<td>Phillips cassette</td>
<td>2</td>
<td>2</td>
<td>Variable</td>
<td>300</td>
<td>5</td>
<td>550</td>
<td>$2,500</td>
</tr>
<tr>
<td>Sykes-Compu/Corder</td>
<td>cassette</td>
<td>1</td>
<td>Single</td>
<td>2</td>
<td>500</td>
<td>5</td>
<td>1,000</td>
<td>$2,950*</td>
</tr>
<tr>
<td>DICOM-100 Series</td>
<td>Phillips cassette</td>
<td>1</td>
<td>Single</td>
<td>Variable</td>
<td>500</td>
<td>10</td>
<td>550</td>
<td>$1,125</td>
</tr>
<tr>
<td>Computer Terminal Corporation 3300T</td>
<td>Phillips cassette</td>
<td>1</td>
<td>Single</td>
<td>100</td>
<td>300</td>
<td>1-7/8</td>
<td>1,200</td>
<td>$2,250</td>
</tr>
<tr>
<td>Cipher Data Products</td>
<td>cassette</td>
<td>1</td>
<td>Dual</td>
<td>Variable</td>
<td>600</td>
<td>6</td>
<td>1,600</td>
<td>$1,050**</td>
</tr>
<tr>
<td>Universal Data Acquisition Co., Inc.</td>
<td>cassette</td>
<td>2</td>
<td>2</td>
<td>--</td>
<td>110</td>
<td>Incremental</td>
<td>400</td>
<td>$2,450</td>
</tr>
</tbody>
</table>

**MAGNETIC TAPE CASSETTES AND CARTRIDGES**

**(MACHINE READABLE MEDIA)**

**TABLE F-1**

* Includes interface to mini-computer and software driver

** Price does not include power supplies
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Track Format</th>
<th>Recording Speed (Asynchronous Chars/Second)</th>
<th>Rec. Density (bits per inch)</th>
<th>Reel Size (in.)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cipher Data Products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 70H</td>
<td>7/9</td>
<td>0-300</td>
<td>200/556</td>
<td>7</td>
<td>$2-3K</td>
</tr>
<tr>
<td>Model 85H</td>
<td>7/9</td>
<td>0-600</td>
<td>200/556/800</td>
<td>8 1/2</td>
<td>$2.5-3.5K</td>
</tr>
<tr>
<td>Model 100</td>
<td>7/9</td>
<td>0-1000</td>
<td>200/556/800</td>
<td>10 1/2</td>
<td>$3-4K</td>
</tr>
<tr>
<td>Digi-Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Series 1400</td>
<td>7/9</td>
<td>0-200</td>
<td>200/556/800</td>
<td>10 1/2</td>
<td>$3.2-6K</td>
</tr>
<tr>
<td>Series 1300</td>
<td>7/9</td>
<td>0-500</td>
<td>200/556/800</td>
<td>8 1/2</td>
<td>$2.1-4.3K</td>
</tr>
<tr>
<td>Series 1500</td>
<td>7/9</td>
<td>0-500</td>
<td>200/556/800</td>
<td>10 1/2</td>
<td>$2.5-4.7K</td>
</tr>
<tr>
<td>Kennedy Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1600</td>
<td>7</td>
<td>0-500</td>
<td>200/556</td>
<td>8 1/2</td>
<td>$2.7-4.5K</td>
</tr>
<tr>
<td>Model 1610</td>
<td>7</td>
<td>0-500</td>
<td>200/556/800</td>
<td>10</td>
<td>$3.5-4.8K</td>
</tr>
<tr>
<td>Model 1600/360</td>
<td>9</td>
<td>0-750-1500</td>
<td>200/556</td>
<td>8 1/2</td>
<td>$3.9-5.2K</td>
</tr>
<tr>
<td>Model 1610/360</td>
<td>9</td>
<td>0-750-1500</td>
<td>200/556/800</td>
<td>10</td>
<td>$4.7-6.0K</td>
</tr>
<tr>
<td>Peripheral Equipment Corp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Series 1000</td>
<td>7/9</td>
<td>0-700</td>
<td>200/556/800</td>
<td>8 1/2</td>
<td>$4-6.5K</td>
</tr>
<tr>
<td>Series 2000</td>
<td>7/9</td>
<td>0-1000</td>
<td>200/556/800</td>
<td>10 1/2</td>
<td>$4.5-7K</td>
</tr>
<tr>
<td>Precision Instruments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model PI-1387</td>
<td>7</td>
<td>0-200</td>
<td>200</td>
<td>7</td>
<td>$2.4K</td>
</tr>
<tr>
<td>Model PI-1207</td>
<td>7</td>
<td>0-600</td>
<td>200/556/800</td>
<td>10 1/2</td>
<td>$6K</td>
</tr>
<tr>
<td>Model PI-1209</td>
<td>9</td>
<td>0-600</td>
<td>200/556/800</td>
<td>10 1/2</td>
<td>$7.5K</td>
</tr>
</tbody>
</table>

INCREMENTAL MAGNETIC TAPE RECORDERS
(MACHINE READABLE MEDIA)

TABLE F-2
Clarification of Terms Used in Table F-1

Type of Unit - whether the unit uses a cartridge or a cassette.

Number of Tape Units - the number of individual tape units included in one device.

Number of Read/Write Heads - the number of read/write heads included in a device.

Buffer Size - the number of characters contained in the buffer included in the device.

Transfer Rate - the number of bytes per second transferred to or from the device.

Tape Transport Speed - the rate at which tape is moved through the device in inches per second.

Recording Density - the density in bits per inch in which information is recorded in a single track on the tape.

Clarification of Terms Used in Table F-2

Track Format - whether the device reads and writes 7 or 9 tracks in parallel.

Recording Speed - the rate in characters per second at which information is recorded. Since incremental magnetic tape records are asynchronous a range from 0 to the maximum value is shown.

Rec. Density - the density in bits per inch in which information is recorded in a single track on the tape.

Reel Size - the diameter of a reel of magnetic tape that the device can handle.
**Cassettes and Cartridges**

The tape cassettes included in this survey are reel-to-reel cassette devices. Some of the manufacturers design their own tape transport while others use the Norelco tape transport. The Norelco type cassette was not originally intended to be used as a digital storage device and it does not have bi-directional fast stop/start capability. The tolerance variations in the cassette are substantial. There are manual tolerances and skew angles which can cause edge wear and rubbing problems. These all contribute to a reliability problem for digital recording along with the fact that the thin tape used in audio tape cassettes to get larger data storage capacities can cause several tape handling problems in the tape transport.

Reliable bi-directional and high performance operation must be achieved in order for the tape cassette recorder to be acceptable in computer applications. Either the cassette itself must be improved or the transport mechanism must be designed to overcome these deficiencies. Certified 1-1/2 mil computer tape has been added to conventional tape cassette devices. Since several manufacturers are working in this area, there is a good chance that the standard Norelco type tape cassette may be upgraded for digital applications requiring higher performance in reliability. However, its suitability at present is questionable.

In application such as inputting of keyboard data, which is done in an incremental or asynchronous fashion, there has been a great deal of interest in incremental tape cassette drives. To date, two manufacturers say that they plan to have incremental tape transport capability with their cassettes, but they do not presently offer it. The trend towards incremental operation may not materialize because of the low cost of buffer storage which is continually coming down in price. This will make continuous tape drives much more practical and lower cost. The appropriate buffer size can be tailored to the application at hand to permit writing records on the tape in a continuous manner.

The magnetic cartridge device, which has a different type of enclosure than
the device, has gained considerable consumer attention with an endless
loop tape recorder technique applied to this tape drive. The cost is reduced
by virtue of the fact that the endless loop device allows all the driving to be
done by one motor and the tape is pulled off the center of the reel and onto
the outside. It is not bi-directional.

The recording techniques on cassettes and cartridges are basically one of
two types: phase encoding which places both clock and data on a single
track, thereby producing simplicity, and the non-return to zero (NRZ)
recording technique which requires two tracks since NRZ data is not
self-clocking. When the single track head is used with phase encoding,
recording costs are less than for the dual track head. Since skew problems
can occur with more than one track, the packing density is substantially
reduced for multi-track heads and tapes. Final consideration must be
given to means of error detection and correction. The dual gap (read-after-
write head) provides the user with absolute certainty of the data being
properly recorded on the tape. Read-after-write allows the user to do a
check on the data immediately after it is written to assure himself that the
data is correct. The other method employed is to not detect errors but
to provide redundancy on the tape through dual tracks. With dual tracks
one must use more complicated error correction schemes including
vertical and longitudinal parity checks.

Incremental
The strongest advantage in using incremental magnetic tape recorders as
opposed to cassette/cartridge units is the fact that the tape is written in a
computer compatible fashion on standardized reels of 1/2" wide computer
tape. This recorder tape is indistinguishable from the tape produced by
conventional computer transport in both physical appearance and the format.
It is recorded at densities of 200, 556, and 800 bits per inch, including nor-
mal beginning of block and end of block marks and end of record gaps. The
major advantage in using incremental tape is not having to make a
conversion from the tape cassette to a computer grade tape format as
would be necessary with tape cassette cartridge units; thus, time savings and efficiency in terms of getting information into the computer.

When fairly large amounts of data are to be recorded for entry into the system, a one thousand foot reel of paper tape has approximately one hundred thousand character capacity whereas a one hundred foot reel of incremental magnetic tape is able to record 9.6 million characters at 556 bits per inch. Note that both reels are about the same diameter because of the greater thickness of paper tape.
APPENDIX G

SUMMARY AND COMPARISON OF PRESENTLY AVAILABLE SMALL COMPUTERS

The emphasis in the survey of small computers in this study is primarily for their potential use as controllers in tying together different terminal modules that the Library of Congress will require in several areas within the CBS. Small computers will be used primarily to provide functions (e.g., storage) common to several terminals and to interface to the communications link and format the data for remote entry into the computer system with the central computer system.

This survey and Table G-1 covers all of the available low cost computers offered in the marketplace at the time this report was written but new entries are appearing all the time. The small computers included in this Appendix are restricted to low cost units selling for less than $25,000. The price information included in this table is meant to include all of the equipment necessary to make an operational system suitable for interfacing to the communications link but not including the modem.

The prime reasons for using small computers in the terminal controller application are:

1. Low cost
2. Programmable flexibility. Read-only memories and other protective techniques are available once the controller design is frozen.
3. Versatility of these units to interface with various modules both electrically and from a functional standpoint.
4. Previous use of small computers in other terminal configurations indicates their usefulness and minimizes the engineering development cost as opposed to designing from scratch special-purpose controllers to do the same job.
### CPU FEATURES

<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>R/O Memory (std, opt, no)</th>
<th>Instruction Word Length(s)</th>
<th>No. Acc. (or Indirect) or other</th>
<th>No. Gen. Purp. Registers that can be used as Accumulators</th>
<th>No. Hdwr. Reg. not including Index Registers</th>
<th>No. Index Reg. (hdwr., memory, or other)</th>
<th>Indirect Addressing (multi-level, single-level, no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Automation 216/816</td>
<td>no</td>
<td>16</td>
<td>1</td>
<td>6</td>
<td>1 hardware</td>
<td>2 hardware</td>
<td>multi-level</td>
</tr>
<tr>
<td>Data General Nova</td>
<td>yes</td>
<td>16</td>
<td>4</td>
<td>10</td>
<td></td>
<td>16 memory</td>
<td>multi-level</td>
</tr>
<tr>
<td>Data Mate Computer Systems 16</td>
<td>no</td>
<td>16</td>
<td>2</td>
<td>6</td>
<td>1 hardware</td>
<td></td>
<td>multi-level</td>
</tr>
<tr>
<td>Redcor RC-70</td>
<td>no</td>
<td>16/32</td>
<td>1</td>
<td>5</td>
<td>1 memory</td>
<td></td>
<td>single-level</td>
</tr>
<tr>
<td>GRI Computer Co 909</td>
<td>opt.</td>
<td>16</td>
<td>1</td>
<td>4</td>
<td>1 auto index</td>
<td></td>
<td>single-level</td>
</tr>
<tr>
<td>Hewlett Packard 2114A/2114B</td>
<td>no</td>
<td>16</td>
<td>2</td>
<td>7</td>
<td>none</td>
<td></td>
<td>multi-level</td>
</tr>
<tr>
<td>Hewlett Packard 2115A</td>
<td>no</td>
<td>16</td>
<td>2</td>
<td>7</td>
<td>none</td>
<td></td>
<td>multi-level</td>
</tr>
<tr>
<td>Honeywell H-316</td>
<td>no</td>
<td>16</td>
<td>2</td>
<td>4</td>
<td>1 hardware</td>
<td></td>
<td>multi-level</td>
</tr>
<tr>
<td>Honeywell DDP-416</td>
<td>no</td>
<td>16/32</td>
<td>1</td>
<td>4</td>
<td>none</td>
<td></td>
<td>multi-level</td>
</tr>
<tr>
<td>Information Tech, Inc. ITI-4900 (Model 20)</td>
<td>no</td>
<td>16/32</td>
<td>8</td>
<td>16</td>
<td>6 memory</td>
<td>15 memory</td>
<td>no</td>
</tr>
<tr>
<td>Interdata Model 2</td>
<td>yes</td>
<td>16</td>
<td>16 memory</td>
<td>--</td>
<td>15 memory</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Interdata Model 3</td>
<td>yes</td>
<td>16/32</td>
<td>16</td>
<td>18</td>
<td>15</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Interdata Model 4</td>
<td>yes</td>
<td>16/32</td>
<td>16</td>
<td>33</td>
<td>15</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Lockheed Electronics MAC-16</td>
<td>no</td>
<td>16</td>
<td>1</td>
<td>6</td>
<td>4 memory</td>
<td></td>
<td>multi-level</td>
</tr>
<tr>
<td>Raytheon 703</td>
<td>no</td>
<td>16</td>
<td>1</td>
<td>6</td>
<td>1 hardware</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Raytheon 704</td>
<td>no</td>
<td>16</td>
<td>1</td>
<td>6</td>
<td>1 hardware</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Raytheon 706</td>
<td>no</td>
<td>16</td>
<td>1</td>
<td>6</td>
<td>1 hardware</td>
<td></td>
<td>no</td>
</tr>
</tbody>
</table>

* SMALL COMPUTER CHARACTERISTICS  TABLE G-1
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>Cycle Time (us)</th>
<th>Word Length (bits)</th>
<th>Minimum Size (words)</th>
<th>Increment Size (words)</th>
<th>Maximum Size (words)</th>
<th>Parity Check (std, opt, no)</th>
<th>Protect (std, opt, no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Automation 216/816</td>
<td>2.6/8</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>16K</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Data General Nova</td>
<td>2.6</td>
<td>16</td>
<td>1K</td>
<td>1K, 2K, 4K</td>
<td>32K</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Data Mate Computer Systems 16</td>
<td>1.0</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>opt.</td>
<td>std.</td>
</tr>
<tr>
<td>Redcor RC-70</td>
<td>.860</td>
<td>18</td>
<td>4K</td>
<td>4K</td>
<td>16K</td>
<td>std.</td>
<td>std.</td>
</tr>
<tr>
<td>GRI Computer Co. 909</td>
<td>1.76</td>
<td>16</td>
<td>1K</td>
<td>1K, 4K</td>
<td>32K</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Hewlett-Packard 2114A/2114B</td>
<td>2.0</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>8K</td>
<td>opt.</td>
<td>no</td>
</tr>
<tr>
<td>Hewlett Packard 2115A</td>
<td>2.0</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>8K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Honeywell H-316</td>
<td>1.6</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>16K</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Honeywell DDP-416</td>
<td>0.96</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>16K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Information Tech, Inc ITI-4900 (Model 20)</td>
<td>0.975/1.75</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Interdata Model 2</td>
<td>3.0</td>
<td>16</td>
<td>1K</td>
<td>1K</td>
<td>2K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Interdata Model 3</td>
<td>.980/1.5</td>
<td>16</td>
<td>2K</td>
<td>2K, 4K</td>
<td>32K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Interdata Model 4</td>
<td>.980/1.5</td>
<td>16</td>
<td>2K</td>
<td>2K, 4K</td>
<td>32K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Lockheed Electronics MAC-16</td>
<td>1</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>65K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Raytheon 703</td>
<td>1.75</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Raytheon 704</td>
<td>1.5</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>16K</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Raytheon 706</td>
<td>0.9</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Manufacturer/Model No.</td>
<td>Data Path Width (bits)</td>
<td>Direct Memory Access (DMA)</td>
<td>Max. DMA Word Transfer Rate</td>
<td>No. External Priority Interrupt Levels in Basic System</td>
<td>Max. No. External Interrupts</td>
<td>Other Features</td>
<td>Power Failure &amp; Automatic Restart (std, opt, no)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>------------------------</td>
<td>----------------------------</td>
<td>------------------------------</td>
<td>----------------------------------------------------</td>
<td>-----------------------------</td>
<td>----------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Computer Automation 216/816</td>
<td>8/16</td>
<td>std</td>
<td>125 KHZ</td>
<td>3</td>
<td>256</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Data General Nova</td>
<td>16</td>
<td>std</td>
<td>312 KHZ</td>
<td>16</td>
<td>62</td>
<td>std</td>
<td>opt</td>
</tr>
<tr>
<td>Data Mate Computer Systems 16</td>
<td>16</td>
<td>opt</td>
<td>1 MHZ</td>
<td>8</td>
<td>64</td>
<td>std</td>
<td>opt</td>
</tr>
<tr>
<td>Redcor RC-70</td>
<td>16</td>
<td>opt</td>
<td>1.1 MHZ</td>
<td>1</td>
<td>32</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>GRI Computer Co 909</td>
<td>16</td>
<td>std</td>
<td>570 KHZ</td>
<td>16</td>
<td>64</td>
<td>std</td>
<td>opt</td>
</tr>
<tr>
<td>Hewlett Packard 2114A/2114B</td>
<td>16</td>
<td>yes/yes</td>
<td>~7500 KHZ</td>
<td>8</td>
<td>56</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Hewlett Packard 2115A</td>
<td>16</td>
<td>no/yes</td>
<td>-500 KHZ</td>
<td>8</td>
<td>56</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Honeywell H-316</td>
<td>16</td>
<td>opt</td>
<td>1 MHZ</td>
<td>2</td>
<td>50</td>
<td>std</td>
<td>opt</td>
</tr>
<tr>
<td>Honeywell DDP-416</td>
<td>16</td>
<td>opt</td>
<td>1 MHZ</td>
<td>2</td>
<td>48</td>
<td>std</td>
<td>opt</td>
</tr>
<tr>
<td>Information Tech. Inc. ITI-4900 (Model 20)</td>
<td>16</td>
<td>opt</td>
<td>1 MHZ</td>
<td>8</td>
<td>256</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Interdata Model 2</td>
<td>8</td>
<td>no</td>
<td>--</td>
<td>2</td>
<td>256</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Interdata Model 3</td>
<td>8</td>
<td>opt</td>
<td>450 KHZ</td>
<td>2</td>
<td>255</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Interdata Model 4</td>
<td>8</td>
<td>opt</td>
<td>450 KHZ</td>
<td>2</td>
<td>255</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Lockheed Electronics MAC-16</td>
<td>16</td>
<td>opt</td>
<td>800 KHZ</td>
<td>4</td>
<td>64</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Raytheon 703</td>
<td>16</td>
<td>opt</td>
<td>571 KHZ</td>
<td>1</td>
<td>16</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Raytheon 704</td>
<td>16</td>
<td>opt</td>
<td>1.1 MHZ</td>
<td>1</td>
<td>16</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>Raytheon 706</td>
<td>16</td>
<td>opt</td>
<td>1.1 MHZ</td>
<td>1</td>
<td>16</td>
<td>opt</td>
<td>opt</td>
</tr>
</tbody>
</table>

**SMALL COMPUTER CHARACTERISTICS**

**TABLE G-1 (Continued)**
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>MICRO-Programming (i.e. firmware)</th>
<th>Assembler (1 pass, 2 pass, both)</th>
<th>Relocatable Assembler (yes, no)</th>
<th>Min. Core Size necessary to use Relocatable Assembler</th>
<th>Macro Assembler Capability</th>
<th>Real-time Exec. Monitor Available (yes, no)</th>
<th>Disc Operating System Avail. (yes, no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Automation 416/816</td>
<td>no</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Data General</td>
<td>no</td>
<td>2 pass</td>
<td>no</td>
<td>--</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Nova</td>
<td>no</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Data Mate Computer Systems 16</td>
<td>no</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Redcor</td>
<td>no</td>
<td>1 pass</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>GRI Computer Co 909</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>--</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Hewlett Packard 2114A/2114B</td>
<td>yes</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Hewlett Packard 2115A</td>
<td>yes</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Honeywell H-316</td>
<td>no</td>
<td>both</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Honeywell DDF-416</td>
<td>no</td>
<td>both</td>
<td>no</td>
<td>--</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Information Tech. Inc. ITI-4900 (Model 20)</td>
<td>no</td>
<td>1 pass</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Interdata Model 2</td>
<td>yes</td>
<td>both</td>
<td>no</td>
<td>--</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Interdata</td>
<td>yes</td>
<td>both</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Interdata Model 4</td>
<td>yes</td>
<td>both</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Lockheed Electronics MAC-16</td>
<td>no</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Raytheon 703</td>
<td>no</td>
<td>both</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Raytheon 704</td>
<td>no</td>
<td>both</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Raytheon 706</td>
<td>no</td>
<td>both</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Manufacturer/Model Number</td>
<td>Magnetic Tape Available (yes, no)</td>
<td>Approx. Price For Oper. Unit (Incl. Controller, Comp. Options Nec., etc.)</td>
<td>Mass Storage Device Available (yes, no)</td>
<td>Approx. Price For Oper. Unit (Incl. Controller, Comp. Options Nec., etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------</td>
<td>-------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Automation 216/816</td>
<td>yes</td>
<td>$5,700 to $10,000</td>
<td>yes</td>
<td>$6,500 to $9,950</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data General Nova</td>
<td>yes</td>
<td>$12,000</td>
<td>yes</td>
<td>$6,500 to $9,250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Mate Computer Systems-16</td>
<td>yes</td>
<td>$19,500</td>
<td>yes</td>
<td>$18,000 to $45,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redcor RC-70</td>
<td>yes</td>
<td>$12,000</td>
<td>yes</td>
<td>$15,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRI Computer Co. 909</td>
<td>no</td>
<td>---</td>
<td>no</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hewlett-Packard 2114A/2114B</td>
<td>yes</td>
<td>$12,500 to $15,000</td>
<td>no/yes</td>
<td>--- /26,500 to --- /31,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hewlett-Packard 2115A</td>
<td>yes</td>
<td>$15,500 to $21,500</td>
<td>yes</td>
<td>$26,500 to $31,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeywell H-316</td>
<td>yes</td>
<td>$23,355 to $35,430</td>
<td>yes</td>
<td>$22,300 to $36,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeywell DDP-416</td>
<td>yes</td>
<td>$23,355 to $35,430</td>
<td>yes</td>
<td>$22,300 to $36,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information Tech. Inc. ITI-4900 (Model 20)</td>
<td>yes</td>
<td>$18,000</td>
<td>N/A</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdata Model 2</td>
<td>yes</td>
<td>$9,900</td>
<td>yes</td>
<td>$17,400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdata Model 3</td>
<td>yes</td>
<td>$9,900</td>
<td>yes</td>
<td>$17,400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdata Model 4</td>
<td>yes</td>
<td>$9,900</td>
<td>yes</td>
<td>$17,400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lockheed Electronics Co. MAC-16</td>
<td>yes</td>
<td>$6,000 to $10,000</td>
<td>yes</td>
<td>$17,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raytheon 703</td>
<td>yes</td>
<td>$10,500 to $28,000</td>
<td>yes</td>
<td>$21,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raytheon 704</td>
<td>yes</td>
<td>$10,500 to $28,000</td>
<td>yes</td>
<td>$21,500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N/A = Not Announced or Not Available

SMALL COMPUTER CHARACTERISTICS, TABLE G-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>High Speed Paper Tape Reader (yes, no)</th>
<th>Speed (char/sec)</th>
<th>Approximate Cost of Operational Paper Tape Rdr. (yes, no)</th>
<th>High Speed Paper Tape Punch (yes, no)</th>
<th>Speed (char/sec)</th>
<th>Approximate Cost of Operational Paper Tape Punch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Automation 216/816</td>
<td>yes</td>
<td>300</td>
<td>$2,200</td>
<td>yes</td>
<td>60</td>
<td>$3,300</td>
</tr>
<tr>
<td>Data General Nova</td>
<td>yes</td>
<td>300/150</td>
<td>$2,650/2,150</td>
<td>yes</td>
<td>63.3</td>
<td>$2,200</td>
</tr>
<tr>
<td>Data Mate Computer Systems - 16</td>
<td>yes</td>
<td>300</td>
<td>$2,000</td>
<td>yes</td>
<td>120</td>
<td>$4,000</td>
</tr>
<tr>
<td>Redcor RC-70</td>
<td>yes</td>
<td>300</td>
<td>$2,500</td>
<td>yes</td>
<td>120</td>
<td>$4,000</td>
</tr>
<tr>
<td>GRI Computer Co. 909</td>
<td>yes</td>
<td>300</td>
<td>$2,090</td>
<td>yes</td>
<td>50</td>
<td>$1,750</td>
</tr>
<tr>
<td>Hewlett-Packard 2114A/2114B</td>
<td>yes</td>
<td>300</td>
<td>$2,100</td>
<td>yes</td>
<td>120</td>
<td>$4,100</td>
</tr>
<tr>
<td>Hewlett-Packard 2115A</td>
<td>yes</td>
<td>300</td>
<td>$2,100</td>
<td>yes</td>
<td>120</td>
<td>$4,100</td>
</tr>
<tr>
<td>Honeywell H-316</td>
<td>yes</td>
<td>300</td>
<td>$3,800</td>
<td>yes</td>
<td>110</td>
<td>$4,500</td>
</tr>
<tr>
<td>Honeywell DDP-416</td>
<td>yes</td>
<td>300</td>
<td>$3,800</td>
<td>yes</td>
<td>110</td>
<td>$4,500</td>
</tr>
<tr>
<td>Information Tech. Inc. ITI-4900 (Model 20)</td>
<td>yes</td>
<td>300</td>
<td>$2,500</td>
<td>yes</td>
<td>50</td>
<td>$3,000</td>
</tr>
<tr>
<td>Interdata Model 2</td>
<td>yes</td>
<td>300</td>
<td>$2,500</td>
<td>yes</td>
<td>60</td>
<td>$3,800</td>
</tr>
<tr>
<td>Interdata Model 3</td>
<td>yes</td>
<td>300</td>
<td>$2,500</td>
<td>yes</td>
<td>60</td>
<td>$3,800</td>
</tr>
<tr>
<td>Interdata Model 4</td>
<td>yes</td>
<td>300</td>
<td>$2,500</td>
<td>yes</td>
<td>60</td>
<td>$3,800</td>
</tr>
<tr>
<td>Lockheed Electronics MAC-16</td>
<td>yes</td>
<td>300</td>
<td>$2,200</td>
<td>yes</td>
<td>60</td>
<td>$2,700</td>
</tr>
<tr>
<td>Raytheon 703</td>
<td>yes</td>
<td>300</td>
<td>$3,300</td>
<td>yes</td>
<td>110</td>
<td>$4,200</td>
</tr>
<tr>
<td>Raytheon 704</td>
<td>yes</td>
<td>300</td>
<td>$3,000</td>
<td>yes</td>
<td>110</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

N/A = Not Announced or Not Available
<table>
<thead>
<tr>
<th>Manufacturer/ Model No.</th>
<th>Basic System Price with 4K words incl. Power Supplies</th>
<th>Total System Price incl. ASR-33 Teletype &amp; CPU</th>
<th>Basic System Price with 8K words incl. adequate power supplies, enclosure, control panel</th>
<th>Total System Price incl. ASR-33 Teletype &amp; CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Automation 216/816</td>
<td>$7,990/$9,980</td>
<td>$10,000/$11,990</td>
<td>$12,840/$15,430</td>
<td>$14,850/$17,440</td>
</tr>
<tr>
<td>Data General Nova</td>
<td>$7,600</td>
<td>$9,000</td>
<td>$10,885</td>
<td>$12,285</td>
</tr>
<tr>
<td>Data Mate Computer Systems - 16</td>
<td>$13,900</td>
<td>$15,900</td>
<td>$20,400</td>
<td>$22,400</td>
</tr>
<tr>
<td>Redcor RC-70</td>
<td>$12,800</td>
<td>$14,000</td>
<td>$18,600</td>
<td>$19,800</td>
</tr>
<tr>
<td>GRI Computer Co 909</td>
<td>$8,290</td>
<td>$9,900</td>
<td>$11,530</td>
<td>$13,140</td>
</tr>
<tr>
<td>Hewlett Packard 2114A/2114B</td>
<td>$8,500</td>
<td>$10,500</td>
<td>$12,500</td>
<td>$14,500</td>
</tr>
<tr>
<td>Hewlett Packard 2115A</td>
<td>$14,500</td>
<td>$16,500</td>
<td>$19,500</td>
<td>$21,500</td>
</tr>
<tr>
<td>Honeywell H-316</td>
<td>$9,700</td>
<td>$11,400</td>
<td>$15,200</td>
<td>$16,900</td>
</tr>
<tr>
<td>Honeywell DDP-416</td>
<td>$15,700</td>
<td>$16,900</td>
<td>$23,700</td>
<td>$24,900</td>
</tr>
<tr>
<td>Information Tech. Inc. ITI-4900 (Model 20)</td>
<td>$9,950</td>
<td>$12,450</td>
<td>$15,950</td>
<td>$18,450</td>
</tr>
<tr>
<td>Interdata Model 2</td>
<td>$5,750 (1K)</td>
<td>$7,650 (1K)</td>
<td>$6,650 (2K)</td>
<td>$8,550 (2K)</td>
</tr>
<tr>
<td>Interdata Model 3</td>
<td>$10,800</td>
<td>$12,700</td>
<td>$17,700</td>
<td>$19,600</td>
</tr>
<tr>
<td>Interdata Model 4</td>
<td>$13,800</td>
<td>$15,700</td>
<td>$20,700</td>
<td>$22,600</td>
</tr>
<tr>
<td>Lockheed Electronics MAC-16</td>
<td>$11,950</td>
<td>$11,950</td>
<td>$15,900</td>
<td>$15,900</td>
</tr>
<tr>
<td>Raytheon 703</td>
<td>$15,000</td>
<td>$15,000</td>
<td>$23,000</td>
<td>$23,000</td>
</tr>
<tr>
<td>Raytheon 704</td>
<td>$10,000</td>
<td>$11,900</td>
<td>$15,600</td>
<td>$17,500</td>
</tr>
<tr>
<td>Raytheon 706</td>
<td>$19,000</td>
<td>$19,000</td>
<td>$24,600</td>
<td>$24,600</td>
</tr>
</tbody>
</table>

SMALL COMPUTER CHARACTERISTICS

TABLE G-1 (Continued)
<table>
<thead>
<tr>
<th>CPU FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer/Model Number</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Motorola MDP-1000</td>
</tr>
<tr>
<td>Systems Engineering Lab. 810A</td>
</tr>
<tr>
<td>Tempo Computers Inc Tempo 1</td>
</tr>
<tr>
<td>Varian 620 i</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/1</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/L</td>
</tr>
<tr>
<td>General Automation SPC-12</td>
</tr>
<tr>
<td>General Automation 18/30</td>
</tr>
<tr>
<td>Business Information Technology 480/482</td>
</tr>
<tr>
<td>Computer Automation 208-808</td>
</tr>
<tr>
<td>Micro Systems 800</td>
</tr>
<tr>
<td>Micro Systems 810</td>
</tr>
<tr>
<td>Varian 520 i</td>
</tr>
</tbody>
</table>

SMALL COMPUTER CHARACTERISTICS
TABLE G-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>Cycle Time (us)</th>
<th>Word Length (bits)</th>
<th>Minimum Size (words)</th>
<th>Increment Size (words)</th>
<th>Maximum Size (words)</th>
<th>Parity Check</th>
<th>Protect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorola MDP-1000</td>
<td>2.16</td>
<td>8</td>
<td>4K</td>
<td>4K</td>
<td>16K</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Systems Engineering Lab. 810A</td>
<td>1.75</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Tempo Computers Inc Tempo 1</td>
<td>0.9</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>65K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Varian 620 i</td>
<td>1.8</td>
<td>16/18</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/I</td>
<td>1.5</td>
<td>12</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>opt.</td>
<td>std.</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/L</td>
<td>1.6</td>
<td>12</td>
<td>4K</td>
<td>4K</td>
<td>8K</td>
<td>opt.</td>
<td>std.</td>
</tr>
<tr>
<td>General Automation SPC-12</td>
<td>2.0</td>
<td>8</td>
<td>4K</td>
<td>4K</td>
<td>16K</td>
<td>opt.</td>
<td>no</td>
</tr>
<tr>
<td>General Automation 18/30</td>
<td>1.2</td>
<td>16</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>std.</td>
<td>std.</td>
</tr>
<tr>
<td>Business Information Technology 480/482</td>
<td>3.0</td>
<td>8</td>
<td>1K</td>
<td>1K, 2K, 4K</td>
<td>65K</td>
<td>opt.</td>
<td>no</td>
</tr>
<tr>
<td>Computer Automation 208-808</td>
<td>2.6/8.0</td>
<td>8</td>
<td>4K</td>
<td>4K</td>
<td>16K</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Micro Systems 800</td>
<td>1.1</td>
<td>8</td>
<td>1K</td>
<td>1K, 4K</td>
<td>32K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Micro Systems 810</td>
<td>1.1</td>
<td>8</td>
<td>1K</td>
<td>1K, 4K</td>
<td>32K</td>
<td>opt.</td>
<td>opt.</td>
</tr>
<tr>
<td>Varian 520 i</td>
<td>1.5</td>
<td>8</td>
<td>4K</td>
<td>4K</td>
<td>32K</td>
<td>opt.</td>
<td>std.</td>
</tr>
</tbody>
</table>

**SMALL COMPUTER CHARACTERISTICS**

**TABLE G-1 (Continued)**
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Data Path Width (bits)</th>
<th>Direct Memory Access (DMA)</th>
<th>Max. DMA Word Transfer Rate</th>
<th>No. External Priority Interrupt Levels in Basic System</th>
<th>Max. No. External Interrupts</th>
<th>OTHER FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorola MDP-1000</td>
<td>8</td>
<td>opt</td>
<td>400 KHZ</td>
<td>2</td>
<td>64</td>
<td>opt std</td>
</tr>
<tr>
<td>Systems Engineering Lab. 810A</td>
<td>16</td>
<td>opt</td>
<td>572 KHZ</td>
<td>3</td>
<td>96</td>
<td>std opt</td>
</tr>
<tr>
<td>Tempo Computers Inc. Tempo 1</td>
<td>8/16</td>
<td>opt</td>
<td>800 KHZ</td>
<td>4</td>
<td>256</td>
<td>std opt</td>
</tr>
<tr>
<td>Varian 620 i</td>
<td>16/18</td>
<td>opt</td>
<td>200 KHZ</td>
<td>none</td>
<td>64</td>
<td>opt opt</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/1</td>
<td>12</td>
<td>opt</td>
<td>666 KHZ</td>
<td>1</td>
<td>64</td>
<td>opt opt</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/L</td>
<td>12</td>
<td>opt</td>
<td>625 KHZ</td>
<td>1</td>
<td>64</td>
<td>opt opt</td>
</tr>
<tr>
<td>General Automation SPC-12</td>
<td>8/12</td>
<td>opt</td>
<td>430 KHZ</td>
<td>2</td>
<td>256</td>
<td>opt std</td>
</tr>
<tr>
<td>General Automation 18/30</td>
<td>16</td>
<td>opt</td>
<td>833 KHZ</td>
<td>6</td>
<td>59</td>
<td>std std (3)</td>
</tr>
<tr>
<td>Business Information Technology 480/482</td>
<td>8</td>
<td>std</td>
<td>250 KHZ</td>
<td>1</td>
<td>1</td>
<td>opt opt</td>
</tr>
<tr>
<td>Computer Automation 208-808</td>
<td>8</td>
<td>no</td>
<td>--</td>
<td>3</td>
<td>64</td>
<td>opt opt</td>
</tr>
<tr>
<td>Micro Systems 800</td>
<td>8</td>
<td>opt</td>
<td>910 KHZ</td>
<td>no</td>
<td>--</td>
<td>opt opt</td>
</tr>
<tr>
<td>Micro Systems 810</td>
<td>8</td>
<td>opt</td>
<td>910 KHZ</td>
<td>8</td>
<td>64</td>
<td>opt opt</td>
</tr>
<tr>
<td>Varian 520 i</td>
<td>8/16</td>
<td>opt</td>
<td>660 KHZ</td>
<td>3</td>
<td>11</td>
<td>opt opt</td>
</tr>
</tbody>
</table>

SMALL COMPUTER CHARACTERISTICS

TABLE G-1 (Continued)
<table>
<thead>
<tr>
<th>MANUFACTURER/ MODEL No.</th>
<th>MICRO-Programming (i.e. firmware)</th>
<th>Assembler (1 pass, 2 pass, both)</th>
<th>Relocatable Assembler (yes, no)</th>
<th>Min. Core Size necessary to use Relocatable Assembler</th>
<th>Macro Assembler Capability</th>
<th>Real-time Exec. Monitor Available (yes, no)</th>
<th>Disc Operating System Available (yes, no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorola MDP-1000</td>
<td>no</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Systems Engineering Lab. 810A</td>
<td>no</td>
<td>2 pass</td>
<td>yes</td>
<td>8K</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Tempo Computers Inc. Tempo 1</td>
<td>no</td>
<td>both</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Varian 620 i</td>
<td>yes</td>
<td>2 pass</td>
<td>no</td>
<td>--</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/I</td>
<td>no</td>
<td>both</td>
<td>yes</td>
<td>8K</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/L</td>
<td>no</td>
<td>both</td>
<td>yes</td>
<td>8K</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>General Automation 6SPC-12</td>
<td>no</td>
<td>1 pass</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>General Automation 18/30</td>
<td>no</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Business Information Technology 480/482</td>
<td>no</td>
<td>3 pass</td>
<td>no</td>
<td>--</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Computer Automation 208/808</td>
<td>no</td>
<td>2 pass</td>
<td>no</td>
<td>--</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Micro Systems 800</td>
<td>yes</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Micro Systems 810</td>
<td>yes</td>
<td>both</td>
<td>no</td>
<td>--</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Varian 520 i</td>
<td>no</td>
<td>2 pass</td>
<td>yes</td>
<td>4K</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

SMALL COMPUTER CHARACTERISTICS

TABLE G-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>Magnetic Tape Available (yes, no)</th>
<th>Approx. Price For Oper. Unit (Incl. Controller, Comp. Options Nec., etc.)</th>
<th>Mass Storage Device Available (yes, no)</th>
<th>Approx. Price For Oper. Unit (Incl. Controller, Comp. Options Nec., etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raytheon 706</td>
<td>yes</td>
<td>$10,500 to $28,000</td>
<td>yes</td>
<td>$21,500 to $12,000</td>
</tr>
<tr>
<td>Motorola MDP-1000</td>
<td>yes</td>
<td>$18,000</td>
<td>yes</td>
<td>$19,500</td>
</tr>
<tr>
<td>Systems Engineering Lab. 810A</td>
<td>yes</td>
<td>$24,000</td>
<td>yes</td>
<td>$30,000</td>
</tr>
<tr>
<td>Tempo Computers, Inc. Tempo 1</td>
<td>yes</td>
<td>$12,000</td>
<td>yes</td>
<td>$16,600</td>
</tr>
<tr>
<td>Varian 620 i</td>
<td>yes</td>
<td>N/A</td>
<td>yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Digital Equipment Corporation PDP 8/1</td>
<td>yes</td>
<td>$24,700</td>
<td>yes</td>
<td>$8,700 to $15,700</td>
</tr>
<tr>
<td>Digital Equipment Corporation PDP 8/L</td>
<td>yes</td>
<td>$24,700</td>
<td>yes</td>
<td>$6,000 to $15,000</td>
</tr>
<tr>
<td>General Automation SPC-12</td>
<td>yes</td>
<td>$11,000</td>
<td>yes</td>
<td>$6,000 to $15,000</td>
</tr>
<tr>
<td>General Automation 18/30</td>
<td>yes</td>
<td>$14,000 to $25,000</td>
<td>yes</td>
<td>$14,000 to $30,000</td>
</tr>
<tr>
<td>Business Information Technology 480/482</td>
<td>yes</td>
<td>$18,700 to $22,500</td>
<td>yes</td>
<td>$7,390</td>
</tr>
<tr>
<td>Computer Automation 208/808</td>
<td>yes</td>
<td>$5,700 to $10,000</td>
<td>yes</td>
<td>$6,500 to $9,950</td>
</tr>
<tr>
<td>Micro Systems 800</td>
<td>no</td>
<td>--</td>
<td>yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Micro Systems 810</td>
<td>no</td>
<td>--</td>
<td>yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Varian 520 i</td>
<td>yes</td>
<td>$9,000</td>
<td>yes</td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A = Not Announced or Not Available

SMALL COMPUTER CHARACTERISTICS

TABLE G-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
<th>High Speed Paper Tape Reader (yes, no)</th>
<th>Speed (char/sec)</th>
<th>Approximate Cost of Operational Paper Tape Rdr. (yes, no)</th>
<th>Speed (char/sec)</th>
<th>Approximate Cost of Operational Paper Tape Punch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raytheon 706</td>
<td>yes</td>
<td>300</td>
<td>$3,000</td>
<td>yes</td>
<td>110</td>
</tr>
<tr>
<td>Motorola MDP-1000</td>
<td>yes</td>
<td>300</td>
<td>$3,000</td>
<td>yes</td>
<td>120</td>
</tr>
<tr>
<td>Systems Engineering Lab. 810A</td>
<td>yes</td>
<td>300</td>
<td>$4,000</td>
<td>yes</td>
<td>100</td>
</tr>
<tr>
<td>Tempo Computers Inc. Tempo 1</td>
<td>yes</td>
<td>400</td>
<td>$2,700</td>
<td>yes</td>
<td>120</td>
</tr>
<tr>
<td>Varian 620 i</td>
<td>yes</td>
<td>300</td>
<td>$2,900</td>
<td>yes</td>
<td>60</td>
</tr>
<tr>
<td>Digital Equipment Corporation PDP 8/I</td>
<td>yes</td>
<td>300</td>
<td>$2,000</td>
<td>yes</td>
<td>50</td>
</tr>
<tr>
<td>Digital Equipment Corporation PDP 8/L</td>
<td>yes</td>
<td>300</td>
<td>$2,000</td>
<td>yes</td>
<td>50</td>
</tr>
<tr>
<td>General Automation SPC-12</td>
<td>yes</td>
<td>300</td>
<td>$3,000</td>
<td>yes</td>
<td>120</td>
</tr>
<tr>
<td>General Automation 18/30</td>
<td>yes</td>
<td>300</td>
<td>$2,500</td>
<td>yes</td>
<td>60</td>
</tr>
<tr>
<td>Business Information Technology 480/482</td>
<td>yes</td>
<td>300</td>
<td>$2,300</td>
<td>yes</td>
<td>60</td>
</tr>
<tr>
<td>Computer Automation 208/808</td>
<td>yes</td>
<td>300</td>
<td>$2,200</td>
<td>yes</td>
<td>60</td>
</tr>
<tr>
<td>Micro Systems 800</td>
<td>yes</td>
<td>300</td>
<td>$2,750</td>
<td>yes</td>
<td>110</td>
</tr>
<tr>
<td>Micro Systems 810</td>
<td>yes</td>
<td>300</td>
<td>$2,750</td>
<td>yes</td>
<td>110</td>
</tr>
<tr>
<td>Varian 520 i</td>
<td>yes</td>
<td>300</td>
<td>$2,900</td>
<td>yes</td>
<td>60</td>
</tr>
</tbody>
</table>

N/A = Not Announced or Not Available

SMALL COMPUTER CHARACTERISTICS

TABLE G-1 (Continued)
<table>
<thead>
<tr>
<th>Manufacturer/Model No.</th>
<th>Basic System Price with 4K words incl. Power Supplies</th>
<th>Total System Price incl. ASR-33 Teletype &amp; CPU</th>
<th>Basic System Price with 8K words incl. adequate power supplies, enclosure, control panel</th>
<th>Total System Price incl. ASR-33 Teletype &amp; CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorola MDP-1000</td>
<td>$8,500</td>
<td>$9,700</td>
<td>$11,500</td>
<td>$12,700</td>
</tr>
<tr>
<td>Systems Engineering Lab. 810A</td>
<td>$18,000</td>
<td>$18,000</td>
<td>$23,000</td>
<td>$23,000</td>
</tr>
<tr>
<td>Tempo Computers Inc. Tempo 1</td>
<td>$15,000</td>
<td>$15,000</td>
<td>$19,000</td>
<td>$19,000</td>
</tr>
<tr>
<td>Varian 620 i</td>
<td>$9,950</td>
<td>$11,750</td>
<td>$15,850</td>
<td>$17,650</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/1</td>
<td>$12,800</td>
<td>$12,800</td>
<td>$16,300</td>
<td>$16,300</td>
</tr>
<tr>
<td>Digital Equip. Corp. PDP 8/L</td>
<td>$8,500</td>
<td>$8,500</td>
<td>$13,200</td>
<td>$13,200</td>
</tr>
<tr>
<td>General Automation SPC-12</td>
<td>$4,000</td>
<td>$5,100</td>
<td>$7,400</td>
<td>$8,500</td>
</tr>
<tr>
<td>General Automation 18/30</td>
<td>$18,000</td>
<td>$19,500</td>
<td>$25,000</td>
<td>$26,500</td>
</tr>
<tr>
<td>Business Information Technology 480/482</td>
<td>$9,310</td>
<td>$9,310</td>
<td>$11,250</td>
<td>$11,250</td>
</tr>
<tr>
<td>Computer Automation 208/808</td>
<td>$5,990/$4,990</td>
<td>$8,000/$7,000</td>
<td>$8,940/$7,690</td>
<td>$10,950/$9,700</td>
</tr>
<tr>
<td>Micro Systems 800</td>
<td>$5,700</td>
<td>$6,900</td>
<td>$8,200</td>
<td>$9,400</td>
</tr>
<tr>
<td>Micro Systems 810</td>
<td>$6,900</td>
<td>$8,100</td>
<td>$9,400</td>
<td>$10,600</td>
</tr>
<tr>
<td>Varian 520 i</td>
<td>$7,500</td>
<td>$8,900</td>
<td>$10,000</td>
<td>$11,400</td>
</tr>
</tbody>
</table>

**Small Computer Characteristics**

**Table G-1 (Continued)**
Clarification of Terms Used in Table G-1

CPU Features - features and characteristics of the central processing unit.

R/O Memory - whether a read only memory is available as standard equipment or an option.

Instruction Word Length - the length of the instruction word in bits.

No. Acc. or Gen. Purp. Registers that can be used as Accumulators - the number of accumulators in the computer or the number of general purpose registers that can be used as accumulators.

No. Hdwr. Reg. not including Index Registers - the number of registers in the machine implemented with separate hardware (i.e. not main memory locations) not including the index registers.

No. Index Reg. - the number of effective index registers in the computer and whether they are implemented by separate hardware or as locations in the main memory.

Indirect Addressing - whether indirect addressing is provided and whether it is single level or multi-level.

Memory Characteristics - the characteristics of the computer's main memory.

Cycle Time - the time to complete a memory cycle in microseconds.

Word Length - the length in bits of words stored in the memory.

Minimum Size - the minimum size of memory available in thousands of words.

Increment Size - the size of the increments in which memory can be increased in thousands of words.

Maximum Size - the maximum size of memory that can be utilized in thousands of words.

Parity Check - whether a parity check is provided and whether it is standard or optional.

Protect - whether memory protection is available and whether it is standard or optional.

SMALL COMPUTER CHARACTERISTICS
TABLE G-1 (continued)
Clarification of Terms Used in Table G-1 (continued)

Input/Output Capability - the capability of the computer for handling input/output data.

Data Path Width - the number of bits transferred into and out of the computer in parallel.

Direct Memory Access Channel - whether a direct memory access channel is available and whether it is standard or optional.

Max. DMA Word Transfer Rate - the maximum rate at which words are transferred into and out of the memory through the direct memory access channel.

No. External Priority Interrupt Levels in Basic System - the number of external priority levels that are provided in the basic computer without adding options.

Max. No. External Interrupts - the maximum number of external priority interrupt levels which the computer can handle if optional equipment is added.

Power Failure & Automatic Restart - whether the ability to detect power failures, save register contents, and restart automatically when the power is recovered is provided and whether this is standard or optional.

Real-time Clock or Internal timer - whether a real time clock or internal timer is available and whether this is standard or optional.

Micro-programming - whether micro-programming capability is provided.

Assembler - whether a software assembler is available and whether it assembles object codes in one or two passes.

Relocatable Assembler - whether the memory location of the assembler can be relocated or not.

Min. Core Size necessary to use Relocatable Assembler - the minimum memory capacity required in the computer if the relocatable assembler is to be used.

Macro Assembler Capability - whether a macro assembler is provided or not.
Clarification of Terms Used in Table G-1 (continued)

Real-time Exec. Monitor Available - whether a real time executive monitor is provided or not.

Disc Operating System Avail. - whether a disc operating system is available or not.

Peripherals Available - peripheral equipments offered for which interfaces to the computer are provided.

Magnetic Tape Available - whether magnetic tape is available or not.

Mass Storage Device Available - whether a mass storage, such as a disc or drum, is available or not.

High Speed Paper Tape Reader - whether a high speed paper tape reader is available or not.

Speed - the speed of the paper tape reader in characters per second if one is available.

High Speed Paper Tape Punch - whether a high speed paper tape punch is available or not.

Speed - the speed of the paper tape punch in characters per second if one is available.

SMALL COMPUTER CHARACTERISTICS

TABLE G-1 (continued)
Because of communication terminal applications similar to the Library of Congress terminal requirements, several computer manufacturers have developed an eight bit word machine in the last year which is compatible with the eight bit character interface used over standard voice grade lines at present.

The chart in Table G-1 compares the features of computers grouped into the following categories:

- Memory
- Read-only memory
- CPU characteristics
- I/O capability
- Microprogramming
- Software
- Basic mainframe costs
- Peripherals

Until recently twelve and sixteen bit word length machines dominated the small computer market but in 1968 and 1969 several eight bit word length machines were introduced. These minicomputers, as they are sometimes called, are priced below $10,000. Their most obvious advantage is that of a smaller word length which costs less in storage, registers, and logic. Also the eight bit machines offer the advantages of manipulating data on an eight bit byte basis which is usually the way communications line controllers work to adjust between the terminal modules and communications interface. Many of the twelve and sixteen bit machines have added features to their organization that facilitate handling operations on an eight bit byte basis; hence, they are also well suited to use as a controller.

Read-only (R-O) memories are used to implement in hardware a set of instructions which act as a stored program to cause the machine to follow a predetermined programmed sequence. This allows faster execution and a greater degree of protection than conventional core memory, but this
R-O memory usually cannot be modified easily. This capability provides custom program sequences to meet special requirements in the particular application for which it is programmed. Also, the cost of read-only memory is usually less than that for read/write memory of equivalent speed. This type of memory is referred to as permanent or semi-permanent since the contents ordinarily cannot be changed without physically replacing the R-O memory card.

Some "read-only" memories are electrically alterable so that physical replacement is not required. These are sometimes called "read-mostly" memories. The read-only memory is used to store microprograms - i.e., stored logic - which control formatting, buffering, and sequencing of information from the terminal modules to the communications interface.

The CPU features of any small computer organization determine the flexibility and efficiency with which program sequences can be executed. The number of registers available to do operations with is an important factor since more registers minimize memory accessing. The CPU organization also affects to a large extent the addressing capabilities and the speed and ease with which subroutines and dots can be branched to or manipulated in carrying out the particular program sequence desired. Since small computers will be used as a controller in the Library's application and not as a scientific computer, the arithmetic operation speeds and hardware multiply-divide execution times are not included in Table G-1. They are not important to the use of small computers in a controller environment. The Library of Congress requirements are not computation oriented. Storage, control, and communication capabilities are of more importance in this application.

Of major significance and importance in the evaluation of small computers for a control operation is their capability to handle input/output (I/O) operations efficiently and easily. In particular, an I/O capability for eight bit byte oriented data transfers is important. It is very important to note that direct memory I/O data transfer refers to data transfer.
between either the terminal modules or the telephone line directly into
the memory bus, without necessarily being under CPU control for each
data byte transferred.

Of particular importance in evaluating I/O capabilities of a small computer
is whether the computer has a fully buffered channel which means that each
channel has two registers associated with it to hold the necessary data
and control information so that the CPU is not tied up waiting for a data
transfer. This buffering then permits several I/O channels to operate
concurrently. The type of channel most commonly used in these applica-
tions is frequently called a direct memory access (DMA) channel. With a
DMA, the channel data transfer rates approach the maximum data transfer
rate of the computer's main memory because this channel is tied directly
on the memory bus.

A minimal of CPU overhead and programming should be associated with
transferring data between the external computer and the memory bank
associated with that computer. In addition to this it is very important that
the external I/O operations be associated or triggered by external inputs
to the small computer so that there is no delay or bottleneck when data is
to be transferred over the data communications line and/or to the terminal
peripheral modules. Capable interrupt systems are important for these
reasons. Note that the data rates associated with the DMA channel are
shown as the maximum speeds so that data throughput computations can
be estimated in order to quickly evaluate whether the computer can main-
tain the data transfer speeds necessary to make this system fully operational
with terminals. In carefully analyzing the small computer requirements
for terminals of these kinds, it becomes extremely important to evaluate
the I/O capability of the computer to be used. One major problem in
comparing the I/O channel configurations offered by different manufacturers
is that one computer may have much more hardware capability, thus re-
quiring the use of fewer instruction sequences, than another machine for
carrying out the same I/O data transfers. For example, some machines
provide the programmer with one instruction to execute input or output automatically, while in other machines additional programming is required, such as testing program loops to see if the channel is busy, providing the address of the external device, etc.

Two other very important features are the real-time clock option available with most of the systems. This feature allows immediate access to current timing information which can be used to control and synchronize all operations. It provides time of day information and facilitates keeping track by the executive program of time intervals since a given event or time elapsed between given events. Another important feature is the power failure and automatic restart capability which insures that if a power failure occurs there will be a safe orderly shutdown. In this case, the contents of the CPU registers are saved so that the program can be restarted at that point in an orderly fashion when power is restored.

Microprogramming is a special technique in which the organization structure of the machine allows various special instructions to be implemented by the subcommand structure of the computer. Different terms such as micro-instructions, micro-operations and machine subcommands are used to refer to these types of operations. Only a few of these machines presently offer the ability to bring the wires controlling these subcommand operations out to the connector so the user can provide logic to generate certain desired micro-operations. In these machines each bit in the address field of the register-to-register instruction format might refer to a register operation such as complementing, shifting, etc. With these subcommands, several additional operations not already available in the basic computer repertoire can be implemented. Microprogramming is sometimes associated with read-only memories where these special memories are used to store predetermined program sequences that interpret and execute a set of micro-instructions which make up macro-instructions particularly suited to the application at hand.

Software, which is the next category of characteristics presented in the survey chart, is particularly important from the applications point of view.
It is the software and programming that permits the operation of the small computer to be tailored to meet all the requirements in the terminal module controller. In particular, terminal and controller applications would be implemented in assembly language to be most efficient and to minimize time and memory requirements. A very powerful and expedient method used frequently now is to assemble a small computer program using a larger computer system, such as the IBM 360 or another large system, so that the program can be written and debugged before it is tried out on the actual small computer equipment itself. In this way, the lead time in developing and delivering the running program can be in parallel with the hardware check-out so that the total slapsed time for these two items is minimized.

Characteristics of these small computers with respect to higher level languages, such as FORTRAN and conversational compilers, are not included because such software is not relevant to the use of a small computer as a terminal controller. The real-time executive monitors available with these small computers vary greatly depending to a large extent upon how much memory is required and whether it is used in more than one application rather than a single dedicated application. Therefore this monitor may not in itself be directly used in the terminal or controller, but it could aid in debugging the program faster and in determining how the interrupts and I/O structure can best be tied into the program structure of the controller or terminal. Similarly, a disc operating system might be of interest in terms of other considerations in using the computer but the disc operating system as such would probably not be used in the terminal or controller.

Cost of these machines with 4,096 and 8,192 (4K and 8K) word memory increment are included along with the price for a standard teletype I/O device. In addition, the peripheral devices available and their approximate cost are also included in case it is necessary to have some peripheral
device associated with the computer system. No peripherals may be needed once the final installation is made, but that will not necessarily be the case; hence these are included in order to keep options open for the trade-off analyses.
This Appendix discusses devices and techniques that have been developed or that are under development for handling oriental languages. The discussion of a device or technique in this Appendix should not be interpreted as meaning that the device is fully developed or commercially available at a reasonable price. Most of these devices are in a developmental stage, or in one or two cases an early pre-production stage. For several, only one to three units have been built. Hence, cost for initial units would probably be quite high.

1. The Chinese Typewriter
The principle of operation of the Chinese typewriter is extremely simple. The type faces are on individual slugs which are stored separately in compartmented boxes with the faces visible. The location of the individual slugs is given by a diagram in which the characters are arranged in a semi-mnemonic order. The individual slugs are removed from the box and placed into position on the typewriter. A key stroke provides the impact to imprint the character through a ribbon and the carriage is automatically advanced. The slug is then replaced.

The speed of operation is roughly comparable to forming the character with brush strokes. The primary advantage is uniformity of character size and spacing. Attempts are being made to adapt the "selectric" principle with multiple type balls but with little success. Automation of the typewriter and its use as an input/output device is not practical.

2. The RCA Ideographic Composing Machine (ICM)
This is a limited production device (2 - 3 models) built by RCA for Army use. The keyboard is modified typewriter. The entry and output principles
have been described earlier. A repertoire of 10,000 characters is available on any one photo image plate. The speed is not explicitly given since it depends on operator skill but the machine is said to be comparable in with a "conventional English typewriter."

The machine has been modified to use a holographic image plate in place of the photo image plate. The advantage of the holographic technique is primarily one of size and weight. No additional speed is provided. The size and spacing of the characters are selectable. The machine is large and relatively expensive, about $100,000. Further information may be obtained from Applied Research, Defense Electronic Products, RCA, Camden, New Jersey.

3. The ITEK Chicoder
This is believed to be a limited production machine, built by the Itek Corporation of Lexington, Massachusetts. A speed of 40 ideographs per minute is cited. The initial vocabulary was 10,518 characters with extension to 30,000 characters said to be possible. An 18 bit code is used. Impartial sources describe the output as having poor legibility. The principles of operation are based on feature selection. The operator identifies a pair of top and bottom features by two keystrokes. All ideographs containing these features are displayed and the operator selects one of them by means of a third keystroke. Further information may be obtained from Itek Corporation, Lexington, Massachusetts.

4. The SINCO System
The SINCO system developed at the University of Kansas, uses typewriter keys to describe the element of the characters. As such it can be used as an input device. SINCO is an acronym, "Synthetic Index Nomenclature for Chinese Orthography." SINCO permits the composition of variably serial
logographs, such as Chinese characters, from a small number of simple elements using mechanical, electromechanical, or electronic techniques. A simple typewriter keyboard is used. The output of the keyboard provides the machine compatible string incorporating all morphological features of the original graph. Since this system is truly synthetic, memory requirements are no greater than for other simpler orthographies. In one demonstration of this system, a standard keypunch keyboard was used and the data was analyzed by a GE 635 computer which produced taped writing instructions. The computer analysis included determination of the appropriate juxtapositional mode according to built-in orthographic rules and the sizing of the alphabetic elements. The taped writing instructions produced by the computer were used to drive a plotter which drew each syllabic character in an 0.2" square. A sample of this output is shown in Figure H-1. Finer resolution is expected in the future.

The SINCO system should be followed closely as a possible solution to the oriental language problem but it is unlikely that it will be in an adequate state of development for the Library of Congress applications by 1972. No information is available on potential costs for this system.

Current state is still experimental. The work is being performed by Professor Carl Leban at the University of Kansas.
집달리몇

나보기가 역계의 가실때에는
달없이 고이 보니 드리오리다

영년의 역산 집달리몇
아름마다 가실길에 뿌리오리다

가시는 겉음 겉음 놓인 그 꿁을
사뿐히 지리봉고 가시음소서

나보기가 역계의 가실때에는
즉어도 아니 눈물 풀리오리다

김소월

SAMPLE OF ORIENTAL LANGUAGE PRINT-OUT PREPARED
BY SINCO SYATEM FROM STANDARD KEYBOARD INPUT
USING COMPUTER ANALYSIS AND PLOTTER DRAWING
OF THE ORIENTAL LANGUAGE CHARACTERS,
FIGURE H-1
H-4
5. The Kanji Teletypewriter
This is a thoroughly workable device being used by the Japan Information Center of Science and Technology for bibliographical purposes. Information is available from the JICST, Tokyo, Japan.

It is limited to 2496 input and 3071 output characters. The difference is due to the inclusion of boldface and italics for the Katakana, Hiragana, Russian, Roman, and Greek alphabets and the Arabic and Roman numerals which it can also handle. It has been incorporated into an operational library data processing system by JICST. The line printer is capable of handling all of the languages listed, but it is more expensive to use this device for languages, such as Russian which can be handled with less expensive devices such as flexowriters. Software for conversion of the flexowriter code to the Kanji Teletypewriter code are available. The working system of the JICST uses the hardware complement shown in Table H-1 which includes alphanumeric and Russian flexowriters as well as Kanji teletypewriters. Characteristics of the Kanji Teletypewriter are given in Table H-2.

6. The Chinese Teleprinter
This device permits the encoding and punching into paper tape codes for 2400 characters and is thus comparable with the Kanji Teletypewriter in capability. In its original form no provision for Roman, Greek or other special alphabets exists. It is useful primarily for communication purposes in which the messages can be rephrased into the limited vocabulary available (compare with basic English, for example). It is not sufficiently versatile for literary or scientific work.

A new version capable of handling 4600 Chinese plus 200 other special characters is being readied for sale. There are 600 keys plus an eight
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Model</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer (1)</td>
<td>FACOM230-50</td>
<td>1</td>
</tr>
<tr>
<td>Memory unit</td>
<td>F2520B</td>
<td>1</td>
</tr>
<tr>
<td>Magnetic tape unit</td>
<td>F603D</td>
<td>8</td>
</tr>
<tr>
<td>Magnetic drum unit</td>
<td>F624</td>
<td>1</td>
</tr>
<tr>
<td>Magnetic disc unit</td>
<td>F631B</td>
<td>1</td>
</tr>
<tr>
<td>Console Typewriter</td>
<td>F2540B</td>
<td>1</td>
</tr>
<tr>
<td>Line printer</td>
<td>F642B</td>
<td>1</td>
</tr>
<tr>
<td>(alphanumeric and Kana, printable characters 128)</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Card reader (80-column)</td>
<td>F664A</td>
<td>1</td>
</tr>
<tr>
<td>Paper tape punch</td>
<td>F767A</td>
<td>1</td>
</tr>
<tr>
<td>Paper tape reader</td>
<td>F748A</td>
<td>1</td>
</tr>
<tr>
<td>Typewriter</td>
<td>E791A</td>
<td>4</td>
</tr>
<tr>
<td>Computer (2)</td>
<td>FACCM 270-20</td>
<td>1</td>
</tr>
<tr>
<td>Memory unit</td>
<td>F7220A</td>
<td>1</td>
</tr>
<tr>
<td>Magnetic tape unit</td>
<td>F603D</td>
<td>3</td>
</tr>
<tr>
<td>Paper tape reader</td>
<td>F748A</td>
<td>1</td>
</tr>
<tr>
<td>Typewriter</td>
<td>F801A</td>
<td>1</td>
</tr>
<tr>
<td>High/speed Kanji line printer</td>
<td>JEM 3800</td>
<td>2</td>
</tr>
<tr>
<td>(printable characters:3071)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Film recorder</td>
<td>PT200</td>
<td>2</td>
</tr>
<tr>
<td>Soft printer (Electrofax)</td>
<td>PT-600</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>PT-700</td>
<td>1</td>
</tr>
<tr>
<td>Kanji teletypewriter</td>
<td>SCK-201</td>
<td>40</td>
</tr>
<tr>
<td>Alphanumeric flexowriter</td>
<td>F802A</td>
<td>9</td>
</tr>
<tr>
<td>Russian flexowriter</td>
<td>F802A</td>
<td>3</td>
</tr>
<tr>
<td>Paper tape reader punch</td>
<td>PTS</td>
<td>1</td>
</tr>
<tr>
<td>IBM Card punch with Katakana</td>
<td>Model 10029 A12</td>
<td>1</td>
</tr>
<tr>
<td>IBM Printing card punch</td>
<td>0029 A22</td>
<td>2</td>
</tr>
<tr>
<td>IBM Card verifier</td>
<td>0059 002</td>
<td>1</td>
</tr>
<tr>
<td>IBM Sorter</td>
<td>0083 001</td>
<td>1</td>
</tr>
</tbody>
</table>

**HARDWARE CONFIGURATION FOR JICST SYSTEM**

**TABLE H-1**

H-6
<table>
<thead>
<tr>
<th>INPUT</th>
<th>Kanji tele-typewriter</th>
<th>Flexowriter</th>
<th>OUTPUT</th>
<th>(TYPE FACE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Alphanumeric</td>
<td>Russian</td>
<td></td>
</tr>
<tr>
<td>Kanji</td>
<td>1861</td>
<td></td>
<td>1861</td>
<td>(regular)</td>
</tr>
<tr>
<td>Katakana</td>
<td>81</td>
<td></td>
<td>162</td>
<td>(regular, boldface)</td>
</tr>
<tr>
<td>Hiragana</td>
<td>77</td>
<td></td>
<td>154</td>
<td>( -dc- )</td>
</tr>
<tr>
<td>Roman alphabet</td>
<td>65</td>
<td>52</td>
<td>195</td>
<td>(regular, italic, boldface)</td>
</tr>
<tr>
<td>Russian alphabet</td>
<td>66</td>
<td>63</td>
<td>198</td>
<td>( -dc- )</td>
</tr>
<tr>
<td>Greek alphabet</td>
<td>33</td>
<td></td>
<td>99</td>
<td>( -dc- )</td>
</tr>
<tr>
<td>Arabic numerals</td>
<td>10</td>
<td>10</td>
<td>30</td>
<td>( -dc- )</td>
</tr>
<tr>
<td>Roman numerals</td>
<td>20</td>
<td></td>
<td>40</td>
<td>(regular, italic)</td>
</tr>
<tr>
<td>symbols</td>
<td>199</td>
<td>31</td>
<td>17</td>
<td>248</td>
</tr>
<tr>
<td>space</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>reserve</td>
<td>78</td>
<td></td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2496</td>
<td>94</td>
<td>91</td>
<td>3071</td>
</tr>
</tbody>
</table>

CHARACTERS, LETTERS, SIGNS, AND SYMBOLS
FOR A KANJI TELETYPETRITER

TABLE H-2

H-7
position shift. Printing is by mechanical impact and up to five carbons can be prepared. Characters outside the standard repertoire generally can be replaced by a sequence of the two or three characters of which they are a composite without loss of intelligibility. Information may be obtained from the Chinese Teleprinter Corporation, Taipei, Taiwan.

7. The Fujitsu Electrostatic Printer
Fujitsu Limited of Japan has been working an Electrostatic Printer capable of multiple copies for a number of years. The hardware problems appear to have been solved, but the software problems are formidable. This is because the characters are formed on a 16 x 24 dot matrix. As has been pointed out earlier, memory requirements for decoding into the dot matrix form are excessive. The simpler Khana characters can be printed on a 5 x 7 matrix if desired, but since the Kanji and Katakana usually are combined in text no real saving is possible.

8. The Harvard/American Mathematical Society Plotter and Scanner
Input to the system is by RAND tablet. Sheets of paper containing ruled squares each containing a character are placed on the tablet. The operator designates the identification number of the sheet and points to the desired character. Software is provided to convert the character location on the RAND tablet to the correct straight line stroke combination. A PDP-1 computer performs the output conversion.
APPENDIX I

This Appendix contains a complete manufacturer address list for each type of equipment included in Appendices A through G.

Keyboards and Keyboard/Printers (Appendix A)

- Manufacturers Included in this Appendix:

Keyboards
1. George Risk Industries
   672 - 15th Avenue, Columbus, Nebraska 68601
   (402) 564-2777

2. Datanetics Corporation
   2828 Spreckles Street, Redondo Beach, California 90278
   (213) 542-4355
   Richard Gerlach

3. Microswitch Inc.
   A Division of Honeywell
   Freeport, Illinois 61032
   (815) 232-1122

4. Connecticut Technical Corporation
   3000 Main Street, Hartford, Connecticut 06120
   (203) 522-6167
   Harold M. Kneller

5. Synergistics Inc.
   10 Tech Circle, Natick, Massachusetts 01760
   (617) 655-1340

   6615 West Irving Park Road, Chicago, Illinois 60634
   (312) 282-4040

7. IKOR, Inc.
   Northwest Industrial Park, Burlington, Massachusetts 01803
   (617) 272-4400
   William E. Polley

8. Clare-Pendar Company
   P.O. Box 785, Post Falls, Idaho 83854
   (208) 773-4541

9. Invac Corporation, A Division of Digitronics Corp.
   26 Fox Road, Waltham, Massachusetts 02154
   (617) 899-2380
10. Control Research Corporation
   P.O. Box 5037, 11762 Western St., Garden Grove, Calif.
   (714) 892-9415
   Kurt Stevens

11. Friden Inc.
   2350 Washington Avenue, San Leandro, California 94577
   (415) 357-6800
   S. W. Terry

12. Navcor Inc., A Division of KDI Corporation
   Valley Forge Industrial Park, Norristown, Pa., 19401
   (215) 542-3835
   Bill Taylor

13. Mechanical Enterprises, Inc.
   3127 Colvin Street, Alexandria, Va. 22314
   (703) 549-3434
   Richard A. Thomas

14. Keykode, A Division of Nutronics
   P.O. Box 72, Paramus, New Jersey 07652
   (201) 652-4220

15. Transistor Electronic Corp.
   P.O. Box 6191, Minneapolis, Minnesota 55424
   (612) 941-1100
   A. V. Klizas

   Easton and Wyandotte Roads, Will Grove, Pa. 19090
   (215) 657-0655
   Burbon F. Drill

Keyboard Printers

1. Anderson Jacobson Inc.
   2235 Mora Drive, Mountainview, California 94040
   (415) 968-2400
   George Fish

2. Computer Transceiver Systems Inc.
   123 Pleasant Avenue, Upper Saddle River, New Jersey 07458
   (201) 825-0220
   John Powers

3. Connecticut Technical Corporation
   300 Main Street, Hartford, Connecticut 06120
   (203) 522-6167
   Harold Kneller
4. Data Products Corporation (formerly Stelma)
   6219 De Soto Avenue, Woodland Hills, California 91364
   (213) 887-8000
   Ed Rosland

5. Datel Corporation
   1 Tysons Corner Center, McLean, Virginia 22101
   (703) 893-3700
   T. A. Jenkins

6. Dura, A Division of Intercontinental Systems Inc.
   2600 El Camino Real, Palo Alto, California 94306
   (415) 328-5660
   Steve Bishop

7. Invac Corporation, A Division of Digitronics Corp.
   26 Fox Road, Waltham, Massachusetts 02154
   (617) 899-2380

8. Computer Equipment, Division of Electronic Engineering Company of California
   1601 E. Chestnut Avenue, Santa Ana, California 92702
   (714) 547-5501

9. Friden, Division of Singer Corporation
   2350 Washington Avenue, San Leandro, California 94577
   (415) 357-6800
   S. W. Terry

10. General Electric Company
    Communication and Control Devices Dept.
    Waynesboro, Virginia 22980
    (703) 942-8161

11. IBM Corporation
    Data Processing Division
    112 E. Post Road, White Plains, New York 10601
    (914) 949-1900

12. Kleinschmidt, Division of SCM Corporation
    Deerfield, Illinois 60015
    (312) 945-1000
    Robert O. Carlson

13. Microdyne, Inc.
    1600 So. Hicks Road, Rolling Meadows, Illinois 60008
    (312) 774-9022
    L. R. Coffey

14. MITE Corporation
    445 Blake Street, New Haven, Connecticut 06515
    (203) 387-2572
    Ralph M. Hirsch
15. Teletype Corporation
5555 Touhy Avenue, Skokie, Illinois 60076
(312) 676-1000
Michael Harris

16. Terminal Equipment Corporation
750 Hamburg Turnpike, Pompton Lakes, New Jersey 07442
(201) 839-3000
James J. Hopkins

17. Texas Instruments Inc.
The Industrial Products Division
P.O. Box 66027, Houston, Texas 77006
(713) 494-5115
W. E. Gott

18. Novar Corporation
2370 Charleston Road, Mountain View, California 94040
(415) 964-3900
William C. Bennett

19. Omnitec, Electronic Products Division
903 North Second Street
Phoenix, Arizona 85004
(602) 258 8246

Manufacturers contacted but excluded because their equipment products were not applicable to the Library of Congress requirements:

1. ACS Industries
15726 Saticoy, Van Nuys, California
(213) 873-1193
Mr. Lachman

2. All Data Processing Machines, Inc.
105 Hinricher Street, Willow Springs, Illinois 60480

3. American Communications Corporation
178-15 Eleventh Road, Jamaica, New York

4. American Computer & Communications
2576 W. Carson Street, Torrance, California 90503

5. Burroughs, OEM Sales Department
1649 Wilshire Blvd., Los Angeles, California

6. California Electro Scientific Corporation
2203 South Grand Avenue, Santa Ana, California

7. Combined Data Group, Inc.
180 Broadway, New York, New York 10038

8. Com Data Corporation
7544 Oakton Street, Niles, Illinois 60648
9. Communityype Corporation
   767 Fifth Avenue, New York, New York

10. Compiler Systems Inc.
    Laurel Lane, Ridgefield, Connecticut 06877

11. The Computer Exchange, Inc.
    30 East 42nd Street, New York, New York 10017

12. Computer Micro-Data Systems
    16561 Ventura Boulevard, Suite 215E,
    Encino, California 91316

13. Computer Processing Inc.
    200 Manhattan Building, Muskogee, Oklahoma 77401

14. Computerware, Inc.
    131 East 23rd Street, New York, New York 10010

15. Computronics Engineering
    4949 Hollywood Boulevard, Los Angeles, California

16. Connecticut Consolidated Industries
    60 Cambridge Street, Meriden, Connecticut

17. Control Data Corporation, Rabinow Division
    1425 Research Boulevard, Rockville, Maryland 20850

18. Creed and Company, Ltd.
    Hollingbury, Brighton BN1.8 AL, England

19. Cummins-Chicago Corporation
    4760 North Ravenswood Avenue, Chicago, Illinois 60640

    Carterfone Communications Corporation
    4230 Central Avenue, N.E., Minneapolis, Minnesota 55421

21. Data Copy Company
    760 Bryant Street, San Francisco, California 94107

22. Data Trends Inc.
    1259 Route 46, Parsipanny, New Jersey 07054

23. Datron Systems Inc.
    21 North Hamilton Avenue, Greensburg, Pennsylvania 15601

24. Decitek, Inc.
    15 Sagmore Road, Worcester, Massachusetts 01605

25. DI/AN Controls Inc.
    944 Dorchester Avenue, Boston, Massachusetts 02125
26. Dimensions, Inc.
   93 Madison Avenue, Hempstead, New York 11550

27. Direct Access Computing Corporation
   24175 Northwestern Highway, Southfield, Michigan 48075

28. Display Control Division
   Luminator, Inc., Box 278, Plano, Texas

29. Diversified Numeric Applications
   Division of Avnet, Inc., 9801 Logan Avenue, South,
   Minneapolis, Minnesota 55431

30. Dynamco, Ltd.
    Chertsey, Surrey, England

31. Elbit Computers, Ltd.
    88 Hagiborim Street, Haifa, Israel

32. Elec-Trol, Inc.
    21018 Soledad Canyon Road, Saugus, California

33. Electronic Data Systems
    1300 EDS Center, Exchange Park, Dallas, Texas 75235

34. Facit-Odhner, Inc.
    501 Winsor Drive, Secaucus, New Jersey 07094

35. Ferranti-Packard, Ltd.
    Electronics Division, 121 Industry Street, Toronto 15,
    Ontario, Canada

36. Fujitsu, Ltd.
    Furekawa Building 8, Marunouchi 2, Chiyoda-ku, Tokyo, Japan

37. Geo Space Systems, Inc.
    6301 49th Street North, St. Petersburg, Florida

38. Hallmarkets International, Ltd.
    55 West 42nd Street, New York, New York 10036

39. Information Control Systems, Inc.
    109 East Madison, Ann Arbor, Michigan 48108
40. Information International, Inc.
   545 Technology Square, Cambridge, Massachusetts 02139

41. Information Machines Corporation
   8024 John Trowers Avenue, Santee, California 92071

42. Information Research Associates, Inc.
   3065 Rosecrans Place, San Diego, California 92110

43. International Computer Equipment
   1231 25th Street, N. W., Washington, D. C. 20037

44. International Datacon, Inc.
   15158 South Cicero, Oak Forest, Illinois 60452

45. International Scanatron Systems Corporation
   1623 Straight Path, Wyandanch, New York

46. Interstate Computer Services, Inc.
   754 4th Avenue, Brooklyn, New York 11232

47. Litton Industries, Automated Business Systems Division
   600 Washington Avenue, Carlstadt, New Jersey 07022

48. Litton Industries
   Datalog Division, 343 Sansome Street, San Francisco, Calif.

49. Loral Electronic Systems
   Division of Loral Corporation, 688 White Plains Road,
   Scarsdale, New York 10583

50. Measurement Research Center, Inc.
   Division of Westinghouse Learning Corporation,
   Box 30, Iowa City, Iowa 52240

51. Mergenthaler Linotype Company
   One Mergenthaler Drive, Plainview, Long Island, N. Y. 11803

52. Metro Processing Corporation of America
   64 Prospect Street, White Plains, New York 10606

53. Milgo Electronics Corporation
   7620 N. W. 36th Avenue, Miami, Florida
54. Milli-Switch Corporation  
Box 67, Gladwyne, Pennsylvania

55. Nanosecond Systems, Inc.  
176 Linwood Avenue, Fairfield, Connecticut 06430

56. National Cash Register Company  
Publix Relations Department, Dayton, Ohio 45409

57. National Computer Systems  
1015 South 6th Street, Minneapolis, Minnesota 55415

58. Nippon Electric New York Inc.  
200 Park Avenue, New York, New York

59. Northern Scientific Inc.  
2551 West Beltline, Middleton, Wisconsin

60. Novar Corporation  
2370 Charleston Road, Mountain View, California 94040

61. Nuclear Enterprises Ltd.  
Edinburgh 11, Scotland

62. Nutronics, KeyKode Division  
Box 72, Paramus, New Jersey 07652

63. Oki Electronics Industries, Ltd.  
202 E. 44th Street, New York, New York 10017

64. Olivetti Underwood Corporation  
One Park Avenue, New York, New York 10016

65. Philco-Ford Corporation  
3900 Welsh Road, Willow Grove, Pennsylvania 19090

66. Philips-Electrologica, N.V.  
P.O. Box 345, Apeldoorn, Holland

67. Pinlites, Inc.  
1275 Bloomfield Avenue, Fairfield, New Jersey 07006

68. Potter Instrument Co., Inc.  
Bethpage Road, Plainview, New York
69. PPM Inc.
7016 Euclid Avenue, Cleveland, Ohio

70. Raytheon Company
Industrial Components Operation
465 Center Street, Quincy, Massachusetts

71. Realist, Inc., Microform Products Division
N93 W16288 Megal Drive, Minomee Falls, Wisconsin 53057

72. Republic Advanced Technology Systems
9754 Deering Street, Chatsworth, California 91311

73. Scientific Data Systems
701 South Aviation Boulevard, El Segundo, California

74. Scope, Inc.
1860 Michael Faraday Drive, Reston, Virginia 22070

75. SEACO Computer Display, Inc.
2714 National Circle, Garland, Texas 75040

76. Siemens America, Inc.
350 Fifth Avenue, New York, New York 10001

77. Sierra Research Corporation, Computer Products Department
167 Bedford Street, Burlington, Massachusetts 01803

78. Soroban Engineering, Inc.
P.O. Box 1690, Melbourne, Florida 32901

79. Transcom, Inc., Subsidiary of HI-G Inc.
Spring Street and Route 75, Windsor Locks, Connecticut

80. Tyco Instrument Division
16 Hickory Drive, Waltham, Massachusetts

81. Ultronic Systems Corporation, Subsidiary of Sylvania
Electronic Products, Mt. Laurel Park, Moorestown, New Jersey

82. Univac Division, Sperry-Rand
P.O. Box 8100, Philadelphia, Pennsylvania 19101

83. Vernitron
50 Gazza Boulevard, Farmingdale, New York 11735
84. Viatron Computer Systems Corporation  
    Department M-1

85. Victor Comptometer Corporation, Business Machine Group  
    3900 North Rockwell, Chicago, Illinois 60618

86. Wang Labs, Inc., Department 6AC  
    836 North Street, Tewksbury, Massachusetts

87. Wyle Labs  
    128 Maryland Street, El Segundo, California

Badge Readers (Appendix B)  
Manufacturers Included in this Appendix:

1. Friden, Inc.  
   2350 Washington Avenue, San Leandro, California 94577  
   (415) 357-6800  
   S. W. Terry

2. G. E. Information Service  
   4000 N. W. 39th Street, Box 123.3, Oklahoma City, Oklahoma 73112  
   (405) 946-5421

3. Hickok Electrical Systems  
   Cleveland, Ohio  
   (216) 541-8060  
   Robert Kerzman

4. IBM - Systems Development Division  
   9045 Lincoln Boulevard, Los Angeles, California 90045  
   (213) 670-8350

5. Key Data Machines  
   310 East 44th, New York, New York 10017  
   (212) 686-4986  
   Bradley Welsh

   Belleville, New Jersey  
   (201) 759-6500  
   Don O'Brien  
   Bill Smythe

7. Sealectro Corporation  
   Mamaroneck, New York 10543  
   (914) 698-5600  
   Howard F. Gordon

8. Synergistics, Inc., Ten Tech Circle  
   East Natick, Massachusetts 01760  
   (617) 655-1340  
   George Rice  
   I-10
9. Addo-X Inc.  
437 Madison Avenue, New York, New York 10022  
(212) 758-9171  
Tom Kibby

10. American Computer and Communications  
2576 West Carson Street, Torrance, California 90503  
(213) 320-8810  
Tom C. McGeary  
Bill DeVore  
Mark Kimmel

11. AMP Incorporated  
Harrisburg, Pennsylvania 17105

12. Audac Corporation  
175 Bedford Street, Burlington, Massachusetts 01803  
(617) 272-6720  
Peter Bryan

13. Control Data Corporation  
8100 34th Avenue So., Minneapolis, Minnesota 55440  
(612) 888-5555

14. Credit Systems Inc.  
1350 Broadway, New York, New York 10018  
(212) 736-7927  
J. Frank

15. Data Pathing Incorporated  
370 San Aleso Avenue, Sunnyvale, California 94086  
(408) 734-0100  
Bob Vanderburg

16. Digital Identification Systems  
3074 Miraloma Avenue, Anaheim, California 92808  
(714) 630-1350  
Alfiero F. Balzano

Manufacturers Contacted but Excluded because their equipment products were not applicable to the L.O.C. requirements:

1. Franklin Fibre-Lamitex Corp.  
901-905 East 13th Street, Wilmington, Delaware

2. Isotopes  
50 Van Buren Avenue, Westwood, New Jersey
3. Landauer, R. S. Jr. & Co.
Science Road, Glenwood, Illinois

4. LTV Electro Systems, Inc., Garland Division
Box 6118, Dallas, Texas

339 South Robertson Boulevard, Beverly Hills, California

6. Nuclear Equipment Chemical Corp.
165 Marine Street, Farmingdale, New York

7. U.S. Testing Co., Inc.
1415 Park Avenue, Hoboken, New Jersey

**Alphanumeric CRT Displays (Appendix C)**

Manufacturers Included in this Appendix:

1. A. B. Dick Company
5700 Touhy Avenue, Chicago, Illinois 60648
(312) RO 3-1900
Charles Hurst

2. Atlantic Technology Corporation
7th & New Hampshire, Sommers Point, New Jersey 08244
(609) 927-8131
Jim Foy

15808 Syandotte, Van Nuys, California 91406
(213) 781-8350
D. S. Siegel

4. Bunker Ramo Corporation
445 Fairfield Avenue, Stamford, Connecticut 06904
(203) 348-4291

5. Burroughs Corporation
The Defense Space & Special Systems Group
Central Avenue, Paoli, Pennsylvania 19301
(215) NI 4-4700

6. Computer Communications Inc.
701 W. Manchester Blvd., Inglewood, California 90301
(213) 674-5300
Vess Vilips
7. Computer Terminals Inc.
Pentagon Park, 4815 W. 77th Street, Minneapolis, Minn. 55435
(612) 920-2784
Ray Merwin

8. Computer Terminal Corp.
P. O. Box 6967, San Antonio, Texas 78209
(512) 696-4520
Jack Jones

9. Conrac Corp., Conrac Division
600 N. Rimsdale Avenue, Covina, California 91722
(213) 966-3511
A. L. Landesperger

10. Control Data Corporation, Data Display Division
2401 North Fairview Avenue, St. Paul, Minnesota 55113
(612) 633-0371
C. S. Morell

11. Courier Terminal Systems Inc.
2202 East University Drive, Phoenix, Arizona 85034
(602) 258-7271
Albert Hagan

12. Data Discs Inc., Display Division
1275 California Avenue, Palo Alto, California 94304
(415) 326-7602
Chuck McEwan

Woodhaven Industrial Park, Cornwalls-Heights, Pa. 19020
(215) 639-9400
H. Barry Maser

P. O. Box 12313, Oklahoma City, Oklahoma 73112
(405) WI 6-5421
Byran R. Hays

15. IBM, Data Processing Division
112 East Post Road, White Plains, New York 10601

332 Second Avenue, Waltham, Massachusetts 02154
(617) 891-7300
Richard A. Hendrickson

17. National Cash Register Co., Industrial Products Division
Main and K Streets, Dayton, Ohio 45409
18. Philco-Ford Corporation, Philco Houston Operations  
1002 Gemini, Houston, Texas 77058  
(713) 488-1270

19. Radiation Inc., Systems Division  
P.O. Box 37, Melbourne, Florida 32901  
(305) 727-4000  
C. G. Dawdy

20. Raytheon Co., Equipment Division  
40 Second Avenue, Waltham, Massachusetts 02154  
(617) 899-8400  
John S. Barber

21. RCA, Electro Magnetic & Aviation Systems Division  
8500 Balboa Boulevard, Van Nuys, California 91409  
(213) 894-8111  
Len Hess

22. Sanders Associates Inc.  
Daniel Webster Hwy., So., Nashua, New Hampshire 03060  
(603) 885-4220  
Jack Margolies

23. Stromberg Carlson, Data Products Division  
P.O. Box 2449, San Diego, California 92112  
(714) 298-8331

24. Transistor Electronics Corp.  
P.O. Box 6191, Minneapolis, Minnesota 55424  
(612) 941-1100  
A. V. Klizas

Morristown, New Jersey 08057  
(609) 235-7300

P.O. Box 8100, Philadelphia, Pennsylvania 19101  
(215) 646-9000

27. Wyle Laboratories, Systems Division  
128 Maryland Street, El Segundo, California 90245  
(213) 678-4251  
John Herring
28. Xerox Data Systems  
   1649 17th Street, Santa Monica, California 90404  
   (213) UP 1-0960  
   Kas Terhorst

29. Infoton Inc.  
   Second Avenue, Burlington, Massachusetts 91803  
   (617) 272-6660  
   John McFail

30. Video Systems Corporation  
   5300 North Crescent Boulevard, Pennsauken, New Jersey 08110  
   (609) 665-6688

31. Alphameric Data Corp.  
   Princeton-Highstown Road, Cranbury, New Jersey 08152  
   (609) 799-1599

32. Sugarman Laboratories Inc.  
   295 Northern Boulevard, Great Neck, New York 11021  
   (516) 466-0080

33. Beehive Electrotech Inc.  
   1473 South Sixth West, Salt Lake City, Utah 84104  
   (801) 487-0741

34. Lear Siegler Inc., Electronic Instrumentation Division  
   714 North Brookhurst Street, Anaheim, California 92803  
   (714) PR 4-1010  
   Lee R. Coutts

35. Honeywell Inc., EDP Division  
   60 Walnut Street, Wesley Hills, Massachusetts 02181  
   (617) 235-7450  
   Clark Neill

36. Computer Displays Inc.  
   223 Crescent Street, Waltham, Massachusetts 02154  
   (617) 899-0480  
   Robert H. Stotz

37. Computek Inc.  
   143 Albany Street, Cambridge, Massachusetts 02139  
   (617) 864-5140  
   Don Herring

38. Computer Optics Inc.  
   Berkshire Industrial Park, Bethel, Connecticut 06801  
   (203) 744-6720  
   Edward J. Shaughapssy
Manufacturers Contacted but Excluded because their equipment products were not applicable to the L.O.C. requirements:

Data Terminal, Display and Visual Input/Output Devices

1. A. D. Data Systems  
   830 Linden Avenue, Rochester, New York 14625  
   (716) 381-2370

2. All Data Processing Machines, Inc.  
   105 Hinricher Street, Willow Springs, Illinois 60480  
   (312) 839-5164

3. American Computer & Communication Co.  
   2576 W. Carson Street, Torrance, California 90503  
   (213) 320-8810

4. Ampex Corp., Videofile Information Systems  
   1020 Kifer Road, Sunnyvale, California 94086  
   (408) 738-4910

5. Applied Peripheral Systems Inc.  
   7120 Harwin Dr., Houston, Texas 77036  
   (713) 785-5040

   18325 W. McNichols, Detroit, Michigan 47219  
   (313) 535-5800

7. BFA, Inc.  
   1309 Inca Street, Denver, Colorado 80223  
   (303) 744-3301

8. California Computers Products, Inc.  
   305 N. Muller Street, Anaheim, California 92803  
   (714) 774-9141

9. CPU, Inc.  
   7750 N.W. 7 Ave., Miami, Florida 33150  
   (305) 693-3623

10. Chicago Cash Register Co.  
    1201 West Madison Street, Chicago, Illinois 60607  
    (312) 666-5555
11. Clary Corp.
408 Junipero Serra Drive, San Gabriel, California 91776
(213) 287-6111

12. Colorado Video, Inc.
250 Pearl Street, Boulder, Colorado 80302
(303) 444-3972

13. Combined Data Group Inc.
180 Broadway, New York, New York 10038
(212) 964-1084

14. Comdata Corp.
7544 West Oakton Street, Niles, Illinois 60648
(312) 692-6107

15. Compat Corp.
177 Cantiague Road, Westbury, New York 11590
(516) 822-1320

P.O. Box 29185, Atlanta, Georgia 30329
(404) 636-8090

317 Main Street, Rochester, New York 14445
(716) 381-0479

722 East Evelyn Avenue, Sunnyvale, California 94086
(408) 738-0530

2801 East Oakland Park Blvd., Fort Lauderdale, Florida 33306
(305) 565-9565

20. Computer Test Corp.
3 Computer Drive, Cherry Hill, New Jersey 08034
(609) 424-2400

21. CTC Computer Corporation
1018 Palo Alto Office Ctr., Palo Alto, California 94301
(415) 328-5630

22. Computrols, Inc.
1470 Doollittle Drive, San Leandro, California 94577
(415) 562-7779
23. Data Central Inc.
200 South Hanley Road, St. Louis, Missouri 63105
(314) 863-4000

24. Data Interface Corp.
18455 Burbank Boulevard, Tarzana, California 91356
(213) 345-8723

25. Data Processing Supplies Inc.
1216 East McMillan St., Cincinnati, Ohio 45206
(513) 961-0776

26. Data Products Corp.
6219 De Soto Avenue, Woodland Hills, California 91364
(213) 887-8000

27. Data Systems Analysts Inc.
Cooper Parkway Office Bldg., North Park Drive
Pennsauken, New Jersey 08109
(609) 665-6088

28. Data Vox, Division of Data Technology Corp.
1050 East Meadow Circle, Palo Alto, California 94303
(415) 321-0551

29. Datanetics Corp.
2828 Spreckels Lane, Redondo Beach, California 90278
(213) 542-4355

30. Dataq Inc.
6709 North Olie, Oklahoma City, Oklahoma 73116
(405) 842-1313

31. Datarol Inc.
Kane Industrial Drive, Hudson, Ma. 01745
(617) 562-3422

32. Datron Systems Inc.
100 Route 46, Mountain Lakes, New Jersey 07046
(201) 334-4521

33. Decca Radar Canada Ltd.
23 Six Point Rd., Toronto 18, Ontario, Canada
(416) 239-1161

34. Dialight Corp.
60 Stewart Avenue, Brooklyn, New York 11237
(212) 497-7600
35. Digi, Inc.  
37 West 2950 South, Salt Lake City, Utah 84115  
(801) 487-0753

36. Digital Equipment Corp.  
146 Main Street, Maynard, Ma. 01754  
(617) 897-5111

37. Digital Logic Corp.  
1853 Raymond Avenue, Anaheim, California 92801  
(714) 871-4653

38. Digital Scientific Corp.  
11661 Sorrento Valley Road, San Diego, California 92121  
(714) 453-1534

39. Digital Systems Corp., University Circle Research Center  
11000 Cedar Avenue, Cleveland, Ohio 44106  
(216) 721-3334

40. Direct Access Computing  
24175 Northwestern Highway, Southfield (Detroit), Mich. 48075  
(313) 358-5000

41. Discon Corp.  
1150 N.W. 70th Street, Ft. Lauderdale, Florida 33309  
(305) 933-4551

42. Diversified Numeric Applications, Div. of Avtex, Inc.  
9801 Logan Avenue S., Minneapolis, Minnesota 55431  
(612) 884-4777

43. Dynatronics Operation, Electronics Division of General Dynamics  
P.O. Box 2566, Orlando, Florida 32802  
(305) 838-6161

44. Ecco Business Systems Inc.  
50 E. 42nd Street, New York, New York 10017  
(212) 682-3244

45. Electronic Associates Inc.  
185 Monmouth Pkwy., West Long Branch, New Jersey 07764  
(201) 229-1100
46. Fairchild Space & Defense Systems
   Division of Fairchild Camera & Instrument Corporation
   300 Robbins Lane, Syosset, New York 11791
   (516) 931-4500

47. Ferranti Electric Inc.
   East Bethpage Road, Plainview, New York 11803
   (516) 293-8383

48. Foto Mem, Inc.
   2 Mercer Road, Natick, Ma. 01760
   (617) 655-4600

49. Four Phase Systems Inc.
   991 Commercial Street, Palo Alto, California 94303
   (415) 327-7444

50. HF Image Systems Inc.
   11244 Playa Ct., Culver City, California 90230
   (213) 390-3378

51. Houston Instrument, Div. of Bausch and Lomb, Inc.
   4950 Terminal Avenue, Bellaire, Texas 77401
   (713) 667-7403

52. Hughes Aircraft Co.
   Centinela Avenue and Teale Street, Culver City, Calif. 90230
   (213) 391-0711

53. Hydra Computer Corp.
   4208 Six Forks Road, Raleigh, North Carolina 27609
   (919) 782-1051

54. Imlac Corp.
   296 Newton Street, Waltham, Massachusetts 02154
   (617) 891-1600

55. Industrial Electronic Engineers Inc.
   7720 Lemona Avenue, Van Nuys, California 91405
   (213) 787-0311

56. Inforex Inc.
   15 Lunda St., Waltham, Massachusetts 02154
   (617) 899-6634
57. Information Development Corp.
30 Merz Boulevard, Akron, Ohio 44313
(216) 836-0221

58. Information Displays Inc.
333 North Bedford Road, P. O. Box 688, Mt. Kisco, New York 10549
(914) 241-1000

59. Information International Inc.
11161 West Pico Boulevard, Los Angeles, California 90064
(213) 478-2571

60. Information Network Corp.
3003 North Central Ave., Suite 1211, Phoenix, Arizona 85012
(602) 264-9721

61. Information Research Assoc.
3065 Rosecrans Pl., San Diego, California 92110
(714) 224-3797

62. Interdata, Inc.
2 Crescent Pl., Oceanport, New Jersey 07757
(201) 229-4040

63. Intermec Inc.
5503 232nd S. W., Mountlake, Terr., Wa. 98043
(206) 774-4156

64. International Automation Co.
1687 Tuille Cir. N. E., Suite 206, Atlanta, Georgia 30329
(404) 633-4239

65. International Computer Equipment Inc.
1231 25th St., N. W., Washington, D. C. 20037
(202) 293-3910

66. International Datacon Inc.
15158 South Cicero, Oak Forest, Illinois 60452
(312) 687-5550

1025 Goshen Ave., P. O. Box 2692, Fort Wayne, Ind. 46808
(219) 484-3111

68. Limited Fours Unltd. (LFU)
2895 East College #47, Boulder, Colorado 80302
(303) 443-9103
69. Litton Industries Inc., Data Systems Division
8000 Woodley Avenue, Van Nuys, California 91406
(213) 781-8211

70. Logic Corp.
15 East Euclid Avenue, Haddonfield, New Jersey 08033
(609) 428-4626

71. Management Data Corp.
1424 Walnut Street, Philadelphia, Pennsylvania 19102
(215) 546-6600

72. Marketing Operations Inc. (Mark/OPS)
475 Commonwealth Avenue, Boston, Massachusetts 02215
(617) 266-1930

73. NARS Computer Systems Inc.
65 North Orange Avenue, Orlando, Florida 32801
(305) 841-6500

74. Nanosecond Systems Inc.
176 Linwood Avenue, Fairfield, Conn. 06430
(203) 255-1008

75. Naybor, E. V. Laboratories, Inc.
26 Manorhaven Boulevard, Port Washington, New York 11050
(516) 767-4300

76. Ochman, Edward, Systems
Box 141, Fairfield, Connecticut 06430
(203) 259-1927

77. Optomechanisms Inc.
40 Skyline Drive, Plainview, New York 11803
(516) 433-8100

2803 Buffalo Speedway, Houston, Texas 77006
(713) 621-7250

79. Penn Keystone Corp.
Division Street, Ansonia, Connecticut 06401
(203) 734-3301
101 North 33rd Street, Philadelphia, Pennsylvania 19104
(215) 382-8500

81. Pinlite’s Inc.
1275 Bloomfield Avenue, Fairfield, New Jersey 07006
(201) 226-7724

82. RADC/EMIIF
Griffiss Air Force Base, Rome, New York 13440
(315) 330-4824

83. Raycon Inc.
2097 Chartier, Dorval 760, Quebec, Canada
(514) 636-1903

84. Rayonic Corp.
1934 East Hagert Street, Philadelphia, Pennsylvania 19125
(215) 634-6970

85. Redcor Corp.
7800 Deering Avenue, P.O. Box 1031, Canoga Park, Calif. 91304
(213) 348-5892

86. Schultz Instruments Inc.
P.O. Box 13385, Gainesville, Florida 32601
(904) 378-1750

87. Scientific Resources Corp.
7320 Old York Road, Philadelphia, Pennsylvania 19126
(215) 635-5100

88. Scope Inc.
1860 Michael Faraday Drive, Reston, Virginia 22070
(703) 471-5600

89. Seaco Computer Display Inc.
2714 National Circle, Garland, Texas 75040
(214) 271-2521

90. SEFAC
761 Miami Cir. N.E., Atlanta, Georgia 30324
(404) 261-4168
91. Sierra Research Corp., Computer Products Dept.
167 Bedford Street, Burlington, Ma. 01803
(671) 272-6534

92. Source Data Automation
19 West 44th Street, New York, New York 10036
(212) 869-1140

93. Systems Concepts Inc.
200 Second Street, Cambridge, Massachusetts 02142
(617) 864-4423

94. Systems Engineering Labs, Inc.
6901 W. Sunrise Blvd., Ft. Lauderdale, Florida 33313
(305) 587-2900

95. TLW Computer Industries
4 Executive Park E., N. E., Atlanta, Georgia
(404) 633-2579

96. Telecomputing Inc.
1626 Edison Street, Dallas, Texas 75207
(214) 748-0751

97. Theta Instrument Corp.
Fairfield, New Jersey 07006
(201) 227-1700

98. Time Share Peripherals Corp.
90 Danbury Road, Wilton, Ct. 06897
(203) 762-3348

99. Timeshare Devices Inc.
225 Crescent Street, Waltham, Massachusetts 02154
(617) 899-3560

100. Trans Data Co.
6394 Freeport Boulevard, Sacramento, California 95822
(916) 421-8285

101. Tymshare Inc.
525 University Avenue, Suite 220, Palo Alto, Calif. 94301
(415) 328-5990

102. Vanguard Data Systems
3835 Birch Street, Newport Beach, California 92660
(714) 540-7640
<table>
<thead>
<tr>
<th>No.</th>
<th>Company Name</th>
<th>Address</th>
<th>City, State, Zip</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>Western Data Services Inc.</td>
<td>99 East Magnolia Boulevard, Suite 315, Burbank, Calif. 91502</td>
<td>(213) 848-4151</td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>Zehntel, Inc.</td>
<td>1450 Sixth Street, Berkeley, California 94710</td>
<td>(415) 527-5440</td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>CBS Laboratories</td>
<td>227 High Bridge Road, Stamford, Connecticut 06905</td>
<td>(203) 327-2000</td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>Data Trends</td>
<td>1259 Route 46, Parsippany, New Jersey 07054</td>
<td>(201) 334-1515</td>
<td></td>
</tr>
<tr>
<td>108</td>
<td>Hancock Telecontrol</td>
<td>320 Park Avenue, New York 22, New York</td>
<td>PLaza 2-5630</td>
<td></td>
</tr>
<tr>
<td>109</td>
<td>Informatics</td>
<td>5430 Van Nuys Boulevard, Sherman Oaks, California 91401</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>Interface Mechanisms</td>
<td>5503 232 S.W., Mountlake Terr., Wa. 98043</td>
<td></td>
<td></td>
</tr>
<tr>
<td>111</td>
<td>International Computers Ltd.</td>
<td>ICT Huuseputney, London, SW 15 England</td>
<td></td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>Laboratory for Electronics</td>
<td>1075 Commonwealth Avenue, Boston, Massachusetts 02215</td>
<td></td>
<td></td>
</tr>
<tr>
<td>113</td>
<td>Norden</td>
<td>Helen Street, Norwalk, Conn. 06856</td>
<td>(203) 838-4471</td>
<td></td>
</tr>
<tr>
<td>114</td>
<td>Philco - Ford Corp., Houston Operations</td>
<td>1002 Gemini, Houston, Texas 77058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>115</td>
<td>Planning Research</td>
<td>1101 Glenden Avenue, Los Angeles, California 90024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>116</td>
<td>Singer General Precision Corp.</td>
<td>1150 McBridge Avenue, Little Falls, New Jersey 07424</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
117. Tasker
   7838 Orion Avenue, Van Nuys, California 91409
   (213) 781-3150

118. Texas Instruments
   P.O. Box 5474, Dallas, Texas 75222

119. Thomas Electronics
   100 Riverview Drive, Wayne, New Jersey 07470
   (201) 696-5200

120. Viatron Corp.
   1720 Military Road, Buffalo, New York 14217
   (716) 874-3300

121. Zenith Integrated-DP Inc.
   950 Fulton Avenue, Sacramento, California 95825

122. Hendrix Electronics
   Old Wilton Road, Milford, New Hampshire 03055
   (603) 673-4560

123. Hypertech
   7343 West Wilson Avenue, Harwood Heights, Illinois 60656

**Remote Printers (Appendix D)**

Manufacturers Included in this Appendix:

1. A. B. Dick Co.
   5700 Touhy Avenue, Chicago, Illinois 60648
   (312) RO 3-1900
   Charles Hurst

2. Computer Terminals Inc.
   Pentagon Office Park, 4815 W. 77th St., Minneapolis, Minn. 55435
   (612) 920-2784
   Roy L. Merwin

3. Codamite Corp.
   11822 Western Avenue, Stanton, California 90680
   (714) 894-3535
   R. W. Johnson
E. 37th & Perkins Avenue, Cleveland, Ohio 44114  
(2 16) 361-3315  
John F. Staggs

5. Datamark Inc.  
Cantiague Road, Westbury, L. I., New York 11590  
(516) ED 3-8910  
Carl I. Wassermann

6. Data Printer Corp.  
225 Monsignor O'Brien Hwy., Cambridge, Mass. 02141  
(617) 492-7484

7. Data Products Corp.  
6219 De Soto Ave., Woodland Hills, Calif. 91364  
(213) 887-8000  
Ed Rosland

8. Digitronics Corp.  
Albertson, Long Island, New York 11507  
(516) 484-1000  
Don F. Novak

P.O. Box 12313, Oklahoma City, Oklahoma 73112  
(405) 946-5421

10. Gulton Industries Inc., Computer Systems  
13041 Cerise Ave., Hawthorne, California 90250  
(213) 679-0111  
Marvin Lawrence

11. Honeywell, Inc., Electronic Data Processing Peripheral Device Operations, OEM Sales  
300 Concord Road, Billerica, Mass. 01821  
(617) 667-3111

12. IBM, Data Processing Division  
112 E. Post Road, White Plains, New York 10601

13. Mohawk Data Sciences Inc., OEM Marketing  
122 E. Ridgewood Avenue, Paramus, New Jersey 07652  
(201) 265-7333
14. Motorola Instrumentation and Control Inc.
P. O. Box 5409, Phoenix, Arizona 85010
(602) 959-1000
M. D. Shapiro

15. National Cash Register Co., Industrial Parks Division
Main and K Streets, Dayton, Ohio 45409

94 Nickerson Road, Ashland, Mass. 01721
(617) 881-3160
Richard Holzman

17. Potter Instrument Co., Inc.
715 E. Mission Drive, San Gabriel, California 91776
(213) 283-8177
Donald C. Squires

1222 E. Pomona Street, Santa Ana, California 92707
(714) 542-1196

19. Teletype Corp.
5555 Touhy Avenue, Skokie, Illinois 60076
(312) 676-1000
Michael Harris

20. Univac, Division of Sperry Rand, OEM Marketing Dept.
P. O. Box 8100, Philadelphia, Pennsylvania 19101
(215) 646-9000

21. Vogue Instrument Corp., Shepard Division
131st Street at Jamaica Ave., Richmond Hill, New York 11418
(212) 641-8800
B. Wagner

22. Control Data Corp.
1480 N. Rochester Road, Rochester, Michigan 48063
(313) 651-8810
Harrison Craig

Manufacturers Contacted but Excluded because their equipment products were not applicable to the L. O. C. requirements:

1. Advanced Space Age Products Inc.
4308 Wheeler Avenue, Alexandria, Virginia 22304
(703) 751-3320
2. All Data Processing Machines, Inc.
   105 Hinricher Street, Willow Springs, Ill. 60480
   (312) 839-5164

3. American Computer and Communication Co.
   2576 West Carson Street, Torrance, California 90503
   (213) 320-8810

4. Anadex Instruments, Inc.
   7833 Haskell Avenue, Van Nuys, California 91406
   (213) 833-6620

5. Applied Data Processing, Inc.
   155 Whitney Avenue, New Haven, Connecticut 06510
   (203) 787-4107

   821 Kalamazoo Street, Lansing, Michigan 48903
   (517) 484-4455

7. Burroughs Corp.
   6071 Second Avenue, Detroit, Michigan 48232
   (313) 875-2250

8. California Electro-Scientific
   2203 S. Grand Avenue, Santa Ana, California 92705
   (714) 546-9550

9. Clary Corp.
   408 Junipero Serra Drive, San Gabriel, California 91776
   (213) 287-6111

10. Comdata Corp.
    7544 West Oakton Street, Niles, Illinois 60648
    (312) 692-6107

11. Compiler Systems, Inc.
    Laurel Lane, Ridgefield, Ct. 06877
    (203) 438-4736

    P. O. Box 29185, Atlanta, Ga. 30329
    (404) 636-8090

    701 West Manchester Blvd., Inglewood, California 90301
    (213) 674-5300
1276 West Third Street, Cleveland, Ohio 44113  
(216) 241-3990

15. Computer Exchange, Inc.  
30 East 42nd Street, New York, New York 10017  
(212) 661-5870

2301 Fifth Avenue, Seattle, Washington 98121  
(206) 623-2413

17. Computer Time-Sharing Corp.  
1018 Palo Alto Off. Ctr., Palo Alto, California 94301  
(415) 328-5630

P.O. Box 373, Waltham, Massachusetts 02154  
(617) 899-3750

19. Custom Data Processing Service  
2931 North 30th Ave., Phoenix, Arizona 85017  
(602) 272-9371

20. Cyber-Tronics, Inc.  
4 Nevada Drive, New Hyde Park, New York 11040  
(416) 488-1300

7501 John W. Carpenter, Dallas, Texas 75247  
(214) 637-6340

22. Data Copy Co.  
760 Bryant Street, San Francisco, California 94107  
(415) 391-1811

23. Data Processors Supply Co.  
Box 3263, Huntsville, Alabama 35810  
(205) 852-2295

24. Datagraphics, Inc.  
740 Rush Street, Chicago, Illinois 60611  
(312) 944-2166

25. Decitek, Inc.  
15 Sagamore Road, Worcester, Ma. 01605  
(617) 757-4577
26. Digital Equipment Company  
   146 Main Street, Maynard, Ma. 01754  
   (617) 897-5111

27. Digital Scientific Corp.  
   11861 Sorrento Valley Road, San Diego, California 92121  
   (714) 453-1534

28. Foto-Mem, Inc.  
   2 Mercer Road, Natick, Ma.  
   (617) 655-4600

   300 Baker Avenue, Concord, Ma. 01781  
   (617) 369-4400

30. Hewlett-Packard Co.  
   1501 Page Mill Road, Palo Alto, California 94034  
   (415) 326-7000

31. Hickok Electrical Instrument Co.  
   10514 Dupont Avenue, Cleveland, Ohio 44108  
   (216) 541-8060 X212

32. Infotran, Inc.  
   860 Fifth Avenue, New York, New York 10021  
   (212) 535-7500

33. International Automation Co.  
   1687 Tuille Cir. N. E., Suite 206, Atlanta, Ga. 30329  
   (404) 633-4239

34. International Computer Equipment, Inc.  
   1231 25th Street, N. W., Washington, D. C. 20037  
   (202) 293-3910

35. Keltron Corp.  
   225 Crescent Street, Waltham, Ma. 02154  
   (617) 894-0525

36. Kleinschmidt, Div. of SCM Corp.  
   Lake-Cook Road, Deerfield, Illinois 60015  
   (312) 945-1000

   955 Waterman Ave., E. Providence, R.I. 02914  
   (401) 434-4207
38. Nanosecond Systems, Inc.
   176 Linwood Avenue, Fairfield, Ct. 06430
   (203) 255-1008

   225 Crescent Street, Waltham, Ma. 02154
   (617) 891-6770

40. Non-Linear Systems, Inc.
    P. O. Box N, Del Mar, California
    (714) 755-1134

41. Optomechanisms, Inc.
    40 Skyline Drive, Plainview, New York 11803
    (516) 433-8100

42. Philips-Electrologica, N. V.
    P. O. Box 245, Apeldoorn, Holland
    (05760-30123

43. RCA Information Systems Div.
    Route 38, Cherry Hill, N. J. 08034
    (609) 963-8000

44. Radiation, Inc.
    P. O. Box 37, Melbourne, Florida 32901
    (305) 727-4000

45. Scope, Inc.
    1860 Michael Faraday Dr., Reston, Virginia 22070
    (703) 471-5600

46. SEACO Computer-Display Inc.
    2714 National Circle, Garland, Texas 75040
    (214) 271-2521

47. Standard Processing Co., Inc.
    225 W. Park, Pharr, Texas 28577
    (512) 787-1717

48. Systems Engineering Laboratories, Inc.
    6901 West Sunrise Blvd., Ft. Lauderdale, Florida 33313
    (305) 587-2900

49. TLW Computer Industries, Inc.
    4 Executive Park E., NE, Atlanta, Georgia 30329
    (404) 633-2579
<table>
<thead>
<tr>
<th>No.</th>
<th>Company Name</th>
<th>Address</th>
<th>City, State, Zip Code</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Technitrend, Inc.</td>
<td>7300 N. Crescent Blvd., Pennsauken, New Jersey 08110</td>
<td>Pennsauken, NJ 08110</td>
<td>(609) 665-4910</td>
</tr>
<tr>
<td>51</td>
<td>Typagraph Corp.</td>
<td>7525 Convoy Ct., San Diego, California 92111</td>
<td>San Diego, CA 92111</td>
<td>(714) 279-5690</td>
</tr>
<tr>
<td>52</td>
<td>University Computing Co.</td>
<td>1300 Frito-Lay Tower, Dallas, Texas 75235</td>
<td>Dallas, TX 75235</td>
<td>(214) 350-1211</td>
</tr>
<tr>
<td>53</td>
<td>Western Data Services, Inc.</td>
<td>99 E. Magnolia Blvd. #315, Burbank, California 91502</td>
<td>Burbank, CA 91502</td>
<td>(213) 848-4151</td>
</tr>
<tr>
<td>54</td>
<td>Addressograph Multigraph Corp.</td>
<td>1200 Babbitt Road, Cleveland, Ohio 44117</td>
<td>Cleveland, OH 44117</td>
<td>(216) 731-8000</td>
</tr>
<tr>
<td>55</td>
<td>Bull Corp. of America</td>
<td>1 E. 57th St., New York, New York 10022</td>
<td>New York, NY 10022</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Bunker Ramo</td>
<td>445 Fairfield Ave., Stamford, Conn. 06904</td>
<td>Stamford, CT 06904</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>Computer Measurements</td>
<td>12970 Bradley Ave., San Fernando, California 91342</td>
<td>San Fernando, CA 91342</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Consolidated Electronics Industries Corp.</td>
<td>100 E. 42nd St., New York, New York 10017</td>
<td>New York, NY 10017</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>DI/AN Controls Inc.</td>
<td>944 Dorchester Ave., Boston, Massachusetts 02125</td>
<td>Boston, MA 02125</td>
<td>(617) 288-7700</td>
</tr>
<tr>
<td>60</td>
<td>Franklin Electronics Inc.</td>
<td>E. Fourth St., Bridgeport, Pa. 19405</td>
<td>Bridgeport, PA 19405</td>
<td>(215) 272-4800</td>
</tr>
<tr>
<td>61</td>
<td>Information Control Systems Inc.</td>
<td>327 S. 4th Ave., Ann Arbor, Michigan 48108</td>
<td>Ann Arbor, MI 48108</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Interface Mechanisms</td>
<td>5503 232nd St., SW, Mountlake Terrace, Wash. 98043</td>
<td>Mountlake Terrace, WA 98043</td>
<td></td>
</tr>
</tbody>
</table>
63. Litton Systems, Datalog Division  
   One Executive Park, Suite 29, Englewood, Colorado 80110  
   (303) 771-2010

64. Photon Inc.  
   355 Middlesex Ave., Wilmington, Mass. 01887

65. Presin Co.  
   Trap Falls Road, Shelton, Conn. 06484

66. Tele-Dynamics Div., American Bosch Arma Corp.  
   5000 Parkside Ave., Philadelphia, Pennsylvania 19131

67. Xerox Corp.  
   Rochester, New York 14603

68. Computer Solutions  
   50 Washington Terrace, East Orange, New Jersey 07017  
   (212) 349-1531

69. Peripheral Data Machines Inc.  
   1546 E. Chestnut St., Santa Ana, California 92701  
   (714) 835-3636

70. Syner-Data Inc.  
   Route 128, Brimball Avenue, Beverly, Mass. 01915

Machine Readable Unit Document Devices (Appendix E)

Manufacturers Included in this Appendix:

Optical and Magnetic Character Recognition and Mark Sense

1. Burroughs Corporation  
   1818 East First Street, Santa Ana, California 92702  
   (714) 541-4111  
   E. J. O'Brien

2. Control Data Corporation  
   Rabinow Labs - 1455 Res. Blvd., Rockville, Maryland 20850  
   (301) 762-5310  
   Dave Rabinow

3. Farrington  
   5881 Leesburg Pike, Falls Church, Va. 22041  
   (703) 354-5000  
   A. L. Kaplan
4. General Electric Co., Information Devices Department  
   4000 N.W. 39th Street, Oklahoma City, Oklahoma 73112  
   (405) 946-6421  
   Jerry L. Crosby

5. General Electric Co./Bull  
   4000 N.W. 39th St., Oklahoma City, Oklahoma 73112  
   (405) 946-6421  
   Jerry L. Crosby

6. Honeywell - EDP  
   60 Walnut Street, Wellesley Hills, Massachusetts 02181  
   (617) 235-7450  
   R. C. Bishop

7. IBM - Ind. Products, Federal Systems  
   18100 Frederick Pike, Gaithersburg, Maryland 20760  
   (301) 840-6622  
   Dave Lyman

8. National Cash Register, Industrial Products Division  
   3100 Valleywood Drive, Dayton, Ohio 45429  
   (513) 449-6751  
   Jim Glanville

9. Optical Scanning Corp.  
   P.O. Box 40, Route 332 East, Newtown, Pa. 18940

    3900 Welsh Road, Willow Grove, Pennsylvania 19090  
    (215) 659-7700  
    George W. Rees

11. Recognition Equipment Inc.  
    1500 West Mockingbird Lane, Dallas, Texas 75235

12. Scan-Data  
    800 East Main Street, Norristown, Pennsylvania 19401  
    (215) 277-0500

13. Hewlett Packard, Cupertino Division  
    11000 Wolfe Road, Cupertino, California 95014  
    (408) 257-7000  
    Fred Waldren

I-35
P. O. Box 5409, Phoenix, Arizona 85010
(602) 959-1000

15. Potter Instruments Company
East Bethpage Road, Plainview, New York
(516) 694-9000
Joel Levine

Manufacturers Contacted but Excluded because their equipment products were not applicable to the L. O. C. requirements:

1. AMP Incorporated
Box 3608, Harrisburg, Pennsylvania

2. Bendix Corporation, Electro-Optics Division
1975 Green Road, Ann Arbor, Michigan

3. Digital Instruments, Inc.
13735 Victory Blvd., Van Nuys, California

4. Litton Industries, Electron Tube Division
960 Industrial Road, San Carlos, California

200 Park Avenue, New York, New York

6. RCA, Elec. Data Processing Division
1730 West Olympic, Los Angeles, California

7. Western Union Telegraph Co.
215 N. Broadway, Santa Ana, California

8. Cognitronics Corporation
549 Pleasantville Road, Briarcliff, New York 10510

9. Scan-Optics Inc.
100 Prestige Park Road, East Hartford, Conn. 06108

Tape Devices for Machine Readable Media (Appendix F)

Manufacturers Included in this Appendix:

A. Magnetic Tape Cassettes and Cartridges
1. Tri-Data Corp.
800 Maude Avenue, Mountainview, California 94040
(415) 969-3700
John Craver
2. International Computer Products Inc.
P.O. Box 34484, Dallas, Texas 75234
(214) 239-5381

3. Sykes Datatronics Inc.
375 Orchard St., Rochester, New York 14606
(716) 458-8000
Paul A. Mallon

4. Dicom Industries
684 West Maude Avenue, Sunnyvale, California 94086
(408) 732-1060
Richard Lewis

5. Computer Terminal Corp.
P.O. Box 6967, San Antonio, Texas 78209
(512) 696-4520
Jack Jones

6. Cipher Data Products
7655 Convoy Ct., San Diego, California 92111
(714) 277-8070
Frank W. Loeschner

7. Universal Data Acquisition Co., Inc.
3928 Hartsdale Drive, P.O. Box 36166, Houston, Texas 77026
(713) 782-5761

B. Incremental Mag Tape Recorders

1. Cipher Data Products
7655 Convoy Ct., San Diego, California 92111
(714) 277-8070
Frank W. Loeschner

2. Digi-Data Corp.
4315 Baltimore Ave., Baldensburg, Md. 20710
(301) 277-9378

540 W. Woodbury Road, Altadena, California
(213) 798-0953
David S. Krueger

4. Precision Instrument Co.
3170 Porter Drive, Palo Alto, California 94304
(415) 321-5615
Manufacturers Contacted but Excluded

None

Calculating Unit and Controller-Small Computers (Appendix G)

Manufacturers Included in this Appendix:

1. Computer Automation Inc.
   895 W. 16th St., Newport Beach, California 92660
   (714) 642-9630
   Dave Methvin

2. Data General Corp.
   Southboro, Mass. 01772
   (617) 485-9100
   Ed Decastro

3. Datamate Computer Systems Inc.
   P. O. Box 310, Big Spring, Texas 79720
   (915) 267-8766
   Allan Fulmer

4. Redcor Corp.
   P. O. Box 1031, Canoga Park, California 91304
   (213) 348-5892

5. GRI Computer Corp.
   76 Rowe St., Newton, Massachusetts 02166
   (617) 969-7346
   Irwin M. Stone

6. Hewlett Packard
   11000 Wolf Road, Cupertino, California 95014
   (408) 257-7000
   William Davidow

7. Honeywell Computer Control Division
   Old Connecticut Path, Framingham, Mass. 01701
   (617) 879-2600
   J. A. Ridgeway
8. Information Technology Inc.
   164 Wolfe Road, Sunnyvale, California 94086
   (408) 245-8772
   James T. Chao

9. Interdata Inc.
   2 Crescent Place, Oceanport, New Jersey 07757
   (201) 229-4040
   Victor Spencer

10. Lockheed Electronics Co., Data Products Division
    6201 E. Randolph, Los Angeles, California 90022
    (213) 722-6810
    Robert Miller

11. Raytheon Computer
    2700 S. Fairview, Santa Ana, California 92704
    (714) 546-7160
    William A. Tracey

12. Systems Engineering Laboratories
    6901 West Sunrise Boulevard, Ft. Lauderdale, Florida 33310
    (305) 487-2900

13. Tempo Computers Inc.
    1550 S. State College Blvd., Anaheim, California 92806
    (714) 633-3660
    Ed MacAteer

14. Varian Data Machines
    2722 Michaelson Drive, Irvine, California 92664
    (714) 833-2400
    Vernon Smith

15. Digital Equipment Corp.
    146 Main Street, Maynard, Massachusetts 01754
    (617) 897-4111

    706 W. Katella Avenue, Orange, California 92667
    (714) 633-1091
    Burton A. Yale

17. Motorola Instrumentation & Control Inc.
    P.O. Box 5409, Phoenix, Arizona 85010
    (602) 959-1000
    George Sickler
18. Business Information Technology Inc.
5 Strathmore Road, Natick, Massachusetts 01760
(617) 237-2930

644 E. Young Street, Santa Ana, California 92705
(714) 540-6730
William Roberts

Manufacturers Contacted but Excluded because their equipment product information is too preliminary or it was not applicable to the L.O.C. requirements:

1. Multi-Data
15142 Golden West Circle, Westminster, California 92683
(714) 892-8347
Bruce Chancelor

2. Compiler Systems Inc.
P.O. Box 366, Ridgefield, Conn. 06877
(203) 438-0488

3. Computer Development Corp.
3001 Daimler Street, Santa Ana, California 92705
(714) 557-9720
Lambuth Cox

4. Uni-Comp
18219 Parthenia Street, Northridge, California 91324
(213) 886-7722

5. Transistor Electronics Corp.
P.O. Box 6191, Minneapolis, Minn. 55424
(612) 941-1100
A. V. Klizas

6. Digital Scientific Corp.
11455 Sorrento Valley Road, San Diego, California 92121
(714) 453-6050

7. Clary Datacomp Systems Inc.
404 Junipero Serra Drive, San Gabriel, California 91776
(213) 283-9485
Scott P. Davis

8. Xerox Data Systems
1649 17th St., Santa Monica, California 90404
(213) UP 1-0960
332 Second Avenue, Waltham, Massachusetts 02154
(617) 891-7300
Richard A. Hendrickson

10. Digital Equipment Corp.
146 Main Street, Maynard, Massachusetts 01754
(617) 897-4111

11. Control Data Corporation
4455 Eastgate Mall, La Jolla, California 92037
(714) 453-2500
D. L. Baker

185 Monmouth Park Hwy., W. Long Branch, N. J. 07764
(201) 229-1100

13. Electromechanical Research Inc.
8801 Bloomingham Fwy., Minneapolis, Minnesota 55420
(612) 888-9581
Carl A. Larson

14. Honeywell, Inc.
Old Connecticut Path, Framingham, Mass. 01701
(617) 879-2600
J. A. Ridgeway

15. IBM
112 E. Post Road, White Plains, New York 10601
(914) 949-1900

16. Systems Engineering Laboratory
6901 West Sunrise Blvd., Ft. Lauderdale, Florida 33310
(305) 487-2900

17. Westinghouse, Westinghouse Electric Corp.
Hagan/Computer Systems Division
200 Beta Drive, Pittsburgh, Pennsylvania 15238
(412) 782-1730
Bates Murphy

18. General Electric, Process Computer Department
2255 West Dessert Cove Road, Phoenix, Arizona 85029
(602) 943-2341