

UNCLASSIFIED

AD 414564

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



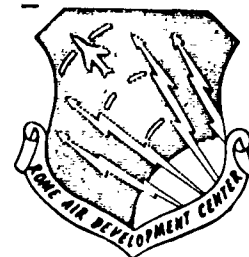
UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

414564

414564

RADC-TDR-63-160
FINAL REPORT



CATALOGED BY DDC

AS AD No.

AN ON-LINE COMPUTING CENTER

TECHNICAL DOCUMENTARY REPORT NO. RADC-TDR-63-160

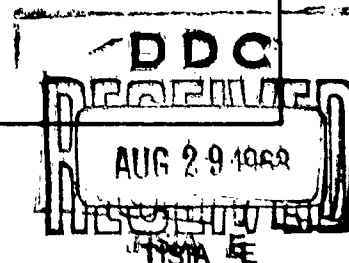
July 1963

Information Processing Laboratory
Rome Air Development Center
Research and Technology Division
Air Force Systems Command
Griffiss Air Force Base, New York

System No.730J

Project No. 5581 , Task No. 558104

(Prepared under Contract No. AF30(602)-2762 by Thompson Ramo Wooldridge, Inc.,
Canoga Park, California; Glen J. Culler and Burton D. Fried)



DDC AVAILABILITY NOTICE

Qualified requesters may obtain copies from Defense Documentation Center, Cameron Station, Alexandria, Va., 22314. Orders will be expedited if placed through the librarian or other person designated to request documents from DDC.

LEGAL NOTICE

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related government procurement operation, the government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

DISPOSITION NOTICE

Do not return this copy. Retain or destroy.

AN ON-LINE COMPUTING CENTER

Foreword

This is a final report covering work performed from February 11, 1962 through February 11, 1963 under Contract AF 30 (602) 2762. The objective was to create an on-line computer system allowing direct use of a high speed digital computer by a mathematician or scientist in the solution of problems in his own field of specialization. This has now been accomplished

Of crucial importance is the provision of a direct two-way coupling between the scientist and the computer, allowing the two to interact and strongly influence one another so as to take maximum advantage of the capabilities peculiar to each: the machine's capacity for rapid calculation and data processing and the man's deep understanding of, and experience with his particular problem area. The feedback from computer to user is conventional, involving oscilloscope displays of curves and occasional numbers. The control of the computer by the scientist is also mechanically simple, involving conventional keyboards. However, it is quite sophisticated as regards the organizational concepts, since achievement of the desired close coupling requires elimination of conventional programming procedures with their attendant

"turn-around time" and of conventional programmers, who cannot be expected to translate to the computer the scientist's intuition or his experience in attacking problems in his field.

The report is divided into two parts. The first provides a description of the system from a user's point of view, explaining the general aspects and then giving a fairly detailed specification of the various capabilities and their use, without, however, touching on the underlying computer programs. The second part provides, chiefly for reference purposes, a listing of all programs used in the system and also information concerning the allocation of data within the computer system, the location, by overlay and key, of the individual hand programs described in the first part, etc.

ABSTRACT

An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields.

This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.

PUBLICATION REVIEW

This report has been reviewed and is approved.

Approved:

Frank J. Tomaini

FRANK J. TOMAINI

Chief, Information Processing Laboratory
Directorate of Intelligence & Electronic Warfare

Approved:

Robert J. Quinn, Jr.

ROBERT J. QUINN, JR., Col, USAF

Director of Intelligence & Electronic Warfare

FOR THE COMMANDER:

Irving J. Gabelman

IRVING J. GABELMAN

Director of Advanced Studies

TABLE OF CONTENTS

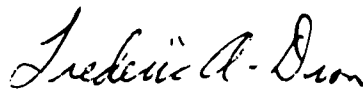
I.	Introduction	1
II.	The On-Line System	5
	An Illustrative Problem	21
	Discussion	33
	Acknowledgments	41
	Appendix	43
	References and Notes	56
	Illustrations	58
	System Programming	62
	Programs	70

EVALUATION OF FINAL REPORT ON CONTRACT AF30(602)-2762

The contractual effort resulted in a set of techniques that enable a scientist to discover the mathematical approach needed to solve his scientific problems numerically. The techniques allow a scientist to bring to bear his own experience and intuition and to compound them with the computational power of a modern high-speed computer. The scientist not only is able to solve problems that previously could not be solved, but is also heuristically led to deeper insights during the solution process.

The effort thus provides one more tool in the continuing research being done on ways to process data and solve problems using digital computers.

The information from this research effort is already being used to set up a similar facility in Building 240 providing the capability for RADC and other Air Force scientists to solve many of their scientific problems. An additional in-house effort has begun, aimed at adapting the philosophy and techniques developed under the contract to AF Command and Control Systems.



FREDERIC A. DION

RADC Project Engineer

A. GENERAL DESCRIPTION OF THE ON-LINE SYSTEM

I. INTRODUCTION

Despite the impressive achievements in computer hardware and programming techniques in recent years, the most significant gains presently realizable are associated with new approaches to the use, the organization and the logical structure of computers. One line of research has had as its goal the assumption by the computer of certain activities generally associated with human beings; the resultant study of learning machines, adaptive machines, et al has been very fruitful. Quite a different approach has been taken by those who instead seek ways of improving the man-machine communication so that the computer can more effectively assist the man in those jobs (requiring intuition, judgment, evaluation) for which he is best suited. Although no universally accepted nomenclature seems to exist, it is sometimes characterized as a means of getting a man "on-line" with a computer¹⁾, as opposed to his usual "off-line" status of wading through reams of computer print-out .

Adopting this term, we describe here an operating "on-line" computer research center which provides an unusually close coupling between the man who originates a problem and a (modern, large electronic digital) computer. We hope this example of what can be accomplished using computer hardware well within the existing state-of-the-art will be useful to others concerned with the development of on-line techniques.

This work was initially motivated by the troubles which have been commonly encountered in using a computer to solve research problems whose structure is for the most part unknown and frequently

surprising. It is notoriously difficult to obtain a satisfactory computer program if one does not understand, a priori, the general character of the solution. In fact, information about the general character is often what we really want, rather than quantitative details. It is possible in principle to attempt a kind of experimental mathematics, starting with some promising method of solution and the associated program and modifying one or both in the light of the results obtained. However, the lapse of time between the selection of a new method, or the modification of an old one, and the return of information from the computer to the user is in most cases so long as to make this almost infeasible.

The source of the difficulty is basically the poor communication between the "user" (by which we shall henceforth mean the scientist or mathematician who originates a problem and knows most about it) and the computer, consequent upon considerations of economy and, as well, upon the inherent difficulty of imparting to a programmer the detailed and specialized knowledge one acquires about a particular problem area after working in it for some time. One anticipates a significant improvement in a system, such as that described here, which provides for a rapid, direct, comfortable interchange of information between man and machine. In fact, however, one reaps even greater rewards; if the communication link is established in the proper way it becomes possible for the user to apply, simultaneously, to the problem his own intuition, experience, and knowledge of specialized techniques on the one hand and the tremendous computational power of the machine on the

other. As we shall see, it is possible for him to build a representation, in the computer, of those analytic tools he believes valuable for a particular problem or problem area. Without any necessity for learning conventional programming techniques, he is able, using only the concepts of classical mathematics, to create his own machine language, one tailor-made to his own needs. He can freely manipulate the elements of this language, in precisely the same fashion one composes mathematical techniques, and can easily modify them to incorporate the knowledge gained from their use in problem solving, so that his computing capability grows with his understanding of the problems.

We shall describe this "on-line" system from the point of view of a typical user rather than that of a "computer expert", by which we shall henceforth mean someone skilled in the art of programming, as opposed to the "user" whom we assume to be totally unversed in such matters. The programming principles and details will be the subject of a separate article. We shall only discuss the presently existing system, as it has been operating since August, 1962. While this will inevitably entail the mention of certain specific aspects of the particular computer used (AN/FSQ-27; RW-400), it should be kept firmly in mind, that while the detailed organizational choices were such as to take maximum advantage of the particular characteristics of this machine, the on-line techniques are in no way dependent upon

these characteristics. In the last chapter we sketch a method for using these on-line techniques with a standard operational computer center, a method consistent with the usual economic constraints on computer time.

In what follows, we restrict ourselves to the use of on-line techniques in the solution of mathematical and physical problems, this being the area of principal interest to us and the only one in which we have actual experience with an on-line system. We believe, however that the techniques can be extended to quite different areas of computer applications, a point to which we return in the last chapter. Meanwhile, we shall, in the interests of clarity, confine ourselves to a very specific description of the present system.

This work is an extension of an initial effort in which a particular problem, the energy gap integral equation of the Bardeen-Cooper-Schrieffer theory of superconductivity, was solved with an on-line approach²⁾. However, in that work, which was carried out in the period July through December 1961, all of the subroutines for the problem were programmed in a conventional way. While the user was free to compose these elements in various ways using the control and display capabilities of the control console in solving the gap equation, he had no freedom to modify, on-line, the subroutines or create new ones, a freedom which is an essential characteristic of the present system. Thus, the earlier work comprised some aspects of items A and B, described below, but none of item C, the console programming.

II. THE ON-LINE SYSTEM

At the outset, we should emphasize that each aspect of the design of such a system involves a number of choices. We shall describe here our own, with no representation that they are in every case the optimum ones; in fact, in some cases experience has indicated how some of these might be improved. Nonetheless, the resulting system operates in a very satisfactory manner.

Three principal features, independent but interacting, characterize the system:

A. Functional Orientation

The programming structure is such that in the computer, as it appears to the user, functions (sets of 101 points) rather than individual numbers constitute the elements while the repertoire of "commands" consists of operations on functions (e.g., arithmetic, differential, and integral operations).

B. Control and Display Capability

Central to the operation of the system is a control console having a number of push buttons or keys, which allow for user control of the computer, and two 17 inch CRT oscilloscopes (with line-drawing capability) which provide direct graphical representation of computational results. An 8 inch CRT with alphanumeric capability and a flexwriter provide numerical output when required.

C. Console Programming

A simple procedure allows the user to construct, directly at the console, new subroutines, using as building blocks an initial

set of hand programmed³⁾ subroutines, plus any subroutines previously created by this "console programming"⁴⁾ procedure.

We shall now flesh out this skeletal description with further details. The keys of the control console are divided into three groups: 24 are used for function storage; 30 to designate operations on these functions; and 11 (the digits 0 through 9, $\oplus$ and $\ominus$) for the input of individual numbers⁵⁾. Throughout we mean by a "function" a set of 101 points, i.e., 202 numbers, represented in the computer as 202 machine words, each word having 26 bits. (The choice of 100 intervals for the description of a function is one example of the arbitrary choices mentioned in the first paragraph. With fewer points one cannot adequately represent very much structure, while if 100 are insufficient one should probably use a different scale, or a different representation.) In addition to the 202 numbers, which all lie between -1 and 1, each function carries two scale factors (to base 2), one for abscissa values (s_x), the other for ordinates (s_y). The actual function values are thus the product of the 101 mantissas y_n , $1 \leq n \leq 101$ and the common scale factor, 2^{s_y} . For convenience, a block of 256 words is assigned to each function, the remaining 52 words being available for other labeling, for functional values (in the sense of Volterra), etc.

Because the computer module (CM) of the RW-400 has only 1024 words, functions are stored on an 80,000 word magnetic drum.

Half of the CM memory is used for two "function registers", called the C and D registers, each having a capacity of 256 words. They play a role for functions quite analogous to that which the accumulator in a computer plays for numbers: functions to be operated upon are loaded into the C and D register and the resulting function is eventually stored back on the drum.

Each of the 24 function storage keys addresses a particular section of the drum but this is of no concern to the user, who may think of the keys themselves as the storage locations. These keys initially carry some neutral labeling (e.g., the letters A through X) but as the user stores functions in them he relabels them (using any convenient nomenclature) to indicate the function stored there.

We can now describe some of the basic operator keys. LOAD and STORE bring any desired function from the drum into the D register or, conversely, store the contents of the D register into any specified function location. For example, pressing the LOAD key and then some function key, say R (or in a shorthand notation we shall employ henceforth, in which each word or symbol corresponds to the name of a particular operator or function key, LOAD R) brings the function stored in key R into the D register. Similarly, STORE F transfers whatever function may be in the D register to location F. In both cases, the words written (on the drum or in the CM memory) replace whatever was previously in that location. (The contents of the cells from which the information was taken are left unchanged so that immediately after LOAD A or STORE A both the D register and the A key contain the same function.)

The operator key J-GEN creates the identity function, $y = x$, ($-1 \leq x \leq 1$) and puts it in the D register. The arithmetic keys (+, -, ', $\div$) cause the computer to carry out the indicated operation on the ordinates of two designated functions, assuming the abscissas to be the same. For example, pushing the four keys

LOAD A + G

causes the computer to load whatever function is in location A into the D register; to load the function in location G into the C register; to add the y coordinates of the C and D registers, with differences, if any, in the y scale values properly taken into account; and finally to store the result in the y coordinates of the D register, leaving the x coordinates of the D register unchanged. If the user wishes the sum stored in some function storage location, say P, he then pushes STORE P. Alternatively, he can continue on with a series of arithmetic operations, all of which follow the same pattern. (Once the + button has been pushed, one may add as many functions as desired by simply pushing the + button again. This is true in general; once an operator button has been pushed that operation is continued as long as no other operator buttons have been pushed.)

Individual numbers can be put into the computer in a variety of ways. Since constant functions are sometimes required, we use them to represent also constant numbers, but this is by no means necessary. The procedure is simply: push the LOAD button; then type in the sign, followed by a mantissa less than 1, and any

desired power of 10, positive or negative. (For example, 11.56 is entered as 1156 $\oplus$ 02.) A constant function whose value is equal to this number is thereby loaded into the D register (i.e., the x values of the D register range as usual from -1 to +1 and the y values are all equal to the desired constant).

The DISPLAY key allows the user to see a graphical representation of any of the stored functions. DISPLAY A, for example, causes the computer to display on one of the 17 inch CRT scopes, the 101 points stored as functional values in location A, with adjacent points connected by straight line segments. Pressing the A key once more will erase the display curve from the scope (although not of course from the drum location where it is stored). Since only the mantissa values of a function are displayed on the CRT, we sometimes wish to check the scale of the whole function. This is done with the DISPLAY SCALE key, which causes the ordinate scale value, s_y , of the D register to be displayed on the alphanumeric scope. One thus has the capability of carrying out arithmetic and algebra on functions and examining the results graphically whenever desired.

The essential elements of calculus are provided by the Δ and Σ keys. The former simply takes differences of adjacent ordinate values in the D register and leaves the result in the D register, e.g., $(y_n - y_{n-1})$ replaces y_n , $2 \leq n \leq 101$, with a special treatment at the lefthand end point (for example, the first difference computed on the basis of a second or third

order fit to the function values at that end replaces y_1). $\sum$ is just a cumulative sum of the ordinate values in the D register with the result left in the D register (0 replaces y_1

and $\left(\sum_{k=1}^{n-1} y_k\right)$ replaces y_n , $2 \leq n \leq 101$).

From these two keys it is easy to construct approximations of any desired accuracy to the derivative and (indefinite) integral operators.

At this point, the general nature of items A and B above should be clear. One has, in effect, a powerful, and exceedingly fancy, combination hand computer and plotting machine. Any desired function can be readily created in the computer (using power series, asymptotic series, etc.) and one can perform all of the operations of classical analysis upon them. Suppose, for example, one wants the sine of some function, f , which has been loaded into the D register and suppose further f is sufficiently small so that the first two terms of a power series

$$\sin f = f - \frac{f^3}{6} \quad (1)$$

suffice. Select two function keys, F and G, as "working space". The following keys would then be pushed:

$$\text{STORE } F \cdot F \cdot F \text{ STORE } G \text{ LOAD } 0.166667 \oplus 00 \cdot G + F \quad (2)$$

If f was initially in the D register, $\sin f$, to the accuracy of Eq. (1), will now be there. In precisely similar fashion one could

obtain a representation of the sine function to any desired number of terms of the power series. However, it is clearly infeasible to go through this sequence of key pushes every time one wants the sine function. It is at this point that feature C, "console programming", comes in; like a giant lever (or a strong bootstrap) it provides an enormous multiplication of the capability available to the user.

Clearly, all that is required is that the computer be able to "remember" and suitably record a sequence of key pushes such as that given in the example above. Moreover, it should then, in some sense, attach this list of key pushes to some previously blank key, which thereby acquires significance. The procedure is simple: we select some key, hitherto blank, which we decide will be the SINE key, and so label it. We then "program" this key using the PROGRAM key in the following way. First push PROGRAM; then push the (hitherto blank) key which will henceforth be the SINE key; then push precisely the buttons listed in (2); finally, at the end, push the PROGRAM button again. The result is that the machine goes through a "dry run", i.e., executes the commands (2) in precisely the same fashion as if we had not pushed the PROGRAM button; examination (e.g., via the display capability) of the result of this dry run immediately provides a first check on the console program just created. In addition, however, the computer constructs a list of these key pushes, termed a "subroutine", and "inserts" it under the SINE key. If at any time in the future we

push the SINE key, the computer will go through precisely this sequence of operations⁶⁾. Furthermore, we can in the same fashion program other keys, using as component keys not only the initial hand programmed ones (such as +, etc.) but also any keys which have been console programmed in the above fashion. These new keys can, in turn, be used as components of other console programs, and so on, to a depth limited only by the storage volume. (The present system allows for 256 such console programs but this could easily be expanded by several factors of 2.) In this way the operator creates his own subroutines, of arbitrary complexity, and pyramids these to achieve whatever computing capability he desires.

At this point it becomes difficult to describe adequately the generality and utility of the resultant system, just as it would be difficult to explain to a college freshman (in less than a few semesters) why algebra or calculus, whose basic principles can after all be rather concisely stated, is so useful. The on-line system has a structure very close to that of mathematics in its open-endedness, its generality and the constructive capability it affords the user. We shall therefore simply use the rest of this section to describe briefly the other hand programmed keys which are initially provided to every user when he begins work, and in the next section illustrate how this capability was used for one particular, fairly illustrative problem. A detailed characterization of all the hand programmed keys is given in Appendix A.

To begin with, the 30 operator keys physically present on the control console are by no means enough to encompass the initial hand programs plus the console programs needed in a typical problem. We therefore employ the concept of "overlays". To each overlay corresponds a set of meanings for the operator keys; changing the overlay changes the significance of all of these keys. The number of overlays is limited only by the size of the large volume storage in the computer system; in our case there are 32 overlays. One key common to every overlay is OVERLAY IN. The user changes overlays by simply pressing OVERLAY IN and then typing in, on the numerical keys, the number of the overlay he wishes to use. The 256 word program (which comprises the overlay from the programming point of view) is thereupon brought from the drum into the computer and all further key pushes will be interpreted by the computer in terms of that overlay until the operator makes a change of overlay. (In addition to the OVERLAY-IN and PROGRAM keys, five others, to be described later - REPEAT, OVERLAY-OUT, DISPLAY-OV-NUMBER, INSERT and DO - are common to all overlays, leaving a total of $24 \times 32 = 768$ keys in the present system, each of which can have a hand program or a console program.) The existence of multiple overlays modifies the console programming procedure slightly in that we must inform the computer not only which key is to be programmed but also which overlay we want that key to be on. The latter is accomplished by simply typing in the desired overlay number (on the numerical keys) immediately after

pushing the key being programmed: for example, PROGRAM SINE 10 followed by the key pushes (2) and then PROGRAM would attach the subroutine (2) to the indicated key of Overlay 10.

In a similar way, the total number of function storage keys available can be multiplied up from the 24 keys physically present to an extent again limited only by storage space. In the present system, we have 6 "banks" of these function keys, giving a total of 144 function storage locations. This too can be accomplished in many ways; at present, in place of the LOAD and STORE keys described above, we have in fact six LOAD and six STORE keys. Thus, $LOAD_I A$ will load into the $\underline{D}$ register whatever function is under key A on bank I; $STORE_{VI} F$ will store into key F of bank VI whatever function is in the $\underline{D}$ register, etc. (We use Roman numerals to label banks, Arabic to label overlays, thus minimizing a possible source of confusion.)

In typical operation, a user begins with an initial complement of hand programs and, working for a period of one to two hours⁷⁾, creates and checks (by observing the character of displayed curves, examining individual numerical values, running test cases, etc.) the console programs he needs. When his period of operation is finished, he pushes the SYSTEM DUMP button which stores the entire system (contents of the computers and of the drum) into a designated section of magnetic tape. When he next returns to the machine his system is loaded back from this tape and the computer is in precisely the same state as when he left. In the interim

another user comes to the machine, and loads his system from tape. All of the buttons, save for the initial core of hand programs, will typically be different for two users so that arguments concerning the value, efficiency or desirability of any particular console programming need never arise; each user makes his own choice, i.e., literally creates his own language.

When a user returns to the machine, SYSTEM LOAD (the inverse of SYSTEM DUMP), using his tape, restores the system (computer and drum) to precisely the state in which he left it, so that he can continue on, creating new console programs or, when he has built sufficient capability, attacking his problem. If, in the latter case, he immediately discovers a need to create new console programs or modify existing ones he is free to do so. (To reprogram a key he simply programs it as though it were blank; any previous program is simply buried.)

The SYSTEM LOAD and DUMP buttons are part of a "system" overlay which allows one to control the several components of the RW-400 system: to write out a block of data on (or read a block from) a tape unit, a buffer, the drum, etc.; aside from the tape operations, these are of interest principally to the computer expert rather than to the typical user, so we shall leave further details for the Appendix. (See Section A⁴, System Control Capabilities.)

The remaining hand programmed keys fall into three groups:

1. Mathematical Operations

These include first of all the arithmetic operations (on functions!) which have been mentioned already but require further comment. There are at least three ways of carrying out the function arithmetic: fixed point (with respect to the entire function), floating point (with respect to the entire function) or floating point for each point of the function. Since each has its own virtues, it is desirable to allow the user a free choice. Thus on Overlay 01 the arithmetic is done in a fixed point fashion. For example, when two functions are added, the y scales are compared and the smaller of the two is made equal to the larger one, the associated mantissa values being decreased (i.e., shifted to the right) enough times so that the functional values (mantissa plus scale) remain unchanged; the mantissa y values are then simply added together. If at some point the sum of these happens to be greater than 1, there will be an overflow. This is readily apparent if the sum is displayed, but it may happen in the course of a console program (unless one has correctly anticipated all scaling aspects of the problem) and can then be a considerable nuisance. Similar comments apply to divide, which will overflow at any points where the mantissa of the numerator exceeds the mantissa of the denominator. A second arithmetic overlay, 02, provides protection against such overflows by first floating and then contracting both

summands before addition. In division, the numerator and denominator are first floated and then the numerator is contracted enough times to prevent overflow at any point, if no more than 12 contractions are required, but no more than 12 are made in any case. An Overlay 03, in which the arithmetic is done on a floating point basis for each individual point of the functions, has recently been incorporated into the system but we have not yet sufficient experience to compare it with the other two. Of the latter, Overlay 02 is generally the more convenient, but in special circumstances (larger range of variation within a single function) can lead to more loss of accuracy than would result from the careful use of Overlay 01.

In addition, we have the following: EXPAND y decreases s_y by 1 and doubles all the mantissas of the D register; CONTRACT y is its converse. (They are needed in conjunction with the arithmetic on Overlay 01 and also allow examination (on the CRT) of small amplitude structure of a curve, display of curves at common scale, etc.) FLOAT MANTISSA does EXPAND y as many times as possible without causing overflow at any point. EVALUATE picks out the value of the function in the D register at the x coordinate closest to any designated value. REFLECT interchanges the x and y coordinates of the D register; SUBSTITUTE puts the y coordinates of the C register in place of the x coordinates of the D register. (Using REFLECT and SUBSTITUTE one can create, from the real function arithmetic hand programs, console programs for complex function arithmetic. Using REFLECT and EVALUATE one can find extrema of

a function.) δ -FUNCTION creates in the D register a function which is 1 at any desired point and zero elsewhere. INTEGRAL-TRANSFORM transforms the function f in the D register, using a kernel $K(x, x')$ previously stored on tape as 101 functions of x' , and leaves the result, $\tilde{f}(x) = \int dx' K(x, x') f(x')$, in the x coordinates of the D register. EXPONENTIAL, SINE and COSINE operate on the function contained in the D register, leaving the result in the D register. LEFT-SHIFT and RIGHT-SHIFT perform the indicated operations on the y coordinates of the D register. RELATIVE INTERPOLATE accepts graphical point inputs (via user-controlled crosshairs on the CRT) and modifies the function in the D register so that it passes through these data points, preserving its initial shape between data points.

2. Aids to Console Programming

These include besides the PROGRAM key already described, also REPEAT, a key which allows any console program keys to be repeated any desired number of times, and two keys (TALLY and COMPARE) which provide the capability for branching within a console program.

3. Display and Output Keys

These provide the capability to display on the alphanumeric scope the number of the overlay currently in the computer; to erase all curves from the CRT; to display (on the alphanumeric scope) the binary scale of the function in the D register, as well as the value of the first point of that function; to input

individual points graphically, using a movable crosshair; to print a hard copy of any desired curve on the flexwriter; to produce English language labels for kernels stored on tape, dumps stored on tape, or curves printed out on the flexwriter; to display curves on either of the two 17 inch CRT's; to use other display formats (dots along, crosses, circles, etc.) as well as the usual display of line segments.

In addition to these, there are Aids for the Hand Programmer involving the convenient input of machine words from the console, the display of sections of memory in machine language, etc.,. These are described in the Appendix, together with more detailed specification of all the keys already mentioned.

In a class by itself is the SECOND-COMPUTER key which at first glance seems highly specific to the RW-400 and yet really provides an excellent illustration of how to set up an on-line system for an arbitrary computer. In the RW-400 system, there are two identical computer modules, CM-1 and CM-2. The control console is tied directly to CM-1 and this is the only one used in all of the operations described so far. Suppose however that operator key $[K]$ on Overlay 10 is a rather long program, requiring several minutes or more to run. It is then efficient to use the SECOND-COMPUTER key, as follows: press SECOND-COMPUTER, press $[K]$, and type in the number (in this case 10) of the overlay on which $[K]$ is located. CM-2 then performs this program, taking the subroutines and curves needed from the drum in the same way that CM-1 would do.

While this is going on, however, the user is free to operate in the normal fashion with the control console and CM-1, doing computations; examining, if he likes, intermediate results as they are generated by CM-2; preparing new programs; setting up material for the next case; etc. In the last chapter we will explain how this serves as a model for an on-line system using a conventional, large central computer.

AN ILLUSTRATIVE PROBLEM

As an illustration of the use of the on-line system, we describe briefly one problem we have studied, a linear integral equation for a complex function of a real variable. While a single problem can no more exhibit the power and generality of the on-line system than any one application of, say, calculus, can illustrate the utility of classical analysis, we include it to show the ease with which rather sophisticated mathematical techniques can be employed in a system of this sort.

We present the problem as a mathematical one, essentially suppressing the context of physics from which it arose; outline the mathematical methods used; indicate some of the principal console programs generated to implement these methods; and show a few sample results. We can state, but not easily illustrate, one essential point: the method of solution finally adopted was itself the result of experimentation with the on-line system. Several approaches were tried; some quickly proved themselves unsuitable, but as we learned more about the nature of the solutions, we were able to develop satisfactory methods for obtaining them. Thus, quite apart from questions of mathematical convergence (e.g., of an iteration process), one sees a convergence in a kind of space of mathematical techniques.

A study of the electrostatic wave fluctuations in an electron-ion plasma subjected to an external electric field leads to the following integral equation⁸⁾ for the fluctuation electric field, of wave number k , as a function of time:

$$E(t) + \int_0^t dt' \left\{ K_e(t-t') \exp i \left[\phi(t) - \phi(t') \right] + \right. \\ \left. \delta K_i(t-t') \exp i\delta \left[\phi(t') - \phi(t) \right] \right\} E(t') = I(t), \quad (3)$$

$$0 \leq t \leq T$$

where

$$K_e(t) = t e^{-k^2 t^2/4} \quad K_i(t) = t e^{-\delta k^2 t^2/4}$$

$$\phi(t) = \mathcal{E} t^2/2 + ut \quad \delta = 1/1836$$

and $I(t)$ is given. (We have chosen units in which the electron thermal speed $(2T/m)^{1/2}$ and the plasma frequency, $(4\pi n e^2/m)^{1/2}$, are unity.) We shall say no more here about the physics of the problem since this is discussed elsewhere⁹⁾, and only sketch the on-line techniques used to solve it.

Using an operator notation for the integral transforms in (3),

$$\underline{K}_e \cdot E \equiv \int_0^t dt' K_e(t-t') E(t'), \text{ etc.} \quad (4)$$

we can write (3) as

$$E + e^{i\phi} \underline{K}_e \cdot (e^{-i\phi} E) + \delta e^{-i\delta\phi} \underline{K}_i \cdot e^{i\delta\phi} E = I \quad (5)$$

Over the time interval of interest ($T \leq 10\pi$) the norm of the first operator in (5) is so large, for $k \leq 1$, that an attempt at direct iteration proved useless. (As can be seen from the soluble special case, $k = \delta = \phi = 0$, this corresponds to computing

sin t by a power series on the interval $0 \leq t \leq T$.) However, the transformation

$$F = e^{-i\phi} E \quad (6)$$

gives an integral equation for F,

$$F + \underline{K}_e \cdot F + \delta e^{-i\psi} \underline{K}_1 (e^{i\psi} F) = J \equiv I e^{i\phi}, \quad \psi \equiv (1+\delta)\phi \quad (7)$$

which can be solved by iterating only the last of the terms on the left hand side. The equation

$$F + \underline{K}_e \cdot F = A \quad (8)$$

has the solution

$$F = A - \underline{L}_e \cdot A \quad (9)$$

where $\underline{L}_e$ is, like $\underline{K}_e$, a translate type integral operator and hence specified by a single function L_e

$$\left[\text{i.e., } \underline{L}_e \cdot A \equiv \int_0^t dt' L_e(t-t') A(t') \right]$$

which must obey an equation like (8) with A replaced by $\underline{K}_e$:

$$\underline{L}_e + \underline{K}_e \cdot \underline{L}_e = \underline{K}_e \quad (10)$$

Having once found (for given k) the function L_e , we write (7) as

$$F = (1 - \underline{L}_e) \cdot \left[J - \delta e^{-i\psi} \underline{K}_1 \cdot (e^{i\psi} F) \right] \quad (11)$$

and solve it by iteration

$$F_{n+1} = (1 - \underline{L}_e) \cdot \left[J - \delta e^{-i\psi} \underline{K}_1 \cdot (e^{i\psi} F_n) \right] \quad (12)$$

With a reasonable initial guess, e.g., $F_0 = J$, we find that this converges splendidly (three iterations). From F we compute, finally, $E = e^{i\phi} F$.

The first step is to find L_e from (10). For the reasons noted above, straight iteration is ruled out. While (10) can indeed be solved with Laplace transforms, the transform of L_e involves the error function of complex argument⁹⁾ and hence is difficult to invert. Instead, we take advantage of the fact that problems which are "adjacent" in a mathematical sense are, within the on-line system, adjacent also in a computational sense. If K_e is replaced by

$$R = N^2 t e^{-at}, \quad (13)$$

then the inverse kernel function, L_R , satisfying

$$L_R + \underline{R} \cdot L_R = R \quad (14)$$

is simply

$$L_R = N e^{-at} \sin Nt. \quad (15)$$

We therefore write (10) in the form

$$L_e + \underline{R} \cdot L_e = K_e + \underline{D} \cdot L_e \quad (16)$$

$$D = R - K \quad (17)$$

and choose N and a so as to make the norm of D small (e.g., $a = k$, $N = 2$), thus permitting an iterative solution,

$$L_e^{(n+1)} = (1 - \underline{L_R}) \cdot (K_e + \underline{D} \cdot L_e^{(n)}) \quad (18)$$

This converges nicely (three or four iterations) to yield a result which will differ from the exact solution of (10) only in consequence of the approximation inherent in numerical methods. However, we can exploit the linearity of (10) to obtain a more accurate solution as follows. Let L be the result obtained by iterating (18) until it has converged. The error in L is measured by the size of

$$P \equiv K_e - L - K_e \cdot L \quad (19)$$

and the difference $\eta = L_e - L$ satisfies

$$\eta + K_e \cdot \eta = P \quad (20)$$

or equivalently

$$\eta = (1 - K_e) \cdot (P + K_e \cdot \eta), \quad (21)$$

i.e., an equation identical with (18) save for the inhomogeneous term. If L is determined from (18) up to a percentage error of order ϵ , we can find η from (21), also with a percentage error of order ϵ , and hence get an approximation, $L + \eta$, to L_e which has an error of order ϵ^2 . In a similar fashion we can find a correction to η , and so forth.

We now indicate how the on-line system was used to solve (7) by these methods. To begin with, certain function keys are assigned to the constant parameters of the problem and to the principal independent and dependent variables as shown in Table I. Locations for constant functions which one finds it convenient to have on hand are assigned as the need arises. (The notation in Table I

ε	k	u	T
δ	N	a	Δt
t	K_e	K_1	R
L_R	L_e	0	$\frac{1}{2}$
L	L'	L''	L'''
f	$\tilde{f}$	kernel source	working space

Table I

Assignment of function storage spaces (keys) on Bank I
for the plasma oscillation problem. Significance of the symbols
is given in Eqs. (3) through (23).

is the same as in Eqs. (3) through (23); the meaning of other symbols will be explained below.) Once assigned, the labels on the function keys are used in referring to these keys rather than the neutral ones (A, B, ...X) of the preceding chapter.

Operator keys are then created, using the console programming procedure, some of the principal ones being as follows:

$[t]$ This creates the function $t = T(x+1)/2$ (assuming that the desired value of T has been previously stored in the T key of bank I) and stores it in t on bank I. It also computes Δt and stores it in Δt . As an illustration of console programming, we list the key pushes made in programming this key¹⁰⁾, which we suppose is to be on, say, overlay 10:

PROGRAM $[t]$ 10 OVERLAY-IN 02 J-GEN . 1/2
+ 1/2 . T STORE t Δ STORE Δt PROGRAM (22)

INITIAL SET-UP This simply displays on the alphanumeric scope the names of the constant parameters (Σ , T , k , δ) and, next to each, the value presently stored for it on bank I. If the user wishes to change any of these he can, of course, do so before running the problem. This program also stores the various constants indicated in Table I and finally pushes the $[t]$ key. Thus one knows that everything is in order for the start of a calculation.

$[K_e]$ This simply computes the kernel function $K_e(t)$ and stores it on bank I.

$[R]$ This computes and stores the function, $R(t)$ defined by (13), using whatever values the user has stored in N and a on bank I.

$[L_R]$ This computes and stores the function $L_R(t)$ defined by (15). It, for example, was programmed by:

```
PROGRAM LR 10 OVERLAY-IN 02 LOAD t · N SINE STORE LR LOAD -1
· t a EXP · N LR STORE LR PROGRAM.
```

(Note that in this we have used the L_R key as a temporary working space to store one factor of the final answer.)

We frequently need to generate, on tape, the 101 functions which comprise one of our translate kernels. To produce this capability, we first program a KERNEL-GENERATE-AUXILIARY (KGA) key as follows:

```
PROGRAM KGA 10 OVERLAY-IN 02 LOAD KERNEL-SOURCE TAPE-WRITE
LEFT-SHIFT STORE KERNEL-SOURCE OVERLAY-IN 10 PROGRAM.
```

This subroutine takes whatever function is in the kernel-source space on bank I, writes it out on tape, left shifts it, (y_{n+1} replaces y_n) and stores it back in the kernel-source space. We end it by calling in the overlay (10) on which KGA has been programmed in order that it be a repeatable key. The key which will actually produce the kernel on tape is then made by simply repeating the KGA key, i.e., we make a KERNEL-GEN key as follows:

```
PROGRAM KERNEL-GEN 10 OVERLAY-IN 10 REPEAT KGA 101 PROGRAM.
```

(Repeat $[K]$ followed by a number, n , causes key $[K]$ to be repeated n times.)

It is clearly now a simple matter to make, for any desired value of k , the various functions and kernels needed for (18).

Since we will be taking many integral transforms, it proves convenient to incorporate the hand-programmed integral transform key (which produces in the x-coordinates of the $\underline{D}$ register the transform of the function in the y-coordinates of the $\underline{D}$ register) into a simple console program which will produce in the $\tilde{f}$ space of bank I the transform of whatever function has been stored in f on bank I. We designate this as INT-TRANS and, using it, program a new key, ITERATE- L_e which does one pass of (18) as follows. Assume that the kernel D has been stored on tape and, following it, the kernel L_R ; that the tape is positioned to the beginning of the D kernel; and that some initial guess, or the result of a previous iteration is in L_e on bank I. We then do

```

PROGRAM ITERATE- $L_e$  10 OVERLAY-IN 02 LOAD  $L_e$  STORE  $f$  OVERLAY-IN 10
INT-TRANS OVERLAY-IN 02 LOAD  $\tilde{f} + K_e$  STORE  $f$  OVERLAY-IN 10
INT-TRANS OVERLAY-IN 02 LOAD  $f - \tilde{f}$  STORE  $L_e$  REWIND-TAPE
OVERLAY-IN 10 PROGRAM

```

(23)

Although the program (23) is adequate, we add to it certain display and storage features which increase the convenience of operation. That is, after checking (with simple examples, special cases, etc.) the correctness of (23), we program another key, $[L_e]$ which first pushes the ITERATE- L_e key (23) and then goes on to store the resultant L_e in key L , having first moved the contents of L'' into L''' , L' into L'' , and L into L' . Thus as the new key $[L_e]$ is repeated, we are able to examine the results of the most recent four passes (and could, of course, save even earlier ones if desired, by using one of the other banks). In

addition, the new key erases the scope and then displays on it the contents of L' (dotted) and the contents of L (usual dot-plus line display). Thus, each time the key is pushed the user sees, as soon as the pass has been completed, both the new result and, for comparison, the previous one, so that he can judge the convergence characteristics of the iteration process (18). (One could as well display the ratio or difference of the old and new curves, etc.)

The reader who has followed the details of the last few paragraphs can supply those omitted from what follows. Having created the programs needed for (18), we can use them also for (21) and, by repeating the correction process, obtain a very accurate L_e . From it we make an L_e kernel (using KERNEL-GEN) and also the K_i kernel and are then in a position to solve (12), i.e., to make a key which will do one iteration of (12). The only new complication lies in the complex character of F , but this causes no real difficulty. We simply write out on tape two copies of K_i kernel, followed by two of L_e . The ITERATE-F key then multiplies F by $e^{i\psi}$, uses the INT-TRANS key to transform the real part of the product with K_i , stores that in some working-space function key, transforms the imaginary part with K_i , combines the results into a single complex function, multiplies this by $\delta e^{-i\psi}$, subtracts that from J , transforms the real part with L_e , then the imaginary part, etc.

This requires, of course, that one create also keys which produce $e^{+i\psi}$ (used only after a change of $\mathcal{E}$ or u) and keys which give complex arithmetic capability. Using REFLECT and SUBSTITUTE, one can easily program, for example, a COMPOSE key (which, given two real functions, $f_R(t)$ and $f_I(t)$, in two standard locations composes them into a single complex function $f=(f_R, f_I)$ with the parameter t eliminated) and a DECOMPOSE key which is its inverse. For example, designate 3 keys as f_R , f_I , f and then make COMPOSE by

```
PROGRAM COMPOSE 10 OVERLAY-IN 02 . f_R LOAD f_I
SUBSTITUTE STORE f PROGRAM
```

(We use $\cdot f_R$ as a way of loading f_R into the $\underline{C}$ register.)

Similarly we have

```
PROGRAM DECOMPOSE 10 OVERLAY-IN 02 LOAD 0 + f STORE f_I
LOAD f REFLECT STORE f_R LOAD 0 + f_R STORE f_R PROGRAM
```

(LOAD 0 + f_R STORE f_R is just a way of restoring standard x coordinates to f_R so that it will look normal when displayed.) From these, it is then a simple matter to make the keys for complex function arithmetic.

Using the ITERATE-F key, and the L_e kernels generated by the procedure described above, it is an easy matter to obtain solutions of (3) for a variety of values of the parameters k , u and $\mathcal{E}$. As we see from Figure 2 the kernel L_e , which is a sine wave for $k = 0$, is increasingly damped with increasing k . (Having computed L_e one can compare it with the result obtained by keeping only the least damped pole of the Laplace transform

of L_e when inverting the latter by contour integration⁹⁾; as shown in Figure 2, the agreement is fairly good save near $t = 0$.) Understanding the somewhat exotic curves which result is assisted by comparing them with analytically soluble problems, e.g., those obtained by omitting the K_1 operator in Eq. (3) or setting $\mathcal{E}$ equal to 0. Some typical results are shown in Figure 3 through 8 for the case $I(t) = 1$. An analysis of the results and a discussion of their significance is given elsewhere⁹⁾.

DISCUSSION

The on-line system we have described is specific both as regards the computer used and the area of mathematics emphasized (classical analysis), the choice of the computer being a consequence of its availability, while the selection of problem areas was dictated by the research interests of the participants. On the basis of the experience gained in the design and operation (since July, 1962) of this particular system, the extension of these on-line techniques to other computers and to other areas of application appears rather straightforward.

We first outline a system which would be suitable for a conventional, large central computer and which would permit an operation identical, from the user's point of view, with that we have described here. Besides the central computer itself, one needs a large volume storage element, such as a disc file, and a small satellite computer, one with a memory of the order of 8,000 to 10,000 words and a 5 to 10 microsecond cycle time. As input/output equipment, the satellite computer would have two electric typewriters, whose keys take the place of the control console keys, and two CRT display scopes, each capable of displaying of the order of 1000 points furnished by the satellite computer, and connecting pairs of these with line segments when desired.

The operation parallels that of the present system when the SECOND COMPUTER key is used, the control console and the

first computer module of the RW-400 being replaced by the satellite computer plus its input/output equipment; the drum (where curves and subroutines are stored) being replaced by the disc file; and the second RW-400 computer module being replaced by the (larger and far more rapid) central computer. The satellite computer is used to compose and check console programs and for all trivial computing: examination and comparison of curves, formation of ratios and differences, simple test cases, etc. Only when the user has progressed to a point of having a substantial computational task which he wishes performed, is the central computer involved. He simply presses the CENTRAL COMPUTER key and then any of the keys he has previously console programmed (with the satellite computer). The CENTRAL COMPUTER is not interrupted, but when it finishes the task on which it is presently engaged and returns to its own control system for a next assignment, it is directed to take from the disc file the satellite's request, carry it out and return the results to the disc file. The central computer then proceeds to other work while the user examines the results, perhaps modifies his program or decides on a next case. The central computer is brought in only for significant computational tasks and never waits for the user. The user may occasionally have to wait a short time for the central computer¹¹⁾, but since the tasks he gives it are only those requiring a considerable amount of computation, this is not unreasonable.

In a sense, the satellite computer functions as a kind of informational impedance matching device between the man and the large central computer. Taken by themselves, these are mismatched with respect to both operations per second and dollars per hour. However, the satellite computer is economically matched to the man (i.e., rents for a figure comparable to his salary) and at the same time is sufficiently well matched to the central computer in terms of data transfer so as to be consistent with the economic constraints concerning the latter's use. Of course, many variants of this basic scheme are possible, some more suited to a particular computer center than others. Because our experience indicates that it is convenient to have of the order of 50 to 60 keys, we specify two typewriter keyboards, but in principle the necessary control capability, including that required for console programming, could be provided with far fewer keys. (Ten, representing the digits 0 through 9, plus one more ___ to, so to speak, change overlays ___ is probably the minimum required to provide a reasonable degree of operational comfort.) Because the simultaneous display of many curves on a single CRT scope gets quite confusing, it is very convenient to have two scopes, particularly for problems where one wishes to examine a mapping from one plane to another. One scope might be sacrificed, but we would argue strongly against the elimination of both, having found the rapid feedback of information in graphical form to be a tremendous asset in studying the structure of a problem and of the tools one creates, in the

form of console programs, to solve it, not to mention its value in checking and trouble shooting the latter. In any case, the effective implementation of such a system will share some of the problems inherent in any time-sharing arrangement¹²⁾.

We consider briefly the generalization of on-line techniques to other problem areas. The emphasis on functional orientation is particularly important for non-local problems but it is straightforward to include also a capability for dealing with individual numbers, something which would be useful, for instance, in solving differential or difference equations. This requires only an overlay (04, say) which interprets the function keys as single numbers, i.e., allows the function keys to address individual cells of the computer memory rather than function storage blocks on the drum, the arithmetic on Overlay 04 being just the conventional single number arithmetic of the computer itself¹³⁾. Console programming would allow the composition of operations on this overlay in the usual fashion.

The extension to areas of mathematics other than classical analysis also seems feasible. To handle matrix problems, for example, one would replace the functional format by one in which matrices could be stored in the "function keys", with the basic operators being now those of matrix arithmetic rather than function arithmetic. For an algebra machine or a logic machine, the basic, hand programmed keys would correspond to the fundamental operations of these disciplines, but at present this

is still somewhat speculative. In each case, the general organizational scheme of the present system, including the control and console programming aspects, would be preserved, and only those parts (actually a small fraction) of the programming associated with the functional orientation and with the graphical displays would be altered. While this is true also of other areas of computer application (e.g., those involving information processing rather than mathematics), the identification of the basic operations from which all others can be compounded by console programming appears far more difficult, there being no analog for the experience accumulated in the physical and mathematical sciences during the past 300 years.

We turn now to the system as it presently exists. We note that much of its power derives from the fact that substitution can be carried out at several levels: substitution of numbers, of functions and of programs. Substitution of different parameter values is carried out by simply writing the console programs with the parameters in question represented by certain function keys; one then has only to insert the desired constant functions into these keys before running a program. The capability for functional substitution is provided by the REFLECT and SUBSTITUTE keys. Given two functions $u(x)$ in the C register and $v(x)$ in the D register, the SUBSTITUTE key produces in the D register the function $v(u)$. When displayed,

this will be a curve in the (u,v) plane. Conversely, given such a curve, $v(u)$, we can (as illustrated in the preceding chapter) easily obtain the parameterized curves $u(x)$ and $v(x)$.

Most important perhaps is the possibility of substitution at the program level. Suppose that we wish to make a change in a console programmed key $[K]$ which is one of the components of another key $[L]$, $[L]$ in turn being a component of still a third key, $[M]$. If we wish to substitute a new console program for the one presently under $[K]$, we simply program $[K]$ in the same way as one does with a blank key; the program formerly associated with $[K]$ will be buried. Alternatively, we may find that the console program associated with $[K]$ is so basic and takes so long to run that it should be replaced with a hand program. (For this replacement the "user" must get the help of a "computer expert".) In either case, the program associated with key $[M]$ will run precisely as before, save for the desired modification in $[K]$, for the program in $[M]$ recognizes $[K]$ only as a key push, regardless of the significance of the subroutine it calls in.

One thus has the ability to manipulate console programs with approximately the same freedom as one juggles the mathematical operations which they represent, a feature not present in conventional programming languages. As a result, problems which are adjacent in the mathematical sense become so computationally as well; one can proceed from the simple to the more complicated, always building upon the results of what one has learned, without

the necessity for redoing all of the programming as new pieces are added or old ones are modified.

While we have characterized the "user" of the on-line system as a scientist unversed in conventional programming methods, it is clear that the creation of console programs involves the very essence of programming, albeit with most of the drudgery eliminated, and that "users" would benefit from the advice of someone familiar with programming. Indeed, operation of the on-line system involves two activities which at first sight appear separable: a) the creation of those console programs needed for a problem; and b) the use of these in its solution. Why not let someone we may call a "console programmer" (since his qualifications will differ somewhat from those appropriate to programmers in the standard meaning of the word) take care of a), the "user" being involved only with b)? The point is just that a) and b) are in fact strongly coupled; as soon as one starts to use b) he typically finds that some changes or additions are needed and he must revert back to a). If the user does not actually do a) himself, he must certainly work very closely with the "console programmer" who does, in order that he thoroughly understand the significance of the keys in his system. Moreover, unless the user is familiar, from hand computation or other experience, with numerical methods, a mathematician skilled in such matters had better be available for consultation; for the privilege of having direct access to a

computer, the user must pay the price of being exposed also to questions of scaling, error accumulation and all the other technical problems which are of course involved in any computational work but which are seen dimly, if at all, by the user when, as in most conventional organizations, he is insulated from the computer by several layers of intermediaries.

In conclusion, we should emphasize that there will be many computer applications for which these on-line techniques will be of little or no value. If one thoroughly understands the structure of a problem and knows a method of solution which is certain to work, then the experimentation and feedback characteristic of the on-line system are unnecessary. Indeed, such problems are handled very nicely by computer centers as presently constituted. It appears, however, that for problems whose structure is not clear, either a priori or on the basis of previous experience, and for which successful solution techniques need to be developed, an on-line system which allows the technical intuition of the user to play a central role in the solution process can be of considerable value. In this system, the user has a direct and convenient access to the computer, a fast response for computations which are essentially trivial, and a graphical representation of information where appropriate. He can build programs consisting of his own constructs within his own field, combine these in any desired way, and, if appropriate, make a

trial-and-error study of the various features of his problem. Indeed, the interplay of the structural elements is often more important than the solution itself in terms of the information desired in a research problem. Since he has control over the transformations, operators and other mathematical objects involved in his problem, he is able to get hold of the pieces and study the ingredients from the point of view of validity as well as from the point of view of structure. When he has found successful methods, he can combine these into an operating program without the necessity of reprogramming. Finally, from the bulk data available after solving a problem, he is able to select only that which he really desires, either as hard copy, numerical output or in the form of pictures of curves displayed on the CRT.

ACKNOWLEDGEMENTS

We are greatly indebted to the Information Processing Laboratory at Rome Air Development Center for support of this work and for the AN/FSQ-27 portion of the equipment; to Dr. Robert Huff, George Boyd and Robert Bolman for invaluable assistance in the programming tasks; and to Professor R. P. Feynman for suggestions concerning the possible extension to an algebra machine. We acknowledge with special thanks the efforts of Professor J. R. Schrieffer, Professor Karl Menger, Professor H. W. Wyld, Jr., Professor K. A. Johnson, Fred Dion and Martin Schultz who spent much of the summer of 1962 as cooperative guinea pigs, using the on-line system

for research problems in their own fields, notwithstanding its then somewhat raw and rough-edged character, thus contributing greatly to its present state of development and to our understanding of the user's needs and desires in an on-line system.

APPENDIX - DESCRIPTION OF BASIC SUBROUTINES FOR
AN ON-LINE SYSTEM

The initial hand programmed keys which at present comprise the basic system from which every user starts may be divided into five categories, save for the especially significant SECOND COMPUTER key, which stands by itself:

1. Mathematical operations.
2. Capabilities which provide assistance in the creation of console programs.
3. Programs having to do with displays or with other input/output aspects.
4. Operations involved in management of the computer system.
5. Conveniences for the computer expert who may be concerned with hand programming.

Many other items could be added to the list which follows and some of those given here could be omitted. While our set is neither exhaustive nor minimal, it has proved to be extremely convenient. Names of operator keys are in capital letters; headings not capitalized refer to groups of keys so closely related that to save space we have not listed them separately. In the description of keys we shall, in the interest of simplicity, ignore the multiplicity of function banks¹⁴⁾.

A1. Mathematical Keys

LOAD LOAD_I A brings the function in key A of bank I into the D register. (It also remains in A on bank I.) Similarly for LOAD_{II} , --- LOAD_{VI} .

STORE STORE_I puts the function in the D register into key A on bank I, leaving it also in the D register. Similarly for STORE_{II} --- STORE_{VI} .

FLOAT-MANTISSA The y values of the D register are shifted left as many times as possible without causing any one of them to overflow, and the scale value s_y is adjusted appropriately. The x values of the D register are unchanged.

+ On Overlay 01, + A puts the function stored in key A into the C register, and then compares the y scales of the C and D registers. If the scales are equal, the y values are added together and left in the D register. If the y scales are unequal, the function with the smaller scale is contracted until the scales are equal and the addition is then performed. The x coordinates of the D register are unchanged. If the same operation is performed on Overlay 02, both functions are floated, each is contracted once, and the addition is then carried out as on Overlay 01.

. On Overlay 01, . A loads the function stored in key A into the C register, multiplies its y values by those of the D register, adds the scales, and leaves the result in the D register. In the same operation on Overlay 02, each function is first floated.

- Subtraction is performed in the same fashion as addition.

÷ On Overlay 01, $\div$ B loads the function stored in key B into the C register, divides the y values in the D register by those in the C register, subtracts the scale values, and leaves the result in the D register. When the same operation is performed on Overlay 02, each function is first floated and the numerator is then contracted enough times to prevent overflow at any point unless this requires more than 12 contractions, in which case the numerator is simply contracted 12 times.

√ $\sqrt{\quad}$ takes the square root of the function stored in the D register and leaves the result in the D register.

LEFT-SHIFT The y values of the D register are shifted one place to the left: y_{n+1} replaces y_n , $1 \leq n \leq 100$, and y_{101} is left unchanged.

RIGHT-SHIFT The y values of the D register are shifted one place to the right: y_{n-1} replaces y_n , $2 \leq n \leq 101$, and y_1 is left unchanged.

EVALUATE This allows one to evaluate the function in the D register at the value of the x coordinate nearest to any selected number, previously stored as a constant function in one of the function storage spaces. The operation is as follows: EVALUATE B loads the function stored in B into the C register and subtracts the y coordinates of the C register from the x coordinates of the

D register. The y value in the D register corresponding to the smallest of these differences is selected and all y coordinates of the D register are set equal to that value.

EXPAND y The y values of the D register are multiplied by two (shifted one place to the left) and the scale value s_y is reduced by 1.

CONTRACT y The y values of the D register are multiplied by $1/2$ (shifted right one place) and the scale value s_y is increased by 1.

Both EXPAND and CONTRACT leave the numerical value of the function invariant since a change in scale appropriately compensates the alteration in mantissa values. However, since only the latter are displayed, the appearance of the function on the CRT is altered. One can use EXPAND to examine in detail the small amplitude structure of a curve, letting the other parts overflow being careful, of course, to retain the original representation of the function in another storage spot ; it thus complements FLOAT-MANTISSA. If one uses Overlay 01 (fixed point arithmetic) CONTRACT is necessary in order to avoid overflow in addition, subtraction. Finally, both EXPAND and CONTRACT are useful in bringing curves to a common scale for visual comparison.

δ FUNCTION This creates a Kronecker- δ type function, i.e., one which has the value 1 at one point and zero everywhere else. To create the function $\delta_a = \delta(x - a)$, load the number a into the D register then push the δ function button. The desired function

then appears in the D register, i.e., all of the y coordinates in the D register are made 0, save the one corresponding to the value of x nearest to (or equal to) a, and it is set equal to 1.

EXPONENTIAL The exponential of the function in the D register is computed and the result is left in the D register.

SINE-COSINE The sine and cosine of the function in the D register are computed. The sine is put in place of the y values of the D register; the cosine is put in place of the x values of the D register. (This may alternatively be considered as a complex exponential e^{if} , where f is the function in the D register.)

J-GEN The identity function, $y = x$, $-1 \leq x \leq 1$ is put in the D register.

REFLECT The x and y values of the D register are interchanged, as are also the scale values, s_x and s_y .

SUBSTITUTE The y coordinates of the C register replace the x coordinates of the D register and similarly for the scale values. This permits, for instance, the cross plotting of two dependent variables which are functions of the same independent variable. Together with REFLECT, it allows one easily to create console programs for complex-valued functions of complex arguments using only real function hand programs (i.e., those described in the foregoing part of this section).

INTEGRAL TRANSFORM

The integral transform of the function

$$\tilde{f}(x) = \int_a^b dx' K(x, x') f(x')$$

f stored in the D register is computed, using a kernel $K(x, x')$ which has been stored out on magnetic tape in the form of 101 functions of x' , one for each value of x . Assuming that the tape has been correctly positioned and that f is in the D register, we simply push the INTEGRAL TRANSFORM key. The first of the 101 functions, i.e., $K(a, x')$, is then read into the C register and multiplied by the function in the D register. The definite integral is computed and the resulting number is stored in the first x coordinate of the D register. The next function, i.e., $K(a + \epsilon, x')$, $\epsilon = (b - a)/100$, is then read from tape into the C register and the process repeated, the result being stored as the second x value of the D register. At the completion of the operation, which requires 7 seconds, f is still contained in the y coordinates and $\tilde{f}$ is in the x coordinates of the D register. To transform the latter into standard form one could, for example: REFLECT STORE A, LOAD 0 + A (the addition to 0 being one means of restoring the x coordinates of the D register to the canonical form used for the displays).

RELATIVE-INTERPOLATE

This uses individual data points, put in with the graphical input techniques described below (Section A3), to modify the function, say f , which has been loaded into the D register. If P_a and P_b are two of the data points, the

program first finds the two points, $\bar{P}_a$ and $\bar{P}_b$, of f whose x coordinates match those of P_a and P_b . If L is the straight line $P_a P_b$ and $\bar{L}$ is the line $\bar{P}_a \bar{P}_b$, the function f is replaced by $(f - \bar{L} + L)$ for $x_a \leq x \leq x_b$. The function is left unchanged between $x = -1$ and the smallest of the x_a . (Before f is loaded into the D register, it should be displayed on the CRT scope to serve as a guide for placing the data points on the screen with the crosshair.)

A2. Aids to Console Programming

PROGRAM Press PROGRAM; then press the key to which the program to be written is to be attached; then type in the overlay number on which that key is to be located; then press the keys which will make up the desired program; at the end press PROGRAM again.

REPEAT Press REPEAT; then press any repeatable key (i.e., either a hand programmed key, or a console programmed key whose program ends on the same overlay on which the key itself is located); then type in on the numerical keys the number of times the operation is to be repeated. This repeat operation can, of course, itself be incorporated into a console program.

TALLY This is used only within a console program and is one of two capabilities for program branching. TALLY must be imbedded in some console programmed subroutine; that is to say, it must be one of the series of key pushes which make up some console programmed key. When, in the running of that subroutine,

the computer comes to the point where the TALLY key was pushed, it checks the scale value s_y , of the D register. If s_y is positive the computer reduces s_y by 1 and proceeds to the next key in the subroutine; if the scale is 0 or negative, it jumps to the end of this particular subroutine.

COMPARE This operates in the same fashion as TALLY but uses as its criterion the sign of the first y value, y_1 , of the D register. If this is positive, the computer continues to the next key push; otherwise, it jumps to the end of the subroutine in which COMPARE is imbedded.

(These keys make possible the incorporation of standard programming techniques - loops, tallys, etc. - at the console programming level.)

A3. Display and Output Keys

DISPLAY OVERLAY NUMBER The number of the overlay currently in the computer is displayed on the alphanumeric scope.

ERASE All curves are erased from the CRT.

DISPLAY DISPLAY A causes the function stored in location A to be displayed; pushing A again erases that curve from the scope. Subsequently pushing other keys will cause the curves stored in them to be displayed also, until some other operator key is pressed.

DISPLAY VALUE AND SCALE, BINARY The mantissa of the first y value of the D register and the y scale, s_y , of the D register are displayed on the alphanumeric scope.

DISPLAY VALUE, DECIMAL If y_1 is the mantissa of the first y value in the D register and s_y the scale of the function, the number $y_1 \cdot 2^{s_y}$ is displayed as a decimal mantissa times a power of 10.

GRAPHICAL INPUT Press POINT-INPUT; then DISPLAY-CROSSHAIR. A crosshair, whose position can be controlled by a lever, is displayed on the screen. After positioning it at any desired point, push TRANSMIT-CROSSHAIR-COORDINATE. The x and y coordinates of the selected point are then transmitted to the computer and a small crosshair symbol is displayed on the scope at that point. The points thus put in are accumulated and can be used in conjunction with the RELATIVE INTERPOLATION key described in Section A1.

PRINT Any curve loaded into the D register will be printed out on the flexwriter in conventional format, i.e., the x and y values will be listed in decimal form.

LABEL After this is pushed, the function keys serve as typewriter keys and can be used to compose any desired alphanumeric message. (Each letter or number is displayed on the alphanumeric scope as it is typed.) This is useful for generating a label to go with a kernel stored on tape, a message which is to be written on tape along with a system dump, or an identifying legend to accompany a hard copy curve when the PRINT key is used.

LEFT SCOPE A word in the display routine is set so that any curve subsequently displayed with the usual DISPLAY key will appear on the lefthand 17 inch CRT.

RIGHT SCOPE A word in the display routine is set so that any curve subsequently displayed with the standard DISPLAY key will appear on the righthand scope.

Alternative Display Formats There are several keys which allow the capability of displaying curves in other than the usual format. Ordinarily 100 straight line segments connecting the 101 points are displayed. However, one can instead display only the 101 dots with no connecting line, or other symbols such as crosses, circles, etc.

A4. System Control Capabilities

The keys in this group allow for convenient management of the entire computer system. Only the first few are needed by the typical user; those with an asterisk are used only by the computer expert and may be disregarded by readers not in that category.

SYSTEM LOAD An entire system - overlays, curves, subroutines, etc. - is loaded from tape into the computer system. Whenever a user starts a period on the machine, he has his tape put on the tape unit and pushes SYSTEM LOAD, thereby putting the entire computer system into the same state it was when he last used it.

SYSTEM DUMP This is the inverse operation to SYSTEM LOAD, and is used at the end of each user's run.

TAPE READ This reads a block of 512 words from magnetic tape into the C and D registers of the computer.

TAPE WRITE This writes contents of the C and D registers as a 512 word block on magnetic tape.

Tape Manipulation There are keys for erasing a block on tape, skipping a block on tape, skipping to an end of file, writing an end of file; rewinding the tape, etc.

DRUM READ* DRUM READ nm reads into the C and D registers, from the drum, the computer program corresponding to Overlay nm. This allows the computer expert to examine or modify the actual machine words comprising the hand programs of this overlay.

DRUM WRITE* This is the inverse of the DRUM READ operation and is used to replace an overlay on the drum after it has been examined or modified.

SUBROUTINE READ* SUBROUTINE READ nml stores the automatic subroutine with identification number nml into the C register where it can be examined or modified by a computer expert.

SUBROUTINE WRITE* This is the inverse of SUBROUTINE READ.

A5. Aids for the Hand Programmer

All of these keys are for the computer expert alone and, like the last items in Section A4, should be ignored by readers who are not in this class. Their descriptions are included here only for completeness.

OVERLAY OUT OVERLAY OUT nm stores the overlay now in the computer onto the drum in the appropriate place. This is necessary after hand program alterations have been made in an overlay.

INSERT This is a convenient method of inserting short hand programs into the system. Press INSERT, then a CM address (4 digits on the numerical keys), then ENTER, then a machine word (10 digits on the numerical keys), then ENTER. Any number of additional machine words can now be typed in (each followed by ENTER); they will be stored in sequence in the locations following the first one. In addition, each word (and the address of the first one) is displayed on the alphanumeric scope.

DO This is simply a convenient means of causing the computer to execute any single instruction on command from the control console. Press DO, then type in on the numerical keys any machine command (again, 10 digits for this particular computer) followed by ENTER.

DISPLAY OF MEMORY CONTENTS This is a convenient means of examining the contents of any portion of the CM memory. Push DISPLAY MEMORY, then type in the four digits specifying an address in the CM. That address and the (10 digit) machine word it contains are then displayed on the alphanumeric scope. If a number n is now entered on the numerical keys, the next n words of the CM memory will be displayed, an operation which can be repeated as often as desired. DISPLAY MEMORY need be pushed again only if one wishes to examine a non-contiguous portion of the memory. The incorporation of this capability into suitable console programs provides the computer expert with a convenient means of dynamically debugging a hand program.

A6. The SECOND COMPUTER Key

In a class by itself is the SECOND COMPUTER key (although in a logical sense it probably could be included in Section A4). The RW-400 system has two identical computer modules, CM-1 and CM-2. The control console normally communicates directly with CM-1, and CM-2 is not used. However, pressing the second computer key, then any previously programmed key [K], followed by the number of the overlay on which [K] is located, causes the SECOND COMPUTER to carry out whatever program is associated with key [K], taking from the drum the subroutines, curves, and other information needed in doing this. While this is going on, the user at the control console is free to use CM-1 for any of the normal operations, e.g., to examine the results being generated by CM-2, to prepare for the next case to be run, to create new console programs, etc.

REFERENCES AND NOTES

1. J. C. R. Licklider and W. E. Clark, "On-Line Man-Computer Communication", Proc. of Spring Joint Computer Conference (May 1962). The first two pages of this contain a cogent statement of the motivation for an on-line system and of some general principles to be observed in constructing one.
2. Glen J. Culler and Robert W. Huff, "Solution of Non-Linear Integral Equations Using On-Line Computer Control", Proc. W. J. C. C., May, 1962.

Glen J. Culler, Burton D. Fried, Robert W. Huff and J. Robert Schrieffer, "Solution of the Gap Equation for a Superconductor", Phys. Rev. Letters 8 399 (1962).

Glen J. Culler, Burton D. Fried, Robert W. Huff and J. Robert Schrieffer, "Use of On-Line Computing in the Solution of Scientific Problems" (RW Research Laboratory Report, April, 1962, unpublished).
3. We use the term "hand program" to denote a computer program of the classical sort, i.e., a list of machine words, in contrast to a "console program", which, as described below, is essentially a list of key pushes.
4. The term "automatic programming" might be better, but unfortunately it already has a different significance.
5. The numerical keys include also ENTER, which must be pushed at the end of any sequence of numbers. When we give below illustrative lists of key pushes we shall generally omit ENTER, although in actual operation it must always be included.
6. This example is only illustrative, since in an operating system it is more sensible to make SINE a hand programmed key. In the early stages of development of the present system, however, we actually used, for SINE and COSINE, console programs based on 10 terms of the power series for functions with scale $s_y \leq 1$ and repeated use of the double angle formulas when $s_y > 1$.
7. Experience shows that operation by one user for less than one hour or more than two tends to be inefficient.
8. B. D. Fried, M. Gell-mann, J. D. Jackson and H. W. Wyld, "Longitudinal Plasma Oscillations in an Electric Field", J. Nuclear Energy; Part C 1 190 (1960).
9. Glen J. Culler and Burton D. Fried, "Plasma Oscillations in an External Electric Field", (to be published).

REFERENCES AND NOTES - Continued

10. To avoid confusion between operator keys and function keys having the same label, e.g., t, we shall, in writing lists of key pushes like (22), use [] for any operator key whose label coincides with that assigned to some function key. Of course, in actually using the console no confusion arises since the operator keys are physically distinct (and separated) from the function keys. Also, since all functions involved in our examples are on the same bank, we omit the bank subscripts, writing simply LOAD and STORE in place of $LOAD_I$ and $STORE_I$.
11. We assume the on-line work to occur during a period of the day when the central computer is being used only for short problems (maximum of a few minutes running time).
12. See, e.g., C. Strachey, "Time Sharing in Large, Fast Computers", Proc. of International Conference on Information Processing, UNESCO, p. 336 (June, 1959), and A. L. Leiner, W. A. Notz, J. L. Smith and R. B. Marimont, "Concurrently Operating Computer Systems", loc. cit., p. 353.
13. Although "complete" in the sense of being very useful for a wide range of problems, the present system is still growing in the sense that this overlay and some of the other extension described in this chapter will be incorporated in the near future.
14. The only complication which can arise concerns operations with functions stored on two different banks. Thus, in place of $Load_I A + B$ which we would use to add two functions stored on I, we use $Load_I A Load_{III} + R$ to add functions on banks I and III; here the $Load_{III}$ key functions only as a bank indicator.



Figure 1. Control console used in the On-Line Computer Center.

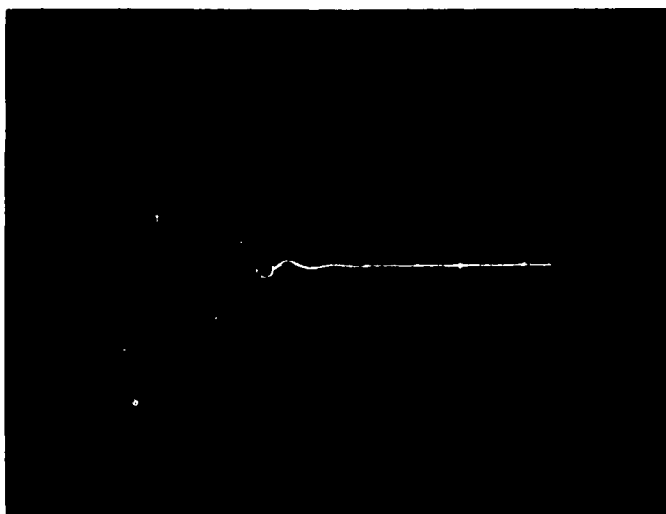


Figure 2. The kernel function L_e , defined by (10), as obtained by iterating (18), correcting the result using (21), etc. The slightly damped curve is for $k = 0.4$; the strongly damped one is for $k = 1.0$. A dotted curve shows the result for $k = 1$ obtained by retaining only the two least damped poles in the Laplace transform of L_e when inverting the transform by contour integration. Grid lines: $y = 0, \pm 1/2$; $t = 7.5, 15, 22.5$.



Figure 3. $E(t)$ in the complex plane for $1 \leq t \leq 30$ with $k = 0$, $\xi = 0$ and (reading from left to right) $u = 0.8, 0.9, 1.0, 1.1, 1.2$. These u values bracket the region of resonance, i.e., of growing waves. The curves all start at the point $E = 1$. Also shown are the real and imaginary E axes and the circles $|E| = 8$ and $|E| = 16$.



Figure 4. $E(t)$ for $k = 0$, $\varepsilon = 0.1$. The range of $d\psi/dt$, $0 \leq \dot{\psi} \leq 3$, includes the values used in Figure 3 (where $\dot{\psi}$ is constant). The approach of E to an approximate limit circle centered at $E(t = 0)$ can be predicted analytically for the single species case ($\delta = 0$). The circles $|E| = 4$ and $|E| = 8$ are shown.

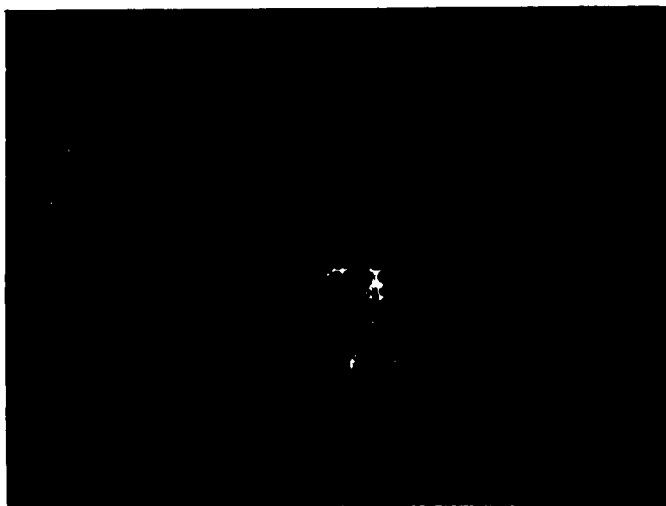


Figure 5. $E(t)$ for $k = 0.4$, $\varepsilon = 0$ and (from left to right) $u = 0.9, 1.0, 1.1, 1.14, 1.2$. Note the increased damping as compared with the $k = 0$ case. The circle $|E| = 8$ is shown.



Figure 6. $E(t)$ for $k = 0.4$, $\epsilon = 0.1$. The analytic solution for the single species case ($\delta = 0$) shows that the radius of the limit "circle" approached by E should be a slowly decreasing function of t . The circles $|E| = 4$ and $|E| = 8$ are shown.



Figure 7. $E(t)$ for $k = 1.0$, $\epsilon = 0$ and (left to right) $u = 0.8, 1.0, 1.2, 1.3, 1.4, 1.5, 1.7, 1.8$. The high frequency (electron plasma) oscillations, $\omega \approx 1$, damp out completely during the time interval depicted, leaving only low frequency waves (associated with ion motion) which appear as bright "tails" on the curves. Arcs of the circles $|E| = 1$ and $|E| = 2$ are shown.



Figure 8. $E(t)$ for $k = 1$, $\epsilon = 0.1$. The limit circle for $\delta = 0$ in this case should damp as $e^{-0.4t}$. The circles $|E| = 1$ and $|E| = 2$ are shown.

B. ON LINE SYSTEM PROGRAMMING

This section provides a record of most of the hand programming done during the contract. In certain cases patches exist that normally would have been corrected prior to publication but the programs do work and problem solving takes priority over vanity.

Table A shows the DAC keys designated by the CM address to which the programs jump to when that button is pressed. The six programs that are common on all overlays are also shown.

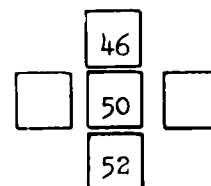
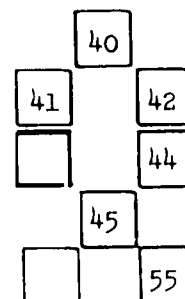
Table B lists the hand programmed buttons on the system overlays.

Table C lists the computer memory assignment for the on-line system.

Table D lists the storage assignment for the DMB and DM.

Following this material is a complete listing of programs as shown in the index on Page 69.

1	7	15	24	32
2	10	16	25	33
3	11	20	26	34
4	12	21	27	35
5	13	22	30	36
6	14	23	31	37



Programs Common on All Overlays

<u>DAC Key</u>	<u>Program</u>
1	BEGIN
2	PROGRAM
3	REPEAT
4	OVERLAY IN
5	OVERLAY OUT
6	INSERT

Table A
DAC Key Designation by CM Address Jumped To and
Programs Common on All Overlays

DAC Key	OV No.	01	02	4	5	6	7	10	17	20
1-6		Common on all overlay. See Table A.								
7		OV 20	OV 20	Do	Do	Do	Do	OV 20	Do	Do
10		+	+	Kill L	Erase					
11		-	-	$\overleftarrow{D}$	D +					
12		X	X	$ Dy $	D-					
13		./.	./.	$ Dx&y $	OV					
14		$\sqrt{\Delta}$			PE					
15		Σ	Float	D Cont			Nxt line	OV 01		Reflect
16		OV 10	Extract	Kill R			CBS ₁₀	OV 02		Substitute
20			OV 10	D $\rightarrow$			CBS ₈			OV 10
21				$ Dx $						
22				Auto-Ev						
23		X Gen	X Gen	Evaluate						Tally
24		=1	=1	=1				=1		Compare
25		=2	=2	=2				=2		
26		=3	=3	=3				=3		
27		=4	=4	=4				=4		
30		=5	=5	=5				=5		
31		=6	=6	=6				=6		
32		L ₁	L ₁	L ₁				L ₁		
33		L ₂	L ₂	L ₂				L ₂		
34		L ₃	L ₃	L ₃				L ₃		
35		L ₄	L ₄	L ₄				L ₄		
36		L ₅	L ₅	L ₅				L ₅		
37		L ₆	L ₆	L ₆				L ₆		
40		Suppress				8			Repack	
41		Expand X								
42		Contract X								
44		Display	Display	Continue	Continue			Display		
45		Continue	Continue	Interrupt	Interrupt			Continue		
46		Interrupt	Interrupt	Seal	Seal			Interrupt		
50		Seal	Seal					Seal		
52		Load K	Load K							
55										

Table B
Hand Program Buttons on System Overlays

DAC Key	<u>21</u>	<u>22</u>	<u>23</u>	<u>24</u>	<u>25</u>	<u>30</u>	<u>34</u>	<u>35</u>	<u>36</u>	<u>37</u>	<u>Blank</u>
1-6	Common on All Overlays. See Table A.										
7	Do	Do	Do	Do	Do	Do	Do	Do	Do	Do	Do
10				Pt.Input	TM → D		Memory		Type	TM R	
11				Erase	TM → C			Cards		DM R	
12				Interp.	Skip EOF			L Scope		DMB R	
13										Clear	
14										Initiate	
15								Line	D CBS	Skip EOF	
16										TM W	
20								R Scope	End Type	DM W	
21										DMB W	
22											
23											
24											
25											
26											
27											
30											
31											
32											
33											
34											
35											
36											
37											
40											
41											
42											
44											
45											
46											
50											
52											
55											

Table B (Continued)
Hand Program Buttons on System Overlays

<u>Computer Address</u>	<u>Use</u>
1	Search word for overlay in and out
2-16	Jump to these addresses when DAC P 1-16 key pushed
17	Jump to 400
20-37	DAC F Key 20-37
40-51	DAC D Key 1-10
53	Link 72 53 400 to get number
54	D keys
55	Cross hairs
56	Light Gun Left
57	Light Gun Right
60-77	Constant
101-377	Overlays
376	Overlay number for CBS display
377	Overlay number
400-700	DAC Reader
700-777	Automatic Subroutine
777	Subroutine number
1000	Search Word for C register
1000-1377	C register, 1000 = X, 1001 = y.
1375	C register scale
1400	Search word for D register
1400-1776	D register
1775	D register scale

Table C
Computer Memory Assignment for the On-Line System

STORAGE

$$4 \text{ drums} \times 24 \text{ bands/drum} = 96 \text{ bands}$$
$$13 \text{ blocks} \times 64 \text{ words/block} = 832 \text{ words} = 1500_8 \text{ words/band}$$

Blocks (0-14)

0	11	12	23	24	35	36	47	48	59	60	71	72	83	95		
0	Blk	0	27	30	VI		57	60	IV		107	110	137			
3											II					
4																
7	14	V			43	44	III			73	74	I	123			
10													75	10		
14			SUBROUTINES													
0	13															
unused																
14															113 ₈ 123 ₈	

SUBROUTINE	0	1	11	
	100	101	111	
	200	201	211	
	300	301	311	
	400	401	411	500

SUBROUTINES

Bands 14-113, 320₁₀, or 500₈ total subroutines

Blocks 10-14 = $5 \times 100 = 500$

Table D

Storage Assignment for the DMB and DM

Curves	Bands	Blocks	Top Left D Key		Next D Key	
			Band ₈	Block ₈	Band ₈	Block ₈
L-1	74-123	4-7	74	4-	75	4-
2	74-123	0-3	74	0	75	0-
3	44-73	4-7	44	4	45	4
4	44-73	0-3	44	0-	45	0-
5	14-43	4-7	14	4-	15	4-
6	14-43	0-3	14	0-	15	0-

ID WORDS

Subroutines

Word 777 in op.

Block No - 10	Band No -14
3 bits	6 bits

Add 10₈ to block

Add 14₈ to band

Words 1177, 1277, 1377, 1477, 1577 during dump or load

CURVE

1776

Band No. 7 bits	Block No. 4 bits.
-----------------	-------------------

DM STORAGE

Overlay AB, B is band number, A is search word.

SW

A = 0	0000
1	0400
2	1000
3	1400

Table D (Continued)
Storage Assignment for the DMB and DM

Index for Program Listings

	<u>Page</u>
DAC Reader	70
Modified DAC Reader for Second Computer	72
Buffer Block One	73
Buffer Block Two	77
Blank Subroutine	81
Blank Overlays	82
Overlays: 00; 01; 02; 03; 04; 05; 06; 07; 10; 17; 20; 21; 22; 23; 24; 25; 30; 34; 35; 36; 37	

DAC READER

31 0076 0403 0400	70 0000 0400 0470	34 0000 0552 0560
33 0000 0000	00 0001 0000	70 0000 0600
75 1000 0402	72 0420 0400	31 0564 0530
70 0000 0426	31 0474 0420	70 0000 0600
70 0000 0405	72 0403 0401	70 0000 0624
30 0043 0001	36 0072 0643	00 0000 0017
36 0077 0407	72 0427 0423	70 0000 0501
70 0000 0430	01 0060 0630	70 0000 0405
31 0376 0074 0410	70 0000 0641 0500	00 0000 1400 0570
42 1434 0011	71 0504 0505	00 0007 0000
42 1002 0223	31 0061 0504	34 0000 0436
40 0073 0001	70 0000 0400	70 0000 0624
70 0000 0400	00 0000 0001	31 0414 0402
00 1777 0000	31 0062 0466	72 0402 0400
75 1000 0402	72 0427 0423	07 0000 0436
00 0000 1777	36 0417 0517	70 0000 0701
72 0403 0401 0420	31 0522 0521 0510	31 0060 0436 0600
36 0072 0422	72 0427 0423	72 0721 0546
70 0000 0007	31 0061 0465	31 0552 0777
72 0053 0400	30 0441 0000	72 0623 0614
30 0443 0000	31 0063 0466	70 0000 0574
72 0403 0402	72 0427 0425	72 0732 0550
71 0466 0424	71 0465 0513	72 0623 0614
70 0000 0516	34 0000 0530	70 0000 0400
72 0403 0401 0430	06 0061 0517 0520	30 0044 0001 0610
70 0000 0053	70 0000 0526	30 0012 0000
00 0001 0001	70 0000 0510	36 0557 0001
00 0000 0144	34 0000 0527	70 0000 0616
00 0002 0002	31 0523 0517	07 0000 0777
00 0000 0020	72 0521 0511	72 0613 0610
00 0000 0002	37 0000 0000	05 0556 0000
77 1770 0000	70 0000 1760	36 0555 0621
72 0403 0401 0440	70 0000 0400 0530	42 1420 0010 0620
05 0071 0000	20 1762 0176	42 1002 0350
73 0070 0421	75 1000 0532	41 0700 0100
70 0000 0054	70 0000 0400	70 0000 0607
31 0062 0466	71 0164 0527	06 0061 0777
33 0000 0000	00 0001 1777	72 0623 0614
72 0457 0451	00 0000 0310	70 0000 0576
70 0000 0055	00 0000 0000	75 1000 0402
70 0000 0444 0450	42 1400 0001 0540	00 0000 0000 0630
75 1000 0451	70 0217 0541	00 0000 0000
01 0467 0000	42 1603 0000	00 0000 0000
30 0045 0000	42 1604 0001	00 0000 0000
71 0466 0451	41 0700 0070	00 0000 0000
72 0403 0402	70 0000 0551	00 0000 0000
01 0467 0000	72 0545 0540	00 0000 0000
70 0000 0464	70 0000 0711	00 0000 0000
31 0060 0466 0460	72 0545 0540 0550	00 0000 0000 0640
33 0000 0000	70 0000 0722	31 0402 0627
72 0457 0451	00 0000 0002	72 0402 0643
70 0000 0056	00 0000 0000	71 0630 0026
00 0000 0000	00 1777 1777	31 0627 0402
00 0000 0000	00 0001 1777	70 0000 0400
00 0000 0000	00 0000 0310	31 0676 0001
00 0000 0040	00 0077 0017	70 0000 0661

DAC READER

31 0060 0466	0650	33 0000 0000	0740
72 0427 0423		72 0402 0404	
30 0052 0001		33 0000 0000	
30 0005 0000		72 0402 0404	
36 0570 0001		33 0000 0000	
30 0455 0000		72 0402 0404	
36 0437 0001		33 0000 0000	
70 0000 0661		72 0402 0404	
72 0657 0650	0660	33 0000 0000	0750
07 0000 0001		72 0402 0404	
36 0571 0664		33 0000 0000	
42 1420 0007		72 0402 0404	
42 1007 0202		33 0000 0000	
41 0001 0376		72 0402 0404	
70 0000 0400		33 0000 0000	
72 0657 0650		72 0402 0404	
07 0000 0001	0670	33 0000 0000	0760
36 0571 0673		72 0402 0404	
42 1420 0007		33 0000 0000	
42 1007 0222		72 0402 0404	
40 0001 0376		33 0000 0000	
70 0000 0400		72 0402 0404	
00 0010 0001		33 0000 0000	
72 0254 0676		72 0402 0404	
00 0000 0000	0700	33 0000 0000	0770
72 0402 0403		72 0402 0404	
33 0000 0002		33 0000 0000	
72 0402 0403		72 0402 0404	
33 0000 0012		33 0000 0000	
72 0402 0403		70 0000 0572	
33 0000 0001		00 0000 0000	
70 0000 0605		00 0000 0335	
33 0000 0000	0710		
72 0402 0404			
33 0000 0000			
72 0402 0404			
33 0000 0000			
72 0402 0404			
33 0000 0000	0720		
72 0402 0404			
33 0000 0000			
72 0402 0404			
33 0000 0000	0730		
72 0402 0404			
33 0000 0000			
72 0402 0404			
33 0000 0000			
72 0402 0404			
33 0000 0000			
72 0402 0404			

MODIFIED DAC READER FOR SECOND COMPUTER

```

70 0000 0641 0500
71 0504 0505
00 0000 0000
27 1212 1721
00 0200 0000
31 0001 0001
42 1430 0011
42 1002 0223
40 0503 0001 0510
42 1404 1001
70 1001 0512
42 1400 0002
70 0217 0514
42 1604 1274
31 1777 0501
31 1777 0502
07 0000 0501 0520
72 0657 0652
72 0666 0661
31 0470 0666
42 1404 0000
72 0402 0502
70 0000 0505
70 0000 1760
34 0000 0000 0530

```

BUFFER BLOCK ONE

42 0207 0000 0000	00 0000 0053 0070	40 1000 0100 0160
70 0217 0701	00 0000 0037	70 0000 0400
42 1603 0000	00 0000 0077	00 0000 0000
42 1604 0100	20 0012 0001	00 0000 0000
70 0000 0000	00 0231 0700	00 0000 0477
70 0217 0705	00 0001 0400	00 0000 0035
42 1604 0000	70 0000 0404	00 0000 0000
42 1603 0100	00 0000 0070	77 1777 1777
70 0000 0000 0010	00 0000 0000 0100	72 0105 0101 0170
31 0060 1005	42 1410 0015	31 0414 0105
72 0704 0701	31 0060 1000	02 0167 1376
41 1005 0300	42 1000 1211	71 1376 0400
31 0777 1001	41 1000 0777	72 0105 0101
31 0402 1002	70 0000 0400	72 0135 0125
72 0710 0745	42 1410 0017	72 0105 0101
31 0060 1000	42 1000 1271	06 0061 1376
40 1000 0300 0020	31 0060 1000 0110	36 0067 0166 0200
70 0000 0602	40 1000 0777	30 0046 1375
31 0060 1000	70 0000 0400	03 0166 1376
72 0704 0701	72 0657 0650	30 0052 0000
41 1000 0300	73 0000 0123	04 0473 1375
31 1001 0777	34 0000 1000	34 0000 1375
31 1002 0402	36 0571 0120	72 0135 0125
72 0710 0751	42 1420 0007	71 0165 0177
31 0060 1005 0030	42 1000 0202 0120	72 0105 0101 0210
40 1005 0300	41 1000 0376	72 0161 0152
70 0000 0606	70 0000 0400	06 0061 1077
00 0000 0000	07 0000 0676	71 0164 0211
42 1400 0001	70 0000 0115	72 0105 0101
70 0217 1036	07 0000 1376	72 1042 1035
42 1603 0000	72 0657 0652	72 0105 0101
42 1604 0000	73 0000 0136	72 0135 0125
40 1000 0707 0040	34 0000 1000 0130	33 0000 0037 0220
70 0000 0000	36 0571 0133	72 0657 0652
00 0000 0000	42 1420 0007	70 0000 0661
70 0000 0000	42 1000 0222	72 0505 0222
70 0000 0000	40 1000 0376	72 0505 0223
31 0630 1003	70 0000 0400	72 0505 0224
31 0643 1004	07 0000 0676	72 0505 0225
31 0627 1005	70 0000 0130	72 0505 0226
70 0000 0705 0050	31 0061 0466 0140	72 0505 0227 0230
31 1003 0630	72 0427 0423	72 0505 0230
31 1004 0643	72 0613 0610	72 0505 0231
31 1005 0627	05 0536 0000	72 0505 0232
70 0000 0705	36 0535 0147	72 0505 0233
70 0000 0000	31 0060 1000	72 0505 0234
70 0000 0000	42 1420 0010	72 0505 0235
70 0000 0000	42 1002 0000	72 0505 0236
00 0000 0000 0060	41 1000 0100 0150	72 0505 0237 0240
00 0000 0001	70 0000 0400	72 0505 0240
00 0000 0002	07 0000 1077	72 0505 0241
00 0000 0003	72 0613 0610	72 0505 0242
00 0000 0004	05 0536 0000	72 0505 0243
00 0000 0005	36 0535 0157	72 0505 0244
00 0000 0006	42 1420 0010	72 0505 0245
00 0000 0007	42 1006 0000	72 0505 0246

BUFFER BLOCK ONE

72 0505 0247	0250	72 0505 0337	0340	72 0403 0401	0430
72 0505 0250		72 0505 0340		70 0000 0053	
72 0505 0251		72 0505 0341		00 0001 0001	
72 0505 0252		72 0505 0342		00 0000 0144	
72 0505 0253		72 0505 0343		00 0002 0002	
72 0505 0254		72 0505 0344		00 0000 0020	
72 0505 0255		72 0505 0345		00 0000 0002	
72 0505 0256		72 0505 0346		77 1770 0000	
72 0505 0257	0260	72 0505 0347	0350	72 0403 0401	0440
72 0505 0260		72 0505 0350		05 0071 0000	
72 0505 0261		72 0505 0351		73 0070 0421	
72 0505 0262		72 0505 0352		70 0000 0054	
72 0505 0263		72 0505 0353		31 0062 0466	
72 0505 0264		72 0505 0354		33 0000 0000	
72 0505 0265		72 0505 0355		72 0457 0451	
72 0505 0266		72 0505 0356		70 0000 0055	
72 0505 0267	0270	72 0505 0357	0360	70 0000 0444	0450
72 0505 0270		72 0505 0360		75 1000 0451	
72 0505 0271		72 0505 0361		01 0467 0000	
72 0505 0272		72 0505 0362		30 0045 0000	
72 0505 0273		72 0505 0363		71 0466 0451	
72 0505 0274		72 0505 0364		72 0403 0402	
72 0505 0275		72 0505 0365		01 0467 0000	
72 0505 0276		72 0505 0366		70 0000 0464	
72 0505 0277	0300	72 0505 0367	0370	31 0060 0466	0460
72 0505 0300		72 0505 0370		33 0000 0000	
72 0505 0301		72 0505 0371		72 0457 0451	
72 0505 0302		72 0505 0372		70 0000 0056	
72 0505 0303		72 0505 0373		00 0000 0000	
72 0505 0304		72 0505 0374		00 0000 0000	
72 0505 0305		00 0000 0000		00 0000 0000	
72 0505 0306		00 0000 0000		00 0000 0040	
72 0505 0307	0310	31 0076 0403	0400	70 0000 0400	0470
72 0505 0310		33 0000 0000		00 0001 0000	
72 0505 0311		75 1000 0402		72 0420 0400	
72 0505 0312		70 0000 0404		31 0474 0420	
72 0505 0313		70 0000 0405		72 0403 0401	
72 0505 0314		30 0043 0001		36 0072 0643	
72 0505 0315		36 0077 0407		72 0427 0423	
72 0505 0316		70 0000 0470		01 0060 0630	
72 0505 0317	0320	31 0376 0074	0410	70 0000 0641	0500
72 0505 0320		42 1434 0011		71 0504 0505	
72 0505 0321		42 1002 0223		31 0061 0504	
72 0505 0322		40 0073 0001		70 0000 0400	
72 0505 0323		70 0000 0400		00 0000 0001	
72 0505 0324		00 1777 0000		31 0062 0466	
72 0505 0325		75 1000 0402		72 0427 0423	
72 0505 0326		00 0000 1777		36 0417 0517	
72 0505 0327	0330	72 0403 0401	0420	31 0522 0521	0510
72 0505 0330		36 0072 0422		72 0427 0423	
72 0505 0331		70 0000 0026		31 0061 0465	
72 0505 0332		72 0053 0400		30 0441 0000	
72 0505 0333		30 0443 0000		31 0063 0466	
72 0505 0334		72 0403 0402		72 0427 0425	
72 0505 0335		71 0466 0424		71 0465 0513	
72 0505 0336		70 0000 0235		34 0000 0646	

BUFFER BLOCK ONE

06 0061 0517 0520	30 0044 0001 0610	00 0000 0000 0700
70 0000 0510	30 0012 0000	72 0402 0403
70 0000 0510	36 0557 0001	33 0000 0002
34 0000 0527	70 0000 0616	72 0402 0403
31 0523 0517	07 0000 0777	33 0000 0004
72 0521 0511	72 0613 0610	72 0402 0403
37 0000 0000	05 0556 0000	33 0000 0003
07 0000 0416	36 0555 0621	72 0402 0403
70 0000 0400 0530	42 1420 0010 0620	33 0000 0000 0710
20 1762 0176	42 1002 0350	31 0060 1005
75 1000 0532	41 0700 0100	72 0704 0701
70 0000 0400	70 0000 0607	41 1005 0300
71 0164 0527	06 0061 0777	33 0000 0002
00 0001 1777	72 0623 0614	72 0402 0403
00 0000 0310	70 0000 0576	72 0710 0745
00 0000 0000	70 0000 0732	00 0000 0000
42 1400 0001 0540	00 0000 0000 0630	00 0000 0000 0720
70 0217 0541	00 0000 0000	00 0000 0000
42 1603 0000	00 0000 0000	00 0000 0000
42 1604 0001	00 0000 0000	00 0000 0000
41 0700 0070	00 0000 0000	00 0000 0000
70 0000 0551	00 0000 0000	00 0000 0000
72 0545 0540	00 0000 0000	00 0000 0000
70 0000 0711	00 0000 0000	00 0000 0000
72 0545 0540 0550	00 0000 0000 0640	00 0000 0000 0730
70 0000 0722	31 0402 0627	00 0000 0000
00 0000 0002	72 0402 0643	00 0000 0000
00 0000 0000	71 0630 0010	00 0000 0000
00 1777 1777	31 0627 0402	00 0000 0000
00 0001 1777	70 0000 0400	00 0000 0000
00 0000 0310	31 0676 0001	00 0000 0000
00 0077 0017	70 0000 0661	00 0000 0000
34 0000 0552 0560	31 0060 0466 0650	00 0000 0000 0740
70 0000 0600	72 0427 0423	00 0000 0000
31 0564 0530	30 0052 0001	00 0000 0000
70 0000 0600	30 0005 0000	00 0000 0000
70 0000 0624	36 0570 0001	00 0000 0000
00 0000 0017	30 0455 0000	00 0000 0000
70 0000 0501	36 0437 0001	00 0000 0000
70 0000 0405	70 0000 0661	00 0000 0000
00 0000 1400 0570	72 0657 0650 0660	00 0000 0000 0750
00 0007 0000	07 0000 0001	00 0000 0000
34 0000 0436	36 0571 0664	00 0000 0000
70 0000 0624	42 1420 0007	00 0000 0000
31 0414 0402	42 1007 0202	00 0000 0000
72 0402 0400	41 0001 0376	00 0000 0000
07 0000 0436	70 0000 0400	00 0000 0000
70 0000 0701	72 0657 0650	00 0000 0000
31 0060 0436 0600	07 0000 0001 0670	00 0000 0000 0760
72 0721 0546	36 0571 0673	00 0000 0000
31 0552 0777	42 1420 0007	42 1000 1241
72 0623 0614	42 1007 0222	40 1000 0777
70 0000 0574	40 0001 0376	00 0000 0000
72 0732 0550	70 0000 0400	00 0000 0000
72 0623 0614	00 0010 0001	00 0000 0000
70 0000 0400	72 0254 0676	00 0000 0000

BUFFER BLOCK ONE

00 0000 0000 0770
42 1000 1211
41 0001 1777
00 0000 0000
00 0000 0000
00 0000 0000
00 0000 0000
00 0000 0000

BUFFER BLOCK TWO, ADD 1000 TO ADDRESS

72 0137 0134	31 1043 1050 0070	31 1157 1140 0160
31 0067 0464	31 1044 1055	31 0414 1152
31 1036 1005	31 1045 1060	70 0000 1142
31 1037 1012	31 1046 1064	31 1157 1401
03 1776 0640	37 0000 0000	31 0060 1776
73 0000 1102	34 1375 1376	71 1164 1166
02 0061 1005	34 1377 1400	71 1401 1164
71 0464 1005 0010	07 0000 1401	70 0000 1153
31 0067 0464	11 0000 1401 0100	00 0000 0011 0170
07 0000 0640	70 0000 1117	00 0000 0000
73 0000 1022	31 1041 1401	00 0000 0031
02 0061 1012	31 0060 1776	03 0314 1463
71 0464 1012	71 1103 1105	00 0000 0000
07 0000 0630	71 1401 1103	00 0000 0000
37 0067 0060	31 1123 1103	03 0314 1463
01 1037 1012 0020	07 0000 1005	30 0471 1201
06 0061 0630	36 0417 1111 0110	00 0000 0012 0200
07 0000 1012	31 0060 0635	73 1170 1206
36 0417 1024	72 1031 1025	73 1200 1212
31 1776 0000	31 1115 1031	30 0004 0000
37 0067 0000	70 0000 1032	30 0471 1175
30 0047 1374	70 0000 1116	70 0000 1212
70 0000 1120	72 1101 1047	25 1173 0000
36 0437 1374 0030	70 0000 1032	34 0000 0000
70 0000 1116	06 0064 1374 0120	05 1174 1174 0210
42 1430 0011	30 0455 0000	26 1176 1173
42 1000 0223	70 0000 1030	72 0403 0401
40 1374 0151	31 0060 1776	31 1177 1204
70 0000 0400	72 0505 0124	72 1205 1201
03 1776 0640	72 0505 0125	27 0000 1175
07 0000 0640	72 0505 0126	36 1175 1174
20 0000 0000 0040	72 0505 0127	72 0403 0401
00 1777 1777	72 0505 0130 0130	25 1200 0000 0220
40 0000 0000	72 0505 0131	34 0000 0000
07 0000 1401	72 0505 0132	72 0403 0402
34 0000 1401	72 0505 0133	34 0000 1175
07 0000 1402	40 1374 0151	70 0000 1224
36 0417 1401	72 0505 0135	27 1200 1174
31 0433 0464	72 0505 0136	30 1077 1174
07 0000 1401 0050	40 0000 0144	01 1172 1201
30 0001 0000	77 1777 1777 0140	07 0000 1174 0230
05 1040 0000	01 0061 0464	30 1277 1174
30 0005 0000	31 1140 1401	05 1201 1201
37 1041 1042	31 1140 1402	02 1201 1775
34 0000 1401	06 0062 1137	71 1175 1225
06 0062 1050	23 0433 1137	70 0000 1235
06 0061 1055	34 0000 1140	27 1176 1174
07 0000 1402 0060	06 0062 1142	30 1277 1174
30 0001 0000	06 0062 1143 0150	05 1775 1775 0240
05 1040 0000	71 0464 1142	71 1175 1236
30 0017 0000	70 0000 1160	70 0000 1242
36 0417 1401	03 0433 0060	31 1776 1171
06 0062 1060	34 0000 1137	72 1162 1163
06 0061 1064	07 0000 0433	72 1152 1142
71 0464 1050	70 0000 1141	70 0000 1246
	37 1777 1777	00 0000 0000

BUFFER BLOCK TWO, ADD 1000 TO ADDRESS

72 1246 1244	0250	06 0061 1337	0340	00 0000 0000	0430
07 0000 0367		71 1310 1337		70 0507 1270	
72 1224 1201		70 0000 1360		00 0000 0000	
70 0000 1266		00 0000 0000		67 1270 0510	
71 1201 1263		31 1314 1316		00 0000 0000	
72 1235 1225		31 1315 1317		67 0050 1727	
31 0433 0464		07 0000 1313		00 0000 0000	
31 1174 1402		30 0041 0000		66 0631 1146	
06 0062 1257	0260	05 1313 1312	0350	00 0000 0000	0440
71 0464 1257		06 0061 1323		65 1412 0366	
*70 0000 0400		71 1310 1323		00 0000 0000	
36 1157 1201		31 0414 1032		00 0000 0000	
70 0000 1270		72 1032 0400		64 0753 1024	
73 0000 1256		31 0433 1310		00 0000 0000	
71 1175 1254		70 0000 1320		63 1534 0244	
31 1201 1775	0270	07 0061 1320	0360	00 0000 0000	0450
70 0000 1256		34 0000 1323		63 0314 1463	
72 0505 0272		42 1430 0011		00 0000 0000	
72 0505 0273		31 1361 1312		62 1075 0703	
72 0505 0274		70 0000 1033		00 0000 0000	
72 0505 0275		72 0505 0365		61 1656 0122	
72 0505 0276		72 0505 0366		00 0000 0000	
72 0505 0277		72 0505 0367		61 0436 1341	
72 0505 0300	0300	72 0505 0370	0370	00 0000 0000	0460
72 0505 0301		72 0505 0371		60 1217 0561	
72 0505 0302		72 0505 0372		00 0000 0000	
72 0505 0303		72 0505 0373		60 0000 0000	
72 0505 0304		72 0505 0374		00 0000 0000	
72 0505 0305		00 0201 0100		57 0560 1217	
72 0505 0306		00 0000 0001		00 0000 0000	
72 0505 0307		00 0000 0000		56 1341 0437	
72 0505 0310	0310	00 0000 0000	0400	00 0000 0000	0470
72 0505 0311		37 1777 1565		56 0121 1656	
37 1775 0070		00 0000 0000		00 0000 0000	
14 0177 1170		77 0560 1217		55 0702 1075	
72 0505 0314		00 0000 0000		00 0000 0000	
72 0505 0315		76 1341 0437		54 1463 0315	
72 0505 0316		00 0000 0000		00 0000 0000	
72 0505 0317		76 0121 1656		54 0243 1534	
07 0000 1401	0320	00 0000 0000	0410	00 0000 0000	0500
30 0045 1317		75 0702 1075		53 1024 0754	
30 0052 1316		00 0000 0000		00 0000 0000	
07 0000 1402		74 1463 0315		52 1605 0173	
30 0045 1315		00 0000 0000		00 0000 0000	
30 0052 1314		74 0243 1534		52 0365 1412	
01 1316 1313		00 0000 0000		00 0000 0000	
05 3131 1313		73 1024 0754		51 1146 0632	
02 1315 1317	0330	00 0000 0000	0420	00 0000 0000	0510
25 1317 0000		72 1605 0173		50 1727 0051	
15 1313 1313		00 0000 0000		00 0000 0000	
73 1312 1344		72 0365 1412		50 0507 1270	
31 1361 1312		00 0000 0000		00 0000 0000	
07 0000 1323		71 1146 0632		47 1270 0510	
36 0417 1337		00 0000 0000		00 0000 0000	
31 0060 0000		70 1727 0051		47 0050 1727	
*72 1242 1236	0263	70 0000 1360	0353	65 0172 1605	0443

BUFFER BLOCK TWO, ADD 1000 TO ADDRESS

00 0000 0000	0520	00 0000 0000	0610	00 0000 0000	0700
46 0631 1146		13 1024 0754		35 0702 1075	
00 0000 0000		00 0000 0000		00 0000 0000	
45 1410 0366		14 0243 1534		36 0121 1656	
00 0000 0000		00 0000 0000		00 0000 0000	
45 0172 1605		14 1463 0315		36 1341 0437	
00 0000 0000		00 0000 0000		00 0000 0000	
44 0753 1024		15 0702 1075		37 0560 1217	
00 0000 0000	0530	00 0000 0000	0620	00 0000 0000	0710
43 1534 0244		16 0121 1656		37 1777 1777	
00 0000 0000		00 0000 0000		00 0000 0000	
43 0314 1463		16 1341 0437		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
42 1075 0703		17 0560 1217		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
41 1656 0122		20 0000 0000		00 0000 0000	
00 0000 0000	0540	00 0000 0000	0630	00 0000 0000	0720
41 0436 1341		20 1217 0561		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
40 1217 0561		21 0436 1341		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
00 0000 0000		21 1656 0122		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
00 1217 0561		22 1075 0703		00 0000 0000	
00 0000 0000	0550	00 0000 0000	0640	00 0000 0000	0730
01 0436 1341		23 0314 1463		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
01 1656 0122		23 1534 0244		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
02 1075 0703		24 0753 1024		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
03 0314 1463		25 0172 1605		00 0000 0000	
00 0000 0000	0560	00 0000 0000	0650	00 0000 0000	0740
03 1534 0244		25 1412 0366		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
04 0753 1024		26 0631 1146		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
05 0172 1605		27 0050 1727		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
05 1412 0366		27 1270 0510		00 0000 0000	
00 0000 0000	0570	00 0000 0000	0660	00 0000 0000	0750
06 0631 1146		30 0507 1270		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
07 0050 1727		30 1727 0051		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
07 1270 0510		31 1146 0632		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
10 0507 1270		32 0365 1412		00 0000 0000	
00 0000 0000	0600	00 0000 0000	0670	00 0000 0000	0760
10 1727 0051		32 1605 0173		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
11 1146 0632		33 1024 0754		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
12 0365 1412		34 0243 1534		00 0000 0000	
00 0000 0000		00 0000 0000		00 0000 0000	
12 1605 0173		34 1463 0315		00 0000 0000	

BUFFER BLOCK TWO, ADD 1000 TO ADDRESS

00	0000	0000	0770
40	0001	0777	
00	0000	0000	
00	0000	0000	
00	0000	0000	
40	0001	0310	
00	0000	0000	
72	0254	0775	

BLANK SUBROUTINE

	72 0402 0404		72 0402 0404	0070
	33 0000 0000		33 0000 0000	
.	72 0402 0404		72 0402 0404	
	33 0000 0000		33 0000 0000	
	72 0402 0404		70 0000 0572	
.	33 0000 0000		00 0000 0000	
	72 0402 0404	0010		
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404	0020		
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404	0030		
.	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
.	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404	0040		
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404	0050		
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
.	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404	0060		
.	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			
	72 0402 0404			
	33 0000 0000			

BLANK OVERLAY

70 0000 0646		00 0000 0053	0070
70 0000 0472		00 0000 0037	
70 0000 0660		00 0000 0077	
70 0000 0667		20 0012 0001	
70 0000 0501		00 0231 0700	
70 0000 0523		00 0001 0400	
70 0000 0000	0010	70 0000 0404	
70 0000 0000		00 0000 0070	
70 0000 0000		00 0000 0000	0100
70 0000 0000		70 0000 0560	
70 0000 0000		72 0505 0101	
70 0000 0000		72 0505 0102	
70 0000 0000		72 0505 0103	
70 0000 0000		72 0505 0104	
70 0000 0000		72 0505 0105	
70 0000 0400		72 0505 0106	
70 0000 0000	0020	72 0505 0107	0110
70 0000 0000		72 0505 0110	
70 0000 0000		72 0505 0111	
70 0000 0000		72 0505 0112	
70 0000 0000		72 0505 0113	
70 0000 0000		72 0505 0114	
70 0000 0000		72 0505 0115	
70 0000 0000		72 0505 0116	
70 0000 0000	0030	72 0505 0117	0120
70 0000 0000			
70 0000 0000			
70 0000 0000			
70 0000 0000			
70 0000 0000			
70 0000 0000			
70 0000 0000	0040	72 0505 0347	0350
70 0000 0000		72 0505 0350	
70 0000 0000		72 0505 0351	
70 0000 0000		72 0505 0352	
70 0000 0000		72 0505 0353	
70 0000 0000		72 0505 0354	
70 0000 0605		72 0505 0355	
70 0000 0000		72 0505 0356	
33 0000 0000	0050	72 0505 0357	0360
70 0000 0560		72 0505 0360	
70 0000 0372		72 0505 0361	
70 0000 0424		72 0505 0362	
70 0000 0000		72 0505 0363	
70 0000 0000		72 0505 0364	
70 0000 0000		72 0505 0365	
70 0000 0000		72 0505 0366	
00 0000 0000	0060	72 0505 0367	0370
00 0000 0001		72 0505 0370	
00 0000 0002		72 0607 0605	
00 0000 0003		31 0414 0607	
00 0000 0004		06 0062 0520	
00 0000 0005		70 0000 0400	
00 0000 0006		00 0201 0100	
00 0000 0007		00 0000 0000	

OVERLAY 00

70 0000 0646	00 0000 0052 0070	07 0061 0520 0160
70 0000 0400	00 0000 0037	36 0417 0162
70 0000 0660	00 0000 0077	31 0157 0721
70 0000 0666	20 0012 0001	72 0530 0521
70 0000 0501	00 0000 0000	31 0777 0200
70 0000 0524	00 0000 0000	31 0676 0001
72 0001 0100 0010	70 0000 0404	72 0675 0670
72 0001 0100	00 0000 0070	31 0553 0156
72 0001 0100	31 0120 0501 0100	42 1400 0001 0170
72 0001 0100	06 0432 0100	70 0217 0171
72 0001 0100	71 0104 0100	42 1603 0000
72 0001 0100	70 0000 0105	42 1604 0400
72 0001 0100	00 0000 0036	41 0377 0300
72 0001 0100	02 0061 0001	07 0000 0156
72 0001 0100	36 0417 0513	72 0657 0652
72 0001 0100	31 0200 0777	70 0000 0661
72 0001 0100 0020	06 0061 0777 0110	00 0000 0003 0200
72 0001 0100	72 0623 0614	31 0567 0404
72 0001 0100	31 0414 0600	31 0402 0520
72 0001 0100	70 0000 0501	72 0402 0403
72 0001 0100	00 0000 0000	75 1000 0504
72 0001 0100	00 0000 0000	34 0000 0436
72 0001 0100	00 0000 0000	11 0565 0000
72 0001 0100	72 0402 0400	73 0000 0504
72 0001 0100 0030	72 0666 0660 0120	07 0000 0520 0210
72 0001 0100	31 0414 0666	36 0417 0514
72 0001 0100	72 0600 0371	36 0417 0516
72 0001 0100	31 0530 0600	07 0000 0436
72 0001 0100	31 0101 0000	36 0554 0000
72 0001 0100	03 0061 0505	02 0061 0516
72 0001 0100	36 0417 0512	06 0061 0000
72 0001 0100	36 0417 0403	31 0566 0404
70 0000 0400 0040	07 0401 0777 0130	70 0000 0701 0220
70 0000 0400	34 0000 0000	07 0000 0777
70 0000 0400	31 0403 0000	72 0613 0610
70 0000 0400	07 0000 0377	05 0556 0000
70 0000 0400	72 0657 0652	36 0555 0526
70 0000 0400	72 0675 0670	42 1420 0010
70 0000 0400	31 0377 0553	42 1006 0000
70 0000 0400	31 0536 0561	40 0700 0100
70 0000 0400 0050	33 0000 0521 0140	70 0000 0624 0230
70 0000 0400	36 0417 0573	00 0000 0000
70 0000 0400	31 0676 0001	31 0414 0402
70 0000 0400	72 0666 0661	72 0402 0400
70 0000 0400	31 0414 0666	72 0647 0517
70 0000 0400	31 0414 0675	72 0666 0661
70 0000 0400	70 0000 0150	70 0000 0160
00 0000 0000	31 0060 0436	00 0000 0000
00 0000 0000 0060	31 0201 0501 0150	02 0061 0070 0240
00 0000 0001	06 0432 0150	31 0010 0003
00 0000 0002	71 0154 0150	31 0010 0005
00 0000 0003	70 0000 0240	06 0061 0242
00 0000 0004	00 0000 0036	71 0070 0242
00 0000 0005	72 0530 0521	31 0414 0100
00 0000 0006	00 0000 0000	72 0100 0532
00 0000 0007	70 0000 0605	31 0260 0073

OVERLAY 00

31 0261 0376	0250	31 0522 0521	0340
72 0414 0410		72 0427 0423	
31 0060 0376		31 0061 0465	
31 0470 0414		30 0441 0000	
31 0010 0004		31 0063 0466	
31 0010 0002		72 0427 0425	
72 0414 0400		71 0465 0513	
70 0000 0646		34 0000 0530	
27 1172 1717	0260	06 0061 0517	0350
00 0000 0400		70 0000 0526	
00 0000 0000		70 0000 0510	
00 0000 0000		34 0000 0527	
00 0000 0000		31 0523 0517	
00 0000 0000		72 0521 0511	
00 0000 0000		37 0000 0000	
00 0000 0000		70 0000 0700	
00 0000 0000	0270	34 0000 0000	0360
00 0000 0000		31 0001 0001	
00 0000 0000		75 1000 0532	
00 0000 0000		70 0000 0400	
00 0000 0000		71 0164 0527	
00 0000 0000		00 0000 0000	
00 0000 0000		00 0000 0000	
00 0000 0000		00 0000 0000	
00 0000 0000	0300	00 0000 0000	0370
42 1000 0222		00 0000 0000	
41 0500 0033		00 0000 0000	
70 0000 0400		00 0000 0000	
03 0001 0001		00 0000 0000	
72 0667 0663		00 0000 0000	
31 0414 0667		00 0000 0000	
31 0525 0500		00 0201 0000	
70 0000 0501	0310	00 0000 0000	
31 0416 0402			
31 0645 0404			
31 0530 0573			
07 0000 0377			
72 0657 0652			
72 0667 0663			
31 0414 0673			
03 0001 0001	0320		
72 0665 0661			
31 0777 0200			
31 0414 0665			
70 0000 0504			
00 0000 0000			
00 0000 0000			
00 0000 0000			
00 0000 0000	0330		
71 0504 0505			
31 0061 0504			
70 0000 0400			
00 0000 0001			
31 0062 0466			
72 0427 0423			
36 0417 0517			

OVERLAY 01

		00 0000 0053	0070	06 0434 0157	0160
		00 0000 0037		06 0062 0155	
		00 0000 0077		06 0062 0156	
		20 0012 0001		71 0464 0155	
		00 0301 0100		70 0000 0336	
		00 0001 0400		07 0000 1002	
		70 0000 0404		07 0000 1402	
		00 0000 0070		30 0000 1002	
	0010	70 0000 0560	0100	30 0000 1402	0170
		42 1420 0010		72 0123 0115	
		42 1003 0044		36 0555 0102	
		41 1000 0376		72 0104 0101	
		70 0000 0174		70 0000 0227	
		42 1420 0010		30 0041 1402	
		42 1002 1704		30 0001 1402	
		41 1400 0376		70 0000 0336	
	0020	70 0000 0137	0110	72 0174 0171	0200
		42 1420 0010		03 1375 1775	
		42 1007 0164		73 0060 0210	
		40 1400 0376		31 0165 0155	
		70 0000 0150		30 0052 0156	
		72 0054 0400		06 0167 0156	
		01 0125 0124		02 0157 0157	
		71 0124 0120		70 0000 0231	
	0030	07 0000 0124	0120	03 1775 1375	0210
		30 0044 0000		31 1375 1775	
		05 0136 0124		31 0166 0155	
		70 0000 0135		30 0052 0156	
		00 0000 1704		06 0170 0156	
		00 0000 0055		70 0000 0206	
		00 0000 1704		72 0207 0200	
		00 0000 0300		02 0157 0157	
	0040	00 0000 0574	0130	70 0000 0252	0220
		06 0127 0140		01 1000 1000	
		31 0140 0126		72 0307 0200	
		02 0140 0140		70 0000 0253	
		72 0123 0363		34 0000 1002	
		36 0555 0106		31 1000 1402	
		72 0110 0105		72 0174 0171	
		70 0000 0400		33 0000 0000	
	0050	00 0000 0000	0140	72 0207 0203	0230
		06 0127 0140		70 0000 0234	
		31 0140 0126		00 0000 0000	
		02 0140 0140		72 0231 0226	
		72 0123 0115		06 1375 1775	
		34 0000 1776		70 0000 0246	
		36 0555 0112		30 0041 0000	
		72 0114 0111		06 1000 1002	
	0060	70 0000 0400	0150	72 0231 0226	0240
		72 1023 0115		02 1375 1775	
		36 0555 0102		70 0000 0247	
		72 0104 0101		00 0000 0000	
		70 0000 0154		02 1002 1402	
		07 0000 1314		04 0000 0000	
		30 0000 1314		06 0245 0157	
		26 1314 1714		06 0245 0157	

OVERLAY 01

06 0245 0157	0250	31 0237 0157	0340
06 0245 0157		31 0224 0156	
06 0245 0157		31 0166 0155	
06 0244 0157		72 0164 0354	
31 0433 0464		31 0225 0157	
70 0000 0155		31 0166 0156	
00 0000 0000		31 0177 0164	
31 0433 0464		70 0000 0254	
34 0000 0262	0260	31 0221 0157	0350
36 0417 0263		72 0347 0341	
06 0062 0260		07 1002 1002	
06 0062 0261		01 1004 1000	
71 0464 0260		06 0062 0225	
70 0000 0265		72 0164 0254	
31 0175 0261		02 0062 0225	
31 0166 0260		31 0370 0347	
72 0265 0257	0270	31 0177 0164	0360
02 0061 1775		31 0060 1000	
70 0000 0400		70 0000 0400	
31 0176 0261		72 0053 0115	
31 0166 0260		34 0000 0367	
72 0265 0257		72 0327 0322	
06 0061 1775		70 0000 1250	
70 0000 0400		00 0000 0000	
00 0000 0000	0300	72 0607 0605	0370
02 0300 0300		31 0414 0607	
72 0207 0200		06 0062 0520	
07 0000 1775		70 0000 0400	
36 0061 0300		70 0000 0560	
31 0300 0312		70 0505 0374	
07 0000 1775		00 0201 0100	
30 0001 1775		00 0000 0001	
70 0000 0250	0310		
30 0001 1002			
72 0277 0273			
31 0414 0277			
31 0311 0261			
31 0165 0260			
72 0265 0257			
70 0000 0306			
31 0414 0137	0320		
70 0000 0131			
42 1400 0001			
70 0217 0323			
42 1603 0000			
42 1604 1001			
41 1000 0376			
70 0000 0331			
72 0327 0322	0330		
70 0000 1001			
72 0327 0322			
70 0000 1163			
31 0414 0137			
70 0000 0131			
02 0157 0157			
70 0000 0400			

OVERLAY 02

		00 0000 0053	0070	31 0433 0464	0160
		00 0000 0037		00 0000 0000	
70 0000 0646		00 0000 0077		30 0077 0000	
70 0000 0472		30 0012 0001		73 0153 0167	
70 0000 0660		00 0201 0200		06 0062 0161	
70 0000 0667		00 0001 0400		71 0464 0161	
70 0000 0501		70 0000 0404		70 0000 0166	
70 0000 0055		00 0000 0070		34 0000 0153	
70 0000 0275		70 0000 0560	0100	70 0000 0164	0170
70 0000 0277		42 1420 0010		07 0000 1402	
70 0000 0307		42 1003 0204		00 0000 0000	
70 0000 0313		41 1000 0376		13 0000 0153	
70 0000 0333		70 0000 0225		73 0154 0176	
70 0000 0345		42 1420 0010		07 0000 0154	
31 0060 1775		42 1002 1744		30 0052 0000	
70 0000 0400		41 1400 0376		05 0202 0202	
33 0000 0010	0020	70 0000 0137	0110	31 0433 0464	0200
72 0657 0652		42 1420 0010		00 0000 0000	
70 0000 0661		42 1007 0344		00 0000 0000	
70 0000 0374		40 1400 0376		06 0062 0201	
06 0064 0140		70 0000 0150		06 0062 0202	
06 0130 0140		70 0054 0400		71 0464 0201	
06 0064 0140		01 0125 0124		70 0000 0206	
06 0130 0140		71 0124 0120		30 0040 1402	
06 0064 0140	0030	07 0000 0124	0120	30 0040 1002	0210
70 0000 0141		30 0044 0000		02 0153 1775	
06 0064 0140		05 0126 0124		02 0153 1375	
06 0130 0140		70 0000 0135		31 0414 0137	
06 0064 0140		00 0000 1744		70 0000 0131	
06 0130 0140		00 0000 0055		31 0433 0464	
06 0064 0140		00 0000 1704		70 0000 0000	
70 0000 0213		00 0000 0300		16 0434 0216	
72 0607 0605	0040	00 0000 0574	0130	71 0464 0216	0220
31 0414 0607		06 0127 0140		70 0000 0400	
06 0062 0520		31 0140 0126		72 0123 0115	
70 0000 0400		02 0140 0140		36 0555 0102	
70 0000 0560		72 0123 0370		72 0104 0101	
70 0000 0155		36 0555 0106		70 0000 0225	
70 0000 0605		72 0110 0105		31 0171 0161	
00 0000 0000		70 0000 1002		72 0166 0157	
33 0000 0000	0050	00 0000 0000	0140	70 0000 0230	0230
70 0000 0560		06 0127 0140		31 0252 0161	
70 0000 0040		31 0140 0126		72 0166 0157	
70 0000 0424		02 0140 0140		70 0000 0233	
70 0000 0116		72 0123 0115		31 0171 0201	
33 0000 0020		34 0000 1776		31 0211 0172	
70 0000 0021		36 0555 0112		72 0332 0337	
70 0000 0000		72 0114 0111		70 0000 0243	
00 0000 0000	0060	70 0000 0400	0150	31 0252 0201	0240
00 0000 0001		04 0000 0000		31 0212 0172	
00 0000 0002		00 0000 0000		72 0332 0326	
00 0000 0003		00 0000 0000		72 0206 0172	
00 0000 0004		00 0000 0030		70 0000 0244	
00 0000 0005		72 0361 0354		06 1002 1402	
00 0000 0006		70 0000 1001		02 1002 1402	
00 0000 0007		31 0417 0153		26 1002 1402	

OVERLAY 02

22 1002 1402	0250	70 0000 0327	0340
40 0000 0001		31 0251 0153	
07 0000 1002		72 0244 0234	
00 0000 0012		71 0152 0316	
72 0225 0222		70 0000 0324	
31 0152 0216		72 0230 0226	
72 0230 0226		72 0244 0234	
02 0061 0153		70 0000 0400	
72 0244 0234	0260	72 0054 0560	0350
72 0233 0231		31 0047 0054	
02 0061 0153		72 0402 0054	
72 0244 0240		70 0000 0605	
03 1775 1375		42 1400 0001	
70 0072 0271		70 0217 0355	
21 0437 0153		42 1603 0000	
72 0244 0234		42 1604 1001	
70 0000 0015	0270	41 1000 0376	0360
34 0000 0153		70 0000 0156	
72 0244 0240		07 0000 0320	
70 0000 0215		36 0417 0364	
13 1402 1002		13 0000 0000	
31 0245 0152		73 0061 0322	
70 0000 0254		70 0000 0341	
31 0246 0152		00 0000 0000	
70 0000 0254	0300	72 0053 0115	0370
72 0225 0222		34 0000 0367	
72 0230 0226		72 0361 0354	
72 0244 0234		70 0000 1250	
72 0233 0231		72 0361 0354	
72 0244 0240		70 0000 1163	
70 0000 0306		00 0201 0200	
72 0306 0301		00 0000 0002	
31 0247 0216	0310		
06 1375 1775			
70 0000 0215			
72 0306 0301			
31 0250 0216			
31 0253 0152			
31 0433 0464			
31 0274 0320			
13 1402 1002	0320		
73 0060 0362			
06 0434 0320			
71 0464 0320			
02 1375 1775			
70 0000 0215			
31 0210 0202			
07 0000 0153			
70 0032 0332	0330		
02 0336 0202			
70 0000 0000			
31 0054 0047			
33 0000 0000			
70 0000 0350			
00 0040 0000			
31 0207 0202			

OVERLAY 04

		00 0000 0053	0070	70 0000 0251	0160
		00 0000 0037		06 0062 0155	
70 0000 0646		00 0000 0077		06 0062 0156	
70 0000 0472		20 0012 0001		71 0464 0155	
70 0000 0660		00 0201 0400		70 0000 0215	
70 0000 0667		00 0001 0400		07 0000 1002	
70 0000 0501		70 0000 0404		07 0000 1401	
70 0000 0523		00 0000 0070		30 0000 1002	
70 0000 0277	0010	70 0000 0560	0100	30 0000 1401	0170
70 0000 0324		70 0000 0560		02 1002 1401	
70 0000 0347		42 1002 0000		00 0000 0000	
70 0000 0341		41 1000 0376		42 1420 0010	
70 0000 0267		70 0000 0104		42 1420 0010	
70 0000 0362		42 1420 0010		70 0000 0102	
70 0000 0311		42 1002 0000		31 0433 0464	
70 0000 0400		41 1400 0376		31 0171 0157	
70 0000 0327	0020	70 0000 0710	0110	72 0154 0151	0200
70 0000 0345		42 1420 0010		03 1375 1774	
72 0134 0373		42 1006 0000		73 0060 0207	
70 0000 0260		40 1400 0376		31 0165 0155	
06 0064 0140		70 0000 0114		30 0052 0156	
06 0130 0140		72 0054 0400		05 0167 0156	
06 0064 0140		01 0125 0124		70 0000 0155	
06 0130 0140		71 0124 0120		03 1774 1375	
06 0064 0140	0030	07 0000 0124	0120	31 1375 1774	0210
70 0000 0141		30 0044 0000		31 0166 0155	
06 0064 0140		05 0126 0124		30 0052 0156	
06 0130 0140		70 0000 0152		05 0170 0156	
06 0064 0140		00 0000 0000		70 0000 0155	
06 0130 0140		00 0000 0055		31 0200 0222	
06 0064 0140		00 0000 0000		03 0060 0433	
70 0000 0131		00 0000 0300		34 0000 0464	
70 0000 0000	0040	00 0000 0574	0130	13 0000 1401	0220
70 0000 0000		06 0127 0140		34 0000 0172	
70 0000 0307		31 0140 0126		13 0000 1401	
70 0000 0000		02 0140 0140		73 0172 0235	
70 0000 0305		72 0123 0115		06 0062 0222	
70 0000 0311		36 0555 0106		71 0464 0222	
70 0000 0605		72 0110 0105		31 0433 0464	
70 0000 0000		70 0000 0400		31 1001 1401	
70 0000 0000	0050	00 0000 0000	0140	31 1402 1402	0230
70 0000 0000		06 0127 0140		06 0062 0230	
70 0000 0000		31 0140 0126		06 0434 0227	
70 0000 0424		02 0140 0140		71 0464 0227	
70 0000 0116		72 0123 0115		70 0000 0246	
70 0000 0000		34 0000 1776		34 0000 0173	
70 0000 0000		36 0555 0112		13 0172 0173	
70 0000 0000		72 0114 0111		73 0000 0224	
00 0000 0000	0060	72 0000 0400	0150	07 0061 0222	0240
00 0000 0001		72 0123 0115		36 0417 0242	
00 0000 0002		36 0555 0102		07 0000 0000	
00 0000 0003		72 0104 0174		34 0000 1402	
00 0000 0004		70 0000 0201		31 0173 0172	
00 0000 0005		00 0000 0000		70 0000 0224	
00 0000 0006		00 0000 0000		31 1374 1774	
00 0000 0007		02 1002 1401		70 0000 0400	

OVERLAY 04

70 0000 0560	0250	35 1402 1402	0340
70 1073 0254		72 0355 0345	
06 0434 0157		72 0355 0347	
70 0000 0161		31 0344 0355	
07 0000 0157		70 0000 0400	
36 0417 0256		31 0337 0352	
31 0255 1401		70 0000 0350	
70 0000 0252		31 0340 0352	
70 1033 0261	0260	31 0356 0357	0350
31 0264 0230		07 0000 0360	
31 0265 0227		00 0000 0000	
70 0000 0176		06 0361 0352	
31 1402 1402		71 0357 0351	
31 1001 1401		70 0000 0400	
70 0000 0560		00 0000 0144	
00 0000 0000		00 0000 0000	
00 0000 0143	0270	37 1777 1777	0360
31 0060 1402		00 0002 0002	
31 0060 1546		07 0000 0402	
00 0000 0061		70 0065 0400	
00 0000 0062		31 0054 0372	
00 0000 0000		33 0000 0000	
31 0001 0001		72 0054 0560	
31 0271 0314		31 0372 0054	
31 0273 0275	0300	72 0402 0054	0370
70 0000 0310		70 0000 0605	
00 0000 0000		00 0000 0000	
00 0000 0000		72 0247 0400	
00 0000 0000		70 0000 0605	
00 0000 0000		72 0505 0374	
00 0000 0000		00 0201 0400	
00 0000 0000		00 0000 0004	
70 0000 0314	0310		
31 0001 0001			
31 0272 0314			
31 0274 0275			
00 0000 0000			
06 0062 0314			
71 0275 0314			
70 0000 0400			
31 1404 1402	0320		
06 0434 0333			
31 1710 1712			
02 0434 0333			
31 0320 0333			
31 0321 0334			
70 0000 0331			
31 0322 0333			
31 0323 0334	0330		
31 0001 0001			
31 0270 0275			
31 1714 1712			
06 0434 0333			
71 0275 0333			
70 0000 0400			
35 1401 1401			

OVERLAY 05

		00 0000 0053	0070	07 0000 1402	0160
		00 0000 0037		00 0000 0143	
70 0000 0646		00 0000 0077		00 0000 1774	
70 0000 0472		20 0012 0001		31 0001 0001	
70 0000 0660		00 0201 0500		31 0155 0175	
70 0000 0667		00 0001 0400		70 0000 0171	
70 0000 0501		70 0000 0404		31 0156 0175	
70 0000 0523		00 0000 0070		70 0000 0171	
70 0000 0110	0010	00 0001 0001	0100	31 0157 0175	0170
70 0000 0163		31 0060 1776		31 0001 0001	
70 0000 0166		31 0060 0640		31 0161 0162	
70 0000 0170		00 0000 0000		31 0160 0174	
70 0000 0230		00 0000 0000		07 0000 1410	
70 0000 0000		00 0000 0000		70 0073 0000	
70 0000 0000		02 0000 0400		06 0062 0174	
70 0000 0400		00 0000 0000		71 0162 0174	
70 0000 0000	0020	31 0001 0001	0110	70 0000 0400	0200
70 0000 0000		42 1400 0001		31 0151 0224	
70 0000 0000		70 0217 0112		70 0000 0211	
70 0000 0000		42 1604 1033		31 0150 0224	
70 0000 0000		31 1777 0141		70 0000 0211	
70 0000 0000		42 1404 0000		31 0152 0222	
70 0000 0000		07 0000 0141		31 0153 0223	
70 0000 0000		35 0100 0104		31 0154 0224	
70 0000 0000	0030	30 0455 0000	0120	31 0001 0001	0210
70 0000 0000		05 0104 0105		31 0001 0001	
70 0000 0000		31 0001 0001		42 1430 0011	
70 0000 0000		31 0001 0001		42 1002 0223	
70 0000 0000		31 0101 0126		40 0217 0005	
70 0000 0000		31 0125 1000		42 1404 0000	
70 0000 0000		00 0000 0000		70 0000 0400	
70 0000 0000		71 0126 0130		20 0302 0030	
70 0000 0000	0040	71 1000 0126	0130	22 0613 0100	0220
70 0000 0000		31 0102 0133		27 0610 0000	
70 0000 0000		31 0132 0631		21 1002 1000	
70 0000 0000		00 0000 0000		31 0000 0000	
70 0000 0000		71 0133 0135		00 0000 0000	
70 0000 0000		71 0631 0133		72 0505 0224	
70 0000 0605		31 0063 0103		72 0505 0225	
70 0000 0000		31 0105 1000		00 0000 0000	
33 0000 0000	0050	42 1430 0011	0140	31 0246 0233	0230
70 0000 0560		00 0000 0000		31 0247 0162	
70 0000 0372		40 1000 0400		70 0034 0233	
70 0000 0424		06 0106 1000		07 0000 1776	
70 0000 0000		71 0103 0141		70 0074 0240	
70 0000 0000		42 1404 0000		02 0061 0233	
70 0000 0000		31 0060 1000		71 0162 0233	
70 0000 0000		70 0000 0400		70 0000 0400	
00 0000 0000	0060	27 1533 0200	0150	31 0244 0222	0240
00 0000 0001		26 1442 0600		31 0245 0223	
00 0000 0002		70 0652 0400		31 0233 1770	
00 0000 0003		30 1452 1300		70 0000 0211	
00 0000 0004		27 0660 0000		27 1403 0100	
00 0000 0005		70 0032 0201		24 0633 1000	
00 0000 0006		70 0072 0203		07 0000 1776	
00 0000 0007		70 0073 0205		00 0000 1774	

OVERLAY 05

00	0000	0000	0250
72	0505	0250	
72	0505	0251	
72	0505	0252	
72	0505	0253	
72	0505	0254	
72	0505	0255	
72	0505	0256	
72	0505	0257	0260
72	0505	0260	
72	0505	0261	
72	0505	0262	
72	0505	0263	
72	0505	0264	
72	0505	0265	
72	0505	0266	
72	0505	0267	0270
72	0505	0270	
72	0505	0271	
72	0505	0272	
72	0505	0273	
72	0505	0274	
72	0505	0275	
72	0505	0276	
72	0505	0277	0300
72	0505	0300	
72	0505	0301	
72	0505	0302	
72	0505	0303	
72	0505	0304	
72	0505	0305	
72	0505	0306	
72	0505	0307	0310
72	0505	0310	
72	0505	0311	
72	0505	0312	
72	0505	0313	
72	0505	0314	
72	0505	0315	
72	0505	0316	
72	0505	0317	0320
72	0505	0367	0370
72	0505	0370	
72	0607	0605	
31	0414	0607	
06	0062	0520	
70	0000	0400	
00	0201	0500	
00	0000	0005	

OVERLAY 06

70 0000 0646	00 0000 0053 0070	72 0505 0157 0160
70 0000 0472	00 0000 0037	72 0505 0160
70 0000 0660	00 0000 0077	72 0505 0161
70 0000 0667	20 0012 0001	72 0505 0162
70 0000 0501	00 0201 0600	72 0505 0163
70 0000 0523	00 0001 0400	72 0505 0164
70 0000 0000 0010	70 0000 0404	72 0505 0165
70 0000 0000	00 0000 0070	00 0000 0000
70 0000 0000	00 0000 0000 0100	00 0000 1777 0170
70 0000 0000	70 0000 0560	37 1777 1777
70 0000 0000	72 0505 0101	00 0000 0000
70 0000 0000	72 0505 0102	00 0002 0002
70 0000 0000	72 0505 0103	07 0000 1401
70 0000 0000	72 0505 0104	00 0000 0000
70 0000 0000	72 0505 0105	00 0000 0000
70 0000 0400	72 0505 0106	00 0000 0000
70 0000 0000 0020	72 0505 0107 0110	06 0062 0201 0200
70 0000 0000	72 0505 0110	07 0000 1401
70 0000 0000	72 0505 0111	73 1402 0200
70 0000 0000	72 0505 0112	01 1402 0000
70 0000 0000	72 0505 0113	73 0000 0212
70 0000 0000	72 0505 0114	34 0000 0177
70 0000 0000	72 0505 0115	03 1401 1403
70 0000 0000	72 0505 0116	34 0000 0176
70 0000 0000 0030	72 0505 0117 0120	03 0177 0176 0210
70 0000 0000	72 0505 0120	73 0177 0214
70 0000 0101	72 0505 0121	31 0061 0175
70 0000 0000	72 0505 0122	70 0000 0215
70 0000 0000	72 0505 0123	31 0060 0175
70 0000 0000	72 0505 0124	31 0001 0001
70 0000 0000	72 0505 0125	31 0433 0172
70 0000 0140	72 0505 0126	37 0000 0000
70 0000 0000 0040	72 0505 0127 0130	34 1402 1404 0220
70 0000 0000	72 0505 0130	06 0173 0220
70 0000 0000	72 0505 0131	71 0172 0217
70 0000 0000	72 0505 0132	71 0175 0231
70 0000 0000	72 0505 0133	03 0061 0201
70 0000 0000	72 0505 0134	36 0170 0226
70 0000 0000	30 0000 1402	31 0171 0000
70 0000 0000	30 0040 1402	31 0174 0201
70 0000 0000 0050	07 0000 1775 0140	70 0000 0400 0230
70 0000 0000	70 0072 0146	07 0061 0201
70 0000 0000	30 0052 0000	70 0000 0225
70 0000 0424	05 0137 0152	70 0000 0560
70 0000 0000	70 0000 0151	72 0505 0233
70 0000 0000	00 0000 0000	72 0505 0234
70 0000 0000	11 0000 0000	72 0505 0235
70 0000 0000	30 0052 0000	72 0505 0236
00 0000 0000 0060	05 0136 0152 0150	72 0505 0237 0240
00 0000 0001	07 0000 1402	
00 0000 0002	30 0000 1401	72 0505 0372
00 0000 0003	31 0060 1775	72 0505 0373
00 0000 0004	70 0000 0201	72 0505 0374
00 0000 0005	72 0505 0154	00 0201 0600
00 0000 0006	72 0505 0155	00 0000 0006
00 0000 0007	72 0505 0156	27 1002 1700 0400

			00	0000	0053	0070	70	0072	0174	01
			00	0000	0037		22	0171	0142	
70	0000	0646	00	0000	0077		02	0064	0143	
70	0000	0472	20	0012	0001		06	0061	0141	
70	0000	0660	00	0201	0700		70	0000	0150	
70	0000	0667	00	0001	0400		26	0171	0142	
70	0000	0501	70	0000	0404		06	0064	0143	
70	0000	0523	00	0000	0070		02	0061	0141	
70	0000	0000	00	0000	0000	0100	70	0000	0150	0170
70	0000	0000	70	0000	0560		24	0000	0000	
70	0000	0000	07	0000	1402		00	0000	0000	
70	0000	0000	70	0072	0130		00	0000	0000	
70	0000	0000	25	0140	0000		30	0052	0000	
70	0000	0315	30	0463	0000		36	0415	0177	
70	0000	0145	05	0137	0136		07	0000	0142	
70	0000	0400	34	0000	0000		30	0000	0142	
70	0000	0126	25	0140	0000	0110	31	1775	0172	0200
70	0000	0300	30	0455	0000		31	1402	0173	
70	0000	0300	05	0136	0136		31	0141	1775	
70	0000	0000	34	0000	0000		31	0142	1402	
70	0000	0000	25	0140	0000		72	0256	0020	
70	0000	0000	30	0446	0000		31	0172	1775	
70	0000	0000	05	0136	0136		31	0173	1402	
70	0000	0000	31	0136	0135		02	0213	0260	
70	0000	0000	06	0061	0117	0120	31	0214	0261	0210
70	0000	0000	34	0000	0000		72	0256	0253	
70	0000	0101	72	0122	0104		70	0000	0400	
70	0000	0000	42	1434	0011		00	0010	0001	
70	0000	0000	42	1002	0223		00	0002	0300	
70	0000	0000	40	0133	0003		00	0000	0000	
70	0000	0000	72	0126	0102		05	1000	0000	
70	0000	0201	70	0000	0225		06	0000	0000	
70	0000	0000	31	0135	0134	0130	00	0002	0300	0220
70	0000	0000	70	0000	0104		00	0000	0012	
70	0000	0000	00	0000	0000		00	0000	0000	
70	0000	0000	20	0062	0006		00	0201	0000	
70	0000	0000	00	0130	1200		00	0000	0000	
70	0000	0000	00	0140	1200		30	0060	0222	
70	0000	0000	10	0201	0000		13	0000	1775	
70	0000	0000	10	0201	0000		34	0000	0220	
31	1402	0142	00	0000	0012	0140	07	0000	0220	0230
07	0000	1402	00	0000	0000		73	0221	0235	
73	0000	0020	00	0000	0000		02	0221	0220	
70	0000	0146	00	0000	0000		06	0061	0222	
70	0000	0000	40	0000	0005		70	0000	0230	
70	0000	0000	70	0000	0050					

OVERLAY 07

70 0000 0252	0250	72 0505 0337	0340
06 0217 0224		72 0505 0340	
31 0224 0261		72 0505 0341	
42 1434 0011		72 0505 0342	
42 1002 0223		72 0505 0343	
40 0260 0001		72 0505 0344	
70 0000 0400		72 0505 0345	
00 0000 0000		72 0505 0346	
20 0122 0012	0260	72 0505 0347	0350
00 0000 0000		72 0505 0350	
13 0000 0141		72 0505 0351	
73 0142 0166		72 0505 0352	
07 0141 0000		72 0505 0353	
30 1201 0141		72 0505 0354	
06 0061 0214		72 0505 0355	
70 0000 0262		72 0505 0356	
31 1001 0200	0270	72 0505 0357	0360
31 1002 0201		72 0505 0360	
00 0000 0000		72 0505 0361	
00 0000 0000		72 0505 0362	
00 0000 0000		72 0505 0363	
31 1775 1004		72 0505 0364	
31 1402 1003		72 0505 0365	
31 1001 1402		72 0505 0366	
31 1002 1775	0300	72 0505 0367	0370
72 0212 0145		72 0505 0370	
31 1003 1402		72 0505 0371	
31 1004 1775		72 0505 0372	
31 0270 1251		72 0505 0373	
31 0271 1252		72 0505 0374	
31 1275 1253		00 0201 0700	
33 0000 0030		00 0000 0007	
70 0000 1246	0310		
06 0306 0260			
70 0000 0400			
00 0010 0001			
00 0140 0014			
06 0314 0133			
06 0314 0260			
70 0000 0400			
72 0505 0317	0320		
72 0505 0320			
72 0505 0321			
72 0505 0322			
72 0505 0323			
72 0505 0324			
72 0505 0325			
72 0505 0326			
72 0505 0327	0330		
72 0505 0330			
72 0505 0331			
72 0505 0332			
72 0505 0333			
72 0505 0334			
72 0505 0335			
72 0505 0336			

OVERLAY 10

70 0000 0646		00 0000 0053	0070	70 0000 0661	0160
70 0000 0472		00 0000 0037		72 0605 0607	
70 0000 0660		00 0000 0077		31 0414 0607	
70 0000 0667		20 0012 0001		06 0062 0520	
70 0000 0501		00 0211 0000		70 0000 0400	
70 0000 0156		00 0001 0400		07 0000 0402	
70 0000 0211	0010	70 0000 0404		70 0065 0400	
70 0000 0213		00 0000 0070		31 0054 0175	
70 0000 0215		70 0000 0560	0100	33 0000 0000	0170
70 0000 0341		70 0000 0560		72 0054 0560	
70 0000 0177		42 1002 0000		31 0175 0054	
70 0000 0152		41 1000 0376		72 0402 0054	
70 0000 0154		70 0000 0104		70 0000 0605	
70 0000 0400		42 1420 0010		00 0000 0000	
70 0000 0165	0020	42 1002 1704		00 0000 0000	
70 0000 0177		41 1400 0376		31 0060 0176	
70 0000 0201		70 0000 0137	0110	70 0000 0205	0200
70 0000 0227		42 1420 0010		31 0061 0176	
06 0064 0140		42 1007 0064		70 0000 0205	
06 0130 0140		40 1400 0376		31 0176 1772	
06 0064 0140		70 0000 0150		70 0000 0400	
06 0130 0140		72 0054 0400		33 0000 0010	
06 0064 0140	0030	01 0125 0124		72 0657 0652	
06 0130 0140		71 0124 0120		70 0000 0670	
06 0064 0140		07 0000 0124	0120	70 0000 0560	0210
70 0000 0141		30 0044 0000		33 0000 0001	
06 0064 0140		05 0126 0124		70 0000 0560	
06 0130 0140		70 0000 0135		33 0000 0004	
06 0064 0140		00 0000 1704		70 0000 0560	
06 0130 0140		00 0000 0055		33 0000 0007	
06 0064 0140		00 0000 1704		70 0000 0560	
70 0000 0131		00 0000 0300		33 0000 0012	
70 0000 0203	0040	00 0000 0574	0130	70 0000 0560	0220
70 0000 0223		06 0127 0140		33 0000 0013	
70 0000 0217		31 0140 0126		70 0000 0560	
70 0000 0225		02 0140 0140		33 0000 0014	
70 0000 0221		72 0123 0241		70 0000 0560	
70 0000 0231		36 0553 0106		33 0000 0015	
70 0000 0605		72 0110 0105		70 0000 0560	
00 0000 0000		70 0000 0400		33 0000 0016	
33 0000 0000	0050	00 0000 0000	0140	00 0000 0000	0230
70 0000 0560		06 0127 0140		72 0240 0233	
70 0000 0161		31 0140 0126		70 0000 1001	
70 0000 0424		02 0140 0140		42 1400 0001	
70 0000 0116		72 0123 0115		70 0217 0234	
70 0000 0000		34 0000 1776		42 1603 0000	
70 0000 0000		36 0555 0112		42 1604 1001	
70 0000 0000		72 0114 0111		41 1000 0376	
00 0000 0000	0060	70 0000 0400	0150	70 0000 0240	0240
00 0000 0001		70 0000 0560		72 0053 0115	
00 0000 0002		33 0000 0001		34 0000 0367	
00 0000 0003		70 0000 0157		72 0240 0233	
00 0000 0004		33 0000 0002		70 0000 1250	
00 0000 0005		70 0000 0157		70 0000 0560	
00 0000 0006		33 0000 0020		72 0505 0245	
00 0000 0007		72 0657 0652		72 0505 0246	

OVERLAY 10

72 0505 0247	0250	72 0505 0337	0340
72 0505 0250		72 0505 0340	
72 0505 0251		72 0505 0341	
72 0505 0252		72 0505 0342	
72 0505 0253		72 0505 0343	
72 0505 0254		72 0505 0344	
72 0505 0255		72 0505 0345	
72 0505 0256		72 0505 0346	
72 0505 0257	0260	72 0505 0347	0350
72 0505 0260		72 0505 0350	
72 0505 0261		72 0505 0351	
72 0505 0262		72 0505 0352	
72 0505 0263		72 0505 0353	
72 0505 0264		72 0505 0354	
72 0505 0265		72 0505 0355	
72 0505 0266		72 0505 0356	
72 0505 0267	0270	72 0505 0357	0360
72 0505 0270		72 0505 0360	
72 0505 0271		72 0505 0361	
72 0505 0272		72 0505 0362	
72 0505 0273		72 0505 0363	
72 0505 0274		72 0505 0364	
72 0505 0275		72 0505 0365	
72 0505 0276		72 0505 0366	
72 0505 0277	0300	72 0505 0367	0370
72 0505 0300		72 0505 0370	
72 0505 0301		72 0505 0371	
72 0505 0302		72 0505 0372	
72 0505 0303		72 0505 0373	
72 0505 0304		72 0505 0374	
72 0505 0305		00 0211 0000	
72 0505 0306		00 0000 0010	
72 0505 0307	0310		
72 0505 0310			
72 0505 0311			
72 0505 0312			
72 0505 0313			
72 0505 0314			
72 0505 0315			
72 0505 0316			
72 0505 0317	0320		
72 0505 0320			
72 0505 0321			
72 0505 0322			
72 0505 0323			
72 0505 0324			
72 0505 0325			
72 0505 0326			
72 0505 0327	0330		
72 0505 0330			
72 0505 0331			
72 0505 0332			
72 0505 0333			
72 0505 0334			
72 0505 0335			
72 0505 0336			

OVERLAY 17

		00 0000 0053	0070		40 1400 0100	0160
		00 0000 0037			70 0000 0400	
		00 0000 0077			00 0000 0000	
70 0000 0646		20 0012 0001			00 0000 0000	
70 0000 0472		00 0211 0700			00 0000 0000	
70 0000 0660		00 0001 0400			00 0000 0000	
70 0000 0667		70 0000 0404			00 0000 0000	
70 0000 0501		00 0000 0070			00 0000 0000	
70 0000 0523		00 0000 0000	0100		00 0000 0007	0170
70 0000 0000	0010	42 1410 0017			00 0000 0000	
70 0000 0263		31 0060 1000			00 0000 0000	
70 0000 0000		42 1000 1211			00 0000 0000	
70 0000 0263		41 1000 0777			00 0000 0036	
70 0000 0326		70 0000 0400			33 0000 0000	
70 0000 0000		42 1410 0017			00 0000 0500	
70 0000 0000		31 0060 1000			70 0000 0560	
70 0000 0400		42 1000 1271	0110		06 0061 0170	0200
70 0000 0331	0020	40 1000 0777			72 0122 0113	
70 0000 0000		70 0000 0400			31 0067 0173	
70 0000 0000		72 0657 0652			31 0001 0001	
70 0000 0000		73 0000 0123			06 0061 0173	
70 0000 0000		34 0000 1001			36 0072 0206	
70 0000 0000		36 0571 0120			03 0263 1000	
70 0000 0000		42 1420 0007			36 0417 0210	
70 0000 0000	0030	42 1000 0202	0120		03 0175 0000	0210
70 0000 0000		41 1001 0376			73 0060 0230	
70 0000 0273		70 0000 0400			73 0176 0214	
70 0000 0306		07 0000 0676			70 0000 0230	
70 0000 0000		70 0000 0115			34 0000 0172	
70 0000 0000		07 0000 1377			07 0061 0210	
70 0000 0000		72 0657 0652			36 0417 0217	
70 0000 0345		73 0000 0136			03 0177 0000	
70 0000 0000	0040	34 0000 1001	0130		73 0000 0222	0220
70 0000 0000		36 0571 0133			70 0000 0230	
70 0000 0000		42 1420 0007			07 0000 0172	
70 0000 0000		42 1000 0222			72 0151 0142	
70 0000 0000		40 1001 0376			06 0061 0171	
70 0000 0000		70 0000 0400			34 0000 1477	
70 0000 0605		07 0000 0676			70 0000 0361	
70 0000 0000		70 0000 0130			70 0000 0264	
33 0000 0000	0050	00 0000 0000	0140		03 0174 0173	0230
70 0000 0560		00 0000 0000			73 0060 0204	
70 0000 0334		72 0613 0610			72 0135 0325	
70 0000 0424		05 0556 0000			03 0352 0170	
70 0000 0151		36 0555 0147			73 0060 0200	
70 0000 0000		31 0060 1400			31 0001 0001	
70 0000 0000		42 1420 0010			03 0061 0176	
70 0000 0000		42 1002 0000			72 0151 0142	
00 0000 0000	0060	41 1400 0100	0150		71 1477 0242	0240
00 0000 0001		70 0000 0400			70 0000 0244	
00 0000 0002		07 0000 1477			72 0161 0152	
00 0000 0003		72 0613 0610			70 0000 0240	
00 0000 0004		05 0556 0000			42 1410 0017	
00 0000 0005		36 0555 0157			42 1000 1271	
00 0000 0006		42 1420 0010			42 1006 1411	
00 0000 0007		42 1006 0000			70 0000 0353	

OVERLAY 17

70 0000 0353 0250
 73 0060 0254
 72 0161 0152
 70 0000 0247
 72 0161 0152
 70 0000 0320
 72 0402 0404
 70 0000 0102
 00 0000 0000 0260
 03 0260 1010
 03 0260 1036
 00 0000 1000
 31 0257 0260
 31 0261 0266
 03 0260 1001
 73 0000 0312
 06 0061 0266 0270
 73 0262 0266
 03 0263 0260
 36 0417 0275
 72 0344 0336
 34 0000 0000
 07 0000 0206
 36 0417 0301
 07 0000 0260 0300
 34 0000 0000
 03 0256 1473
 73 0000 0310
 06 0061 0172
 72 0227 0223
 70 0000 0302
 70 0000 0264
 31 0307 0227 0310
 70 0000 0230
 02 0062 0260
 70 0000 0265
 72 0505 0375
 00 0000 0000
 72 0505 0200
 34 0000 1375
 33 0000 0000 0320
 72 0122 0113
 31 0171 1200
 72 0135 0125
 70 0000 0400
 31 0314 0315
 31 0317 0332
 06 0061 0315
 73 0316 0332 0330
 70 0000 0334
 34 0000 0000
 71 0332 0327
 31 0177 1200
 70 0000 0125
 05 0061 0000
 36 0417 0340

31 0177 0000 0340
 70 0000 0343
 70 0000 0312
 07 0175 0171
 70 0000 0275
 42 1410 0017
 42 1000 1231
 42 1000 1231
 42 1000 1231 0350
 70 0000 0200
 00 0000 0015
 31 0063 0370
 72 0105 0101
 70 1034 0250
 71 0370 0250
 42 1000 1411
 70 0000 0103 0360
 31 0063 0370
 72 0112 0106
 70 1022 0363
 70 0205 0227
 71 0370 0227
 42 1000 1411
 70 0000 0110
 72 0505 0367 0370
 72 0505 0370
 72 0505 0371
 72 0505 0372
 72 0505 0373
 72 0505 0374
 00 0211 0700
 00 0000 0017

OVERLAY 20

		00 0000 0053 0070	72 0505 0157 0160
		00 0000 0037	72 0505 0160
		00 0000 0077	72 0505 0161
70 0000 0646		20 0012 0001	72 0505 0162
70 0000 0472		00 0231 0700	72 0505 0163
70 0000 0660		00 0001 0400	72 0505 0164
70 0000 0667		70 0000 0404	72 0505 0165
70 0000 0501		00 0000 0070	72 0505 0166
70 0000 0523		00 0000 0000 0100	72 0505 0167 0170
70 0000 0136 0010		70 0000 0560	72 0505 0170
70 0000 0000		31 0433 0464	72 0505 0171
70 0000 0135		07 0000 1775	72 0505 0172
70 0000 0000		31 1774 1775	72 0505 0173
70 0000 0163		34 0000 1774	72 0505 0174
70 0000 0102		07 0000 1402	72 0505 0175
70 0000 0116		31 1401 1402	72 0505 0176
70 0000 0400		34 0000 1401 0110	72 0505 0177 0200
70 0000 0125 0020		06 0062 0106	72 0505 0200
70 0000 0137		06 0434 0107	72 0505 0201
70 0000 0141		06 0062 0110	72 0505 0202
70 0000 0131		71 0464 0106	72 0505 0203
70 0000 0130		70 0000 0400	72 0505 0204
70 0000 0132		31 0433 0464	72 0505 0205
70 0000 0143		31 1375 1774	72 0505 0206
70 0000 0145		31 1002 1401 0120	72 0505 0207 0210
70 0000 0147 0030		06 0434 0120	72 0505 0210
70 0000 0151		71 0464 0120	72 0505 0211
70 0000 0153		70 0000 0400	72 0505 0212
70 0000 0155		70 0000 0560	72 0505 0213
70 0000 0000		33 0000 0010	72 0505 0214
70 0000 0000		72 0657 0652	72 0505 0215
70 0000 0157		70 0000 0661	72 0505 0216
70 0000 0161		71 1775 0400 0130	72 0505 0217 0220
70 0000 0000 0040		70 0000 0605	
70 0000 0000		07 0000 1402	
70 0000 0000		73 0060 0605	
70 0000 0000		70 0000 0400	
70 0000 0000		70 0000 0560	
70 0000 0000		33 0000 0004	
70 0000 0000		70 0000 0560	
70 0000 0000 0050		72 0505 0137 0140	72 0505 0367 0370
70 0000 0000		72 0505 0140	72 0505 0370
70 0000 0000		72 0505 0141	72 0505 0371
70 0000 0424		72 0505 0142	72 0505 0372
70 0000 0000		72 0505 0143	72 0505 0373
70 0000 0000		72 0505 0144	72 0505 0374
70 0000 0000		72 0505 0145	00 0221 0000
70 0000 0000		72 0505 0146	00 0000 0020
00 0000 0000 0060		72 0505 0147 0150	
00 0000 0001		72 0505 0150	
00 0000 0002		72 0505 0151	
00 0000 0003		72 0505 0152	
00 0000 0004		72 0505 0153	
00 0000 0005		72 0505 0154	
00 0000 0006		72 0505 0155	
00 0000 0007		72 0505 0156	

OVERLAY 21

		00 0000 0053 0070	31 0433 0464 0160
		00 0000 0037	31 0062 0115
		00 0000 0077	31 0121 0165
70 0000 0646		20 0012 0001	31 0122 0170
70 0000 0472		00 0221 0100	26 1402 1401
70 0000 0660		00 0001 0400	25 0102 0000
70 0000 0667		70 0000 0404	05 1002 1002
70 0000 0501		00 0000 0070	26 1402 1401
70 0000 0523		00 0000 0000 0100	25 0103 0000 0170
70 0000 0000 0010		00 0000 0000	05 1001 1001
70 0000 0000		37 1777 1777	06 0124 0165
70 0000 0000		60 0000 0000	06 0124 0170
70 0000 0000		45 0525 0525	71 0115 0164
70 0000 0000		01 0525 0525	06 0434 0164
70 0000 0000		00 0421 0104	06 0434 0166
70 0000 0400		40 0055 1013	06 0434 0167
70 0000 0000 0020		00 0006 1001 0110	06 0434 0171 0200
70 0000 0000		00 0312 0312	71 0464 0161
70 0000 0000		00 0000 0000	31 0433 0464
70 0000 0000		31 0060 1002	31 1001 1401
70 0000 0000		31 0102 1001	31 1002 1402
70 0000 0000		00 0000 0000	06 0434 0203
70 0000 0000		31 0102 1401	06 0434 0204
70 0000 0000		05 1001 1001	71 0464 0203
70 0000 0000 0030		05 1002 1002 0120	70 0000 0217 0210
70 0000 0000		25 0102 0000	00 0000 0000
70 0000 0000		25 0103 0000	00 0000 0000
70 0000 0000		00 0000 0312	00 0000 0000
70 0000 0000		00 0002 0000	00 0000 0000
70 0000 0000		00 0000 0000	00 0000 0000
70 0000 0000		00 0000 0000	00 0000 0000
70 0000 0310		00 0000 0000	00 0000 0000
70 0000 0143		00 0000 0000	31 0433 0464
70 0000 0000 0040		31 0433 0464 0130	27 1401 1402 0220
70 0000 0000		07 0000 1402	30 0041 1002
70 0000 0000		30 0002 1402	27 1402 1402
70 0000 0000		06 0062 0131	34 0000 1001
70 0000 0000		06 0062 0132	27 1401 1401
70 0000 0000		71 0464 0131	01 1001 1001
70 0000 0605		70 0000 0136	06 0434 0220
70 0000 0000		00 0000 0000	06 0062 0221
33 0000 0000 0050		00 0000 0000 0140	06 0434 0222 0230
70 0000 0560		00 0000 0000	06 0062 0223
70 0000 0372		00 0000 0000	06 0434 0224
70 0000 0424		72 0143 0257	06 0434 0225
70 0000 0000		70 0000 0400	71 0464 0220
70 0000 0000		07 1775 0061	02 0111 0220
70 0000 0000		34 0000 0112	02 0111 0222
70 0000 0000		72 0136 0130	02 0111 0224
00 0000 0000 0060		31 0113 0131 0150	02 0111 0225 0240
00 0000 0001		31 0114 0132	02 0123 0223
00 0000 0002		72 0136 0130	02 0123 0221
00 0000 0003		31 0116 0131	02 0111 0203
00 0000 0004		31 0145 0132	02 0111 0204
00 0000 0005		31 0001 0001	72 0210 0202
00 0000 0006		72 0136 0130	71 0112 0217
00 0000 0007		31 0001 0001	02 1775 1775

OVERLAY 21

70 0000 0400	0250	06 0062 0335	0340
00 0000 0000		06 0062 0337	
72 0505 0251		71 0464 0335	
72 0505 0252		31 1775 0112	
72 0505 0253		70 0000 0373	
72 0505 0254		31 0433 0464	
72 0505 0255		31 0303 0347	
31 0433 0464		26 1402 1402	
07 0000 1775	0260	06 0434 0347	0350
73 0060 0263		71 0464 0347	
70 0000 0276		06 1775 1775	
11 0000 0000		71 0112 0371	
73 0277 0266		70 0000 0400	
07 0000 0277		00 0000 0000	
30 0052 0000		07 0000 1402	
05 0300 0271		30 0041 1402	
07 0000 1402	0270	31 0433 0464	0360
30 0000 1402		07 0000 1402	
06 0062 0270		70 0071 0345	
06 0062 0271		06 0062 0361	
71 0464 0270		71 0464 0361	
31 0060 1775		02 0061 1775	
70 0000 0145		31 0356 0131	
00 0000 0031		31 0357 0132	
30 0000 1402	0300	72 0136 0130	0370
00 0000 0000		31 0356 0361	
77 1777 1777		70 0000 0360	
26 1402 1402		31 0061 1775	
00 0001 0000		70 0000 0360	
00 0000 0000		70 0000 0400	
00 0000 0000		00 0221 0100	
00 0000 0000		00 0000 0021	
72 0276 0143	0310		
26 0302 0103			
26 0302 0104			
26 0302 0107			
02 0304 0132			
72 0136 0130			
31 0113 0131			
31 0114 0132			
72 0136 0130	0320		
31 0433 0464			
31 0121 0325			
31 0066 0115			
26 1402 1001			
25 0102 0000			
05 1002 1002			
06 0304 0325			
71 0115 0324	0330		
06 0434 0324			
06 0434 0326			
71 0464 0322			
31 0433 0464			
07 0000 1002			
30 0001 0000			
05 0103 1402			

OVERLAY 22

00 0000 0000		00 0000 0053	0070	06 0061 0113	0160
70 0000 0472		00 0000 0037		02 0112 0110	
70 0000 0660		00 0000 0077		73 0112 0160	
70 0000 0667		20 0012 0001		30 0052 0110	
00 0000 0000		00 0221 0200		70 0000 0360	
31 0032 0007		00 0001 0400		31 0117 0114	
07 0000 0063	0010	70 0000 0404		06 0110 0114	
75 0000 0011		00 0000 0070		27 0110 0110	
07 0000 0062		00 0000 0000	0100	30 0041 0140	0170
75 0000 0013		00 0000 0000		05 0114 0114	
31 0043 0464		07 0000 1050		27 0141 0140	
31 1400 0045		00 0000 3025		25 0110 0140	
07 0000 0045		00 0000 0002		30 0042 0140	
30 0023 0000		00 0000 0013		05 0114 0114	
72 0053 0050	0020	00 0000 0014		26 0110 0140	
07 0000 0045		00 0000 0012		05 0114 0114	
30 0015 0000		00 0000 0000	0110	27 0140 0110	0200
72 0053 0050		05 1056 0441		25 0142 0000	
07 0000 0045		40 0022 0656		30 0042 0000	
30 0006 0000		00 0000 0000		05 0114 0114	
72 0053 0050		00 0000 0000		30 0042 0114	
06 0042 0015		00 0000 0067		70 0000 0367	
71 0464 0015	0030	00 0000 0070		31 0001 0001	
71 0044 0010		07 1777 1777		70 0000 0000	
70 0000 0400		31 0104 1050	0120	31 0117 1001	0210
00 0000 0000		31 0104 1036		31 0060 1377	
00 0000 0000		31 0104 1024		02 0061 0211	
00 0000 0000		31 0107 1046		71 1001 0211	
00 0000 0000		31 0107 1034		31 1775 0110	
70 0000 0007		31 0102 0127		72 0207 0144	
07 0000 0063		31 0103 0464		07 0000 0113	
75 0000 0040	0040	07 0000 1050		70 0032 0235	
70 0000 0251		75 0000 0130	0130	31 0106 1046	0220
00 0001 0000		02 0061 0127		70 0000 0236	
00 0000 0013		71 0464 0127		00 0000 0000	
00 0000 0011		70 0000 0000		31 0060 0143	
00 0000 0000		00 0000 0000		06 0061 0143	
00 0000 0077		00 0000 0000		02 0136 0140	
00 0000 0000		00 0000 0000		73 0000 0232	
37 0046 0060	0050	00 0000 0020		70 0032 0224	
73 0000 0054		00 0000 0000	0140	06 0136 0140	0230
75 0000 0052		12 1252 1252		03 0061 0143	
70 0000 0424		06 0631 1146		70 0000 0000	
33 0000 0016		00 0000 0000		00 0000 0000	
70 0000 0052		31 0060 0113		00 0000 0000	
00 0000 0000		31 0060 0114		31 0105 1046	
70 0000 0661		07 0110 0111		11 0060 0140	
00 0000 0000	0060	30 1257 0110		31 0433 0136	
00 0000 0001		73 0000 0164	0150	72 0232 0223	0240
00 0000 0002		70 0072 0162		05 0137 1045	
00 0000 0003		06 0061 0113		31 0107 0136	
00 0000 0004		06 0112 0110		72 0232 0223	
00 0000 0005		70 0032 0152		05 0137 1044	
00 0000 0006		30 0052 0110		07 0137 0140	
00 0000 0007		31 0001 0001		34 0000 1043	
		70 0000 0164		70 0000 0000	

OVERLAY 22

00 0000 0000 0250	31 0001 0001 0340
72 0247 0210	70 0000 0000
31 0116 1035	00 0000 0000
31 1046 1034	00 0000 0000
31 1045 1033	07 0000 0143
31 1044 1032	70 0000 0333
31 1043 1031	00 0000 0000
31 1774 0110	70 0000 0056
31 0114 0135 0260	31 0104 1050 0350
31 0001 0001	31 0104 1042
72 0247 0215	31 0104 1027
31 0115 1047	31 0063 1026
72 0133 0350	70 0000 0125
31 0001 0001	27 0320 0321
31 0414 0251	05 0061 0321
31 0001 0001	70 0000 0335
31 0001 0001 0270	31 0060 0347 0360
31 0433 0342	13 0000 0110
27 0114 1401	73 0111 0165
31 0105 1047	07 0110 0000
70 0032 0276	30 1201 0110
31 0106 1047	06 0061 0347
11 0000 0140	70 0000 0361
06 0062 0272	71 0347 0371
31 0316 0333 0300	70 0000 0206 0370
72 0341 0322	13 0000 0114
27 0135 1402	25 0114 0114
31 0105 1035	70 0000 0367
70 0032 0306	72 0505 0373
31 0106 1035	72 0505 0374
11 0000 0140	00 0221 0200
31 0317 0333	00 0000 0022
72 0341 0322 0310	
06 0062 0302	
72 0133 0120	
71 0342 0272	
70 0000 0400	
00 0000 0000	
05 0137 0145	
05 0137 1033	
03 0314 1464 0320	
00 0000 0000	
31 0065 0315	
31 0320 0321	
31 0060 0143	
06 0061 0143	
02 0321 0140	
70 0032 0325	
72 0000 0344 0330	
06 0321 0140	
02 0061 0143	
05 0137 0000	
70 0000 0355	
02 0061 0333	
71 0315 0324	
31 0001 0001	

OVERLAY 23

		00 0000 0053	0070	07 0000 0104	0160
		00 0000 0037		30 0000 0104	
70 0000 0646		00 0000 0077		70 0000 0152	
70 0000 0472		20 0012 0001		13 0105 0106	
70 0000 0660		00 0231 0700		73 0060 0170	
70 0000 0667		00 0001 0400		13 0000 0105	
70 0000 0501		70 0000 0404		30 0052 0000	
70 0000 0523		00 0000 0070		70 0000 0000	
70 0000 0205	0010	00 0000 0000	0100	13 0000 0106	0170
70 0000 0217		70 0000 0560		70 0000 0166	
70 0000 0224		27 1402 1002		31 0001 0001	
70 0000 0000		00 0000 0000		70 0000 0400	
70 0000 0000		00 0000 0000		42 1000 1211	
70 0000 0000		00 0000 0000		41 1000 0377	
70 0000 0200		00 0000 0031		70 0000 0120	
70 0000 0400		30 0000 1401		00 0000 0000	
70 0000 0212	0020	30 0000 0104	0110	31 0060 1001	0200
70 0000 0227		07 0000 1401		31 0203 0175	
70 0000 0000		00 0000 0000		70 0000 0113	
70 0000 0000		31 0433 0464		41 1001 0376	
70 0000 0000		42 1410 0016		00 0000 0000	
70 0000 0000		31 0060 1000		31 0433 0464	
70 0000 0000		31 0114 1774		31 0114 1774	
70 0000 0000		70 0000 0174		31 0001 0001	
70 0000 0000	0030	31 0433 0103	0120	72 0117 0120	0210
70 0000 0000		31 0102 0123		31 0433 0204	
70 0000 0000		31 0060 0104		31 1004 1002	
70 0000 0000		27 1402 1002		06 0434 0212	
70 0000 0224		30 0007 0000		71 0204 0212	
70 0000 0205		05 0104 0104		02 0223 0212	
70 0000 0200		06 0434 0123		31 1001 1312	
70 0000 0113		71 0103 0123		06 0222 0216	
70 0000 0000	0040	07 0000 0104	0130	72 0155 0120	0220
70 0000 0000		30 0077 0104		70 0000 0400	
70 0000 0000		05 1774 0000		00 0002 0000	
70 0000 0000		01 1775 0000		00 0312 0312	
70 0000 0000		01 1375 0000		31 0224 1713	
70 0000 0000		01 0067 0105		31 1712 1401	
70 0000 0605		70 0032 0156		02 0232 0225	
70 0000 0000		72 0167 0163		06 0233 0225	
33 0000 0000	0050	05 0107 0145	0140	71 1713 0225	0230
70 0000 0560		03 0464 0433		70 0000 0234	
70 0000 0372		34 0000 0103		00 0002 0000	
70 0000 0424		31 0111 0144		00 0000 0002	
70 0000 0000		07 0000 1401		07 0000 1775	
70 0000 0000		30 0000 1401		34 0000 0000	
70 0000 0000		06 0062 0144		07 0000 1774	
70 0000 0000		06 0062 0145		34 1774 1775	
00 0000 0000	0060	71 0103 0144	0150	70 0000 0400	0240
00 0000 0001		02 0105 1774		72 0505 0240	
00 0000 0002		31 0104 1401		72 0505 0241	
00 0000 0003		06 0062 0152		72 0505 0242	
00 0000 0004		71 0464 0117			
00 0000 0005		70 0000 0172		70 0000 0400	
00 0000 0006		72 0167 0163		00 0221 0300	
00 0000 0007		05 0110 0161		00 0000 0023	
				27 1002 1700	0400

OVERLAY 24

70 0000 0646	00 0000 0053 0070	34 0000 0161 0160
70 0000 0472	00 0000 0037	00 0000 0000
70 0000 0660	00 0000 0077	34 0000 0000
70 0000 0667	20 0012 0001	06 0062 0162
70 0000 0501	00 0221 0000	06 0062 0161
70 0000 0523	00 0001 0400	01 0062 0000
70 0000 0110 0010	70 0000 0404	73 0133 0161
70 0000 0127	00 0000 0070	31 0171 0133
72 0012 0240	00 0000 0000 0100	70 0000 0123 0170
70 0000 0400	00 0000 0000	07 0000 1002
31 0032 0020	03 1401 0370	00 0000 0400
31 0034 0464	00 0000 1000	37 1777 1777
31 0035 0017	04 0000 0000	00 0002 0000
07 0000 1001	05 0104 1002	00 0000 0000
30 0000 1001 0020	02 0000 0400	00 0000 0060
06 0061 0017	31 0060 1377	31 1002 0175
06 0061 0020	31 0110 1001 0110	31 1002 0175 0200
71 0464 0017	31 0060 1377	07 0000 0175
70 0000 0265	71 0111 0113	73 0000 0207
00 0000 0000	71 0101 0111	31 0000 0000
31 0033 0020	31 0107 0111	02 0434 0203
72 0024 0015	31 0105 1375	06 0174 0202
70 0000 0400 0030	31 0106 1001	70 0000 0201
00 0000 0000	72 0055 0400	07 0000 0203
30 0001 1001	31 1375 0121 0120	36 0417 0211 0210
30 0041 1001	00 0000 0000	31 0175 0000
00 0000 0720	06 0062 1375	31 0001 0001
07 0000 1001	42 1434 0011	31 0001 0001
70 0000 0000	42 1000 0223	07 0000 0200
70 0000 0000	40 1001 0140	36 0415 0202
70 0000 0000 0040	70 0000 0116	36 0415 0203
70 0000 0000	31 0132 1151	05 0174 0000
70 0000 0000	72 0055 0400 0130	36 0415 0200 0220
70 0000 0000	30 1012 0000	30 0012 0000
70 0000 0000	34 1146 1145	36 0417 0203
70 0000 0000	07 0000 1002	71 0464 0200
70 0000 0000	70 0027 0155	70 0000 0231
70 0000 0000	01 0104 0000	31 0173 1000
70 0000 0000	30 1012 0000	31 0177 0200
70 0000 0000	34 1150 1147	31 0176 0464
70 0000 0000 0050	01 1145 1147 0140	70 0000 0212 0230
70 0000 0000	25 1147 0000	31 0060 1000
70 0000 0000	34 1147 0000	70 0000 0232
70 0000 0424	02 1146 1150	21 0103 1001
70 0000 0000	25 1150 0000	07 0000 1000
70 0000 0000	30 0005 0000	73 1401 0347
70 0000 0000	05 1147 0000	00 0001 0000
70 0000 0000	73 1151 0152	07 0000 1061
00 0000 0000 0060	06 0062 0133 0150	72 0232 0225 0240
00 0000 0001	70 0000 0133	31 0176 0464
00 0000 0002	34 0000 1151	31 1002 0175
00 0000 0003	31 0133 1152	07 0000 0175
00 0000 0004	70 0000 0150	37 0417 0060
00 0000 0005	07 0000 1152	01 0103 0000
00 0000 0006	36 0417 0162	21 0103 1002
00 0000 0007	07 0062 1152	07 0000 0175

OVERLAY 24

37 0415 0060	0250	31 0001 0001	0340
30 0012 0000		02 0365 0000	
01 0103 0000		07 0352 0334	
21 0103 1001		73 0364 0356	
• 06 0174 0242		02 0062 0300	
06 0062 0246		73 0234 0026	
06 0062 0253		70 0000 0273	
71 0464 0242		01 0172 0000	
• 07 0000 0233	0260	73 0000 0344	0350
34 0000 0253		70 0000 0304	
05 0061 0246		00 0003 0000	
31 0177 0242		30 0012 0000	
70 0000 0014		21 0366 0366	
31 0433 0464		70 0000 0325	
31 1401 0370		06 0174 0334	
31 1402 0371		70 0000 0331	
31 1402 0374	0270	72 0505 0357	0360
31 0102 0364		72 0505 0360	
31 0237 0300		72 0505 0361	
31 0370 0372		72 0505 0362	
31 0371 0373		72 0505 0363	
31 0374 0375		72 0505 0364	
31 0364 0363		72 0505 0365	
31 0235 0301		72 0505 0366	
00 0000 0000	0300	72 0505 0367	0370
• 73 1401 0347		72 0505 0370	
02 0174 0301		72 0505 0371	
70 0000 0300		72 0505 0372	
07 0000 0301		72 0505 0373	
• 31 0001 0001		72 0505 0374	
36 0415 0310		00 0221 0400	
05 0432 0311		00 0000 0024	
31 0000 0370	0310		
00 0000 0000			
07 0061 0300			
34 0000 0314			
00 0000 0000			
34 0000 0374			
03 0374 0371			
34 0000 0367			
03 0372 0370	0320		
34 0000 0366			
03 0375 0373			
01 0367 0000			
70 0000 0353			
07 0000 0301			
• 37 0415 0363			
34 0000 0364			
31 0363 0334	0330		
• 07 0236 0334			
30 0012 0000			
36 0417 0341			
00 0000 0000			
25 0366 0000			
30 0052 0000			
05 0367 0365			

OVERLAY 25

70 0000 0646	00 0000 0053 0070	07 0000 0104 0160
70 0000 0472	00 0000 0037	30 0000 0104
70 0000 0660	00 0000 0077	70 0000 0152
70 0000 0667	20 0012 0001	13 0105 0106
70 0000 0501	00 0231 0700	73 0060 0170
70 0000 0523	00 0001 0400	13 0000 0105
70 0000 0205 0010	70 0000 0404	30 0052 0000
70 0000 0217	00 0000 0070	70 0000 0000
70 0000 0224	00 0000 0000 0100	13 0000 0106 0170
70 0000 0000	70 0000 0560	70 0000 0166
70 0000 0000	27 1402 1002	31 0001 0001
70 0000 0000	00 0000 0000	70 0000 0400
70 0000 0000	00 0000 0000	42 1000 1211
70 0000 0200	00 0000 0000	41 1000 0377
70 0000 0400	00 0000 0031	70 0000 0120
70 0000 0212 0020	30 0000 1401	00 0000 0000
70 0000 0227	30 0000 0104 0110	31 0060 1400 0200
70 0000 0000	07 0000 1401	42 1410 0016
70 0000 0000	00 0000 0000	42 1000 1271
70 0000 0000	31 0433 0464	40 1400 0376
70 0000 0000	42 1410 0016	70 0000 0400
70 0000 0000	31 0060 1000	31 0060 1400
70 0000 0000	31 0114 1774	42 1410 0016
70 0000 0000	70 0000 0174	42 1000 1211
70 0000 0000 0030	31 0433 0103 0120	41 1400 0376 0210
70 0000 0000	31 0102 0123	70 0000 0400
70 0000 0000	31 0060 0104	31 0060 1000
70 0000 0000	27 1402 1002	42 1410 0016
70 0000 0000	30 0007 0000	42 1000 1271
70 0000 0000	05 0104 0104	40 1000 0377
70 0000 0000	06 0434 0123	70 0000 0400
70 0000 0113	71 0103 0123	31 0060 1000
70 0000 0000 0040	07 0000 0104 0130	42 1410 0016 0220
70 0000 0000	30 0077 0104	42 1000 1211
70 0000 0000	05 1774 0000	41 1000 0377
70 0000 0000	01 1775 0000	70 0000 0400
70 0000 0000	01 1375 0000	42 1410 0016
70 0000 0000	01 0067 0105	42 1002 1211
70 0000 0605	70 0032 0156	70 0000 0400
70 0000 0000	72 0167 0163	42 1410 0616
33 0000 0000 0050	05 0107 0145 0140	42 1002 1411 0230
70 0000 0560	03 0464 0433	70 0000 0400
70 0000 0372	34 0000 0103	70 0000 0560
70 0000 0424	31 0111 0144	72 0505 0232
70 0000 0000	07 0000 1401	72 0505 0233
70 0000 0000	30 0000 1401	72 0505 0234
70 0000 0000	06 0062 0144	
70 0000 0000	06 0062 0145	
00 0000 0000 0060	71 0103 0144 0150	72 0505 0367 0370
00 0000 0001	02 0105 1774	72 0505 0370
00 0000 0002	31 0104 1401	72 0607 0605
00 0000 0003	06 0062 0152	31 0414 0607
00 0000 0004	71 0464 0117	06 0062 0520
00 0000 0005	70 0000 0172	70 0000 0400
00 0000 0006	72 0167 0163	00 0221 0500
00 0000 0007	05 0110 0161	00 0000 0025

OVERLAY 30

70 0000 0646		00 0000 0053 0070	72 0505 0157 0160
70 0000 0472		00 0000 0037	72 0505 0160
70 0000 0660		00 0000 0077	72 0505 0161
70 0000 0667		20 0012 0001	72 0505 0162
70 0000 0501		00 0231 0700	72 0505 0163
70 0000 0523		00 0001 0400	72 0505 0164
70 0000 0136 0010		70 0000 0404	72 0505 0165
70 0000 0000		00 0000 0070	72 0505 0166
70 0000 0135		00 0000 0000 0100	72 0505 0167 0170
70 0000 0000		70 0000 0560	72 0505 0170
70 0000 0163		31 0433 0464	72 0505 0171
70 0000 0102		07 0000 1775	72 0505 0172
70 0000 0116		31 1774 1775	72 0505 0173
70 0000 0400		34 0000 1774	72 0505 0174
70 0000 0125 0020		07 0000 1402	72 0505 0175
70 0000 0137		31 1401 1402	72 0505 0176
70 0000 0141		34 0000 1401 0110	37 1777 1777 0200
70 0000 0131		06 0062 0106	30 0077 0231
70 0000 0130		06 0434 0107	34 0000 0232
70 0000 0132		06 0062 0110	27 0231 0243
70 0000 0143		71 0464 0106	05 0243 0233
70 0000 0145		70 0000 0400	03 0233 0200
70 0000 0147 0030		31 0433 0464	21 0233 0244
70 0000 0151		31 1375 1774	25 0244 0245
70 0000 0153		31 1002 1401 0120	25 0234 0000 0210
70 0000 0155		06 0434 0120	05 0235 0000
70 0000 0000		71 0464 0120	25 0245 0000
70 0000 0000		70 0000 0400	05 0236 0000
70 0000 0157		70 0000 0560	25 0245 0000
70 0000 0301		33 0000 0010	05 0237 0000
70 0000 0000 0040		72 0657 0652	25 0245 0000
70 0000 0000		70 0000 0661	05 0240 0000
70 0000 0000		71 1775 0400 0130	25 0245 0000 0220
70 0000 0000		70 0000 0605	05 0241 0000
70 0000 0000		07 0000 1402	25 0245 0000
70 0000 0000		73 0060 0605	05 0242 0000
70 0000 0000		70 0000 0400	25 0245 0000
70 0000 0000		70 0000 0560	25 0244 0000
70 0000 0000		33 0000 0004	05 0244 0233
70 0000 0000		70 0000 0560	70 0000 0000
70 0000 0000 0050		72 0505 0137 0140	00 0000 0000 0230
70 0000 0000		72 0505 0140	00 0000 0000
70 0000 0000		72 0505 0141	00 0000 0000
70 0000 0424		72 0505 0142	02 0210 1042
70 0000 0000		72 0505 0143	02 0210 1042
70 0000 0000		72 0505 0144	02 0730 1166
70 0000 0000		72 0505 0145	02 1642 1643
70 0000 0000		72 0505 0146	03 1070 1616
00 0000 0000 0060		72 0505 0147 0150	04 1111 0222 0240
00 0000 0001		72 0505 0150	06 0631 1146
00 0000 0002		72 0505 0151	12 1252 1253
00 0000 0003		72 0505 0152	20 0000 0000
00 0000 0004		72 0505 0153	00 0000 0000
00 0000 0005		72 0505 0154	00 0000 0000
00 0000 0006		72 0505 0155	77 1777 1777
00 0000 0007		72 0505 0156	26 0271 0060

OVERLAY 30

31 0001 0001	0250	72 0505 0337	0340
06 0062 0252		72 0505 0340	
07 0000 1400		72 0505 0341	
72 0227 0201		72 0505 0342	
03 0232 1775		72 0505 0343	
25 0247 1375		72 0505 0344	
30 1077 1375		72 0505 0345	
70 0000 0321		72 0505 0346	
30 0052 0000	0260	72 0505 0347	0350
36 0415 0265		72 0505 0350	
07 0000 1375		72 0505 0351	
30 0001 1375		72 0505 0352	
03 0233 0060		72 0505 0353	
30 0000 0000		72 0505 0354	
05 1375 1402		72 0505 0355	
02 0061 1374		72 0505 0356	
13 0000 1374	0270	72 0505 0357	0360
34 0000 1002		72 0505 0360	
73 0246 0274		72 0505 0361	
34 0000 0246		72 0505 0362	
06 0062 0271		72 0505 0363	
06 0062 0266		72 0505 0364	
71 0464 0251		72 0505 0365	
31 0246 1775		72 0505 0366	
70 0000 0300	0300	72 0505 0367	0370
31 0433 0464		72 0505 0370	
72 0300 0250		72 0505 0371	
31 0433 0464		72 0505 0372	
03 1002 1775		72 0505 0373	
30 0052 0000		72 0505 0374	
36 0415 0310		00 0231 0000	
07 0000 1402		00 0000 0030	
30 0000 1402	0310		
06 0062 0307			
06 0062 0310			
06 0320 0304			
71 0464 0304			
72 0302 0400			
70 0000 0400			
00 0000 0031			
00 0002 0000	0320		
73 0317 0323			
07 0000 0317			
01 0317 1374			
70 0000 0260			
72 0505 0324			
72 0505 0325			
72 0505 0326			
72 0505 0327	0330		
72 0505 0330			
72 0505 0331			
72 0505 0332			
72 0505 0333			
72 0505 0334			
72 0505 0335			
72 0505 0336			

OVERLAY 34

70 0000 0646		00 0000 0053	0070	30 1412 0000	0160
70 0000 0472		00 0000 0037		33 0000 0000	
70 0000 0660		00 0000 0077		30 1441 0000	
70 0000 0667		20 0012 0001		30 0446 0000	
70 0000 0102		00 0231 0400		05 0213 0227	
70 0000 0110		00 0001 0400		33 0000 0000	
70 0000 0232	0010	70 0000 0404		30 1443 0000	
70 0000 0400		00 0000 0070		30 0443 0000	
70 0000 0400		00 0000 0000	0100	30 1443 0000	0170
70 0000 0400		70 0000 0560		30 0444 0000	
70 0000 0400		31 0216 0225		30 1443 0000	
70 0000 0400		31 0217 0226		30 0446 0000	
70 0000 0400		31 0063 0231		05 0214 0230	
70 0000 0400		72 0255 0242		71 0231 0202	
70 0000 0400		72 0205 0132		31 0227 0225	
70 0000 0400		70 0000 0245		31 0230 0226	
70 0000 0400	0020	31 0215 0225	0110	31 0061 0231	0200
70 0000 0400		31 0060 0226		70 0000 0161	
70 0000 0400		31 0063 0231		42 1002 0023	
70 0000 0400		70 0000 0126		40 0222 0006	
70 0000 0400		72 0205 0132		71 0231 0134	
70 0000 0400		70 0000 0126		70 0000 0000	
70 0000 0400		72 0427 0423		21 1522 0352	
70 0000 0400		31 0220 0225		00 0140 0014	
70 0000 0400	0030	31 0221 0226	0120	01 1300 0330	0210
70 0000 0400		31 0063 0231		00 1010 0100	
70 0000 0400		72 0205 0133		00 0201 0000	
70 0000 0400		07 0061 0150		00 0001 0000	
70 0000 0267		71 0241 0133		10 0201 0000	
70 0000 0400		70 0000 0234		21 1560 0000	
70 0000 0400		31 0256 0253		24 0553 0200	
70 0000 0400		72 0255 0245		22 0613 0300	
70 0000 0400	0040	00 0000 0000	0130	26 0442 1400	0220
70 0000 0400		70 0000 0114		27 0613 1000	
70 0000 0400		03 0061 0253		20 0222 0022	
70 0000 0400		36 0417 0150		72 0505 0222	
70 0000 0400		42 1430 0011		72 0505 0223	
70 0000 0400		72 0262 0257		24 0553 0200	
70 0000 0603		31 0060 0223		22 0613 0300	
70 0000 0400		42 1002 0023		72 0505 0226	
33 0000 0000	0050	40 0222 0001	0140	72 0505 0227	0230
70 0000 0560		06 0207 0222		00 0000 0003	
70 0000 0372		73 0206 0144		31 0062 0466	
70 0000 0424		01 0210 0222		70 0000 0116	
70 0000 0000		34 0000 0531		36 0417 0150	
70 0000 0000		31 0211 0223		72 0427 0423	
70 0000 0000		31 0060 0224		01 0061 0241	
70 0000 0000		71 0231 0157		07 0000 0150	
00 0000 0000	0060	07 0000 0000	0150	70 0000 0117	0240
00 0000 0001		30 1427 0000		00 0000 0000	
00 0000 0002		30 0444 0000		31 0062 0466	
00 0000 0003		30 1443 0000		72 0427 0423	
00 0000 0004		30 0446 0000		36 0417 0253	
00 0000 0005		05 0212 0224		72 0427 0423	
00 0000 0006		70 0000 0161		31 0061 0465	
00 0000 0007		07 0000 0150		30 0441 0000	

OVERLAY 34

31 0063 0466 0250
 72 0427 0425
 71 0463 0247
 34 0000 0000
 06 0061 0253
 70 0000 0000
 34 0000 0130
 03 0017 0530
 73 0000 0263 0260
 31 0266 0144
 70 0000 0000
 31 0531 0222
 70 0000 0262
 70 0000 0145
 70 0000 0560
 33 0000 0032
 70 0000 0560 0270
 72 0505 0270
 72 0505 0271
 72 0505 0272
 72 0505 0273
 72 0505 0274
 72 0505 0275
 72 0505 0276

72 0505 0367 0370
 72 0505 0370
 72 0607 0605
 31 0414 0607
 06 0062 0520
 70 0000 0400
 00 0231 0400
 00 0000 0034

OVERLAY 35

70 0000 0646		00 0000 0053	0070	06 0432 1374	0160
70 0000 0472		00 0000 0037		42 1001 0223	
70 0000 0660		00 0000 0077		06 0064 1374	
70 0000 0667		20 0012 0001		42 1000 0223	
70 0000 0501		00 0231 0500		00 0000 0000	
70 0000 0523		00 0001 0400		72 0505 0164	
70 0000 0170	0010	70 0000 0404		72 0505 0165	
70 0000 0150		00 0000 0070		00 0000 0000	
70 0000 0000		00 0000 0000	0100	42 1444 0013	0170
70 0000 0000		00 0000 0000		70 0220 0171	
70 0000 0000		70 0000 0000		70 0017 0171	
70 0000 0310		72 0403 0401		70 0056 0171	
70 0000 0000		00 0000 0000		31 0261 0257	
70 0000 0400		31 0001 0001		71 0257 0175	
70 0000 0140	0020	31 0001 0001		31 0176 1000	
70 0000 0000		72 0420 0400		31 0260 0200	
70 0000 0000		31 0103 0420	0110	31 0060 1400	0200
70 0000 0000		33 0000 0000		71 0200 0202	
70 0000 0312		75 1000 0112		71 1000 0200	
70 0000 0314		36 0072 0102		42 1001 0104	
70 0000 0316		31 0001 0001		41 1000 0050	
70 0000 0320		31 0060 0466		31 0256 0257	
70 0000 0322	0030	72 0427 0423		71 0257 0206	
70 0000 0000		34 0000 0101		31 1001 0254	
70 0000 0354		42 1400 0002	0120	07 0000 0251	0210
70 0000 0324		70 0217 0121		37 0254 0250	
70 0000 0326		42 1603 1274		73 0000 0242	
70 0000 0330		42 1604 1274		31 0247 0217	
70 0000 0000		31 0101 1777		31 0001 0001	
70 0000 0332		31 0102 1777		31 0001 0001	
70 0000 0000		42 1404 1401		36 0000 0000	
70 0000 0000		42 1430 0011		07 0000 1001	
70 0000 0000	0040	42 1002 0223	0130	30 1417 0254	0220
70 0000 0000		40 0135 0001		35 0255 0000	
70 0000 0000		42 1404 0000		73 0000 0174	
70 0000 0000		70 0000 0400		30 0457 0000	
70 0000 0000		00 0000 0000		30 0443 0254	
70 0000 0605		27 1212 1721		31 0001 0001	
70 0000 0105		00 0000 0000		30 1455 0000	
33 0000 0000	0050	00 0000 0000		35 0255 0000	
70 0000 0560		31 0001 0001	0140	73 0000 0174	0230
70 0000 0536		42 1400 0001		30 0457 0000	
70 0000 0424		70 0217 0142		03 0254 0254	
70 0000 0000		42 1603 1120		73 0000 0233	
70 0000 0000		31 0160 1777		07 0000 0233	
70 0000 0000		42 1603 1033		37 0254 0252	
70 0000 0000		31 0161 1777		73 0000 0174	
70 0000 0000		70 0000 0400		31 0001 0001	
00 0000 0000	0060	42 1400 0001	0150	06 0061 0217	0240
00 0000 0001		70 0217 0151		70 0000 0215	
00 0000 0002		42 1603 1120		07 0000 0262	
00 0000 0003		31 0162 1777		73 0000 0243	
00 0000 0004		42 1603 1033		31 0001 0001	
00 0000 0005		31 0163 1777		42 1404 0000	
00 0000 0006		70 0000 0400		70 0000 0400	
00 0000 0007		00 0000 0000		07 0000 1001	

OVERLAY 35

01 0010 0202	0250		
76 1767 1575			
00 0000 0017			70 0000 0560
77 1777 1760			72 0505 0342
00 0000 0000			72 0505 0343
00 0000 0377			72 0505 0344
00 0000 0020			72 0505 0345
00 0000 0020			72 0505 0346
31 0060 1100	0260		72 0505 0347 0350
00 0002 0000			72 0505 0350
00 0000 0011			72 0505 0351
70 0000 0560			72 0505 0352
72 0505 0263			72 0505 0353
72 0505 0264			72 0505 0354
00 0000 0000			72 0505 0355
40 0000 0000			72 0505 0356
41 0000 0000	0270		72 0505 0357 0360
01 0000 0000			72 0505 0360
02 0000 0000			72 0505 0361
04 0000 0000			72 0505 0362
06 0000 0000			72 0505 0363
10 0000 0000			72 0505 0364
12 0000 0000			72 0505 0365
14 0000 0000			72 0505 0366
16 0000 0000	0300		72 0505 0367 0370
00 0000 0000			72 0505 0370
42 1400 0001			72 0505 0371
70 0217 0303			72 0505 0372
42 1603 1042			72 0505 0373
31 0301 177			72 0505 0374
42 1404 C			00 0231 0500
70 0000 0460			00 0000 0035
31 0267 0301	0310		
70 0000 0302			
31 0271 0301			
70 0000 0302			
31 0272 0301			
70 0000 0302			
31 0273 0301			
70 0000 0302			
31 0274 0301	0320		
70 0000 0302			
31 0275 0301			
70 0000 0302			
31 0276 0301			
70 0000 0302			
31 0277 0301			
70 0000 0302			
31 0300 0301	0330		
70 0000 0302			
06 0271 0301			
70 0000 0302			
31 0270 0301			
70 0000 0302			
72 0607 0605			
31 0414 0607			
06 0062 0520	0340		
70 0000 0400			

OVERLAY 36

		00 0000 0053	0070	00 0000 0020	0160
		00 0000 0037		72 0053 0150	
		00 0000 0077		05 0160 0000	
70 0000 0646		20 0012 0001		31 0061 0157	
70 0000 0472		00 0231 0600		70 0000 0155	
70 0000 0660		00 0001 0400		00 0000 0016	
70 0000 0667		70 0000 0404		00 0000 0000	
70 0000 0501		00 0000 0070		00 0000 0013	
70 0000 0523	0010	00 0000 0000	0100	31 0171 1400	0170
70 0000 0000		00 0000 0000		00 0000 0000	
70 0000 0263		00 0000 0040		20 0002 0000	
70 0000 0000		00 0000 0036		01 1600 0360	
70 0000 0263		00 0000 0044		00 0000 0000	
70 0000 0326		00 0000 0050		00 0770 0000	
70 0000 0000		00 0000 0054		00 0003 1700	
70 0000 0000		00 0000 0060		70 0000 0221	
70 0000 0400	0020	00 0000 0064	0110	31 0167 0464	0200
70 0000 0000		00 0000 0041		07 0061 0167	
70 0000 0000		00 0000 0045		25 0166 0000	
70 0000 0000		00 0000 0051		34 0000 0000	
70 0000 0000		00 0000 0055		05 0170 0210	
70 0000 0000		00 0000 0061		07 0000 0103	
70 0000 0000		00 0000 0065		30 0055 0171	
70 0000 0000		00 0000 0042		31 0177 0220	
70 0000 0000	0030	00 0000 0046	0120	31 0171 1400	0210
70 0000 0000		00 0000 0052		31 0063 0174	
70 0000 0273		00 0000 0056		70 0000 0302	
70 0000 0306		00 0000 0062		42 1430 0011	
70 0000 0000		00 0000 0066		42 1002 0223	
70 0000 0000		00 0000 0043		40 1377 0360	
70 0000 0334		00 0000 0047		06 0173 1377	
70 0000 0244		00 0000 0053		71 0174 0214	
70 0000 0000	0040	00 0000 0057	0130	70 0000 0221	0220
70 0000 0000		00 0000 0063		31 0144 0155	
70 0000 0000		00 0000 0000		72 0156 0161	
70 0000 0000		00 0000 0067		36 0175 0171	
70 0000 0000		00 0000 0070		07 0000 0103	
70 0000 0000		00 0000 0071		30 0046 0000	
70 0000 0605		00 0000 0000		36 0176 0171	
70 0000 0000		00 0000 0000		72 0220 0210	
33 0000 0000	0050	00 0000 0000	0140	71 0157 0311	0230
70 0000 0560		00 0000 0000		31 0145 0155	
70 0000 0346		00 0000 0000		72 0156 0161	
70 0000 0424		30 0063 0146		36 0176 0171	
70 0000 0000		30 0055 0146		31 0210 0235	
70 0000 0000		30 0046 0146		00 0000 0000	
70 0000 0000		00 0000 0000		06 0061 0210	
70 0000 0000		00 0000 0025		07 0000 0103	
00 0000 0000	0060	72 0054 0400	0150	30 0063 0171	0240
00 0000 0001		05 0147 0000		72 0220 0210	
00 0000 0002		36 0417 0153		71 0157 0317	
00 0000 0003		07 0000 0000		71 0464 0250	
00 0000 0004		31 0060 0157		06 0061 0166	
00 0000 0005		30 0063 0146		70 0000 0200	
00 0000 0006		70 0000 0156		00 0000 0000	
00 0000 0007		00 0000 0000		00 0000 0000	

OVERLAY 36

31 0001 0001	0250	42 1420 0010	0340
31 0143 0155		42 1006 0011	
72 0156 0161		40 1361 0266	
07 0000 0103		70 0074 0341	
30 0055 0171		70 0000 0400	
06 0146 0171		70 0000 0560	
72 0220 0210		72 0607 0605	
71 0157 0321		31 0414 0607	
70 0000 0221	0260	06 0062 0520	0350
00 0000 0000		70 0000 0400	
31 0060 0166		70 0000 0506	
72 0272 0265		72 0505 0352	
70 0000 0200		72 0505 0353	
31 0211 1400		72 0505 0354	
31 0060 1776		72 0505 0355	
02 0061 0266		72 0505 0356	
71 1400 0266	0270	72 0505 0357	0360
72 0220 0275		72 0505 0360	
70 0000 0000		72 0505 0361	
72 0272 0265		72 0505 0362	
70 0000 0331		72 0505 0363	
31 0277 0266		72 0505 0364	
31 0060 0171		72 0505 0365	
31 0060 1776		72 0505 0366	
31 0060 0166	0300	72 0505 0367	0370
70 0000 0210		72 0505 0370	
31 0172 1377		72 0505 0371	
07 0000 0402		72 0505 0372	
70 0050 0220		72 0505 0373	
70 0000 0213		72 0505 0374	
31 0172 1377		00 0231 0600	
31 0063 0174		00 0000 0036	
70 0000 0213	0310		
72 0161 0231			
72 0403 0401			
73 0165 0162			
31 0316 0161			
70 0000 0161			
72 0053 0150			
72 0161 0243			
70 0000 0312	0320		
72 0161 0260			
70 0000 0312			
73 0165 0162			
70 0000 0222			
72 0505 0324			
72 0220 0210			
31 0177 0220			
70 0000 0331	0330		
31 0060 1400			
31 0060 1000			
70 0000 0400			
31 0335 1361			
31 0060 1377			
02 0061 0335			
71 1361 0335			

OVERLAY 37

70 0000 0646		00 0000 0053	0070	40 1000 0100	0160
70 0000 0472		00 0000 0037		70 0000 0400	
70 0000 0660		00 0000 0077		00 0201 0000	
70 0000 0667		20 0012 0001		00 0000 0000	
70 0000 0501		00 0231 0700		00 0000 0477	
70 0000 0523		00 0001 0400		00 0000 0035	
70 0000 0101	0010	70 0000 0404		00 0000 0000	
70 0000 0113		00 0000 0070		70 0000 0254	
70 0000 0140		00 0000 0000	0100	72 0105 0101	0170
70 0000 0367		42 1410 0015		31 0414 0105	
70 0000 0170		31 0060 1000		02 0167 1376	
70 0000 0254		70 0000 0353		71 1376 0400	
70 0000 0106		41 1000 0777		72 0105 0101	
70 0000 0400		70 0000 0400		72 0135 0125	
70 0000 0125	0020	42 1410 0017		72 0105 0101	
70 0000 0152		31 0060 1000		06 0061 1376	
70 0000 0000		70 0000 0037	0110	36 0067 0166	0200
70 0000 0225		40 1000 0777		30 0046 1375	
70 0000 0233		70 0000 0400		03 0166 1376	
70 0000 0241		72 0657 0650		30 0052 0000	
70 0000 0243		73 0000 0123		04 0162 1375	
70 0000 0245		34 0000 1000		34 0000 1375	
70 0000 0247	0030	36 0571 0120		72 0135 0125	
70 0000 0252		42 1420 0007		71 0165 0177	
70 0000 0321		42 1007 0202	0120	72 0105 0101	0210
70 0000 0260		41 1000 0376		72 0161 0152	
04 1773 0000		70 0000 0400		06 0061 1077	
00 0000 0000		07 0000 0676		71 0164 0211	
70 0000 0106		70 0000 0115		72 0105 0101	
31 0001 0001		07 0000 1376		72 1042 1035	
31 0063 0051	0040	72 0657 0652		72 0105 0101	
42 1000 1271		73 0000 0136		72 0135 0125	
40 1000 0777		34 0000 1000	0130	33 0000 0037	0220
70 1022 0043		36 0571 0133		72 0657 0652	
70 0205 0052		42 1420 0007		70 0000 0661	
42 1000 1411		42 1000 0222		72 0505 0222	
71 0051 0041		40 1000 0376		72 0505 0223	
42 1000 1211		70 0000 0400		42 1400 0001	
70 0141 0052	0050	07 0000 0676		70 0217 0226	
00 0000 0000		70 0000 0130		42 1603 1001	
70 0000 0112		31 0061 0466	0140	42 1604 0000	0230
70 0000 0424		72 0427 0423		40 1000 0776	
31 0001 0001		72 0613 0610		70 0000 0400	
70 0000 0661		05 0536 0000		31 0060 0466	
31 0001 0001		36 0535 0147		72 0427 0423	
70 0000 0661		31 0060 1000		36 0417 0236	
00 0000 0000	0060	42 1420 0010		42 1414 0015	
00 0000 0001		42 1002 0000		31 0001 0001	
00 0000 0002		41 1000 0100	0150	70 0000 0400	0240
00 0000 0003		70 0000 0400		42 1000 1211	
00 0000 0004		07 0000 1077		70 0000 0400	
00 0000 0005		72 0613 0610		42 1000 1231	
00 0000 0006		05 0536 0000		70 0000 0400	
00 0000 0007		36 0535 0157		42 1000 1411	
		42 1420 0010		70 0000 0400	
		42 1006 0000		42 1000 1271	

OVERLAY 37

70 0000 0400	0250	02 0435 0336	0340
72 0505 0250		71 0320 0334	
42 1006 1411		02 1400 1400	
70 0000 0400		42 1410 0015	
42 1002 1211		42 1002 1411	
70 0000 0400		07 0000 0071	
00 0000 0107		72 0657 0652	
00 0000 0040		70 0000 0056	
31 0067 0464	0260	70 0000 0354	0350
42 1410 0017		72 0505 0350	
42 1000 1231		70 0000 0101	
71 0464 0262		70 1034 0354	
02 0257 0257		31 0063 0051	
72 0657 0652		42 1000 1211	
72 0122 0114		41 1000 0777	
72 0112 0036		70 1034 0365	
06 0061 0257	0270	42 1000 1411	0360
73 0071 0265		71 0051 0355	
42 1420 0010		42 1000 1211	
42 1002 0300		70 0141 0365	
41 1000 0777		00 0000 0000	
72 0112 0106		70 0000 0105	
02 0435 0273		70 0000 0040	
71 0256 0272		31 0060 1000	
31 0072 0256	0300	31 0060 1400	0370
42 1420 0010		70 0000 0400	
42 1002 0310		72 0505 0371	
41 1000 0500		72 0505 0372	
72 0112 0106		72 0505 0373	
02 0435 0302		72 0505 0374	
71 0256 0301		00 0231 0700	
42 1410 0017		00 0000 0037	
31 0001 0001	0310		
31 0001 0001			
42 1000 1271			
31 0001 0001			
07 0000 0071			
72 0657 0652			
70 0000 0054			
00 0000 0000			
00 0000 0107	0320		
72 0105 0352			
72 0135 0125			
07 0061 1376			
73 0071 0321			
72 0105 0101			
42 1420 0010			
42 1006 0300			
40 1000 0777	0330		
02 0435 0327			
71 0320 0325			
31 0072 0320			
72 0105 0101			
42 1420 0010			
42 1006 0310			
40 1000 0477			

CATALOGUE FILE CARD

Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection	Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection
Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection	Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection

CATALOGUE FILE CARD

Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. Unclassified Report An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	Computers 1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection	Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. Unclassified Report An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	Computers 1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection	Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. Unclassified Report An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	Computers 1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection
Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. Unclassified Report An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	Computers 1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection	Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. Unclassified Report An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	Computers 1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection	Rome Air Development Center, Griffiss AF Base, N.Y. Rpt No. RADC-TDR-63-160. AN ON-LINE COMPUTING CENTER. Final Rpt, 6 Mar 63, 118p, incl illus, tables. Unclassified Report An on-line computing system has been developed which allows direct use of a high speed digital computer by mathematicians and scientists in their specialized fields. This report describes the system in detail from a user's point of view. For reference purposes, the report includes a listing of all computer programs used in the system.	Computers 1. Computers 2. Digital computers 3. Input-output devices 4. Programming (computers) I. AFSC Project 5581, Task 558104 II. Cont. AF30(602)-2762 III. Ramo Wooldridge IV. G.J. Culler, B.D. Fried V. In DDC collection