FOREWORD

The research was conducted in support of Project 8119, "Checkout and Hazard Control Techniques," (Robt. D. Sherrill, Project Engineer) which is directed by the Support Techniques Branch (R. J. Gavfert, Chief) of the Air Force Aero Propulsion Laboratory.

This study was initiated by the Performance Requirements Branch of the Behavioral Sciences Laboratory, Human Engineering Division, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, under Project No. 7184. The research was accomplished by IIT Research Institute of Chicago, Illinois 60616, under Contract No. AF 33(657)-10271. Mr. Theodore S. Lewis, Research Mathematician, was the principal investigator for IIT Research Institute. Mr. Walter J. Huebner of the Performance Requirements Branch of the Behavioral Sciences Laboratory was the contract monitor for the Aerospace Medical Research Laboratories. The research sponsored by this contract was started on 1 January 1963 and was completed on 14 December 1963.

The authors acknowledge the invaluable assistance of Mr. Edward Richter, Associate Mathematician, of IIT Research Institute, who assisted in the computer programming phase of the development of error control methods.

The authors acknowledge the willing and complete cooperation of Hughes Aircraft Company, VATE Section, in providing the materials and staff consultation time required to implement, in the VATE System simulation computer program, the error control methods developed on this project; and particularly the assistance of Messrs. Victor Mayper, Roderick Keaton, Charles Wallace, Sam Hecht, Don Merrill, Jim Long, and Dave Caulkins.

An additional task performed under this contract was the design and construction of an error detection device which implemented a specified error detection code. The results of that task are reported in "Error Detection Code and Device," by Theodore S. Lewis and Walter J. Huebner.

ABSTRACT

One of the two objectives of this project was the development of error control techniques for the man-computer interface of an automatic checkout system. To minimize human error in man-computer communication in the automatic checkout complex, precedence and connection matrix techniques for use with total and partial simulation methods were developed to detect errors in operational automatic checkout computer programs. Precedence and connection matrix techniques for use with total simulation methods were incorporated into a simulation computer program which comprised a total simulation of the computer which controls an operational automatic checkout system. The modified simulation was then used to process several computer runs of an operational automatic checkout computer program. The basic conclusions drawn from the results of the study of error control methods were that precedence and connection matrix techniques used with total and partial simulation methods can be useful in detecting errors in operational computer-controlled automatic checkout systems, and that further study and development should be made to allow incorporation of the techniques in present and future computer-controlled automatic checkout systems with minimum modification.

PUBLICATION REVIEW

This technical documentary report is approved.

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Technical Director
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SECTION I

INTRODUCTION

The first objective of this project was to develop error control methods to minimize human error in man-computer communication in the automatic checkout complex.

An automatic checkout complex is a man-machine system in which the status of a hardware system is determined by the use of automatic test equipment and the system is then brought into conformance with predetermined standards by a human operator. The automatic test equipment is controlled by a digital computer, and it is necessary for a man to communicate with this control computer through the use of computer programs. This communication creates a man-computer interface, and it is in relation to this interface that error prevention, detection, and correction techniques were studied. The error control methods which ultimately were developed were the use of precedence and connection matrix techniques with total and partial simulation methods to detect errors in operational automatic checkout programs.

Precedence matrix techniques make use of constraints on the order in which steps may be performed. Connection matrix techniques make use of the connections that exist between automatic checkout equipment and equipment under test. Precedence and connection matrix techniques, implemented as part of total simulation methods, may be used to test the order in which a checkout program is executed and the validity of connections that are requested between equipments. Precedence matrix techniques may be used with partial simulation methods to trace through all paths of an operational automatic checkout program, and to test the order of execution of instructions for conformance with precedence constraints. Partial simulation methods are restricted to programs in which instructions are not modified.

Precedence and connection matrix techniques used with total simulation methods were implemented in a total computer simulation program for an operational automatic checkout system to evaluate the practicability of incorporating the techniques in present and future computer-controlled automatic checkout systems. A number of computer runs were made by processing an operational automatic checkout program through the computer simulation program which had been modified to incorporate precedence and connection matrix techniques. The results were then evaluated, and conclusions and recommendations were made.

SECTION II

AUTOMATIC CHECKOUT SYSTEMS

A. INTRODUCTION

Checkout is a two stage process in which the status of a system is determined, and the status information is then used to bring the system into conformance with predetermined standards. The classical method for determining the status of a system was to manually measure the response of the total system to all valid ranges of appropriate stimuli and to interpret the measurements. The difficulties inherent in this method, such as the problem of sampling from systems produced in large quantities, testing all options and combinations of options, or determining status on a statistical basis, were, in general, solved satisfactorily.

However, for the increasingly complex space and weapon systems, classical checkout methods were no longer adequate. The principal reasons for this were the following:

1. Manual testing involved excessive wear on the equipment under test -- the prime equipment (Ref. 1).

2. Real-time operation required greatly reduced action and reaction times.

3. An entire system could not usually be activated to reproduce operational conditions exactly.

4. System checkout was a single factor in the complex of informational needs of the prime equipment and the total system of which the prime equipment was a part (Ref. 2). Examples of the informational needs were data for failure prediction, reliability estimation, command decisions, supply, logistics, etc.

Thus, some or all of the checkout system must be automated, and the automatic checkout system must be integrated into the total system of which the automatic checkout system and prime equipment are a part. A discussion of the extent to which a system should be automated is contained in other sources (Refs. 3, 4, 5) and will not be considered here. It was assumed in this study, for the reasons discussed above, that the checkout system contains a stored-program digital computer, and that the automatic checkout system and prime equipment are integrated into the total system.

B. MAN-COMPUTER COMMUNICATION IN THE AUTOMATIC CHECKOUT SYSTEM

The existence of a computer in a system creates the need for communication with the computer. There are, in general, two levels of man-computer communication, the compiler level and the assembly or machine language level. Without engaging in a detailed discussion of the precise meaning of the two levels, the assembly language is oriented toward the computer and the compiler language is oriented toward the problem; assembly languages require an intimate knowledge of the computer on which the problem is to be run, while compiler languages require little or no knowledge of the computer; assembly languages describe a problem solution in terms of machine-oriented instructions, compiler languages describe the solution in a language approximating the actual language of the problem.

The principal virtues of a compiler language as compared to an assembly language are that it requires less effort to learn, programs are more easily written and modified, errors are more easily corrected, programs are more easily understood by persons other than the author, and programs may be compiled on a number of different computers. The disadvantages of a compiler are that the efficiency of the compiled program (object program) is generally less than that of an assembled program, the time to compile is greater than the time to assemble, the compiler language program may have to be compiled on a larger computer than the assembly language program, that is, larger than the computer on which it is to be run, (although this can be true of assembly language programs), and finally, it may not be possible to implement certain program modules in compiler language that can be implemented in assembly language.

The advantages and disadvantages of compilers vs. assemblers is a subject which has been exhaustively treated over a number of years. Because a compiler language for automatic checkout equipment (ACE) seems to hold the most promise for future development of not only automatic checkout systems, but the total system (Ref. 6), the existence of a compiler for automatic checkout equipment was assumed for this study. The compiler was assumed to operate on a general purpose digital computer which may or may not be linked directly to the ACE computer (in general, it will not be linked).

C. MAN-MACHINE STRUCTURE IN THE AUTOMATIC CHECKOUT SYSTEM

Figure 1 illustrates the structure of a generalized automatic checkout system which contains a digital computer (ACE computer) which is linked to the automatic checkout equipment. A compiler language exists for the ACE computer and the compiler operates on a general purpose digital computer which is not linked to the ACE computer. The automatic checkout equipment programmer is the human originator of operational checkout programs which are run on the ACE computer and which operate the automatic checkout equipment. The programs are written in the compiler language (source programs) and are compiled on the general purpose digital computer

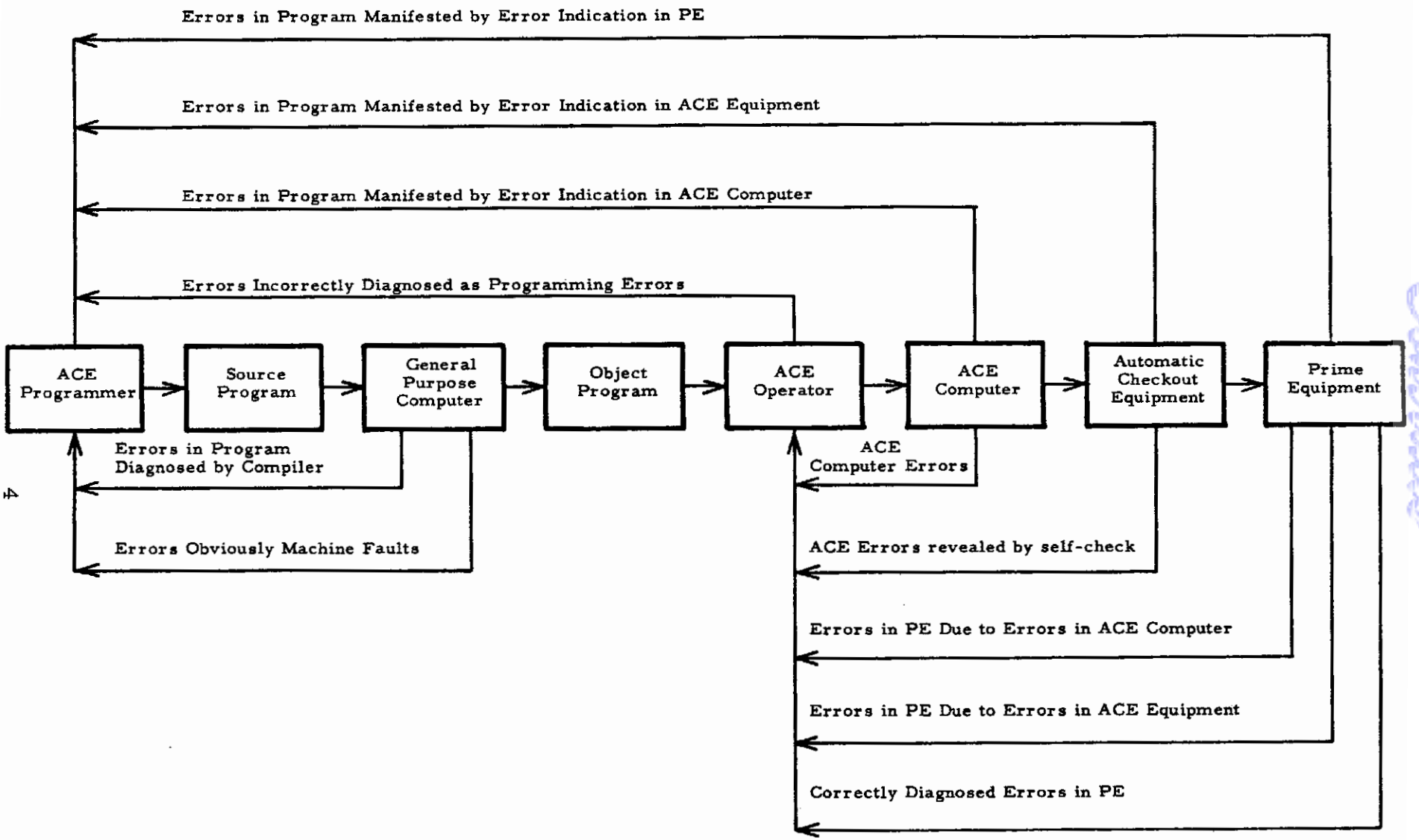


Figure 1 - Automatic Checkout System

to produce the machine language programs (object programs) which operate the ACE computer.

The human operator of the automatic checkout equipment runs the object program on the ACE computer to check out the prime equipment (PE). If the checkout of the prime equipment or the self-checking features of the automatic checkout equipment are not completely under object program control, the feedback from the automatic checkout and prime equipment through the object program allows the operator to perform those functions which are not performed by the object program.

The automatic checkout system has been described as it would perform if no unanticipated errors occurred at any point in the system. However, unanticipated errors do occur and cause degradation of the prime equipment, time delays, increased costs, and loss of confidence in the automatic checkout equipment. Some of the errors which can occur are shown in Figure 1. In general, the errors can be categorized as hardware errors and human errors. The nature of these errors and their impact on the automatic checkout system will now be discussed in detail.

D. ERRORS IN THE AUTOMATIC CHECKOUT SYSTEM-HARDWARE ERRORS

1. Errors in the General Purpose and ACE Computers

Failures can occur in any of the internal components of the computers, in any of the peripheral equipment, and in any of the communication links. Errors can also occur in the input-output media such as magnetic and paper tape and punched cards.

2. Errors in the Automatic Checkout Equipment

Failures can occur in any of the components of the automatic checkout equipment and in any of its communication links.

3. Errors in the Prime Equipment

Failures can occur in any component of the prime equipment and in its communication links with the automatic checkout equipment.

E. ERRORS IN THE AUTOMATIC CHECKOUT SYSTEM-HUMAN ERRORS

1. System Design Errors

Errors can occur in the design of any module of the system or in the configuration of the modules. An error is considered to be any deficiency which does not allow a module or configuration of modules to accomplish its objectives.

2. Computer Programming Errors

Errors can occur in the writing of checkout programs and in the writing of software programs (compilers, assemblers, translators, etc.). The errors can occur in the logic of the programs or in the mechanics of transferring the programs from thought to hard copy.

3. Human Operator Errors

Errors can occur in the human operation of any of the hardware including the general purpose computer, the ACE computer, the automatic checkout equipment, and the prime equipment. However, any errors which are directly or indirectly due to computer programming errors are not to be considered operator errors.

F. IMPACT OF HARDWARE ERRORS ON THE AUTOMATIC CHECKOUT SYSTEM

1. Impact of Errors in the General Purpose Computer, ACE Computer, and Automatic Checkout Equipment

The impact of failures in any of the components, communication links, input-output media of the computers, or the automatic checkout equipment, is a function of the point in the system at which it is possible to detect the errors. For instance, the loss of a bit on a magnetic tape which contains input to the general purpose computer will usually be diagnosed as the tape is being read, and an isolating error indication will be given.

Consider, on the other hand, the alteration of a pair of bits on the tape in such a way that a parity error does not occur, and the alteration manifests itself only as an erroneous failure indication in the prime equipment when a checkout program is run. Considerable effort may be expended in diagnosing the error as an error in the computer program, and considerably more effort in tracing it to a hardware error. The point at which errors can be detected is a function of the design of the system for error detection and correction.

The distance in terms of stages of equipment between the point at which an error occurs and the point at which it is detected is defined to be the error propagation distance. The propagation distance is of great significance because certain types of errors require a measure of time and effort to detect and correct which increases more than linearly with the propagation distance.

Errors in the automatic checkout equipment have a potential propagation distance which is less than that for programming errors, but the difficulty in isolating the errors as not due to the prime equipment is as great.

2. Impact of Errors in the Prime Equipment

One major objective of the automatic checkout system is the detection, isolation, and correction of faults in the prime equipment. The efficiency with which this is accomplished is dependent upon the design of the system, the efficiency of the computer programs written for this purpose, and the skill of the automatic checkout equipment operator. It is also dependent upon the design of the system for the elimination of spurious prime equipment fault indications.

G. IMPACT OF HUMAN ERRORS ON THE AUTOMATIC CHECKOUT SYSTEM

1. Impact of System Design Errors

Manifest errors in system design are serious but will generally become apparent before the system is operational. Errors of omission are even more serious if that which is omitted is the incorporation into the system of error detection and correction features. Because the effect of errors may increase exponentially with their propagation distance, the effect of the omission of error detection and correction and self-checking features may be correspondingly great.

2. Impact of Computer Programming Errors

The effect of computer programming errors both in the operational programs and the compiler is similar to that of hardware errors. The effect is a function of the point at which it is possible to detect the errors. The farther the errors are propagated, the greater the effort required to isolate them from other possible causes of failure. Of even greater concern is the possibility that they may go undetected for long periods or may never be detected. Such a case can occur if errors are in program modules which are exercised infrequently, if they result in a faulty hardware component being diagnosed as faultless, or if the checkout program does not check all possible sources of error. The undetected error is of great concern because it can and has caused the loss of a system or can lead to an erroneous assessment of total system strength.

Correction of programming errors after their detection is generally much easier than the detection. However, the correction can cause considerable delay if the general purpose computer is remote from the automatic checkout equipment. In real time operations, errors may not be tolerable.

3. Impact of Human Operator Errors

The effect of operator errors is, of course, dependent upon the degree to which the operator has control of operation. The greater the degree of sophistication and self-checking of the hardware and programs, the less the opportunity for operator errors.

SECTION III

ERROR PREVENTION, DETECTION, AND CORRECTION (ERROR CONTROL) IN THE AUTOMATIC CHECKOUT SYSTEM

A. INTRODUCTION

The sources of error in the automatic checkout system have been categorized as hardware and human. While the effect of hardware errors is quite significant, the concern of this study is with the human error in the automatic checkout system. Hardware errors will therefore be discussed further only as they relate to human errors.

As has been discussed, human error in the automatic checkout system may occur at three points in the system: the design stage, the computer programming area, and the equipment operation area. Methods for error prevention, detection (including isolation), and correction at each of these three points in the system will now be discussed. For the remainder of this report, error prevention, detection, and correction will be referred to as error control.

B. ERROR CONTROL IN DESIGN STAGE

Error control in the design stage refers to both the error control of design errors and the incorporation of error control techniques into the automatic checkout system. Error control of design errors is the classical systems design, analysis, and engineering problem that has been and is being studied by many groups. It will not be considered further. The incorporation of error control techniques in the automatic checkout system as they relate to human error can be dichotomized into error control for computer programming errors and error control for equipment operation errors. These are included in the following two sections.

C. ERROR CONTROL FOR COMPUTER PROGRAMMING

It has been pointed out that computer programming errors can be propagated through the entire automatic checkout system and can result not only in large expenditures of time and effort for diagnosis and correction, but also in the degradation or loss of the physical system or its capability. The propagation distance must therefore be reduced as far as possible.

There are two categories of computer programming errors: errors in the logic of a program and clerical errors in the mechanics of transferring the program from the mental concept to the hard copy. An example of a logical error is a set of instructions which causes a test sequence to be performed out of order. An example of a clerical error is the writing of an I for a 1. Logical errors are much more significant than clerical errors, but each requires error control. Significant general methods of error control which are presently used or which might be developed for each category are outlined below.

1. Logical Errors in Computer Programming

a. Error Prevention

1) Flow diagrams of the general flow of operations are constructed from the model of the problem to be programmed.

2) Detailed coding flow diagrams are developed from the general flow diagrams.

3) At least one test case is manually traced through the flow diagrams described above using representative data with a small number of significant figures.

4) At least one test case is manually traced through the program instructions of the completed program.

5) Persons other than the author of the program also perform 3) and 4).

b. Error Detection

1) Methods are developed which relate the logical structure of the compiler language program (source program) with the constraints of the hardware which the program tests.

2) The prime equipment, automatic checkout equipment, and ACE computer are simulated on the general purpose digital computer. The machine language program (object program) is then entered into this simulation, and the accuracy of the program is tested by the use of precedence and connection matrix techniques (7, 8).

3) Simulation methods are developed which do not require full-scale simulation of the prime equipment, automatic checkout equipment, and ACE computer. The partial simulation method (9) is used to trace all paths of a program and to test the conformity of every path to precedence constraints.

4) General techniques are developed to indicate to the automatic checkout equipment operator, or to a diagnostic program, those fault indications in the hardware which are due to programming errors.

c. Error Correction

1) Errors are corrected by reprogramming in source language, and the program is recompiled.

2) Errors are corrected by reprogramming in machine language.

3) Techniques are developed to automatically correct certain classes of errors in source language.

4) Techniques are developed to automatically correct certain classes of errors in machine language.

2. Clerical Errors in Computer Programming

a. Error Prevention

1) Pre-printed forms are used which prevent as many syntactical errors as possible.

2) Hard copy at each stage of programming is carefully checked manually for clerical errors.

3) 1.a.3), 4), and 5) apply equally well to the prevention of clerical errors.

b. Error Detection

1) The compiler will contain diagnostic procedures to detect many of the classes of clerical errors which occur.

2) 1.b.2), 3), and 4) apply equally well to the detection of clerical errors.

c. Error Correction

1) Techniques for correction of logical errors apply equally well to the correction of clerical errors.

D. ERROR CONTROL FOR EQUIPMENT OPERATION

There are two major equipment types that are operated by humans in the automatic checkout system: the general purpose computer, and the prime equipment - automatic checkout equipment - ACE computer complex. The operation of the general purpose computer is a classical problem in computer systems operation and will not be considered further. The operation of the automatic checkout complex is a function of the division of operations between the automatic checkout equipment and the human operator. The general categories of human error are set-up errors such as erroneous set-up of hardware, wrongly connected lines, incorrectly mounted tapes, etc. and feedback errors such as erroneous interpretation of output, not correctly following displayed instructions, interpreting prime equipment faults as non-prime equipment faults, etc. Methods of error control that are presently being used or which might be developed for each of these categories are outlined below.

1. Set-up Errors in Equipment Operation

a. Error Prevention

1) The set-up of all hardwares is detailed in clearly-written, unambiguous reference material.

2) Communication points between hardwares are carefully labeled.

3) Dials, knobs, tape mountings, indicators, etc., are designed to prevent erroneous inputs or readings.

4) All anticipated operator errors are detailed in reference material as to nature, symptom, probability of occurrence, method of avoidance.

b. Error Detection

1) The hardware is designed to indicate certain classes of erroneous set-ups or inputs.

2) The computer programs are designed to diagnose and indicate certain classes of erroneous set-up or inputs.

3) 1. a. 4) applies equally well to error detection.

c. Error Correction

1) The error is corrected manually by the operator.

2) The error is corrected automatically by the computer programs.

2. Feedback Errors in Equipment Operation

a. Error Prevention

1) Feedback information is displayed in the manner most conducive to optimal use of the information.

2) Manuals are prepared to aid in the interpretation of feedback information.

b. Error Detection

1) Procedures for reaction to feedback are designed to enhance the probability that incorrect operator reaction produces an error indication.

c. Error Correction

1) The error is corrected manually by the operator.

2) The error is corrected automatically by the computer programs.

E. SELECTION OF ERROR CONTROL METHODS TO BE STUDIED

Of the error control methods that could be developed for use in the automatic checkout system, the use of precedence and connection matrix techniques with total and partial simulation methods to detect errors in

operational automatic checkout programs yielded the best compromise between ultimate pay-off of the techniques and the probability that such techniques could be developed within the scope of the project. We decided that it was not sufficient merely to develop precedence and connection matrix techniques, but that an attempt should be made to evaluate their usefulness in an operational automatic checkout system.

Consequently, precedence and connection matrix techniques used with total and partial simulation methods were developed for use in the automatic checkout system, and implementation of the techniques used with total simulation methods was effected in the computer simulation of a computer-controlled automatic checkout system. The scope of this study did not permit implementation of the techniques used with partial simulation.

The automatic checkout system which was selected for implementation was the VATE (Versatile Automatic Testing Equipment) System constructed by Hughes Aircraft Company. An explanation of precedence and connection matrix techniques, the reasons for selecting the VATE System, the implementation of the techniques in the VATE System, and the evaluation of results are described in detail in subsequent sections.

SECTION IV

PRECEDENCE MATRIX AND CONNECTION MATRIX TECHNIQUES

A. INTRODUCTION

The principal error control methods on which this study focused were the use of precedence and connection matrix techniques with total and partial simulation methods to detect errors in operational automatic checkout computer programs. Precedence matrices are graphical representations of the order in which steps must be performed or in which it is desired to perform them. Thus, it can be said, "Step A precedes Step B," or "Step D follows Step C," or "Step E and Step F can be performed in either order."

Connection matrices are graphical representations of the connections that exist between points in automatic checkout equipment and points in prime equipment. The connecting links may be cables or telemetry communication. The cable or telemetry communication may originate and terminate at either the automatic checkout equipment or the prime equipment.

Total simulation methods are methods that require the total simulation of a system. For the use of precedence and connection matrix techniques, the simulation required is of the digital computer which controls the checkout process. The simulation is constructed so as to process, in a manner as similar to that of the digital computer as possible, programs which have been written for the digital computer. Additional simulations of the automatic checkout and prime equipment are desirable but not essential.

Partial simulation methods are methods that require the simulation of part of a system. For the use of precedence and connection matrix techniques, the required partial simulation is essentially a translation process capable of identifying branching type instructions in the instruction repertoire of the digital computer which controls the checkout process. Every path through a program can be traced using the branching type instructions.

Precedence and connection matrix techniques are used with total simulation methods in the following way. As the simulation processes the instructions of an automatic checkout program, the order of execution of the instructions and the requested connections can be checked against the precedence and connection matrices. Diagnostics can then be written for violations of precedences or invalid connections, or comments written for the ordering of steps or the requesting of connections that are consistent with the precedence and connection matrices.

Precedence and connection matrix techniques are used with partial simulation methods as follows. The partial simulation traces through every path of the automatic checkout program by executing only branching type instructions. As each path is traced, the sequencing of the instructions is checked against the precedence matrix. Diagnostics are written for illegal

sequences, and comments are written for sequences consistent with the precedence matrix.

The remainder of this section contains a more detailed explanation of the use of precedence and connection matrix techniques with total and partial simulation methods. To facilitate understanding of the methods, an artificial, but realistic, example is taken from a subsequence of tests on a missile.

B. EXAMPLE OF SUBSEQUENCE OF TESTS IN AUTOMATIC CHECKOUT PROGRAM

To illustrate precedence and connection matrix techniques, a subsequence of tests on a missile X is presented in Table 1. The first four tests in the Table measure the accuracy, with respect to predetermined limits, of one a.c. and two d.c. voltages which are used as stimuli. The pitch loop is shorted while the yaw loop is tested. A 3 volt d.c. stimulus is applied to the yaw loop, the flippers of the missile are given .8 seconds to stabilize, and the differential voltage across the actuator potentiometer of one of the flippers, which is linearly related to the angular movement of the flipper, is measured.

The voltage is converted to degrees per volt of stimulus and tested against specified limits. If outside of the limits, hydraulic power is removed, a diagnostic is printed, and a branch is made to an adjustment routine. If the degrees per volt is within limits, the second flipper is tested in the same way. When both flippers pass the test, the short is removed from the pitch loop, the yaw loop is shorted, and the pitch loop is tested in the same way. If a branch is made to an adjustment routine, return is then made to step 1. When both the yaw and pitch loops are checked out, the delta max parameter is tested.

Figure 2 shows an approximate testing circuit for the subsystem of missile X. The 15 volt d.c. and 107.5 volt a.c. stimuli are not shown. The numbered points are stimulus, stimulus acceptance, response, and response acceptance points. A stimulus point is a point in the automatic testing equipment at which a stimulus is initiated. A stimulus acceptance point is a point in the equipment under test at which the stimulus induces a physical change - for example, the opening or closing of a switch. A response point is a point in the equipment under test at which a measurement is made, for example, a voltmeter. A response acceptance point is a point in the automatic testing equipment at which a measurement is recorded, usually for transformation to a digital form. Points 1, 5, 7, 9, 13, 17, 19, 21, 25 are stimulus points, points 2, 6, 8, 10, 14, 18, 20, 22, 26 are stimulus acceptance points, points 3, 11, 15, 23, 27 are response points, points 4, 12, 16, 24, 28 are response acceptance points.

The following section describes the use of precedence matrices to detect errors in a computer program embodying the tests described in Table 1 for the hardware diagrammed in Figure 2.

TABLE 1

SUB-SEQUENCE OF TESTS ON MISSILE X

1. Measure + 3 $\pm$ .15 volts d.c. stimuli voltage.
2. Measure + 15 $\pm$ 1.0 volts d.c. stimuli voltage.
3. Measure 107.5 $\pm$ 7.5 volts a.c. (pp) 4 CPS stimuli voltage.
4. Measure 4.0 $\pm$ .2 CPS frequency a.c. stimuli voltage.
5. Apply short to pitch loop.
6. Apply 3 volt d.c. stimulus to yaw loop.
7. Wait .8 seconds for flippers to stabilize at final position.
8. Measure differential voltage across actuator pot of flipper no. 1.
9. Convert differential voltage of flipper no. 1 to degrees. Divide by voltage to obtain degrees/volt.
10. Test 3.16 $\leq$ degrees/volt $\leq$ 3.50.
11. If no, remove hydraulic power, print diagnostic, go to control system adjustment, routine 2 (Step 26).
12. Convert differential voltage of flipper no. 3 to degrees and divide by 3 to obtain degrees/volt.
13. Test 3.16 $\leq$ degrees/volt $\leq$ 3.50.
14. If no, remove hydraulic power, print diagnostic, go to control system adjustment, routine 2 (Step 26).
15. Remove short from pitch loop and apply short to yaw loop.
16. Apply 3 volt d.c. stimulus to pitch loop.
17. Wait .8 seconds for flippers to stabilize at final position.
18. Measure differential voltage across flipper no. 2.
19. Convert differential voltage of flipper no. 2 to degrees and divide by 3 to obtain degrees/volt.
20. Test 3.16 $\leq$ degrees/volt $\leq$ 3.50.
21. If no, remove hydraulic power, print diagnostic, go to control system adjustment, routine 2 (Step 26).
22. Convert differential voltage of flipper no. 4 to degrees and divide by 3.
23. Test 3.16 $\leq$ degrees/volt $\leq$ 3.50.
24. If no, remove hydraulic power, print diagnostic, go to control system adjustment, routine 2 (Step 26).
25. Test Delta Max. Parameter. Go to exit.
26. Make adjustments (Routine 2) and return to Step 1.

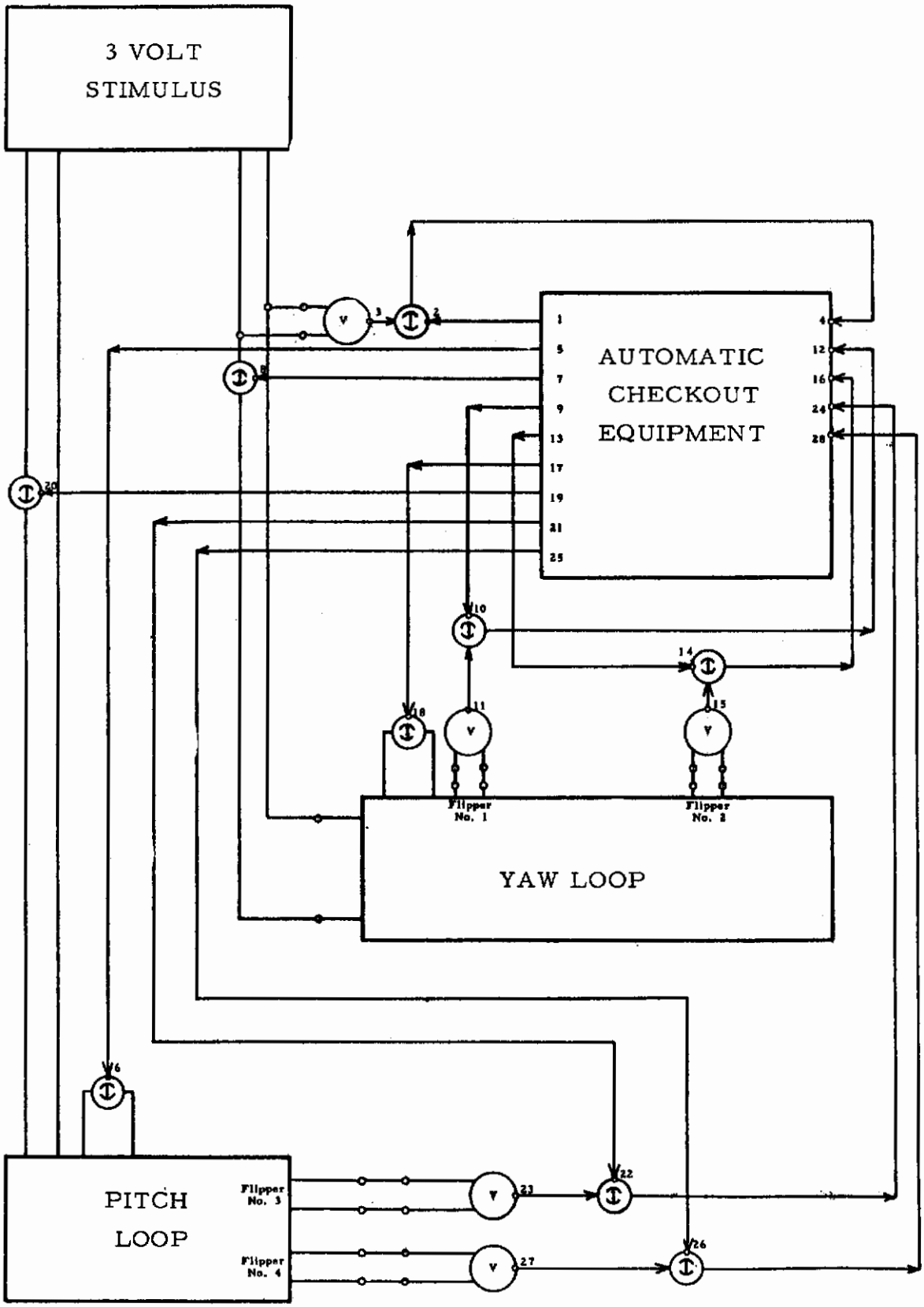


Figure 2 - Diagram of Test Circuit for Subsystem of Missile X

C. PRECEDENCE MATRICES USED FOR ERROR DETECTION

A precedence matrix is a graphical representation of the ordering that exists among a set of elements. Ordering means simply that for each pair of elements A and B in a set of elements, it can be said that A must precede B, B must precede A, or that neither must precede the other. It is not necessary to state explicitly the ordering among all pairs of elements. From the following rules, the ordering relations among certain pairs of elements can be used to find the ordering relation between each pair of elements:

1. If A precedes B and B precedes C, then A precedes C (transitivity).

2. A cannot precede A (non-reflexivity).

3. If A precedes B, B cannot precede A (anti-symmetry).

We refer to Table 1 for examples of these rules. The pitch loop is shorted before a stimulus is applied to the yaw loop to prevent interaction of the two loops. Therefore, step 5 must precede step 6. From rule 2, step 5 cannot precede itself, that is, the pitch loop cannot be shorted before it is shorted. From rule 3, step 6 cannot precede step 5; that is, a stimulus cannot be applied to the yaw loop before the pitch loop is shorted.

Now, step 7 - stabilization of the flippers - cannot take place until the yaw loop is stimulated. Therefore step 6 must precede step 7. From rule 1, step 5 must therefore precede step 7; that is, the pitch loop must be shorted before the flippers are stabilized.

An aid to the visualization of precedences between elements is the use, as illustrated in Figure 3, of a precedence chart, sometimes called a balloon chart. The circles represent steps, and the arrows connect pairs of steps. The tail of the arrow is joined to the step which directly precedes the step to which the head of the arrow is joined. Thus, step 7 directly precedes step 8. A step can be executed only if the steps at the tail of all solid arrows leading into the element have been executed. Thus, step 6 can be executed only after both steps 1 and 5 have been executed.

However, a decision step in the sequence of steps will cause one of two branches to be taken. Whichever branch is taken, some steps will be bypassed. Therefore, it will no longer necessarily be true that all steps with arrows leading into a single step must be executed before that step. An example of this is step 26. It may be executed after any of the steps with arrows leading into it have been executed. To provide for this case, dashed arrows are used to denote this "or" case; that is, if any step whose dashed arrow leads into a step is executed, it satisfies the requirements of all steps having dashed arrows leading into the step.

We are now in a position to construct the precedence matrix illustrated in Figure 4 for the 26 steps of Table 1. It can be constructed

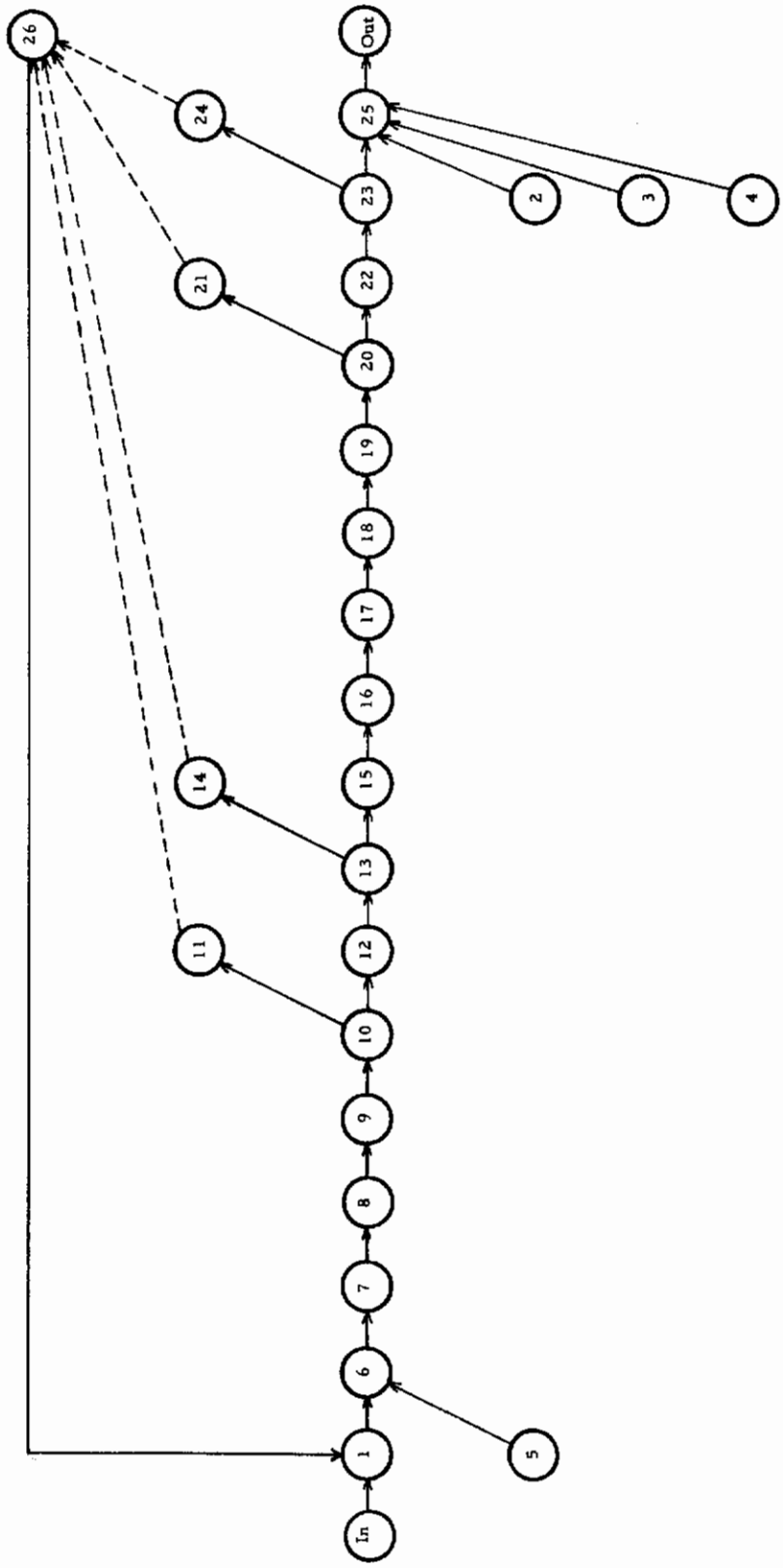


FIGURE 3. PRECEDENCE CHART OF SUB-SEQUENCE OF TESTS ON MISSILE X.

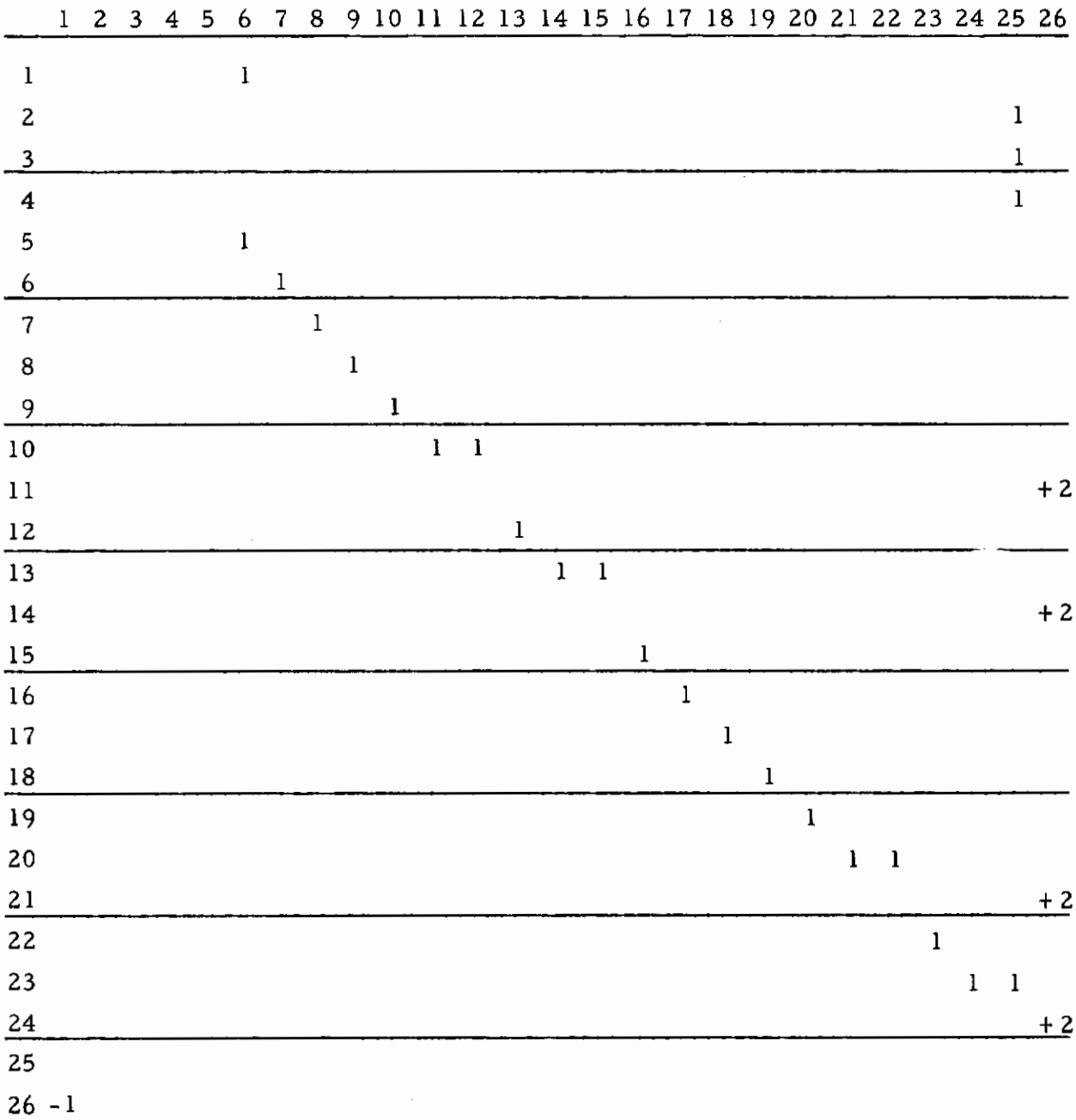


FIGURE 4. PRECEDENCE MATRIX OF SUB-SEQUENCE OF TESTS ON MISSILE X

directly from Table 1 or from the precedence chart of Figure 3. First, the numbers 1 through 26 are listed across the top and down the left-hand side of the matrix. Next, each pair of elements having a direct precedence is entered into the matrix as follows:

The step at the tail of the arrow is found on the left-hand side of the matrix. This is its row. The step at the head of the arrow is found along the top. This is its column. If the arrow is solid, a 1 is placed at the intersection of the row and column. This indicates that the step in the row must precede the step in the column. If the arrow is dashed, a 2 is placed at the intersection to indicate that the step in the row is part of a group of steps, one of which must precede the step in the column.

All pairs of steps joined by a single arrow are entered into the precedence matrix. These are all of the first-order relationships; that is, all of the relationships in which step A directly precedes step B. The balloon chart is especially useful for constructing the precedence matrix as each single arrow indicates a first-order relationship.

Now, the matrix needs one further modification. One of the objectives of constructing the precedence matrix is to test for inconsistencies. Inconsistencies are steps which violate any of the three rules described above which govern precedence; that is, transitivity, antireflexivity, and antisymmetry. However, loops will cause violation of all three rules, and loops exist in practically all computer programs.

A loop is a sequence of steps in which one of the steps returns to a step which has already been executed. For example, in Table 1, step 26 returns to step 1 which has already been executed. This is legitimate because the testing cycle should be repeated after an adjustment has been made to an out-of-tolerance component. However, in testing for illegal loops and other inconsistencies, the legitimate loops will manifest themselves. It is desired then to mark legitimate loops so that they can be identified when testing for inconsistencies.

Legitimate loops are marked by identifying the link which returns to an instruction which has already been executed. The 1 in the precedence matrix for that link is then changed to a -1. For example, step 26 returns to step 1, therefore there is a -1 in the precedence matrix in row 26 and column 1. In all consistency tests performed on the precedence matrix, -1's will be treated as zeros or blanks, thereby eliminating the links completing a loop, and consequently "cutting" the loop.

The precedence matrix has been constructed. It is now necessary to answer two questions. First, does the matrix truly represent the precedences inherent in the hardware or sequence of tests? Secondly, are there any inconsistencies in the matrix?

The answer to the first question is that there is no way to test the matrix itself to appraise its representativeness. However, it is possible to use alternate methods to produce the precedence matrix to obtain a check on

the input matrix. For example, the precedence chart could be input in some form and used to produce automatically the precedence matrix. The two matrices should then be identical; comparison will show whether they are or not.

The answer to the second question can be derived by use of two methods, principal submatrices and matrix multiplication. The principal submatrices method checks the consistency of a precedence matrix by deleting zero rows and columns. In effect, it eliminates entrances and exits until there are no more entrances and exits. If there are rows and columns which have not been eliminated, then there are inconsistencies in the matrix. The method in detail is as follows.

The precedence matrix is scanned for a row or column which contains all zeros (-1's are treated as zeros). If there are none, the process is terminated. If there is a zero row or column, it is deleted along with its corresponding column or row. If all rows and columns have been eliminated when the process is terminated, the matrix is consistent. If not, there are inconsistencies in the matrix.

In Figure 4, row 26 contains all zeros (-1 is treated as zero) and is therefore eliminated. Column 26 is also eliminated. Row and column 25 are eliminated, then row and column 24, etc., until all rows and columns are eliminated indicating that the precedence matrix was consistent. Had there been a 1 at the intersection of row 7 and column 5, for example, row 7 and column 7 could not be eliminated, nor could rows and columns 6, 5, and 1. The matrix would have been shown to be inconsistent which is correct if we require that step 7 precede step 5 when we have required that 5 precede 6 and 6 precede 7.

The matrix multiplication method checks the consistency of a precedence matrix by establishing successively higher-order precedence relationships until no more can be established, or until an inconsistency has been revealed. A higher-order relationship is one in which A precedes B, but A and B are separated by several steps. For example, in Figure 3, step 15 precedes step 20, but four other steps intervene.

An inconsistency is revealed when an element is shown to precede itself. For example, if the loop from step 26 to step 1 had not been cut, higher order relationships would cause element 1 eventually to precede itself because 1 precedes 6 which precedes 7 . . . which precedes 26 which precedes 1. Redundancies are also revealed by this method. A redundancy is a precedence relation, explicitly stated in the precedence matrix, which is implied by other precedence relations. For example, if a 1 had been placed in row 5 and column 7, it would be shown to be redundant because it is implied by the 1's in row 5 and column 6 and row 6 and column 7. Redundancies are not inconsistencies, but they may indicate that an indirect relation was not recognized or that a mistaken entry was made.

The details of the matrix multiplication method are as follows. The precedence matrix is multiplied by itself by normal matrix multiplication, except that each entry is treated as a 1 except -1's which are treated as

zeros. A product of 1 will result in those cases where a 1 occurs in the same numbered rows and columns. For example, in Figure 3, a 1 occurs when row 5 is multiplied by column 7, implying that step 5 precedes step 7. This is a second-order relation and is the implication of row 5 preceding row 6 and row 6 preceding row 7. If the product of a row and a column is greater than one, then there is an error in one of the matrices, and a diagnostic is printed.

The resulting 1's are stored along with the original matrix. If a 1 is generated for which an entry already exists, this redundancy is noted and the process is continued. If a 1 is generated on a diagonal, this implies that a step precedes itself, and constitutes an inconsistency. This is noted and the process is terminated. The matrix which results from multiplying the original precedence matrix by itself is again multiplied by the original precedence matrix, the 1's are stored, and the process continues until either an inconsistency is noted or a matrix of all zeros is produced. The final matrix, which is the collection of the original precedence matrix and all of the 1's generated, will contain all of the explicit and implicit precedence relations which exist among the steps.

We have shown how to construct a precedence matrix, how to appraise its conformity to reality, and how to check its consistency. It remains to describe the use of the precedence matrix in detecting errors in checkout programs.

First, a distinction must be made between the two types of precedences, hardware and flow diagram. Hardware precedences are constraints on the order in which it is physically possible to activate the elements of a hardware system. A power tool, for example, must be plugged in and switched on before it can be operated. The plugging in and switching on must both therefore precede the operating, even though the first two steps can be done in either order.

Flow diagram precedences are constraints on the order in which it is desired to execute steps. They derive their name from the flow diagram, which is a graphical representation of the sequencing of steps. The steps of a flow diagram may represent any process, physical or mental, hardware or software, and their desired order may have any motivation.

For example, flow diagram precedences may constrain a power tool, in the interests of safety, to be plugged in before it is switched on, even though it is physically possible to commute these steps. Or they may constrain the instructions of a computer program, for computational accuracy, to be executed in a given order even though there is a wide latitude on the possible order of execution.

A gray area in the definition of precedences is in the realm of destructive hardware activations. It may physically be possible to activate hardware in a given order, and yet the hardware may be degraded by the process. Precedences which prevent degradation of hardware are flow diagram precedences by the definition given. But they must reasonably be regarded as hardware precedences since it can be assumed that degradation of hardware is always to be avoided.

1. Precedence Matrices Used with Total Simulation

For the total simulation method, it is assumed that a simulation program exists which operates on each instruction of an object (machine language) program. The simulation examines each instruction, checks it for correct format, checks each field of the instruction for validity, then executes the instruction and examines the states of all registers for possible violation of computer hardware restrictions (numeric overflows, underflows, tape redundancies, etc.).

As the object program instructions are executed by the simulator, the precedence matrix is used to check that the sets of instructions which correspond to the steps of the precedence matrix are executed in accordance with the precedence relations expressed in the precedence matrix. The steps in the precedence matrix can refer either to computer program steps or to activations of hardware.

In order to perform the precedence checks, it is necessary that the simulation program have available not only the precedence matrix, but also the link between the matrix and the computer instructions; that is, the simulation program must be able to identify the computer instruction which corresponds to the beginning of each step and the computer instruction which corresponds to the end of the step.

The information which links the precedence matrix to the computer instructions can be expressed in two forms. In the first form, it is assumed that some computer register has unique states for each point of reference to a step in the precedence matrix. For example, arithmetic register A may contain a binary configuration that is unique for each reference to a step in the precedence matrix. A table is then constructed in which one column contains the precedence matrix steps, and the other two columns contain the binary configurations of register A which correspond to the initiation and termination of that step.

In the second form of link, it is assumed that the locations in computer memory are known where starting and ending instructions which correspond to each precedence matrix step are executed. A table is then constructed in which the first column contains the number of the precedence matrix step, the second column contains the location of the instruction which represents the beginning of that step, and the third column contains the location of the instruction which represents the end of that step.

The latter table above can be generated and input by the programmer, or it can be generated by an assembler or compiler if the symbolic name of each assembler or compiler instruction that corresponds to a precedence matrix step is marked in a special way. For example, names starting with ST could be reserved for instructions which correspond to the initiation of a matrix step, and names starting with EN could be reserved for instructions which terminate a matrix step. Numbers appended to letters could give the number of the step. For example, ST13 and EN13 would be the starting and ending instruction of the group of instructions which correspond to step 13 in the precedence matrix.

Whichever form the link between the computer program and the precedence matrix takes, a table is constructed which informs the simulation when it is at the beginning and at the end of a precedence matrix step. Thus, as the simulation processes an instruction, it queries the table to determine if the instruction is the start or end of a precedence matrix step.

If an instruction is the start of a precedence matrix step - call it step Y - then a temporary storage location is tested to determine if the last precedence matrix step initiated has been terminated. If not, a diagnostic is printed. If it was terminated, then the precedence matrix is queried in the following way. Column Y is scanned for entries. If there are no entries, then there are no precedence restrictions on when it can be executed, and execution is performed.

If there are 1's or -1's, then the steps for the rows corresponding to any of the 1's or -1's must be executed before Y can be executed. If there are 2's then the step for one of the rows corresponding to the 2's must be executed before Y is executed. If we assume, however, that a process is used whereby all entries in a column are replaced by zero when the indicated precedences are satisfied, then if the column contains all zeros, execution is performed, and if it contains any non-zero entries, a diagnostic is printed.

The process for reducing a column to zero when all precedences are satisfied is as follows. First, a matrix - call it matrix M - identical to the initial precedence matrix, is constructed. Then, as each step is executed, that is, when both the starting and ending instructions corresponding to the step are executed, all of the entries in the row in matrix M for that step are replaced by zero. For each 2 that is set to zero, all of the other 2's in the same column are also set to zero. This is to satisfy the "or" condition mentioned previously.

One condition must still be satisfied: that of the -1's, the condition of looping. It is handled as follows. When a -1 is replaced by zero, the number of the column in which the -1 appeared is recorded. The next time the step corresponding to that column is executed, the entire matrix M is restored from the original precedence matrix. Thus, when the program loops back, the precedence relations must be satisfied anew.

2. Precedence Matrices Used with Partial Simulation

A partial simulation method may be used to trace through all paths of a program. Precedence matrix techniques may then be used to check that each path is in conformance with the precedence constraints. The method can be used only with programs in which instructions are not altered during execution of the program. The details of this method are as follows.

It is assumed that a simulation program exists which checks the operation code of each instruction of an object program to determine if it is a branching type instruction; that is, to determine if the choice of the next instruction to be executed is limited to one instruction or more than one. If it is not a branching type instruction, the next instruction is processed.

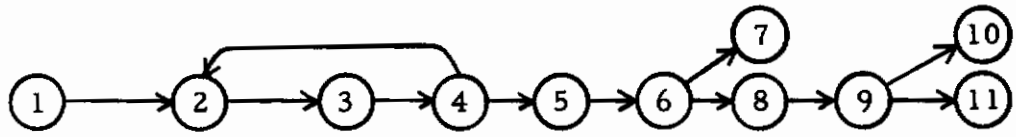
If the instruction is a branching type, then each branch is stored in a table. One of the branches is then chosen, and the program processes that instruction next. The process continues until a termination instruction, stored in a table of termination instructions, is encountered. The simulation program then returns to the last branching instruction, chooses another branch, and continues processing from that instruction. When all the branches of the last branching instruction have been processed, the program returns to the next-to-the-last branching instruction, etc., until all paths of the program have been traced.

Each path, as it is traced, is checked against the precedence matrix. If violations occur, diagnostics are written, the path is terminated, and the next path is taken. Each path is also written out as it is traced. The path may then be used to generate test cases of input data or to manually trace through the program for debugging purposes.

One difficulty in the method is that computer programs contain many legitimate loops. If the loops are not provided for, the simulation program will process the first such loop indefinitely. This can be avoided by storing the location of each instruction executed. If a branch is made to a previously executed instruction, then a comment is written on the trace of that path that a loop back to an instruction is made, and the next branch is processed.

It is not necessary to store in a separate computer word, the location of each step executed. A single bit within a computer word can be set to 1 to indicate that the step corresponding to that bit has been processed. For example, 900 36-bit words could be used to store the execution of 32,400 instructions.

A simple example will illustrate the use of precedence matrices with partial simulation methods. Suppose a program proceeds from location 1 to 2 to 3 to 4 then branches to 5 or back to 2. From 5 it proceeds to 6 then branches to 7 or 8. From 8 it proceeds to 9 then branches to 10 or 11. 7, 10, and 11 are terminating instructions. The balloon diagram for this program is the following:



The partial simulation processes instructions 1, 2, 3, and 4 and stores each number in the table of instructions processed. It notes that instruction 4 is a branching instruction and stores 2 and 5 in the table of branches. It chooses 2 and begins to process it. It then notes that 2 has already been processed and writes out the path of the program as "1, 2, 3, 4, loop back to 2." It then goes to the last branch, which is 5, processes 5 and 6, stores them in the table of instructions processed, and notes that 6 is a branching instruction.

Locations 7 and 8 are stored in the branch table, and 7 is chosen for processing. 7 is a terminating instruction and the path, "1, 2, 3, 4, 5, 6, 7,"

is written out. The program returns to the last branching instruction 6, and now chooses 8 to be processed. 9 is then processed, 10 and 11 are stored in the branch table, and 10 is processed. The path, "1, 2, 3, 4, 5, 6, 8, 9, 10," is written out, 11 is processed, and the path, "1, 2, 3, 4, 5, 6, 8, 9, 11," is written out. All paths have now been traced.

The precedence matrix for this program is the following:

		COLUMN										
		1	2	3	4	5	6	7	8	9	10	11
	1		1									
	2			1								
	3				1							
	4		-1			1						
	5						1					
ROW	6							1	1			
	7											
	8									1		
	9										1	1
	10											
	11											

As each of the four paths is traced, the precedence matrix is checked for violation of precedences. In this example, each of the four paths is in conformance with the precedences, and all 11 program steps are represented in the precedence matrix. In a normal program, the steps in the precedence matrix would probably be limited to branching steps and entry points into loops.

This completes the description of the use of precedence matrices to detect errors in object programs. The following section describes the use of connection matrices to detect errors in object programs.

D. CONNECTION MATRICES USED FOR ERROR DETECTION

A connection matrix is a graphical representation of the connecting links between the automatic checkout equipment and the equipment-under-test, in this case Missile X. The connecting links may be hard-line, that is, cables, or they may be RF links. The significant factor is that points exist in the automatic checkout equipment which generate stimuli or read responses, points exist in the equipment-under-test which accept stimuli or create responses, and a link may or may not exist between any pair of these points.

In Figure 5, the connections between stimulus, stimulus acceptance, response, and response acceptance points are illustrated. The stimulus and response points are entered across the left-hand side and the stimulus

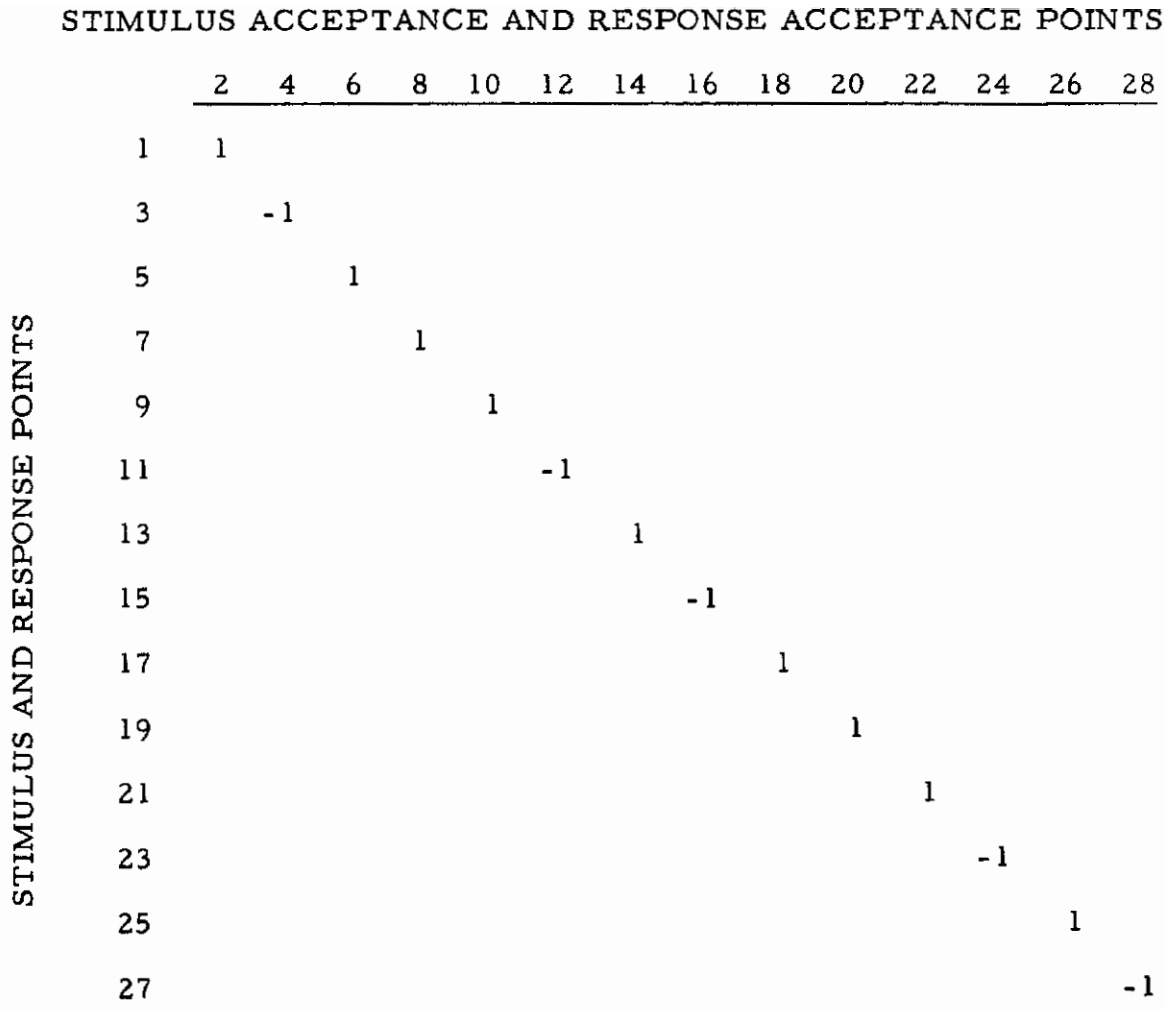


FIGURE 5. CONNECTION MATRIX OF SUB-SEQUENCE OF TESTS ON MISSILE X.

acceptance and response acceptance points are entered across the top. For each stimulus point which is linked to a stimulus acceptance point, a 1 is entered at the intersection of the stimulus point row and stimulus acceptance point column. For each response point that is linked to a response acceptance point, a -1 is entered at the intersection of the response point row and response acceptance point column.

In Figure 5, stimulus point 5 is linked to stimulus acceptance point 6, and a 1 is entered in the row marked 5 and the column marked 6. Response point 3 is linked to response acceptance point 4, and a -1 is entered in the row marked 3 and the column marked 4. As in the case of the precedence matrix, the conformity of the connection matrix to the reality of the hardware must be tested either by carefully checking circuit diagrams of the hardware, or by using an alternate method for producing a connection matrix and comparing the two.

It will be assumed for connection matrices, as for precedence matrices, that a table can be constructed with which the simulation can determine that a row or column entry in the connection matrix has been referenced. The table would consist of one column listing the row entries followed by the column entries and a second column listing either the state of some register when the column or row heading is referenced or the instruction location of the reference.

The connection matrix would then be used as follows. For each instruction, the simulation would scan the table to determine if the connection matrix had been referenced. If so, the number of the reference would be recorded. If a previous reference had been recorded, then the two references would be tested to see if they were both row or column entries. If so, a diagnostic would be printed.

If the two references were not both row or column entries, the intersection of the row corresponding to one and the column corresponding to the other would be tested for a non-zero entry. If the entry is zero, no link exists, the references are not valid, and a diagnostic is printed. If the entry is non-zero, the sign of the entry must be tested. If the first reference was a row reference, then the sign of the entry should be positive. If the first reference was a column reference, then the sign of the entry should be negative. If the test reveals that the sign is incorrect, a diagnostic is printed. If the entry is correct, a flag is set to indicate that a link was completed and that the next reference will be the start of a new link.

The following section describes, in detail, the implementation in the VATE System of precedence and connection matrix techniques used with total simulation methods. The scope of the project did not allow implementation in the VATE System of precedence matrix techniques used with partial simulation methods.

SECTION V

IMPLEMENTATION IN THE VATE SYSTEM OF PRECEDENCE AND CONNECTION MATRIX TECHNIQUES USED WITH TOTAL SIMULATION METHODS

A. INTRODUCTION

To evaluate the practicability of using precedence and connection matrix techniques with total simulation methods to detect errors in checkout programs, it was desired to implement the techniques in an operational computer-controlled automatic checkout system. The automatic checkout system must have a total simulation computer program. As far as could be determined, the VATE (Versatile Automatic Test Equipment) System was the only automatic checkout system which was computer-controlled and had a total simulation computer program.

In the VATE System, Hughes Aircraft Company HCM-111 computers are used to control the checkout process. The HCM-111 is a drum-storage stored program computer with approximately 40,000, 22-bit words of storage. A simulation program was written by Hughes for the IBM 7090 to simulate the operation of the HCM-111. This simulation program, and the other materials and staff consultation time required to incorporate precedence and connection matrix techniques in the VATE System, were made available by Hughes Aircraft Company.

Flow diagram and hardware precedence matrix and connection matrix techniques were successfully implemented in the VATE simulator, and a number of test runs were made with an operational automatic checkout program. This section contains a detailed description of the implementation; the following section contains an evaluation of the results of the implementation.

B. METHOD OF IMPLEMENTATION

In order to implement precedence and connection matrix techniques in the VATE System, the following elements were required to produce a simulation system modified by the techniques:

- Specifications for the HCM-111 and its programming system.
- A link between the precedence and connection matrices and the execution of computer program instructions.
- A precedence matrix for the hardware precedences.
- A precedence matrix for the flow diagram precedences.
- A connection matrix for the connections between the automatic checkout equipment and the prime equipment.

- The simulation computer program.

- A set of computer program modules incorporated in the simulator to test the consistency of the precedence matrices, to read and write data, to test conformance of the order of execution of instructions with the precedences as manifested by the precedence matrices, and to test the validity of requested connections between the automatic checkout and prime equipment.

- An operational automatic checkout computer program with which to validate the techniques.

Given all of these elements, the modified simulation system operates as follows. The precedence and connection matrices, and the data required to relate these to the execution of the object program, are read. The precedence matrix is checked for consistency, and diagnostics are written if inconsistencies are found. The operational automatic checkout program (system program) is then read.

As each instruction of the system program is executed, the data relating instructions to the precedence matrix is used to determine if the precedence matrix has been referenced. If not, execution proceeds. If the matrix has been referenced, the precedences are checked to determine if any have been violated. The connection matrix is then checked to determine if the proper connections have been made.

If violation of precedences or connections occur, diagnostics are written, and the program is terminated. If violations do not occur, comments to that effect are written, and execution of the system program proceeds. Each element of the modified simulation system will now be described in detail.

1. Specifications of the HCM-111 and Its Programming System

The Hughes Aircraft Company HCM-111 is a drum-storage stored program computer with approximately 40,000, 22-bit words of storage. The rotating drum has 128 channels or tracks, most of which contain 320 words or sectors. The instruction repertoire of twenty-three orders varies in format, but basically, each order specifies the channel from which the next order is to be read, the function to be performed by the present order, and the number of sectors to wait (words-to-wait) before reading the order from the next channel.

Thus, if we are presently executing a transfer order from channel 160, sector 100, the next channel to be read is 165, and the words-to-wait are 150; then the next order will be executed from channel 165, sector 251. Channels, sectors, and words-to-wait are expressed in the octal number system, that is, to the base 8, rather than in the decimal system.

A detailed description of the instruction repertoire of the HCM-111 and, in fact, of the entire VATE System, is contained in a five volume set of manuals prepared by Hughes Aircraft Company - VATE Project - Technical

Training Section - and will not be presented here. However, the specific order used to relate hardware activation to the precedence matrix will be discussed.

Digital and analog outputs from the HCM-111 to the automatic checkout equipment and prime equipment, and inputs from these equipments to the HCM-111 are effected by reference to "P," which is the designation of the computer logic and registers which process digital and analog inputs and outputs. Basically, when an order causes information to be sent to P (P as a destination), digital or analog outputs are sent to the automatic checkout equipment and prime equipment. When information is required from P (P as a source), digital or analog inputs from the equipments are derived.

A number of orders can have P as a source and can consequently derive analog or digital inputs. However, the TPK order is the only order in which P is a destination and is consequently the only order which creates digital or analog outputs. Therefore, to simplify modification of the HCM-111 simulator, the TPK order was chosen as the link between the hardware activation precedence matrix and the execution of the operational automatic checkout program.

It is necessary to understand the TPK order in order to understand its use in the implementation of precedence and connection matrix techniques. Suppose the instruction 165TPK001 is stored in channel 165, sector 100 (165.100) and the constant 13770131 is stored in channel 165, sector 101 (165.101). The interpretation of the instruction 165TPK001 is the following: "use the constant stored in 165.101 to create an output to the equipments."

The last three octal digits, 131, of the constant in 165.101 determine whether the output will be digital or analog. They also determine, for analog outputs, which of 64 DC analog memory devices will be selected and, for digital outputs, which of 65 groups of 10 digital outputs (toggle circuits) will be selected.

If a digital output has been referenced, the first ten binary digits (1377=1101111111) of the constant in 165.101 determine the setting (open or ground) of each of ten toggle circuits. If an analog output has been referenced, the first nine bits of the constant are the magnitude (with sign) of the adjustment factor to be applied to the selected analog device.

2. Link Between the Precedence and Connection Matrices and the Execution of Computer Program Instructions

From the above discussion of the TPK instruction, a method of linking hardware precedence and connection matrices to the execution of the checkout program becomes apparent. Digital and analog outputs can be sent to the equipments only by use of a TPK order. Therefore, when the simulator processes a TPK order, a check is made to determine if the precedence matrix has been referenced.

For hardware precedences, the links between the precedence matrix and the checkout program are lists (link lists) of the values that the

constants following the TPK orders will have for the TPK orders that correspond to the initiation and termination of each step in the precedence matrix. For example, if the first step in the precedence matrix is initiated by a TPK order stored in 167.100 and is terminated by a TPK in 162.253, then the first entry in the starting link list will be the value of the constant in 167.101 and in the ending list will be the value of the constant in 162.254.

Flow diagram precedences can be independent of hardware since they can express the flow of computation rather than of hardware activations. To encompass both cases, flow diagram precedences are linked to the checkout program by the HCM-111 locations at which the steps of the flow diagram are initiated and terminated.

For example, if the instruction which initiates the third step in the precedence matrix is executed in 155.320, and that which terminates the third step is executed in 157.113, then the third entry in the flow diagram starting link list will be 157.113 and in the flow diagram ending link test will be 155.320.

Connections between the automatic checkout equipment and the prime equipment occur with digital output hardware activations, with a TPK order creating the digital output. The high order ten binary digits of the constant following the TPK order contain the settings of toggle switches which ultimately create a link between the equipments.

The links between the connection matrix and the checkout program are 1) a list of all permissible combinations of ten bits, 2) for each permissible combination of ten bits, the column in the connection matrix which corresponds to the component in the automatic checkout system at one end of the connection, and 3) the column which corresponds to the component in the automatic checkout equipment at the other end of the connection.

3. Construction of Precedence, Connection, and Link Matrices

The hardware precedence matrix represents the constraints on the order in which elements of the hardware can be activated. The flow diagram precedence matrix represents the constraints on the order in which program steps may be executed. The connection matrix represents the connections which exist between the automatic checkout equipment and the prime equipment. The link matrices link the precedence and connection matrices to the execution of the automatic checkout program.

The hardware precedence and connection matrices are constructed from a knowledge of the flow of computation of the automatic checkout program and of the HCM-111 locations in which selected orders are executed. The construction of each type of matrix will be treated in detail in a later section in which the use of these matrices with a selected automatic checkout program is described.

4. The HCM-111 Simulation Program

The HCM-111 simulator is a several thousand instruction simulation computer program written for the IBM 7090 in assembly language (FAP). The simulator executes HCM-111 orders in a manner not identical, but very similar, to their execution in the HCM-111 itself. The simulator reads an HCM-111 program and additional data which tell the simulator, among other things, where to start and stop execution, which HCM-111 channels can be used for storing orders, and the sequence of values which should be input from the hardware if it is desired that the values be non-zero.

The simulator performs many tests on an order before it is executed. For example, it tests that the order is indeed an order and not a constant. It tests the operation code of the order for validity, and it tests that the value of words-to-wait is within allowable limits. The simulator does not test the order of execution against the hardware precedences or flow diagram precedences, or the validity of connections, although it does produce a listing which could be used to make these tests by hand.

There is a unique set of instructions in the simulator which process the TPK order. A transfer was inserted among these instructions to the computer program modules which process hardware precedence and connection matrices. There is a location in the simulator that is executed for all instructions. A transfer to the computer program module which processes flow diagram precedence matrices was inserted at that location.

5. Computer Program Modules for Precedence and Connection Matrices

Appendix I contains a prose description, flow charts, and a computer program listing of the program modules which were written to implement the use of precedence and connection matrices in the VATE System. The following description of the modules is qualitative and brief and is included here to facilitate the understanding of subsequent material.

Six computer program modules were written for use with the simulator. The six modules are named as follows:

- MAIN PROGRAM
- READ
- WRITE
- START
- CHEKIN
- PREC

MAIN PROGRAM is a small FORTRAN routine which controls the order of execution of the five other subroutines and the simulator.

READ is a FORTRAN subroutine which reads all of the required information, including matrices.

WRITE is a FORTRAN subroutine which writes all of the diagnostics and comments which result from testing for precedences and connections.

START is a FAP subroutine which tests the precedence matrices for consistency.

CHEKIN is a FAP subroutine that tests the flow diagram precedence matrix for violations of precedences when the precedence matrix has been referenced during the execution by the simulator of a checkout program order.

PREC is a FAP subroutine that tests the hardware precedence matrix for violations of precedences, and the connection matrix for illegal connections, when these matrices have been referenced during execution of the simulator.

The Main Program calls READ which reads the dimension of the matrices, the matrices themselves, and a constant which indicates the type of precedence matrix that was read - flow diagram or hardware. START is then called to test the precedence matrix for consistency using the row and column deletion method. If the matrix is not consistent, diagnostic information is written, and the program is terminated.

If the precedence matrix is consistent, a comment to that effect is written, and the HCM-111 simulator is called. The simulator reads the automatic checkout program to be executed and proceeds to process the program. If the precedence matrix is a hardware type, each TPK instruction causes PREC to be called, which tests the constant in K to see if the precedence matrix is referenced. If not, return is made to the simulator and processing continues.

If the TPK instruction references the precedence matrix, the precedences and connections are tested for violations. If violations occur, diagnostics are written and the program is terminated. If they do not occur, a comment to that effect is written and return is made to the simulator.

If the precedence matrix is a flow diagram type, CHEKIN is called as each new order of the checkout program is processed. If the location of that order references the precedence matrix, the precedences are tested, and the program is terminated if violations exist or return is made to the simulator if violations do not exist.

6. Operational Automatic Checkout Programs

The D17 Computer Voltage Output Diagnosis automatic checkout program was used to validate the precedence and connection matrix.

techniques. The D17 program is designed to load and execute instructions in the D17 computer which force the voltage output logic and registers to assume predetermined logic states. If the voltage output logic is faulty, the voltage output registers will assume other than the predetermined logic states.

The program operates in eight sequential segments; the D17 must sequentially pass all eight segments before the voltage output logic may be considered to be functioning correctly. The functions of the eight segments are the following:

- Segments 1 and 2 determine if it is possible to reset all the voltage output flip-flops to their false and true states, respectively.
- Segment 3 determines if any of the set-reset gates for specified flip-flops are faulty.
- Segment 4 determines if the logic driver can be set false.
- Segment 5 determines if specified logic drivers and the corresponding AND-diodes on two primary-AND gates are functioning properly.
- Segment 6 checks specified timing terms and a diode on a specified primary AND gate.
- Segments 7 and 8 check specified diodes on two primary AND gates.

C. DETAILS OF IMPLEMENTATION WITH OPERATIONAL AUTOMATIC CHECKOUT PROGRAM

The modified simulation system was used to process the D17 Computer Voltage Output Diagnosis automatic checkout program (D17 Program). The following six steps in the D17 Program were used to construct a hardware precedence matrix, a connection matrix, and link matrices:

1. Set loading digital outputs.
2. Reset digital outputs CIT and ECI.
3. Set digital output DFF.
4. Set digital output HLT off, digital outputs RUN and SCY on.
5. Set master reset.
6. D17 synchronized, reset master reset.

Each of the six steps correspond to a single TPK order, so that the initiating and terminating order for each step are identical. The channel and sector of execution, and the value of K for each of the steps are the following:

	Channel and Sector	Order	K	Step
1.	160.154	160TPK001	0.1610124	Set Loading DOS
2.	160.374	160TPK001	0.7550135	Reset DOCIT, DOECI
3.	160.376	160TPK001	1.3770131	Set DODFF
4.	160.402	160TPK004	0.2600132	Set DOHLT OFF, DORUN, DOSCY ON
5.	160.407	160TPK001	0.0000136	Set MASTER RESET
6.	160.131	160TPK001	1.0000136	SYNCHED, RESET MASTER RESET

The hardware precedences constrain the six steps to be performed in the order given. Thus, step 1 must precede step 2, step 2 must precede step 3, step 3 must precede step 4, step 4 must precede step 5, and step 5 must precede step 6. The precedence matrix is the following, where an entry of 1 indicates that the step for the row containing the 1 precedes the step for the column containing the same 1:

		COLUMN					
		1	2	3	4	5	6
ROW	1		1				
	2			1			
	3				1		
	4					1	
	5						1
	6						

The KFIRST and KSEC link lists, which contain the value of K for each reference to the start and end of a precedence matrix step, are the following:

	KFIRST	KSEC
1.	000001610124	000001610124
2.	000007550135	000007550135
3.	000013770131	000013770131
4.	000002600132	000002600132
5.	000000000136	000000000136
6.	000010000136	000010000136

The connection matrix is the following, where a 1 represents a link between the row entry device and the column entry device for the row and column in which the 1 appears:

		PRIME EQUIPMENT					
		1	2	3	4	5	6
AUTOMATIC CHECKOUT EQUIPMENT	1	0	1	0	0	0	0
	2	1	0	0	0	0	0
	3	1	0	0	0	0	0
	4	0	0	1	1	0	0
	5	0	1	0	0	0	0
	6	0	0	0	0	0	0

The connection link list contains a list of all permissible bit configurations and the row and column of the connection matrix referenced by each bit configuration. The bit configuration appears in the middle four octal digits, the column referenced appears in the next to the last octal digit, and the row in the low order octal digit. The connection link list is the following:

1. 000001610102
2. 000007550103
3. 000013770201
4. 000002600205
5. 000000000304
6. 000010000404

For the flow diagram precedence matrix, seven program steps were chosen. The steps are executed in the following channels and sectors:

STEP	CHANNEL AND SECTOR
1	166.111
2	014.420
3	174.100
4	160.154
5	160.120
6	161.101
7	176.157

The program flow is from step 1 to step 2 to step 3 to step 4, loop back to step 2, then to step 3, to step 5, loop back to step 2, then to step 3, to step 6, to step 7, and out. The precedence matrix is the following, where 1 is as described above, and a -1 represents a loop back to a previously executed step:

		COLUMN						
		1	2	3	4	5	6	7
	1	0	1	0	0	0	0	0
	2	0	0	1	0	0	0	0
	3	0	0	0	1	1	1	0
ROW	4	0	-1	0	0	0	0	0
	5	0	-1	0	0	0	0	0
	6	0	0	0	0	0	0	1
	7	0	0	0	0	0	0	0

The KFIRST and KSEC link lists are the following:

	KFIRST	KSEC
1.	000000166111	000000166111
2.	000000014420	000000014420
3.	000000174100	000000174100
4.	000000160154	000000160154
5.	000000160120	000000160120
6.	000000161101	000000161101
7.	000000176157	000000176157

Appendix II contains listings of the execution of the D17 Program with the modified simulation system for each of the following conditions:

1. No precedences or connections specified.

2. The hardware precedence matrix, connection matrix, and KFIRST and KSEC lists given above.

3. A modified hardware precedence matrix for which the D17 Program will violate precedences.

4. A modified connection matrix for which the D17 Program will call for invalid connections.

5. The flow diagram precedence matrix and KFIRST and KSEC lists given above.

6. A modified flow diagram precedence matrix for which the D17 Program will violate precedences.

7. An inconsistent flow diagram precedence matrix.

It is seen from Appendix II that comments that the precedence and connections were valid were written when no violation occurred and that diagnostics were written when precedences were violated or connections were not valid. In addition, a comment was written when the precedence matrix was consistent, and diagnostics were written when the precedence matrix was inconsistent.

SECTION VI

EVALUATION OF IMPLEMENTATION IN VATE SYSTEM OF PRECEDENCE AND CONNECTION MATRIX TECHNIQUES USED WITH TOTAL SIMULATION METHODS

A. INTRODUCTION

Precedence and connection matrix techniques developed in this study are general techniques and are intended to be applicable to any computer-controlled automatic checkout system. The techniques were implemented in the VATE System to assess their practicability and to gain a clearer insight into the general problems that are encountered in implementing these techniques in operational systems. One implementation does not establish a general case, but the following evaluations are felt to be reasonable ones.

B. EVALUATION OF HARDWARE PRECEDENCE MATRIX TECHNIQUES

Although hardware precedences can be used to detect errors in operational automatic checkout programs, they are usually not very restrictive. That is, there are normally not very many physical constraints on the sequencing of hardware activation. However, hardware precedences have the advantage of being independent of the computer programs used to test the hardware and of being invariant for as long as the hardware remains unchanged. The hardware precedence and link matrices can be constructed and used unchanged for relatively long periods.

C. EVALUATION OF FLOW DIAGRAM PRECEDENCE MATRIX TECHNIQUES

Flow diagram precedences can be useful in detecting errors in any type of computer program and, specifically, in operational automatic checkout programs. The two difficulties in using them are: 1) they are a function of the desired order of execution of program steps and are subject to frequent change and to greater error in constructing the precedence matrix, and 2) the link matrix may have to contain the location in computer storage in which the steps are executed, in which case it, too, is subject to frequent change because of changes in the coding or in the program steps.

The second difficulty can be minimized if, for each program step, there exists a unique state of some computer register which is not a function of the location of execution of program steps. In the VATE System, the "P" register satisfied this condition for all steps which created analog or digital outputs. The unique states of the register will be invariant, and the link matrix need be changed only when new steps are added to the precedence matrix rather than each time the coding of the program is changed manually or the program is recompiled.

If a compiler language exists for writing automatic checkout programs, then the link matrix can be generated automatically by marking

the start and end of steps, perhaps with special tags, and including computer program modules in the compiler which will generate and write out either the location of execution of the steps or the unique states of some register. This process would minimize the effort and the errors attendant on the construction of the link matrix.

Difficulties in constructing precedence matrices for flow diagram precedences may be minimized by careful construction of the balloon chart illustrated in Figure 3 and careful translation of the balloon chart into the precedence matrix. Alternatively, the precedence matrix could be constructed with and without the use of the balloon chart and the two matrices checked for identity.

D. EVALUATION OF CONNECTION MATRIX TECHNIQUES

Connection matrix techniques are useful in detecting errors in operational automatic checkout programs. The greater the number of possible connections, the more useful are the techniques. In the VATE System, the link matrix could have sufficed to determine legitimate connections without the connection matrix because the link matrix listed all of the bit configurations which represented legitimate connections. However, if the link matrix was constructed as the ultimate list of legitimate connections, but all connections may not yet have been effected, than a connection matrix would be required and could be updated as connecting lines were installed in the operational system.

E. EVALUATION OF PROGRAMMING AND SPACE REQUIREMENTS

The effort required to incorporate precedence and connection matrix techniques in a simulation system is relatively small compared to the effort required to write the total simulation system. However, the space required may be not inconsiderable. If there are N rows in both the precedence and connection matrices, then approximately $3N^2 + 9N$ locations are required for storage of matrices and about 1,000 locations for storage of other data. If there are 30 rows in both the precedence and connection matrices, then roughly 4,000 locations would be required. Sophisticated programming techniques could reduce this requirement. The fact that a simulation is usually written for a larger computer also reduces the severity of this condition.

F. EVALUATION OF SIDE-BENEFIT OF CONSTRUCTION OF MATRICES

The necessity for constructing precedence, connection, and link matrices has a side-benefit in that it requires the person, probably a test engineer, who is forming the precedence and connection matrices to study the precedences and connections in detail and to verify their accuracy and representativeness by various methods. It requires the person, probably an engineer-programmer, who is constructing the link matrices, to study the relation between the program and the hardware in detail. The procedures are desirable even if the matrices are not subjected to machine processing.

SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

The practicability of using precedence and connection matrix techniques with total simulation methods to detect errors in operational automatic checkout computer programs has been demonstrated by implementing the techniques in the VATE System. The techniques should be practicable for any computer-controlled automatic checkout system for which a simulation computer program exists for a large scale computer. If the simulation is written for a smaller computer, storage problems must be analyzed carefully.

The practicability of using precedence and connection matrix techniques with partial simulation methods was not demonstrated with an implementation, but appears to be reasonable. The method has the advantage of requiring only a partial simulation, which entails considerably less effort and storage than a total simulation. It might be possible to implement this method on a medium or small-scale computer.

On the basis of this study, the following recommendations are made:

1. Development of precedence and connection matrix techniques used with total and partial simulation methods should be continued to the point that implementation in any computer-controlled automatic checkout system can be made with minimum effort.

2. Modification of the methods to include automatic error correction, as well as detection, should be investigated.

3. Compiler languages and systems developed for processing automatic checkout computer programs should have provision for the inclusion of modules to process precedence and connection matrix related statements.

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APPENDIX I

COMPUTER PROGRAM MODULES FOR IMPLEMENTATION OF PRECEDENCE AND CONNECTION MATRIX TECHNIQUES

A. INTRODUCTION

Six computer programs were written to implement precedence and connection matrix techniques. They were: MAIN PROGRAM, READ, WRITE, START, CHEKIN, and PREC. MAIN PROGRAM controls the flow of the other five programs. The READ program reads the input data. The WRITE program writes diagnostics and comments. START checks the consistency of the precedence matrix. CHEKIN checks flow diagram precedences. PREC has, as entry points, PINMAT and POUTMT which check hardware precedences. CHEKIN is actually a third entry point of PREC.

Communication between programs is accomplished by use of the FORTRAN COMMON feature. By means of a COMMON statement, variables are placed in a given order at the high order locations in core storage. If all programs have the same COMMON statements, then variables placed in COMMON will have the same location for all programs and can be passed on from one program to the next. The COMMON variables, their meanings, and the present size of variable arrays are the following:

ACON is a 75 x 1 array which contains all of the valid bit configurations for connections from the prime equipment to the automatic checkout equipment.

BCNT is the number of lines of output which have been stored in the write buffer of the VATE simulator.

BCON is a 75 x 1 array which contains all of the valid bit configurations for connections from the automatic checkout equipment to the prime equipment.

COLUMN is temporary storage used in START and PREC.

CONMAT is the 25 x 25 connection matrix.

DATAD is the value in the VATE simulator of the constant following a TP instruction.

ENDYET is a flag to signal that a precedence matrix step has started (1) or ended (0).

FDORTP is an input value which signals that flow diagram precedences (1) or hardware precedences (2) are being processed.

KFIRST is a 25 x 1 array which contains the links between the start of precedence matrix steps and the execution of automatic checkout program instructions.

KSEC is a 25 x 1 array which contains the links between the end of precedence matrix steps and the execution of automatic checkout program instructions.

KTEMER is a variable whose value signals the diagnostic or comment to be written by WRITE.

KWUNS is a 25 x 1 array whose values indicate that a row in the precedence matrix and its corresponding column do (0) or do not (1) contain all zeros.

KXNUM is an input value which is the number of rows in the precedence matrix. It is synonymous with NN.

KXNUMA = KXNUM + 1.

KXSQ = (KXNUM) x (KXNUM).

LUPZER is a variable which contains the number of the column in the precedence matrix in which a -1 was zeroed out. If the row corresponding to that column is executed, then a legitimate loop has been entered.

MATRIX is the 25 x 25 precedence matrix.

NEWMAT is the 25 x 25 precedence matrix whose elements are never altered. It is used to restore MATRIX.

NN is an input value which is the number of rows in the precedence matrix. It is synonymous with KXNUMA.

NPLUS1 = NN + 1.

NSQ = (NN) x (NN).

N2MINN = NSQ - NN.

N2MIN1 = NSQ - 1.

N2MNP1 = NSQ - NN + 1.

SECEX is the sector referenced by the instruction being executed by the VATE simulator.

SGNC is the channel of the instruction being executed by the VATE simulator.

SGNL is the sector of the instruction being executed by the VATE simulator.

SGXC is the channel referenced by the instruction being executed by the VATE simulator.

The computer programs MAIN PROGRAM, READ, WRITE, START, CHEKIN, and PREC are documented in detail on the following pages.

B. MAIN PROGRAM

1. Purpose

MAIN PROGRAM provides executive control over the flow of information through subroutines READ, WRITE, VATE, START, CHEKIN, and PREC.

2. Input Formats

No input data is required for MAIN PROGRAM.

3. Output Formats

There is no output data from MAIN PROGRAM.

4. Method

MAIN PROGRAM calls START, VATE, and then calls EXIT to terminate the run.

5. Error Checks and Diagnostic Printouts

MAIN PROGRAM contains no error checks or diagnostic printouts. They are part of subroutines READ, WRITE, VATE, START, CHEKIN, and PREC.

6. Listings

The following is a listing of MAIN PROGRAM:

```
*       LIST8
*       LABEL
*       FORTRAN
CMAIN PROGRAM
      CALL START
      CALL VATE
      CALL EXIT
      END
```

C. SUBROUTINE READ

1. Purpose

Subroutine READ reads all of the input data, except for the operational automatic checkout program, and writes out the input data.

2. Input Formats

A sample listing of input data is given on the following page. The precise format of the input data, which is on punched cards, is the following:

a. The first input card contains, in columns 1-5, the dimension of the precedence matrix, that is, the number of rows in the precedence matrix. The number must end in column 5.

b. The next set of input cards contains the KFIRST link matrix which is the link between the start of each precedence matrix step and the execution of the object program. There are as many entries as steps in the precedence matrix. Each entry is twelve octal digits and ends in a column which is a multiple of 20. Thus, the four entries on a card would be punched in columns 9-20, 29-40, 49-60, and 69-80. If there were 10 KFIRST entries, 3 cards would be required. For hardware precedences, each entry would have four leading zeros followed by the eight octal digits of the constant following the TPK instruction. For flow diagram precedences, each entry would have 6 leading zeros followed by the six octal digits which are the channel and sector in which the instruction which begins a precedence matrix step is executed.

c. The next set of input cards contains the KSEC matrix which is the link between the end of each precedence matrix step and the execution of the object program. The format is exactly the same as for the KFIRST matrix.

d. The next set of input cards contains MATRIX which is the precedence matrix. The matrix is entered by columns from left to right, and each entry occupies two columns, one for sign, and the other for magnitude. For positive numbers, the sign column may be left blank. All 80 columns are used unless there are less than 80 entries. For example, a 6 x 6 matrix would use only 72 columns; a 7 x 7 matrix would use all 80 columns of the first card and 18 columns of the second card.

e. The next set of input cards contains CONMAT, the connection matrix. The format is exactly the same as for the precedence matrix. The dimension of CONMAT is taken to be the same as for MATRIX. This will not always hold true. The program should probably be modified to allow entry of the dimension of CONMAT separately.

f. The next set of input cards contains the ACON matrix, which is the listing of all bit configurations which represent legitimate connections which would carry inputs from the hardware. The format and dimension is

SAMPLE LISTING OF INPUT DATA FOR HARDWARE PRECEDENCES

```
    6
        000001610124        000007550135        000013770131        000002600132
        000000000136        000010000136
        000001610124        000007550135        000013770131        000002600132
        000000000136        000010000136
0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0
0 1 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

        000001610102        000007550103        000013770201        000002600205
        000000000304        000010000404
    2
```

SAMPLE LISTING OF INPUT DATA FOR FLOW DIAGRAM PRECEDENCES

```
    7
        000000166111        000000014420        000000174100        000000160154
        000000160120        000000161101        000000176157
        000000166111        000000014420        000000174100        000000160154
        000000160120        000000161101        000000176157
0 0 0 0 0 0 0 1 0 0-1-1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0
0 0 0 0 0 0 0 1 0
```

exactly the same as for the KFIRST matrix, except that the leading eight octal digits represent the connection bit configuration, the ninth and tenth digits are the column referenced in the connection matrix, and the eleventh and twelfth are the row.

g. The next set of input cards contains the BCON matrix, which is the listing of all bit configurations which represent legitimate connections which would carry outputs to the hardware. The format is exactly the same as for the ACON matrix. CONMAT, ACON, and BCON must be included even for flow diagram precedences, in which case the appropriate number of blank cards may be used.

h. The last input card contains a 1 or a 2 in column 5 and is the value of FDORTP. A 1 means that the input is for flow diagram precedences; a 2 is for hardware precedences.

3. Output Formats

Each input card is reproduced in the output exactly as it is read, except that FDORTP is written out in column 3.

4. Method

READ is called by, and returns to, subroutine START. The detailed program steps are the following:

1. The first input card is read, stored in KXNUM, and written out.

2. KXSQ is set equal to (KXNUM) x (KXNUM).

3. KFIRST, KSEC, MATRIX, CONMAT, ACON, BCON, and FDORTP are each read, stored, and then written.

4. NN is set equal to KXNUM.

5. NSQ is set equal to KXSQ.

6. Return is made to the calling routine.

5. Error Checks and Diagnostic Printouts

READ contains no error checks or diagnostic printouts.

6. Limitations and Restrictions

CONMAT, ACON, and BCON must be entered even for flow diagram precedences, in which case the appropriate number of blank cards will be used. For KXNUM = 7, for example, 6 blank cards would be used.

7. Listings

A listing of READ is given on the following page.

LISTING OF SUBROUTINE READ

```
*       LIST8
*       LABEL
*       FORTRAN
CREAD
        SUBROUTINE READ
        DIMENSION MATRIX(625),KFIRST(25),KSEC(25),KWUNS(25),
       1 NEWMAT(625),ACON(75),BCON(75),CONMAT(625)
        COMMON CATAC,MATRIX,NEWMAT,KFIRST,KSEC,KWUNS,KTEMER,KXNUM,KXNUMA,
       1 NN,LUPZER,COLUMN,ENDYET,NSQ,N2MINN,N2MNP1,NPLUS1,N2MIN1,
       2 CONMAT,ACON,BCON,KXSQ,SGNC,SGNL,SGXC,SECEX,BCNT,FDORTP
        READ INPUT TAPE 5,10,KXNUM
        WRITE OUTPUT TAPE 6,10,KXNUM
        KXSQ=KXNUM*KXNUM
        READ INPUT TAPE 5,20,(KFIRST(J+1),J=1,KXNUM)
         WRITE OUTPUT TAPE 6,20,(KFIRST(J+1),J=1,KXNUM)
        READ INPUT TAPE 5,20,(KSEC(J+1),J=1,KXNUM)
        WRITE OUTPUT TAPE 6,20,(KSEC(J+1),J=1,KXNUM)
        READ INPUT TAPE 5,30,(MATRIX(J+1),J=1,KXSQ)
        WRITE OUTPUT TAPE 6,30,(MATRIX(J+1),J=1,KXSQ)
        READ INPUT TAPE 5,30,(CONMAT(J+1),J=1,KXSQ)
        WRITE OUTPUT TAPE 6,30,(CONMAT(J+1),J=1,KXSQ)
        READ INPUT TAPE 5,20,(ACON(J+1),J=1,KXNUM)
        WRITE OUTPUT TAPE 6,20,(ACON(J+1),J=1,KXNUM)
        READ INPUT TAPE 5,20,(BCON(J+1),J=1,KXNUM)
        WRITE OUTPUT TAPE 6,20,(BCON(J+1),J=1,KXNUM)
         READ INPUT TAPE 5,40,FDORTP
         WRITE OUTPUT TAPE 6,50,FDORTP
 40      FORMAT(I5)
 50      FORMAT(1X12)
 10     FORMAT(I5)
 20      FORMAT(4(8XC12))
 30      FORMAT(4012)
        NN=KXNUM
         NSQ=KXSQ
        RETURN
        END
```

D. SUBROUTINE WRITE

1. Purpose

Subroutine WRITE writes out the comments and diagnostics which are generated by subroutines START, CHEKIN, and PREC.

2. Input Formats

Input to WRITE is through locations in COMMON. The locations required are KTEMER, MATRIX, KXSQ, KWUNS, NN, SGNC, SGNL, SGXC, SECEX.

3. Output Formats

The following outputs may be written by WRITE:

a. "CONSISTENT MATRIX," if START has verified the consistency of a precedence matrix.

b. "INCONSISTENT MATRIX," if START has discovered an inconsistency in a precedence matrix. The matrices MATRIX and KWUNS will also be written.

c. "ERROR NUMBER___," if an error has occurred in CHEKIN or PREC. The error numbers indicate the following types of errors:

ERROR NUMBER 2 - Present step started before previous step ended (CHEKIN or PREC).

ERROR NUMBER 3 - Number other than -1, 0, 1, or 2 in precedence matrix (CHEKIN or PREC).

ERROR NUMBER 4 - Precedences not satisfied (CHEKIN or PREC).

ERROR NUMBER 5 - Connection not in ACON matrix (PREC).

ERROR NUMBER 6 - Connection not in BCON (PREC).

ERROR NUMBER 11 - Connection not valid (PREC).

d. "PRECEDENCE OK FOR START OF STEP," if CHEKIN or PREC has verified that the start of a precedence matrix step satisfies precedences.

e. "PRECEDENCE OK FOR END OF STEP," if CHEKIN or PREC has verified that the end of a step satisfies precedences.

f. "SGNC. SGNL, SGXC. SECEX," each time CHEKIN or PREC is entered.

g. "CONNECTIONS OK," if PREC has verified that a requested connection is valid.

h. "PRECEDENCE OK FOR ENTRY INTO LEGITIMATE LOOP," if CHEKIN or PREC processes an instruction which is an entry point into a legitimate loop.

4. Method

Write is called by subroutines START, CHEKIN, AND PREC. The details of the method are the following:

a. KTEMER has values from zero to twelve. For use as an index, KTEMER is incremented by 1, and KTEM is set equal to this value. A "GO TO" statement is now executed with KTEM as the index.

b. For KTEMER=0 (KTEM=1), the comment "CONSISTENT MATRIX" is written and return is made to the calling routine.

c. For KTEMER=1 (KTEM=2), the comment "INCONSISTENT MATRIX" is written, and the matrices MATRIX and KWUNS are written. MATRIX contains the values of the precedence matrix at the time that the inconsistency in the matrix is diagnosed. The non-zero, non-negative elements are an aid to diagnosing the inconsistency. An additional diagnostic aid is the KWUNS matrix which contains 1's for rows or columns not zeroed out and zeros otherwise. Return is then made to the calling routine.

d. For KTEMER=2, 3, 4, 5, and 6 (KTEM=3, 4, 5, 6 and 7), a set of instructions in the VATE simulator whose entry point is OUTPDM is called. This causes the VATE output storage region to be written out and to be reinitialized. This is necessary because VATE stores 5 lines (110 words) of data and then writes out the 5 lines in blocked output. If this information is not written out before DUMP is called, it will be lost. The diagnostic "ERROR NUMBER " is then written with the value of KTEMER, and exit is made to the FORTRAN DUMP routine.

e. For KTEMER=7 (KTEM=8), OUTPDM is called to empty the VATE buffer. This is done so that the comment which is about to be written will immediately precede the line of data to which it refers. The comment "PRECEDENCE OK FOR START OF STEP" is then written and return is made to the calling routine.

f. For KTEMER=8 (KTEM=9), the same sequence as in step e is performed, except that the comment "PRECEDENCE OK FOR END OF STEP," is written.

g. For KTEMER=9 (KTEM=10), OUTPDM is called, the values of SGNC, SGNL, SGXC, and SECEX are written, and return is made to the calling routine.

h. For KTEMER=10 (KTEM=11), the comment "CONNECTIONS OK" is written and return is made to the calling routine.

i. For KTEMER=11 (KTEM=12), the same sequence as in step d is performed.

j. For KTEMER=12 (KTEM=13), the comment "PRECEDENCE OK FOR ENTRY INTO LEGITIMATE LOOP" is written and return is made to the calling routine.

5. Error Checks and Diagnostic Printouts

There are no error checks. The diagnostic printouts are listed in "Output Formats."

6. Limitations and Restrictions

There are presently thirteen diagnostics. To add a diagnostic for new values of KTEMER, it is necessary only to add statement numbers to the "GO TO" statement and coding at those statement numbers which print comments or diagnostics.

7. Listings

A listing of WRITE is given on the following page.

LISTING OF SUBROUTINE WRITE

```
*      LIST8
*      LABEL
*      FORTRAN
       SUBROUTINE WRITE
       DIMENSION MATRIX(625),KFIRST(25),KSEC(25),KWUNS(25),
      1 NEWMAT(625),ACON(75),BCON(75),CONMAT(625)
       COMMON DATAC,MATRIX,NEWMAT,KFIRST,KSEC,KWUNS,KTEMER,KXNUM,KXNUMA,
      1 NN,LUPZER,COLUMN,ENDYET,NSQ,N2MINN,N2MNP1,NPLUS1,N2MIN1,
      2 CONMAT,ACON,BCON,KXSQ,SGNC,SGNL,SGXC,SECEX,BCNT,FDORTP
       KTEM=KTEMER+1
        GO TO (100,200,300,300,300,300,300,400,500,600,700,300,750),KTEM
  100  WRITE OUTPUT TAPE 6,110
  110  FORMAT(19H CONSISTENT MATRIX )
       GO TO 900
  200  WRITE OUTPUT TAPE 6,210
  210  FORMAT(21H INCONSISTENT MATRIX )
       WRITE OUTPUT TAPE 6,220,(MATRIX(J+1),J=1,KXSQ)
  220  FORMAT(4012)
       WRITE OUTPUT TAPE 6,230,(KWUNS(J+1),J=1,NN)
  230  FORMAT(20(2X,I2))
        GO TO 900
  300   CALL OUTPOM
        WRITE OUTPUT TAPE 6,310,KTEMER
  310  FORMAT(14H ERROR NUMBER I3)
       GO TO 800
  400   CALL OUTPOM
        WRITE OUTPUT TAPE 6,410
  410  FORMAT(33H PRECEDENCE OK FOR START OF STEP )
       GO TO 900
  500   CALL OUTPOM
        WRITE OUTPUT TAPE 6,510
  510  FORMAT(31H PRECEDENCE OK FOR END OF STEP )
       GO TO 900
  600   CALL OUTPOM
        WRITE OUTPUT TAPE 6,610,SGNC,SGNL,SGXC,SECEX
  610   FORMAT(1X,C3,1H.,C3,10X,C3,1H.,C3)
       GO TO 900
  700   WRITE OUTPUT TAPE 6,710
  710   FORMAT(16H CONNECTIONS OK )
        GO TO 900
  750   WRITE OUTPUT TAPE 6,760
  760   FORMAT(46H PRECEDENCE OK FOR ENTRY INTO LEGITIMATE LOOP )
        GO TO 900
  800   CALL DUMP
  900  CONTINUE
       RETURN
       END
```

E. SUBROUTINE START

1. Purpose

Subroutine START performs the following functions:

a. START calls READ to read all of the input data except the operational automatic checkout program.

b. START computes a number of values required for subsequent subroutines.

c. START determines whether connections called for in the BCON matrix are valid and marks the entries which are not.

d. START tests the consistency of the precedence matrix and writes a comment if it is consistent or a diagnostic if it is not.

2. Input Formats

Input to START is through locations in COMMON. The locations in COMMON required are MATRIX, KFIRST, KSEC, KXNUM, NN, NSQ, CONMAT, ACON, BCON, KXSQ.

3. Output Formats

Outputs from START are the following:

a. Calls to subroutine WRITE to write "CONSISTENT MATRIX" and return, or "INCONSISTENT MATRIX" and exit.

b. The computation of the values of various COMMON variables required for subroutines CHEKIN and PREC. The COMMON variables which are computed are NEWMAT, KXNUMA, N2MINN, N2MNP1, NPLUS1, N2MIN1.

4. Method

The precedence matrix is tested for consistency by eliminating from the precedence matrix all zero rows and their corresponding columns, and all zero columns and their corresponding rows. If all rows are eliminated, the matrix is consistent. If all rows cannot be eliminated, then the matrix is inconsistent. The details of the program are as follows:

a. The index registers are stored and READ is called to read the input data. KXNUMA, NSQ, N2MINN, N2MNP1, NPLUS1, and N2MIN1 are computed, and NN is placed in the decrement of instructions W3D, W13D, W15D, and W4D. REPEAT, LUPZER, ZERCOL, COLUMN, and ENDYET are initialized to zero.

b. The BCON array contains the bit configurations that represent connections between the automatic checkout equipment and the prime

equipment. Each entry in BCON has the bit configurations in octal digits 1-8, the column in the connection matrix referenced by that configuration in digits 9-10, and the row in digits 11-12. An entry of BCON is picked up, digits 9-10 are stored in COLTEM, and digits 11-12 are stored in ROWTEM.

c. The index of the location in the connection matrix = (COLTEM -1)x(NN) + ROWTEM. Thus, if COLTEM=4, ROWTEM=3, and NN=5, then index = 3(5) + 3 = 18; the location would be the 18th entry in CONMAT. For the BCON entry, the entry in CONMAT is picked up.

d. If the CONMAT entry is zero, there is no connection. The sign of the BCON entry is set negative and stored back into BCON. If the CONMAT entry is non-zero, the sign is not changed.

e. If all BCON entries have not been processed, return is made to step b.

f. If all entries have been processed, the entries in MATRIX are stored permanently in NEWMAT, and all of the entries in KWUN are set to 1. There is an entry for each row of the precedence matrix. When that entry is zero, then the row and its corresponding column contain no positive entries. When the KWUNS entry is a 1, then the row and column each contain at least one positive entry.

g. NN is stored in index registers 4 and 2, and 1 in index register 1.

h. A KWUNS entry is picked up.

i. If the KWUNS entry is a zero, transfer is made to step n. If it is non-zero, a MATRIX column entry is picked up.

j. If the MATRIX column entry is positive, transfer is made to step n. If it is zero or negative, index register 4 is decremented by 1.

k. If not all of the entries in the column have been tested, another column entry is picked up and transfer is made to step j.

l. If all column entries have been tested, a zero is stored in REPEAT to signal that at least one zero column has been found, and a zero is stored in the KWUNS entry for this column. ZERCOL, which contains the number of zero columns, is incremented by 1 and tested to determine if it equals NN.

m. If ZERCOL=NN, then all of the rows and columns of the matrix have been eliminated, and the matrix is consistent. Transfer is made to step x. If ZERCOL≠NN, then the row that corresponds to the present zero column is zeroed out.

n. Index register 1 is incremented by 1 to pick up the next column. The value in index register 1 is multiplied by NN and placed in index register 2 to pick up the last entry in the column. The entries are picked up in reverse order.

o. If index register 1 is not greater than NN, then all the columns have not been processed, and transfer is made to step h. If all the columns have been processed, REPEAT is incremented by 1 and tested for the value 3.

p. If REPEAT=3, then there are no more zero rows or columns and the matrix is inconsistent. Transfer is made to step w. If REPEAT is less than 3, then the rows are to be tested for zero rows.

q. NSQ-NN+1 is placed in XR4 to pick up the last row of the precedence matrix. The rows are picked up in reverse order. NN is placed in index register 2, and 1 is placed in index register 1.

r. A KWUNS entry is picked up. If it is zero, transfer is made to step v. If it is not zero, transfer is made to step s.

s. A MATRIX entry is picked up. If it is non-zero, a transfer is made to step v. If it is zero, NN is subtracted from index register 4 to pick up the next row entry.

t. If all the entries in a row have not been processed, transfer is made to step s. If all have been processed, REPEAT and the KWUNS entry for this row are set to zero, and ZERCOL is incremented by 1.

u. If ZERCOL=NN, the matrix is consistent, and transfer is made to step x. If not, the column that corresponds to the zero row is zeroed out.

v. Index register 1 is incremented by 1 to pick up the next row. The value of (index register 1)+NSQ-NN is placed in index register 4 to pick up the last entry of the next row, and index register 2 is set to NN. If all rows have not been tested, transfer is made to step r. If all rows have been tested, REPEAT is incremented by 1 and tested for the value 3. If REPEAT=3, the matrix is inconsistent, and transfer is made to step w. If REPEAT$\neq$3, transfer is made to step g.

w. KTEMER is set to 1, and WRITE is called to write a diagnostic (INCONSISTENT MATRIX). Transfer is made to step y.

x. KTEMER is set to zero, and WRITE is called to write a comment (CONSISTENT MATRIX).

y. MATRIX is restored from NEWMAT, the index registers are restored, and return is made to the calling routine.

5. Error Checks and Diagnostic Printouts

Two basic error checks are made. First, the BCON entries are checked for invalid connections. If any are found, the BCON entry is made negative. Second, the consistency of the precedence matrix is tested. If it is consistent, a comment to that effect is written by setting KTEMER=0 and calling WRITE. If it is inconsistent, a diagnostic is written by setting KTEMER=1 and calling WRITE.

6. Limitations and Restrictions

All of the matrices must have their elements stored backwards and starting at a location one less than the matrix name. This is the way that READ now stores the matrices. This simplifies the indexing of all of the instructions that process the matrices.

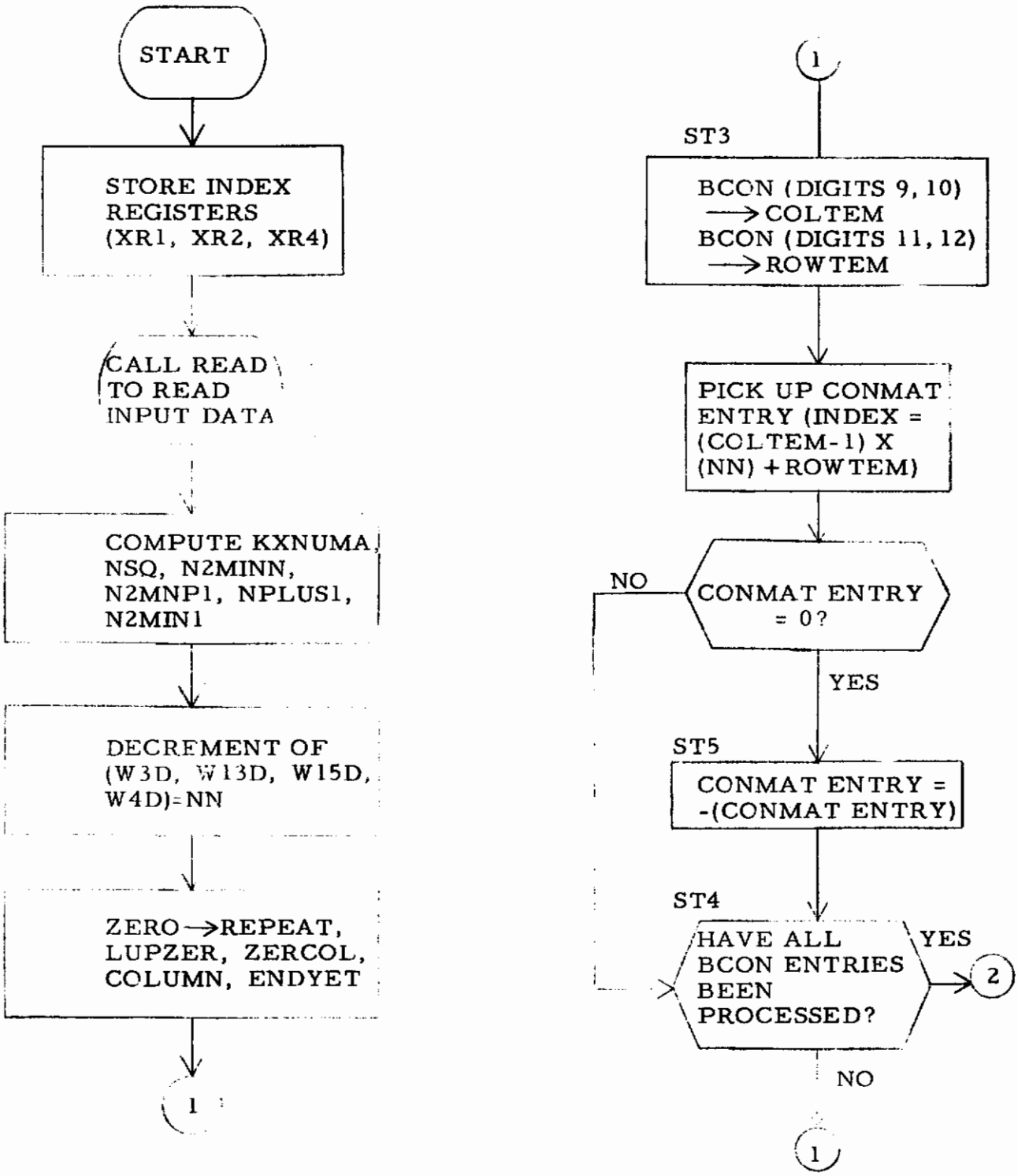
7. Flow Charts

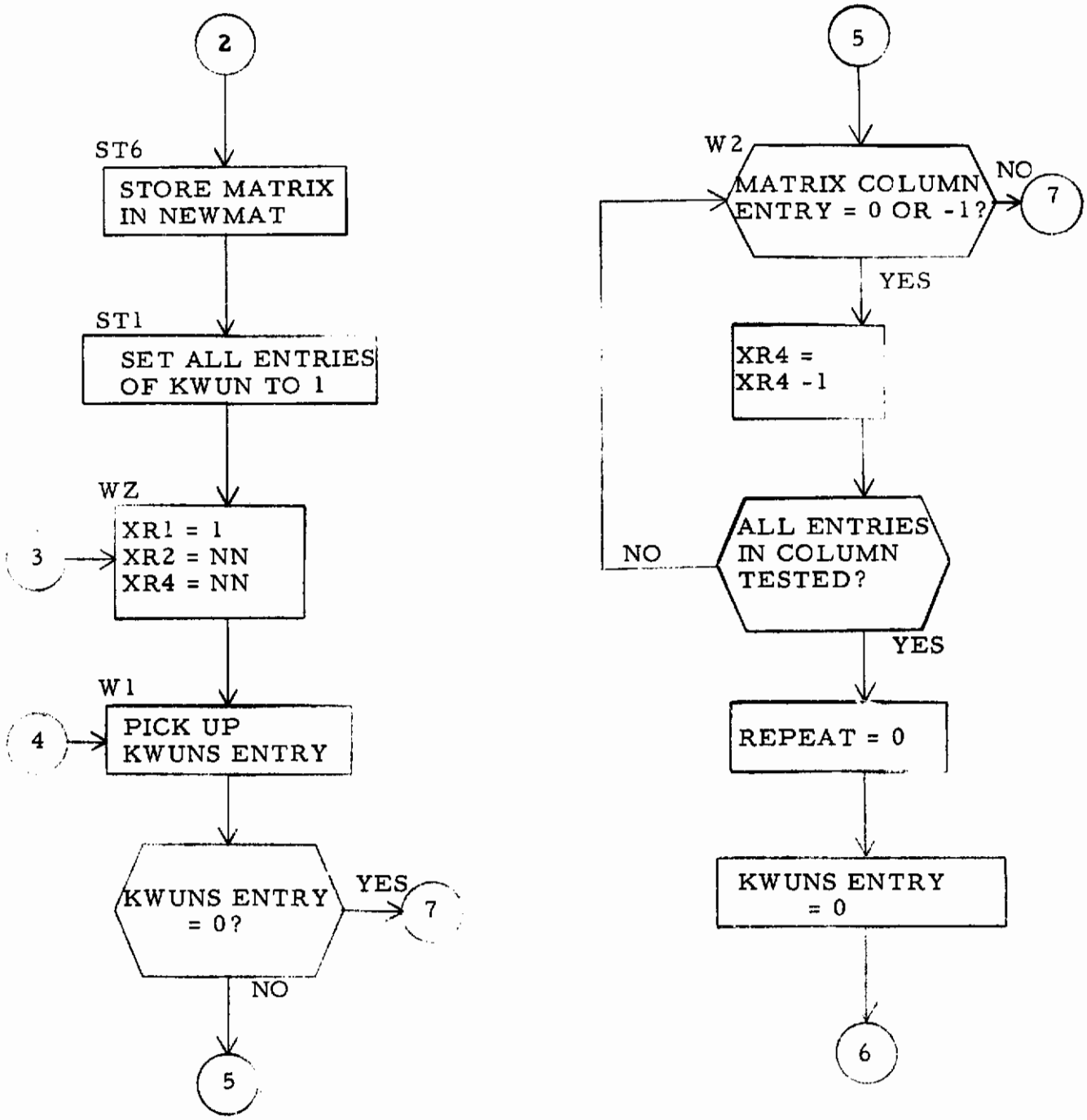
Detailed flow charts are given on the following pages.

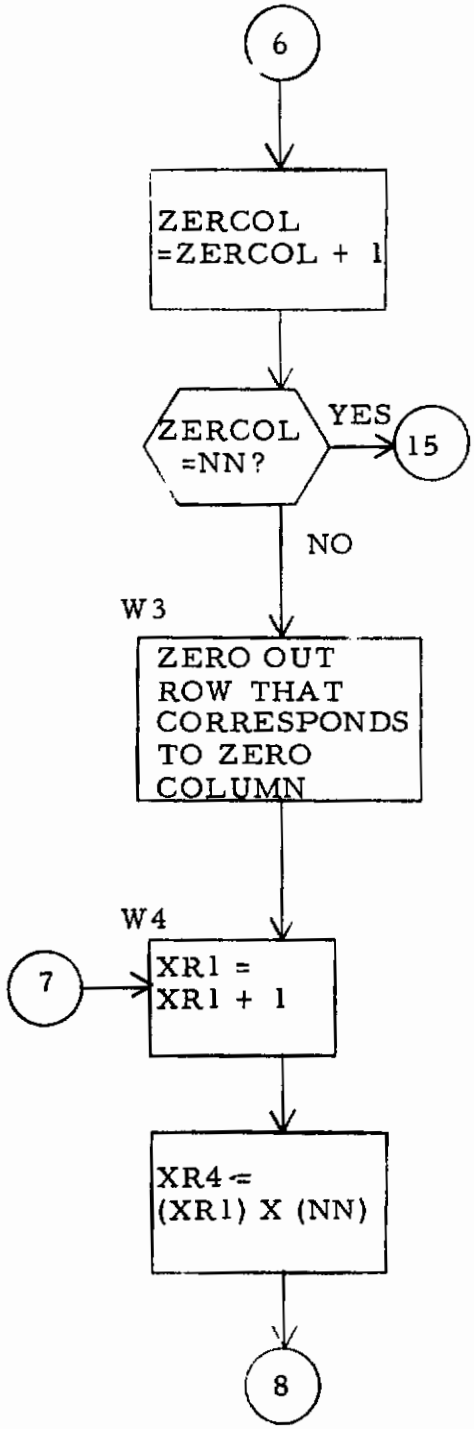
8. Listings

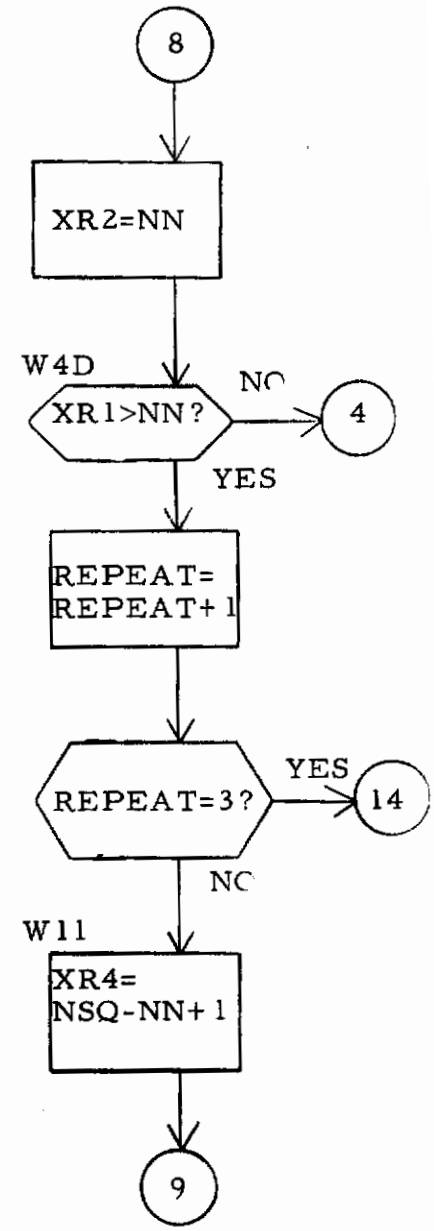
Listings of START are on the four pages following the flow charts.

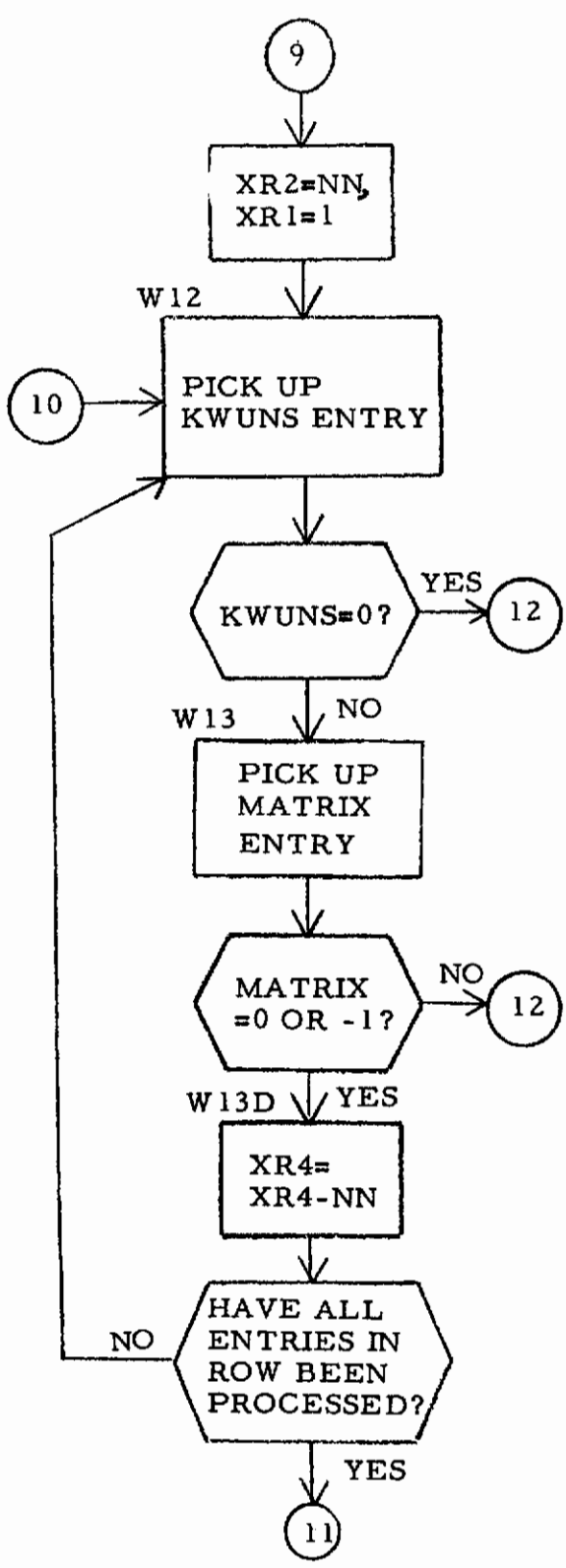
FLOW CHARTS OF SUBROUTINE START

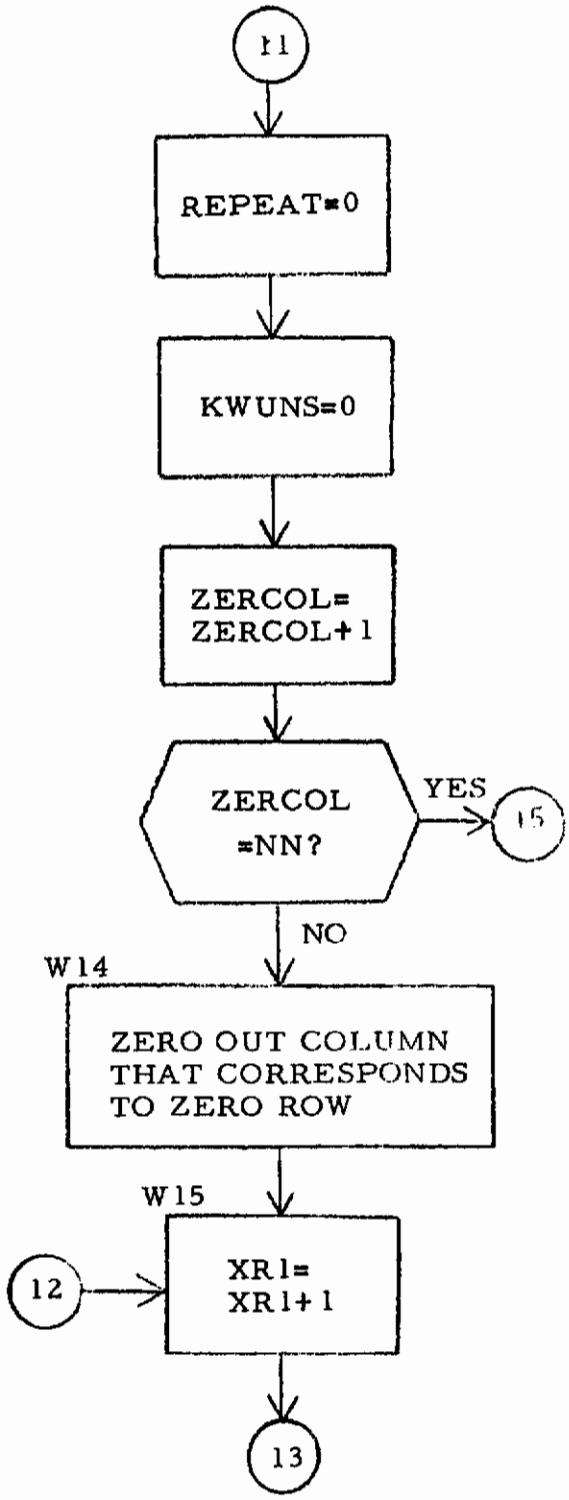


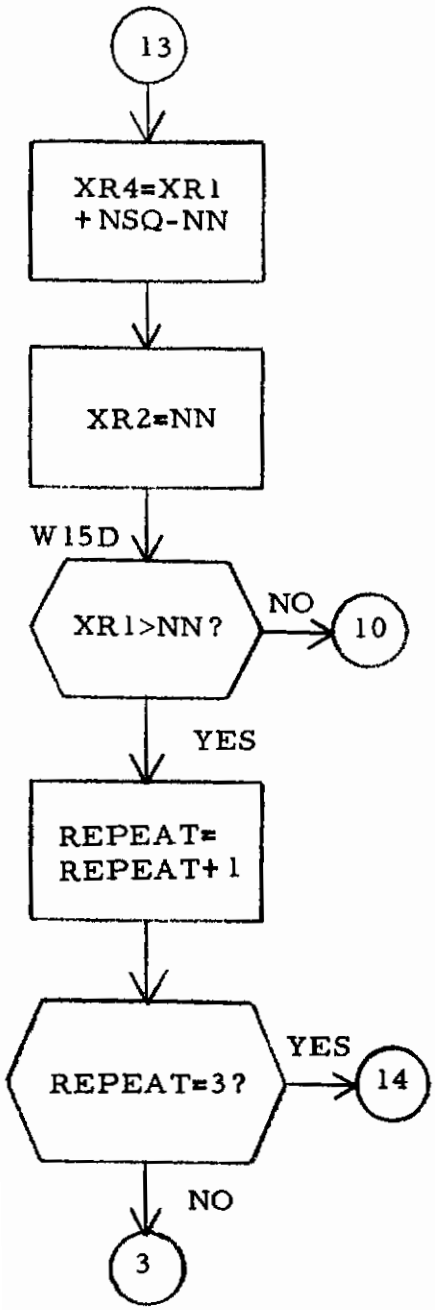


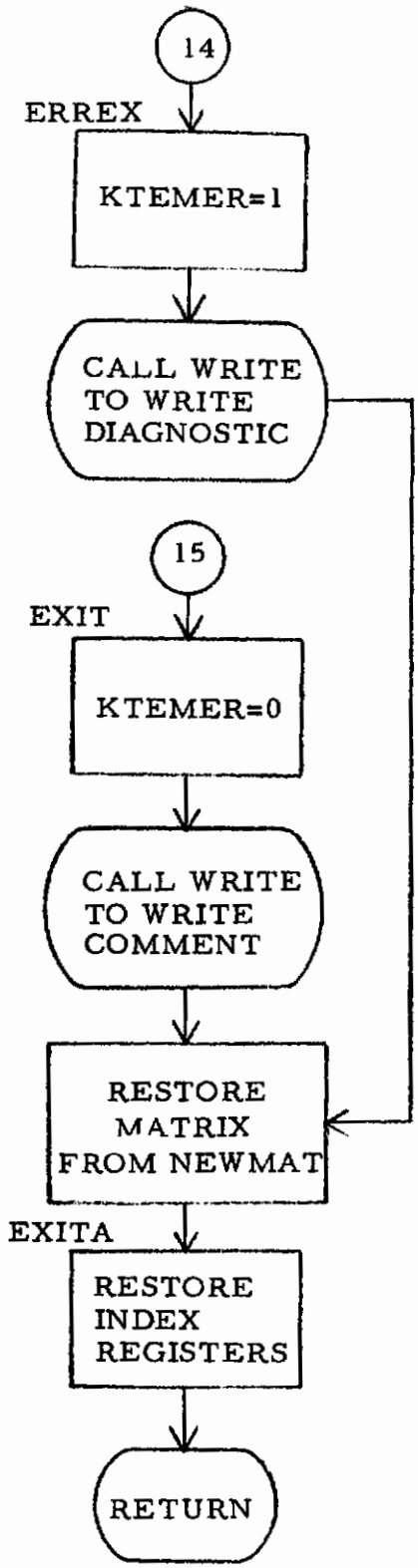












LISTING OF SUBROUTINE START

```
*      LABEL
*      PACK
*      FAP
       COUNT   1000
*START         READS PRECEDENCE MATRIX AND TESTS CONSISTENCY
       ENTRY   START    READS PRECEDENCE MATRIX AND TESTS CONSISTENCY
DATAD  COMMON  1
MATRIX COMMON  625
NEWMAT COMMON  625
KFIRST COMMON  25
KSEC   COMMON  25
KWUNS  COMMON  25
KTEMER COMMON  1
KXNUM  COMMON  1
KXNUMA COMMON  1
NN     COMMON  1
LUPZER COMMON  1
COLUMN COMMON  1
ENDYET COMMON  1
NSQ    COMMON  1
N2MINN COMMON  1
N2MNP1 COMMON  1
NPLUS1 COMMON  1
N2MIN1 COMMON  1
CONMAT COMMON  625
ACON   COMMON  75
BCON   COMMON  75
KXSQ   COMMON  1
 SGNC  COMMON  1
 SGNL  COMMON  1
 SGXC  COMMON  1
 SECEX COMMON  1
BCNT   COMMON  1
FDORTP COMMON  1
START  SXD     XR1,1     STORE INDEX REGISTERS
       SXD     XR2,2
       SXD     XR4,4
       CALL    READ            READ PRECEDENCE MATRIX AND START AND
*                              END OF STEP ARRAYS
       CLA     KXNUM          FORM KXNUM+1
       ADD     ONED
       STO     KXNUMA         STORE IN KXNUMA
       MPY     ZERO            CLEAR ACCUMULATOR AND MQ REGISTERS
       SSP                     MAKE SURE SIGN OF ACCUMULATOR IS POSITIVE
       LDQ     NN              FORM NN SQUARED
       MPY     NN
       ALS     17              COMPENSATES FOR BOTH IN DECREMENT
       STO     NSQ            STORE IN NSQ
       SUB     NN             FORM NSQ-N
       STO     N2MINN         STORE IN N2MINN
       ADD     ONED           FORM NSQ-N+1
       STO     N2MNP1         STORE IN N2MNP1
       CLA     NN             FORM NN+1
       ADD     ONED
       STO     NPLUS1         STORE IN NPLUS1
       ADD     NN             FORM 2NN-1
       SUB     TWOD
       STO     N2MIN1          STORE IN N2MIN1
       CLA     NN
```

```
        STD     W13D
        STD     W15D
        CLA     NN
        STD     W4D
        CLA     N2MNP1
        STD     W15
        STZ     REPEAT          INITIALIZE LOCATIONS
        STZ     LUPZER
        STZ     ZERCOL
        STZ     COLUMN
        STZ     ENDYET
        LXD     NN,4            PUT NN INTO XR4
ST3     CLA     BCON,4          PICK UP ENTRY IN BCON
        LDQ     MASK77          PUT 77 IN ROWTEM AND COLTEM
        STQ     ROWTEM          TO PICK UP LOW ORDER 2 CHARACTERS
        STQ     COLTEM          STORE LOW ORDER 2 DIGITS = COLUMN
        ANS     ROWTEM          PICK UP LOW ORDER 2 CHARACTERS=ROW
        ARS     6               IN CONNECTION MATRIX, SHIFT RIGHT 6
        SUB     =1              PICK UP COLUMN -1 TO COMPUTE CONNECTION
        ANS     COLTEM          MATRIX ENTRY, STORE IN COLTEM,
        ARS     6               DROP COLUMN NUMBER FROM BCON ENTRY
        ALS     12              RESTORE REST OF ENTRY
        STO     BCON,4          STORE 23 BITS BACK INTO BCON
        PXD     0,0             ZERO OUT ACCUMULATOR
        LDQ     NN              PUT NN INTO Q
        LRS     18              SHIFT DECREMENT INTO ADDRESS IN Q
        MPY     COLTEM          FORM (COLUMN-1) NN
        XCA                     PUT Q INTO ACCUM,
        ADD     ROWTEM          FORM NN (COLUMN-1) +ROW
        PAX     ,2              PUT INDEX OF CONMAT INTO XR2
        CLA     CONMAT,2        PICK UP CONNECTION MATRIX ENTRY
        TZE     ST5             IF ZERO, NO CONNECTION=GO TO ST5
ST4     TIX     ST3,4,1         IF NOT ALL BCON PROCESSED, GO TO ST3
        TRA     ST6             IF ALL BCON PROCESSED, GO TO ST6
ST5     CLA     BCON,4          SET BCON ENTRY TO MINUS FOR NO CONNECTION
        SSM
        STO     BCON,4          STORE BACK INTO BCON
        TRA     ST4
ST6     LXD     NSQ,4
 ST2    CLA     MATRIX,4        STORE MATRIX PERMANENTLY IN MEWMAT
        STO     NEWMAT,4
        TIX     ST2,4,1
        LXD     NN,1      PUT NN IN IXR1
ST1     CLA     ONED      PUT 100000 IN ARRAY KWUNS(1=ROW NOT ALL ZEROS)
        STO     KWUNS,1
        TIX     ST1,1,1
  WZ    LXD     NN,4            IXR4 CONTAINS ELEMENT NUMBER
        LXD NN,2 IXR2 CONTAINS NUMBER OF ELEMENTS(=NUMBER OF ROWS)
        AXT     1,1             XR1=COLUMN NUMBER
  W1    CLA     KWUNS,1         TEST IF COLUMN ALREADY ZEROED OUT
        TZE     W4              IF SO, GO TO W4
  W2    CLA     MATRIX,4        IF NOT, PICK UP COLUMN ENTRY
        TZE     *+2             IF ZERO OR MINUS, CONTINUE TESTING
        TPL     W4              IF PLUS, GO TO W4
        TIX     *+1,4,1         SUBTRACT 1 FROM IXR4
        TIX W2,2,1 TEST ALL ENTRIES IN COLUMN TESTED IF NOT, GO TO W2
        STZ     REPEAT          IF COLUMN ALL ZEROS, STORE ZERO IN REPEAT
        STZ KWUNS,1 ZERO OUT ENTRY IN KWUNS TO SHOW COLUMN ALL ZEROS
        CLA     ZERCOL          ZERCOL IS COUNT OF NUMBER ZERO COLUMNS
        ADD     ONED
        STO     ZERCOL
```

```
        SUB     NN              TEST ALL COLUMNS ZERO
        TZE     EXIT            IF SO, GO TO EXIT
        SXD     XRTEM,1         IF NOT, STORE XR1 SO ROW CAN BE ZEROED OUT
        PXD     ,1               PUT XR1 IN ACCUM.
        LXD     NN,1            PUT NN IN XR1
        ADD     N2MINN          FORM COLUMN NUMBER+NSQ-N
        PDX     ,2               PLACE IN XR2
W3      STZ     MATRIX,2        ZERO OUT ROW
W3D     TIX     *+1,2,**        DECREMENT XR2 BY NN
        TIX     W3,1,1          TEST ENTIRE ROW ZEROED OUT IF NOT, GO TO W3
        LXD     XRTEM,1         RELOAD XR1
W4      TXI     *+1,1,1          INCREMENT COLUMN NUMBER BY 1
        MPY     ZERO             CLEAR ACCUMULATOR AND MQ REGISTERS
        SSP                      MAKE SURE SIGN OF ACCUMULATOR IS POSITIVE
        PXD     ,1               FORM (COLUMN NUMBER) X (NN)
        XCA
        MPY     NN
        ALS     17               COMPENSATES FOR BOTH IN DECREMENT
        PDX     ,4               PLACE IN XR4
        LXD     NN,2
W4D     TXL     W1,1,**         IF ALL COLUMNS NOT PROCESSED, GO TO W1
        CLA     REPEAT          ALL COLUMNS PROCESSED, ADD 1 TO REPEAT
        ADD     ONED
        STO     REPEAT
        SUB THREED IF REPEAT IS THREE, NO ROW AND NO COLUMN IS ALL ZEROES
        TZE     ERREX           GO TO ERROR EXIT
        TRA     W11             IF REPEAT IS NOT THREE, GO TO W11
W11     LXD N2MNP1,4 W11 TESTS ROWS FOR ZEROES PUT NSQ-N+1 INXR4 FOR ROW1
        LXD     NN,2            PUT NN IN XR2
        AXT     1,1             PUT 1 IN XR1
W12     CLA     KWUNS,1          IF ROW ALREADY ZERO, GO TI W15
        TZE     W15
W13     CLA     MATRIX,4        IF NOT, TEST FOR ALL ZEROES
        TZE     *+2             IF ZERO OR MINUS, CONTINUE TESTING
        TPL     W15             IF PLUS, GO TO W15
W13D    TIX     *+1,4,**        SUBTRACT NN FROM XR4
        TIX     W13,2,1         TEST WHOLE ROW PROCESSED,IF NOT,GO TO W13
        STZ REPEAT IF ROW ALL ZEROES, ZERO OUT REPEAT TO CONTINUE TESTING
        STZ     KWUNS,1         ZERO OUT ENTRY IN KWUNS
        CLA     ZERCOL          INCREASE COUNT OF ZERO COLUMNS
        ADD     ONED
        STO     ZERCOL
        SUB     NN              TEST ALL COLUMNS ZEROED OUT
        TZE     EXIT            IF SO, GO TO EXIT
        SXD     XRTEM,1         IF NOT, ZERO OUT COLUMN,STORE XR1
        MPY     ZERO             CLEAR ACCUMULATOR AND MQ REGISTERS
        SSP                      MAKE SURE SIGN OF ACCUMULATOR IS POSITIVE
        PXD     ,1               FORM (COLUMN NUMBER) X (NN)
        XCA
        MPY     NN
        ALS     17               COMPENSATES FOR BOTH IN DECREMENT
        PDX     ,2               PUT IN XR2
        LXD     NN,1            PUT NN IN XR1
W14     STZ     MATRIX,2        ZERO OUT ENTRY IN MATRIX
        TIX     *+1,2,1         SUBTRACT 1 FROM XR2
        TIX W14,1,1 TEST WHOLE COLUMN ZEROED OUT,IF NOT,GO TO W14
        LXD     XRTEM,1         RELOAD XR1
W15     TXI     *+1,1,1
        PXD     ,1
        ADD     N2MINN           COMPUTE XR4 TO PICK UP NEXT ROW
        PDX     ,4
```

```
        LXD     NN,2
  W15D  TXL     W12,1,**        IF ALL ROWS NOT TESTED, GO TO W12
        CLA     REPEAT          ALL ROWS TESTED, ADD ONE TO REPEAT
        ADD     ONED
        STO     REPEAT
        SUB THREED IF REPEAT IS THREE, NO ROWS OR COLUMNS ARE ALL ZEROES
        TZE     ERREX           GO TO ERROR EXIT
        TRA     WZ              OTHERWISE, GO TO WZ
 ERREX  CLA     ONED            ERROR EXIT
        STO     KTEMER          STORE ONE IN KTEMER FOR INCONSISTENT MATRIX
        CALL    WRITE           WRITE ERROR MESSAGE
        TRA     EXITA
  EXIT  STZ     KTEMER          STORE ZERO IN KTEMER FOR CONSISTENT MATRIX
        CALL    WRITE           WRITE MESSAGE(0CONSISTENT MATRIX)
EXITA   LXD     NSQ,4            RESTORE MATRIX
EX1     CLA     NEWMAT,4
        STO     MATRIX,4
        TIX     EX1,4,1
        LXD     XR1,1           RESTORE INDEX REGISTERS
        LXD     XR2,2
        LXD     XR4,4
        TRA     1,4             RETURN TO CALLING ROUTINE
ZERO    OCT     0
ONED    OCT     1000000
TWOD    OCT     2000000
THREED  OCT     3000000
XR1     PZE
XR2     PZE
XR4     PZE
ZERCOL  PZE
REPEAT  PZE
XRTEM   PZE
MASK77  OCT     000000000077
ROWTEM  PZE
COLTEM  PZE
        END
```

F. SUBROUTINES CHEKIN AND PREC

1. Purpose

Subroutine CHEKIN checks the order of execution of steps in the automatic checkout program for conformance with flow diagram precedences. Subroutine PREC checks the order of execution for conformance with hardware precedences and the requested connections for validity.

2. Input Formats

a. CHEKIN is actually one of three entry points to PREC. The other two are PINMAT and POUTMT. A CALL CHEKIN statement is used for entry to CHEKIN to check flow diagram precedences. A CALL PINMAT is used for entry to PINMAT to check hardware precedences and connections for digital and analog inputs from the automatic checkout and prime equipment. A CALL POUTMT statement is used for entry to POUTMT to check hardware precedences and connections for digital and analog outputs to the automatic checkout and prime equipment.

b. Inputs to CHEKIN and PREC are through the values of locations in COMMON. The locations required are DATAD, MATRIX, NEWMAT, KXNUM, NN, LUPZER, ENDYET, NSQ, N2MINN, N2MNP1, NPLUS1, N2MIN1, CONMAT, ACON, BCON, KXSQ, SGNC, SGNL, SGXC, SECEX, and FDORTP.

3. Output Formats

There are two basic outputs from PREC, printed diagnostics or comments, and an updated precedence matrix. The diagnostics and comments are detailed in "Error Checks and Diagnostic Printouts." The precedence matrix is updated as follows. If a precedence matrix step is being initiated, ENDYET will be set to 1. If this step is an entry point to a legitimate loop, MATRIX is restored from NEWMAT, and LUPZER is set to zero. If a precedence matrix step is being terminated, ENDYET is set to zero, and the row corresponding to the step is zeroed out. If there is a -1 in the row, it is stored in LUPZER before it is zeroed out. If there are 2's in the row, then all of the 2's in the columns in which the 2's in the row appear are also zeroed out.

4. Method

a. For entry point CHEKIN, KPTEM is set to 3, and FDORTP is tested for the value 1. If FDORTP$\neq$1, then the precedence matrix represents hardware precedences; transfer is made to the calling routine. If FDORTP=1, SGNL is stored in the lower order 9 bits of the accumulator, SGNC is stored in the next 9 bits, and DATEM is set equal to this value. DATEM now contains the channel and sector of execution of the present instruction. This value will be used to determine if a precedence matrix step has been referenced. Transfer is made to step d.

b. For entry point PINMAT, KPTEM is set to 1, and transfer is made to step c. For entry point POUTMT, KPTEM is set to 2, and transfer is made to step c.

c. FDORTP is tested for the value 2. If FDORTP≠2, only flow diagram precedences are being processed; transfer is made to the calling routine. If FDORTP=2, DATEM is set equal to DATAD, and transfer is made to step d.

d. The index registers are stored, NN is stored in the decrement of C4, and KXNUM is stored in index register 4.

e. DATEM is matched against all the KFIRST entries. If there is a match, this instruction is the start of a precedence matrix step; transfer is made to step h. If there is no match, transfer is made to step f.

f. KXNUM is stored in index register 4, and DATEM is matched against the KSEC entries. If there is a match, this instruction is the end of a precedence matrix step. Transfer is made to step i. If there is no match, transfer is made to step g.

g. The index registers are restored, and return is made to the calling routine.

h. COLUMN is set equal to index register 4. This is the precedence matrix step being started. KTEMER=9 and WRITE is called to write "SGNC, SGNL, SGXC, SECEX." ENDYET is tested for zero. If ENDYET≠0, the last precedence matrix step has not been completed. KTEMER=2, and WRITE is called to write "ERROR NUMBER 2." If ENDYET=0, transfer is made to step p.

i. COLUMN=index register 4. This is the precedence matrix step being ended. KTEMER=9, and WRITE is called to write "SGNC, SGNL, SGXC, SECEX." NN is stored in index register 4, and COLUMN+NSQ-NN is stored in index register 2.

j. A row entry is picked up. If it is negative, transfer is made to step l; if it is zero, transfer is made to step k; if 1, transfer to step m; if 2, transfer to step n; if none of these values, KTEMER=3, and WRITE is called to write "ERROR NUMBER 3."

k. Index register 2 is decremented by NN. If all entries in the row have not been processed, transfer is made to step j. If all have been processed, KTEMER=8, and WRITE is called to write the comment, "CONSISTENT MATRIX." Transfer is then made to step t by means of a TSX statement. At the termination of the steps beginning at step t, transfer is made back, at which time transfer is made to step g.

l. LUPZER is set equal to column.

m. The matrix entry is zeroed out, and transfer is made to step k.

n. Index register 1 is set equal to (index register 4) x (NN). Index register 4 is stored, and index register 4 is then set equal to NN.

o. The entries in the column in which a 2 was zeroed out in the precedence matrix row being processed are scanned for 2's. If 2's are found, they are set to zero. Index register 4 is then restored, and transfer is made to step n.

p. ENDYET is set to 1 to signal that a precedence matrix step has been started but not ended. LUPZER is then tested against COLUMN. If they are not equal, transfer is made to step q. If they are equal, entry is being made into a legitimate loop. MATRIX is restored from NEWMAT, LUPZER=0, KTEMER=12, and WRITE is called to write "PRECEDENCE OK FOR ENTRY INTO LEGITIMATE LOOP." Transfer is made to step q.

q. NN is stored in index register 4, and index register 4 is set to (COLUMN) x (NN). Each entry in the column corresponding to the precedence matrix step being started is tested. If any entry is positive, the precedences are being violated; transfer is made to step s. If all of the entries are non-positive, then the precedences are satisfied; KTEMER=7, and WRITE is called to write "PRECEDENCE OK FOR START OF STEP." Transfer is made to step t.

r. KXNUM is stored in index register 4, DATEM is placed in the accumulator, and transfer is made to step f.

s. KTEMER=4, and WRITE is called to write "ERROR NUMBER 4."

t. NN is stored in index register 1; index register 4 is stored. If KPTEM=2, transfer is made to step u. If KPTEM=3, transfer is made to step v. Otherwise, the ten connection bits of DATEM are tested against the ACON entries. If a match is found, TEMPA=index register 4, and transfer is made to step v. If no match is found, KTEMER=5, and WRITE is called to write "ERROR NUMBER 5."

u. TEMPB is set equal to the ten connection bits of DATEM. The magnitude of each BCON entry is matched against TEMPB. If no match is found with any BCON entry, KTEMER=6, and WRITE is called to write "ERROR NUMBER 6." If a match is found, the BCON entry is tested. If negative, KTEMER=11, and WRITE is called to write "ERROR NUMBER 11." If the BCON entry is positive, KTEMER=10, and WRITE is called to write "CONNECTION OK." Index register 4 is restored, and transfer is made to step v.

v. Return is made to the calling routine.

5. Error Checks and Diagnostic Printouts

Diagnostics or comments are written by setting KTEMER equal to the appropriate value and calling subroutine WRITE. The following are the values of KTEMER, the error checks which produced them, the diagnostics

or comments written, and the action taken after the diagnostic or comment is written:

KTEMER=2. The present step was started before the previous step ended. "ERROR NUMBER 2" is written, and the program is terminated.

KTEMER=3. There was an entry other than -1, 0, 1, 2 in the precedence matrix. "ERROR NUMBER 3" is written, and the program is terminated.

KTEMER=4. The precedences are violated. "ERROR NUMBER 4" is written, and the program is terminated.

KTEMER=5. The connection called for is not in the ACON matrix. "ERROR NUMBER 5" is written, and the program is terminated.

KTEMER=6. The connection called for is not in the BCON matrix. "ERROR NUMBER 6" is written, and the program is terminated.

KTEMER=7. The precedences are satisfied for the start of a step. "PRECEDENCE OK FOR START OF STEP" is written and processing continues.

KTEMER=8. The precedences are satisfied for the end of a step. "PRECEDENCE OK FOR END OF STEP" is written and processing continues.

KTEMER=9. The start or end of a step is being processed. "SGNC. SGNL, SGXC. SECEX" is written and processing continues.

KTEMER=10. A requested connection is valid. "CONNECTIONS OK" is written and processing continues.

KTEMER=11. A requested connection is invalid. "ERROR NUMBER 11" is written, and the program is terminated.

KTEMER=12. Entry has been made into a legitimate loop. "PRECEDENCE OK FOR ENTRY INTO A LEGITIMATE LOOP" is written and processing continues.

6. Limitations and Restrictions

a. Only the last -1 found in a row being zeroed out is stored. This should be changed to allow storage of several -1's.

b. PINMAT was not used in this application. Later changes (most of which are in the processing of the connection matrix) were not included in PINMAT processing.

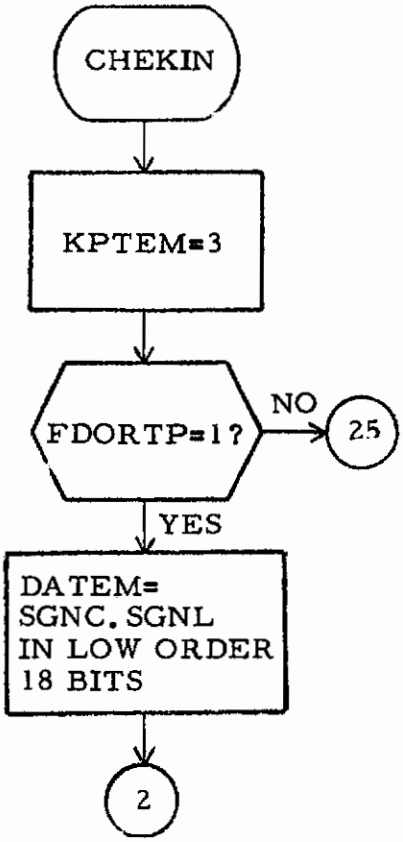
7. Flow Charts

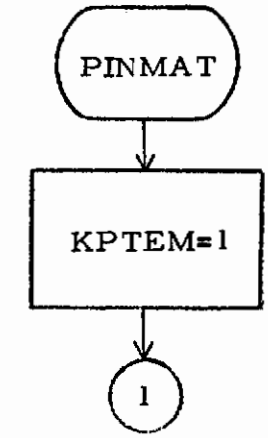
The detailed flow charts of PREC are given on the following eight pages.

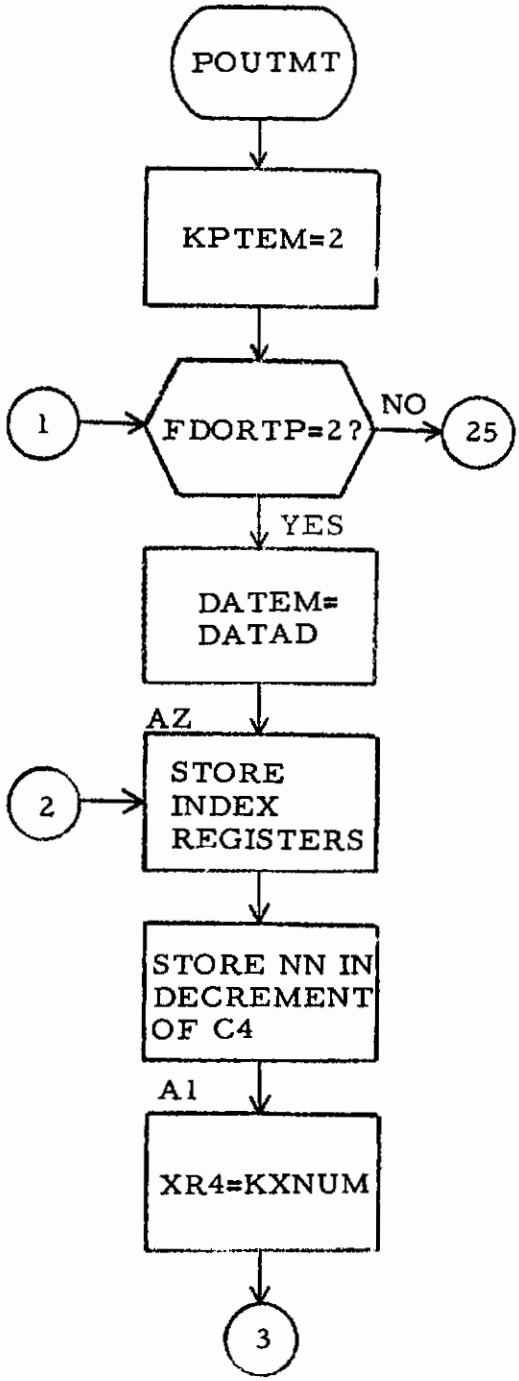
8. Listings

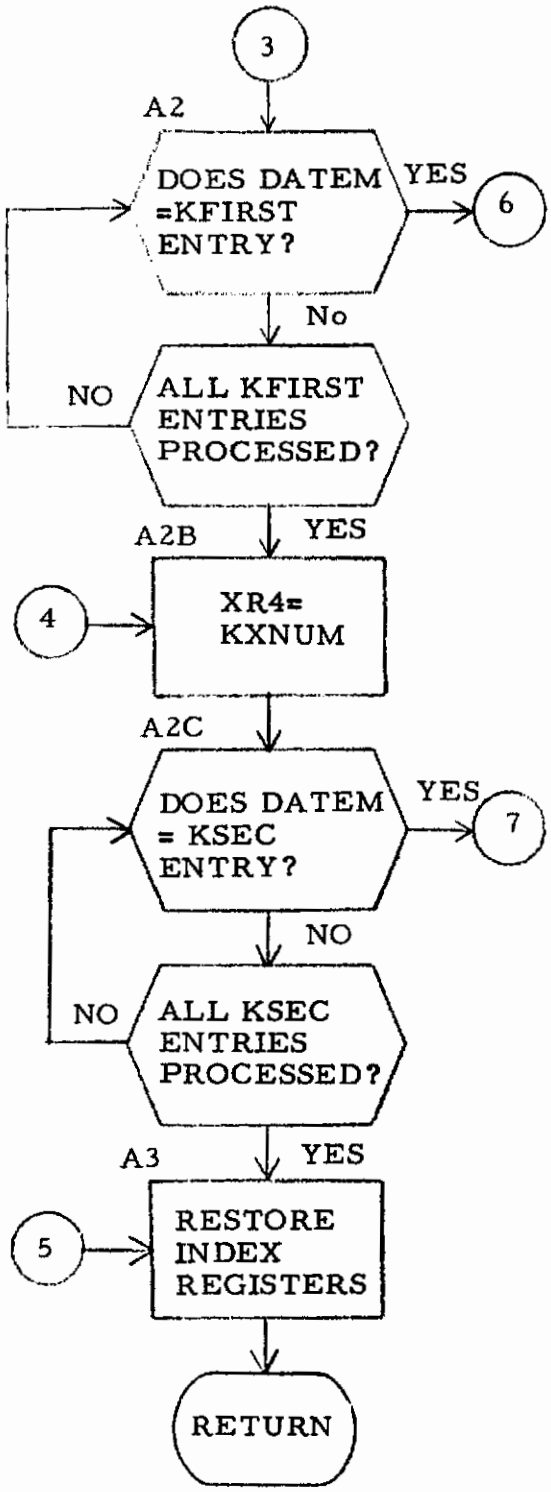
Listings of PREC are given on the pages following the flow charts.

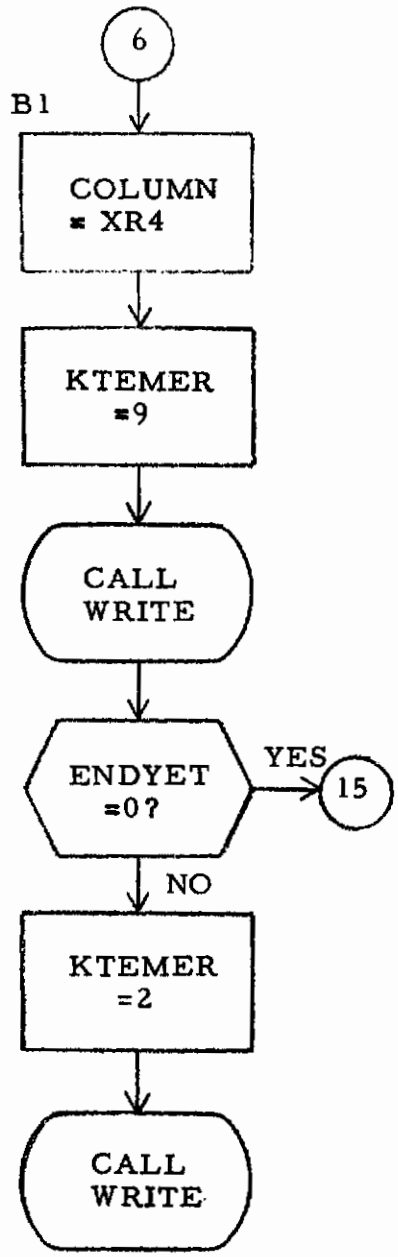
FLOW CHARTS OF SUBROUTINES CHEKIN AND PREC

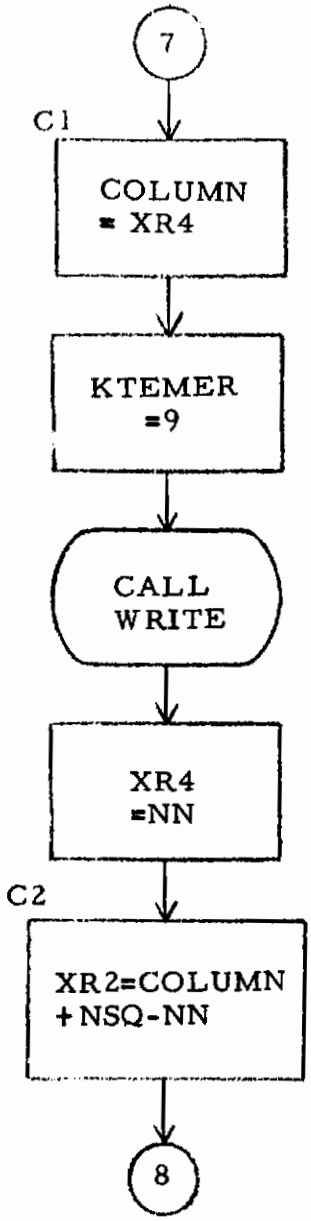


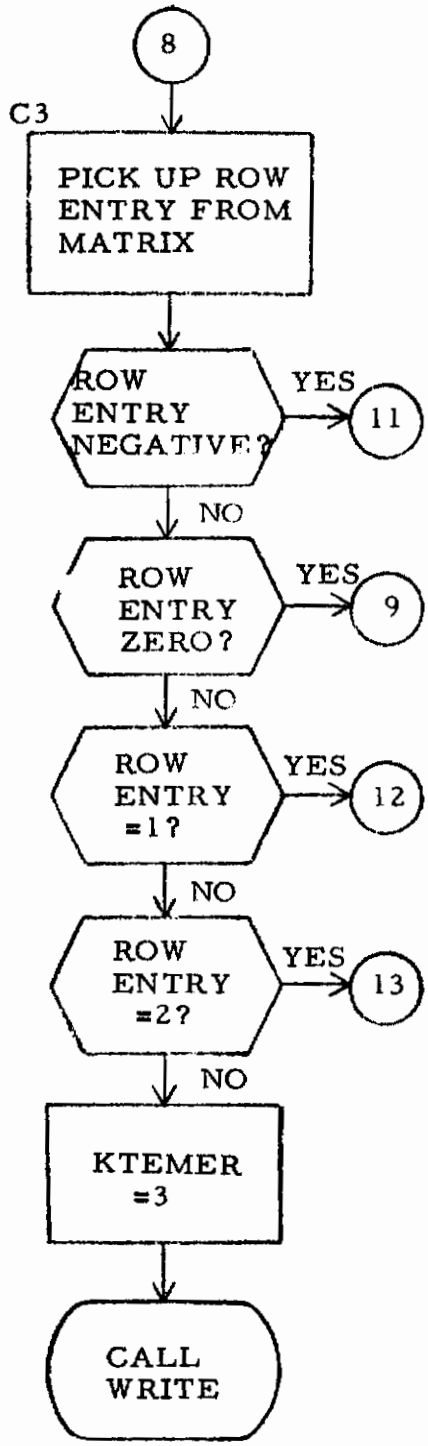


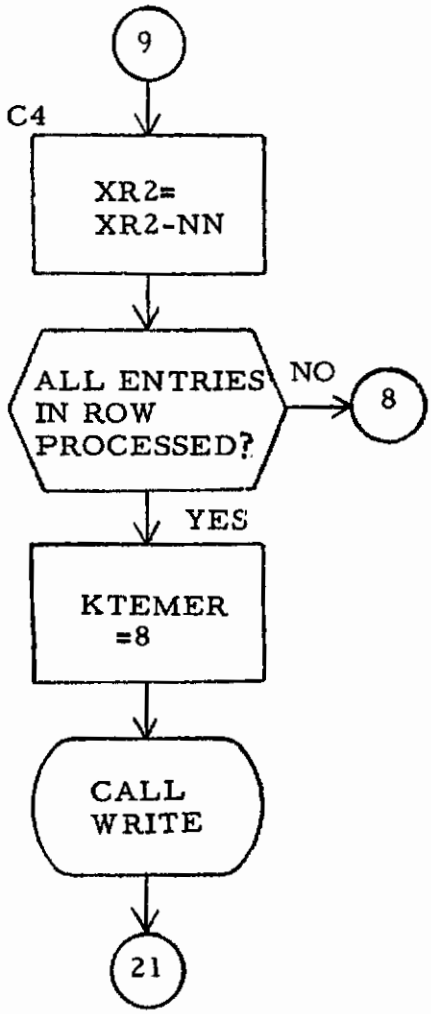


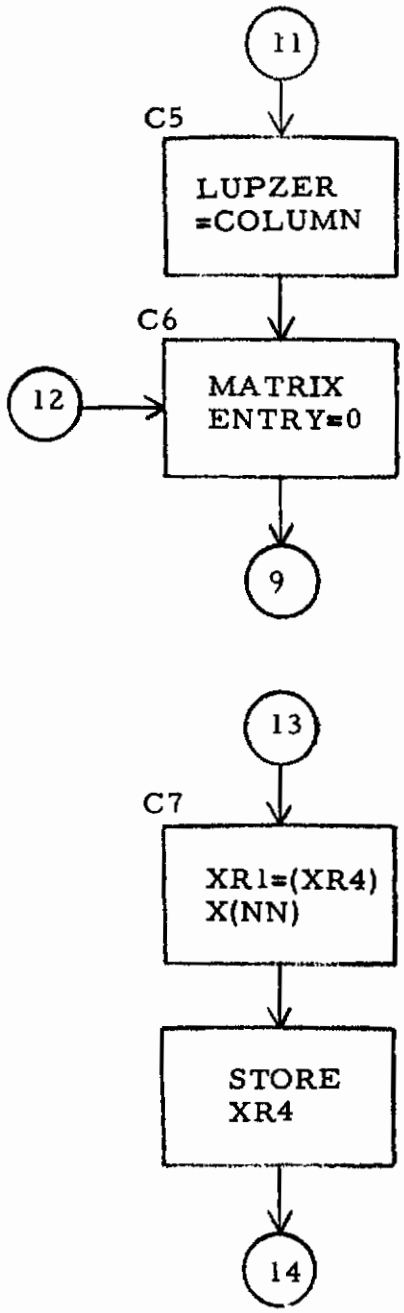


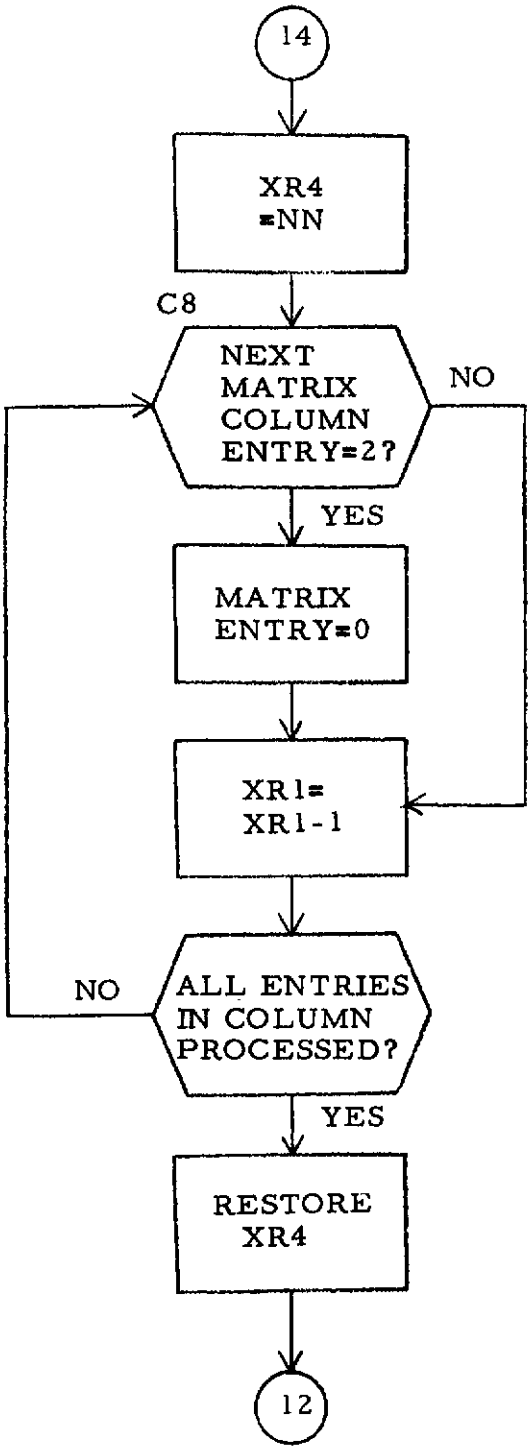


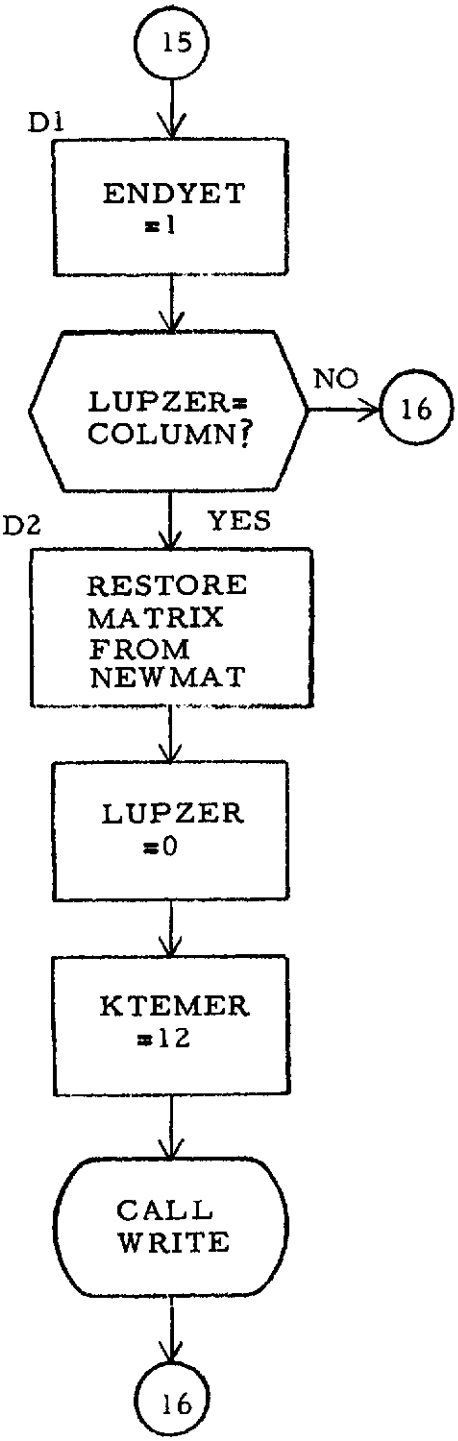


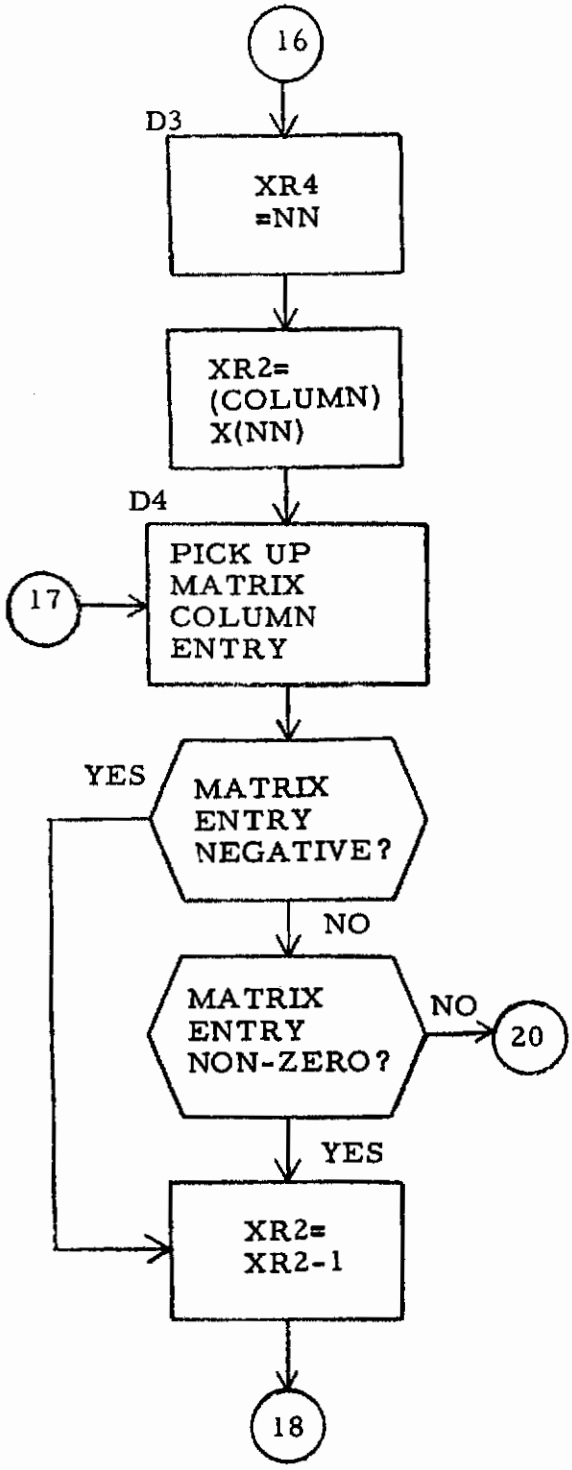


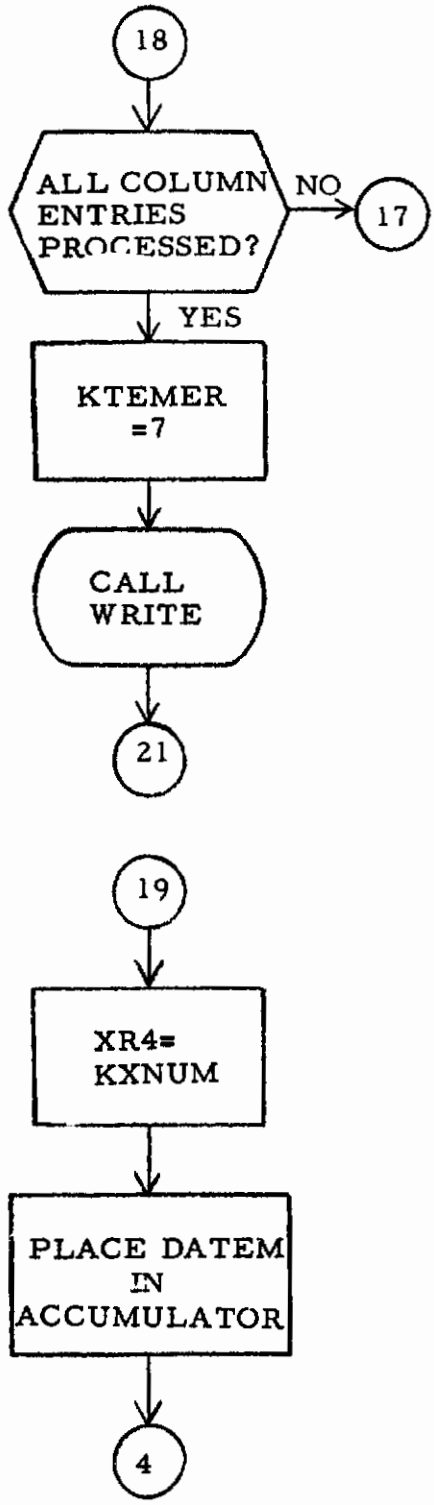


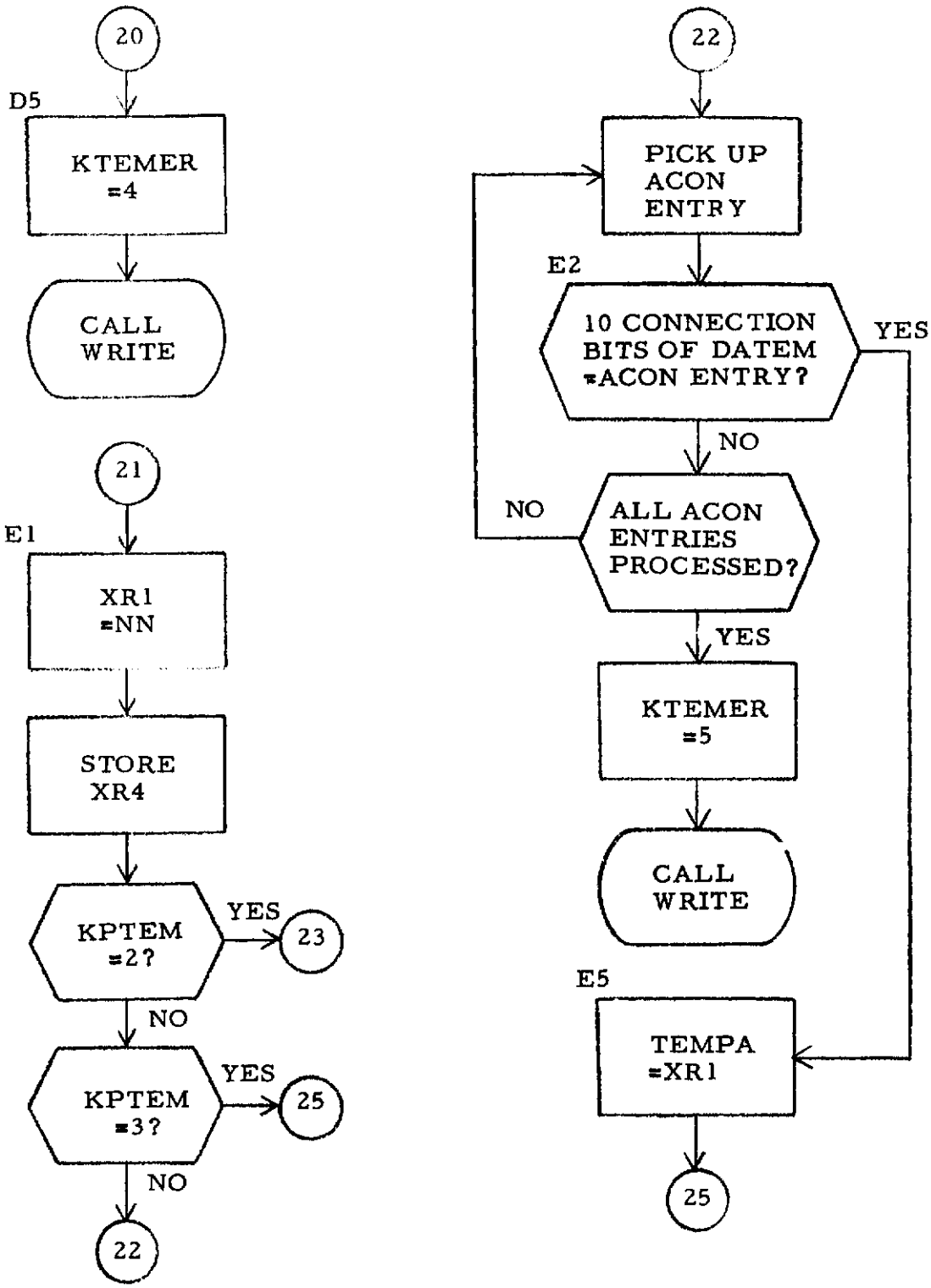


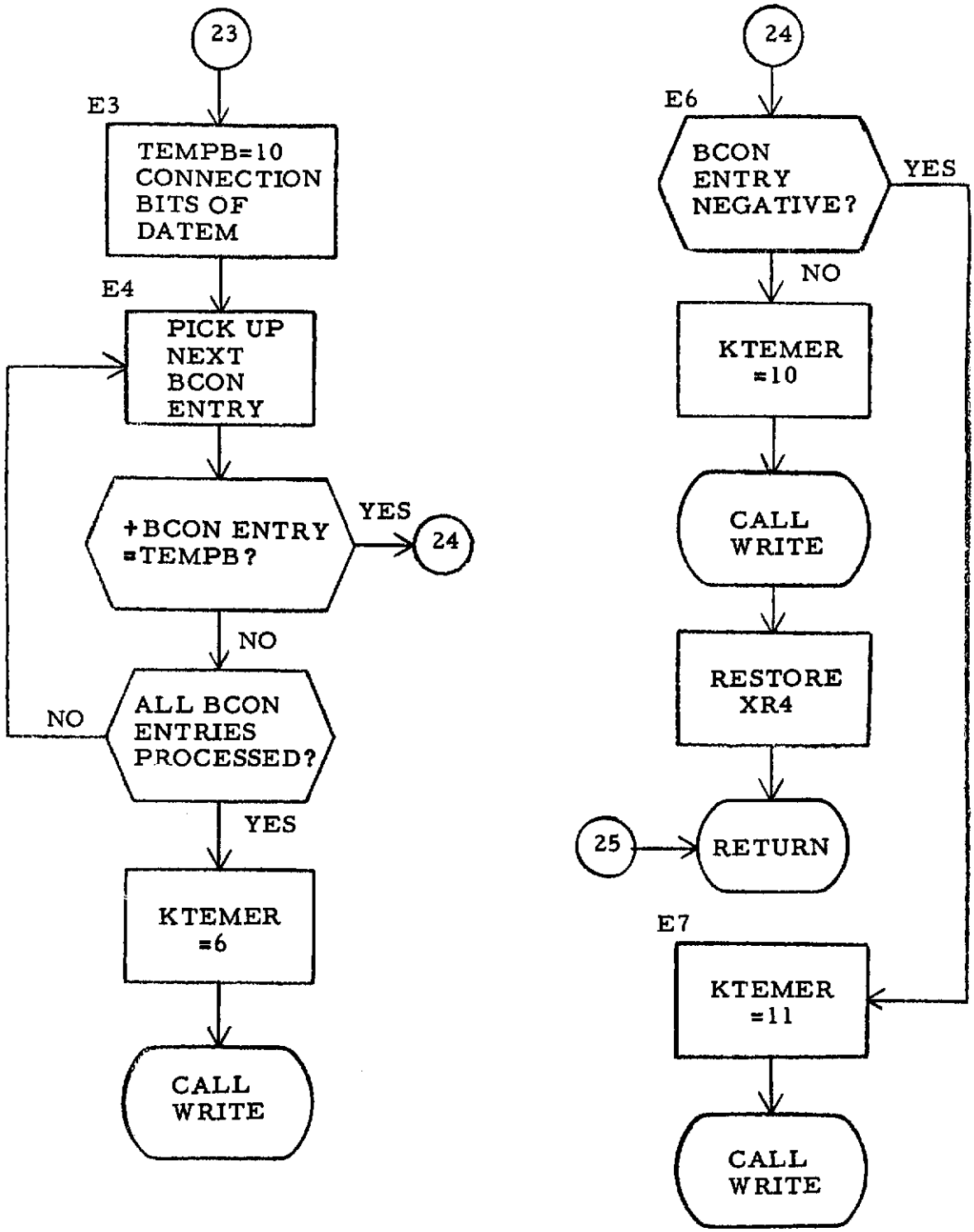












LISTING OF SUBROUTINES CHEKIN AND PREC

```
*      LABEL
*      PACK
*      FAP
        CCUNT   1CCO
*PREC           TESTS PRECEDENCES AND CONNECTIONS
        ENTRY   CHEKIN
        ENTRY   PINMAT
        ENTRY   PCUTMT
DATAC   COMMCN  1
MATRIX  COMMCN  625
NEWMAT  COMMCN  625
KFIRST  COMMCN  25
KSEC    COMMCN  25
KWUNS   COMMCN  25
KTEMER  COMMCN  1
KXNUM   COMMCN  1
KXNUMA  COMMCN  1
NN      COMMCN  1
LUPZER  COMMCN  1
CCLUMN  COMMCN  1
ENDYET  COMMCN  1
NSQ     COMMCN  1
N2MINN  COMMCN  1
N2MNP1  COMMCN  1
NPLUS1  COMMCN  1
N2MIN1  COMMCN  1
CONMAT  COMMCN  625
ACON    COMMCN  75
BCON    COMMCN  75
KXSC    COMMCN  1
 SGNC   COMMCN  1
 SGNL   COMMCN  1
 SGXC   COMMCN  1
 SECEX  COMMCN  1
BCNT    COMMCN  1
PCCRTP  COMMCN  1
CHEKIN  CLA     THREEC          STORE THREE TO SIGNAL FLOW CHART TYPE
        STC     KPTEM
        CLA     PCCRTP          TEST FOR FLOW DIAGRAM TYPE (1)
        SUB     ONEC            IF ONE,THEN THIS IS FLOW DIAGRAM TYPE
        TNZ     1,4             IF NOT =1,RETURN
        CLA     SGNC            SET UP DATEM FOR P.C. COMPARISON
        ALS     9
        ADD     SGNL
        STC     DATEM
        TRA     AZ
PINMAT  CLA     ONEC          PTEM=1 FOR P INPUT
        STC     KPTEM
        TRA     *+3
PCUTMT  CLA     TWOC          PTEM=2 FOR P OUTPUT
        STC     KPTEM
        CLA     PCCRTP          TEST FOR TP TYPE OF BRANCH
        SUB     TWOC            TP TYPE OF BRANCH =2
        TNZ     1,4             IF NOT =2,RETURN
        CLA*    DATAC           PICK UP WORD AFTER TP
        STC     DATEM           PLACE IN TEMPORARY STORAGE
AZ      SXD     XR1,1
        SXD     XR2,2
        SXD     XR4,4
        CLA     NN
```

```
        STC     C4              STORE NN IN DECREMENT OF TIX INSTRUCTION
  A1    LXD     KXNUM,4         KXNUM=NUMBER OF ROWS IN MATRIX
        CLA     CATEM            PICK UP WORD FOLLOWING TPX OR TXP
  A2    CAS     KFIRST,4        COMPARE TO TABLE OF BEGINNINGS OF STEPS
        TRA     *+2
        TRA     B1              IF EQUAL, GO TO B1
        TIX     A2,4,1
A2B     LXD     KXNUM,4          IF NOT, COMPARE TO TABLE OF ENDS OF STEP
        CLA     CATEM
A2C     CAS     KSEC,4
        TRA     *+2
        TRA     C1              IF EQUAL,GO TO C1
        TIX     A2C,4,1          IF NOT, TRY NEXT ENTRY IN KSEC TABLE
  A3    LXD     XR1,1           RELOAD INDEX REGISTERS
        LXD     XR2,2
        LXD     XR4,4
        TRA     1,4             RETURN TO CALLING ROUTINE
B1      SXD     COLUMN,4         PROCESSES START OF PRECEDENCE MATRIX STEP
        CLA     MINUS1
        STO     KTEMER
        CALL    WRITE
        CLA ENDYET DETERMINE IF LAST COLUMN COMPLETELY PROCESSED
        TZE     C1              IF NOT,D1 NOT ZERO AND ERROR OCCURRED
        CLA     TWOO            PUT 2 IN KTEMER TO INDICATE THAT
        STO     KTEMER          STEP STARTED BEFORE PREVIOUS STEP ENDED
        CALL    WRITE           CALL WRITE SUBROUTINE
C1      SXD     COLUMN,4         C1 PROCESSES END OF PRECEDENCE MATRIX STEP
        CLA     MINUS1           WRITE OUT SGNC,SGNL,SGXC,SECEX
        STO     KTEMER
        CALL    WRITE
        STZ     ENDYET
        LXD     NN,4             PUT NUMBER OF ROWS IN XR4
  C2    CLA N2MINN ADD COLUMN NUMBER TO (UNSQUARED-N) AND PUT INTO
        ADD COLUMN IXR2. WANT TO ZERO OUT ROW BECAUSE STEP COMPLETED
        PDX     ,2               BUT MUST ALSO ZERO OUT COLUMNS CONTAINING
                                 Z'S ZEROED OUT
  C3    CLA     MATRIX,2        PICK UP LAST ENTRY IN ROW
        TMI     C5              IF MINUS(ENTRY POINT TO LOOP)GO TO C5
        TZE     C4              IF ZERO, GO TO PICK UP NEXT ENTRY
        SUB     ONED
        TZE     C6              IF ONE, GO TO C6 TO ZERO OUT
        SUB     ONED
        TZE     C7              IF 2,GO TO C7 TO ZERO OUT COLUMN
        CLA     THREED          NUMBER OTHER THAN-1,0,1,2
        STO     KTEMER          STORE 3 IN KTEMER TO INDICATE ERROR
        CALL    WRITE           WRITE ERROR MESSAGE
  C4    TIX *+1,2,** SUBTRACT NN FROM IR2 TO PICK UP NEXT ENTRY IN ROW
        TIX C3,4,1 TEST ALL ENTRIES IN ROW PROCESSED.IF NOT,GO TO C3
        CLA     EIGHTD
        STO     KTEMER
        CALL    WRITE
        TSX     E1,4             TEST CONNECTIONS
        TRA     A3              IF ROW PROCESSED,GO TO A3 TO EXIT
  C5    CLA     COLUMN      THIS IS ENTRY POINT TO BEGINNING OF LOOP.STORE
        STO LUPZER THIS COLUMN NUMBER IN LUPZER SO MATRIX CAN BE RENEWED
        TRA     C6              GO TO C6
  C6    STZ     MATRIX,2        ZERO OUT THIS ROW ENTRY
        TRA     C4              GO TO C4
C7      MPY     ZERO             CLEAR ACCUMULATOR AND MQ REGISTERS
        SSP                      MAKE SURE SIGN OF ACCUMULATOR IS POSITIVE
```

```
        PXD     ,4              ZERO OUT TWOS IN PRESENT COLUMN
        XCA
        MPY     NN
        ALS     17              COMPENSATES FOR BOTH IN DECREMENT
        PDX     ,1
        SXD     XRTEM,4         STORE IXR4 IN XRTEM
        LXD     NN,4            PUT NN IN IXR4
  C8    CLA     MATRIX,1        PICK UP LAST ENTRY IN COLUMN
        SUB     TWOO            TEST IF 2
        TNZ     *+2             IF NOT, DO NOT ZERO OUT
        STZ     MATRIX,1        IF 2, ZERO OUT
        TXI *+1,1,-1 SUBTRACT 1 FROM IXR1 TO PICK UP NEXT ENTRY IN COLUMN
        TIX C8,4,1 TEST ALL ENTRIES IN COLUMN PROCESSED.IF NOT, GO TO C8
        LXD     XRTEM,4         RELOAD IXR4
        TRA     C6              GO TO C6
  D1    CLA     ONED            D1 PROCESSES BEGINNING OF STEP
        STO     ENDYET          STORE 1 IN ENDYET TO SIGNAL STEP BEGUN
        CLA LUPZER TEST IF THIS STEP IS ENTRY INTO START OF LOOP
        SUB     CCOLUMN
        TNZ     D3              IF NO, GO TO D3.
        LXD NSQ,4 IF YES,MATRIX MUST BE REFRESHED.PUT NN SQUARED IN IXR4
  D2    CLA     NEWMAT,4        PICK UP ENTRY IN PERMANENT MATRIX
        STO     MATRIX,4        STORE IN TEMPORARY MATRIX
        TIX     D2,4,1          TEST ALL ENTRIES RESTORED.IF NOT,GO TO D2
        STZ     LUPZER          ZERO OUT LUPZER
        CLA     TWELVD          WRITE COMMENT FOR ENTERING LEGITIMATE LOOP
        STO     KTEMER
        CALL    WRITE
        TRA     A2B             GO TO TEST FOR END OF STEP
  D3    LXD     NN,4            PUT NN IN IXR4 TO TEST COLUMN ALL ZEROES
*                               (PRECEDENCES SATISFIED)
        MPY     ZERO            CLEAR ACCUMULATOR AND MQ REGISTERS
        SSP                     MAKE SURE SIGN OF ACCUMULATOR IS POSITIVE
        LDQ     CCOLUMN         FORM (COLUMN NUMBER) X (NN)
        MPY     NN
        ALS     17              COMPENSATES FOR BOTH IN DECREMENT
        PDX     ,2              PLACE IN XR2
  D4    CLA     MATRIX,2        PICK UP LAST ENTRY IN COLUMN
        TMI     *+2             IF MINUS, TREAT AS ZERO
        TNZ     D5              IF NONZERO,GO TO D5 FOR ERROR MESSAGE
        TXI     *+1,2,-1        SUBTRACT 1 FROM IXR2
        TIX     D4,4,1          TEST ALL COLUMN ENTRIES PROCESSED. IF NOT,
*                               GO TO D4
        CLA     SEVEND
        STO     KTEMER
        CALL    WRITE
        TSX     E1,4            TEST CONNECTIONS
        LXD     KXNUM,4         PUT KXNUM IN IXR4
        CLA     DATEM
        TRA     A2B             GO TO A2B TO TEST FOR END OF STEP
  D5    CLA     FOURD           STORE 4 IN KTEMER TO SIGNAL THAT
        STO     KTEMER          PRECEDENCES NOT SATISFIED
        CALL    WRITE           WRITE ERROR MESSAGE
  E1    LXD     NN,1            PUT NN INTO XR1
        SXD     XRTEM4,4        STORE INDEX REGISTER 4 IN TEMP STORAGE
        CLA     KPTEM
        SUB     TWOO
        TZE     E3
        SUB     ONED
        TZE     1,4
```

```
        CLA     DATEM
        ANA     MASKA
 E2     CAS     ACCN,1
        TRA     *+2
        TRA     E5
        TIX     E2,1,1
        CLA     FIVED
        STC     KTEMER
        CALL    WRITE
E3      CLA     DATEM
        ANA     MASKA           PICK UP TEN BITS THAT ARE DIGITAL OUTPUTS
        STC     TEMPB           STORE IN TEMPB
E4      CLA     BCCN,1          PICK UP BCON ENTRY
        SSP                     MAKE POSITIVE
        CAS     TEMPB           IF EQUAL TO TEMPB, GO TO E6
        TRA     *+2             IF NOT EQUAL, GO TO *+2
        TRA     E6              IF EQUAL, GO TO E6
        TIX     E4,1,1          IF NOT ALL BCON PROCESSED, GO TO E4
        CLA     SIXD
        STC     KTEMER
        CALL    WRITE
 E5     SXD     TEMPA,1
        TRA     1,4
E6      CLA     BCCN,1          PICK UP BCON ENTRY WITH SIGN
        TMI     E7              IF MINUS, THERE IS NO CONNECTION-GO TO E7
        CLA     TEND            IF PLUS, O.K.-WRITE CONNECTION OK.
        STC     KTEMER
        CALL    WRITE           GO TO WRITE
        LXD     XRTEM4,4        RESTORE INDEX REGISTER 4
        TRA     1,4             RETURN
E7      CLA     ELEVD           WRITE NO CONNECTION
        STC     KTEMER
        CALL    WRITE           GO TO WRITE
ZERO    OCT     0
ONED    OCT     1000000
TWOD    OCT     2000000
THREED  OCT     3000000
FOURD   OCT     4000000
FIVED   OCT     5000000
SIXD    OCT     6000000
SEVEND  OCT     7000000
EIGHTD  OCT     10000000
NINED   OCT     11000000
TEND    OCT     12000000        11 IN DECREMENT
ELEVD   OCT     13000000        12 IN DECREMENT
TWELVD  OCT     14000000
KPTEM   PZE
XR1     PZE
XR2     PZE
XR4     PZE
XRTEM   PZE
XRTEM4  PZE
MASKA   OCT     000017770000
TEMPA   PZE
TEMPB   PZE
DATEM   PZE
        END
```

APPENDIX II

LISTINGS OF COMPUTER RUNS OF OPERATIONAL AUTOMATIC CHECKOUT PROGRAM WITH SIMULATOR MODIFIED TO INCLUDE PRECEDENCE AND CONNECTION MATRIX TECHNIQUES

A. INTRODUCTION

The VATE simulator was modified to include flow diagram and hardware precedence matrix techniques and connection matrix techniques. An operational automatic checkout program was then used with the modified simulator to validate the techniques.

The following seven computer runs were made:

1. A run with no precedence constraints.

2. A run in which hardware precedences and connections were satisfied.

3. A run in which hardware precedences were violated.

4. A run in which invalid connections were requested.

5. A run in which flow diagram precedences were satisfied.

6. A run in which flow diagram precedences were violated.

7. A run in which an inconsistent precedence matrix was specified in the input data.

At the time at which the operational automatic checkout program was used for validation, it contained an error which caused termination before completion of execution of the program. However, a sufficient portion of the program was processed to enable validation of the precedence and connection matrix techniques.

On the listings of the runs, after the echo print of the input data, the first column, LABEL, is an identification number taken from the input card of the checkout program instruction being executed. The second column, REV, is the drum revolution during which the instruction is executed. The third and fourth columns, CHN and SEC, are the channel and sector in which the automatic checkout instruction is being executed. The next three columns, NC, OP, and W/W constitute the instruction being executed. The next two columns, DEST and SRC, are the destination and source for this instruction. The next three columns, OLD DEST, SOURCE, and NEW DEST, are the octal contents of the old destination, the source, and the new destination. The next column, TN, contains an 02 for instructions in permanent memory and a 77 for instructions executed in the variable registers. The last column, ERRORS, contains code numbers for the errors that are detected by the simulator during execution of the program. These errors are not necessarily

related to the errors detected by the computer programs which implement precedence and connection matrix techniques.

The validation runs are discussed in detail in the following sections.

B. COMPUTER RUN WITH NO PRECEDENCES

A run was made using no precedence constraints in order to show a listing of the output that would result from a run with the simulator unmodified by precedence and connection matrix techniques. The run is listed on the following pages.

```
          XEC

ENTRY POINTS TC SUBRCUTINES REQUESTED FRCM LIBRARY,
     (FPT)       EXIT        (TSHM)      (RTN)       (STHM)      (FIL)       DUMP

  PREPROCESSING TIME = 000.27 MIN.

        EXECUTICN
   6
        000000000000        0C0000C00CC0        CCCCCCCCC0C0        000000000000
        000000000000        0C0000C00CCC
        000000000000        CCCCCCCCCCCC        CCC0000CCCCC        00C0C0C00000
        000000000000        CCCCCCCCCCCC
0 0 0 0 0 0 1 0 0 0 C 0 C 1 C C 0 0 C C 1 C C C C C C 1 0 0 0 0 0 0 1 0
0 1 1 0 0 0 1 0 0 0 1 0 C C C 1 C 0 C C C 1 0 C C C C C 0 C C 0 0 0 0 0 0
        000000000000        CCC0CCCCCC00        CCCCCCCCC0C0        000000000000
        000000000000        CCC00CC0CCCC
        000001610102        CC000755C103        CCCC13770201        000002600205
        000000000304        CC001CCCC4C4
   2
CCNSISTENT MATRIX
```

LABEL 1	REV	CHN SEC	NC	OP	A/M	DEST	SRC	OLD DEST	SOURCE	NEW DEST	TN	ERRORS
08700	001	166.111	166	BLFK	CC5	F.2	K.112	0.0000000	0.0000200	0.0000200	02	
08700	001	166.111	166	BLFK	CC5	F.3	K.113	0.0000000	0.0000004	0.0000004	02	
08700	001	166.111	166	BLFK	CC5	F.4	K.114	0.0000000	1.6700037	1.6700037	02	
08700	001	166.111	166	BLFK	CC5	F.5	K.115	0.0000000	0.0200000	0.0200000	02	
08700	001	166.111	166	BLFK	CC5	F.6	K.116	0.0000000	0.0000000	0.0000000	02	
08706	001	166.117	166	BLJK	C10	J.C0	K.120	0.0000000	0.2610477	0.2610477	02	
08706	001	166.117	166	BLJK	C10	J.C1	K.121	0.0000000	0.2004500	0.2004500	02	
08706	001	166.117	166	BLJK	C10	J.C2	K.122	0.0000000	0.0450103	0.0450103	02	
08706	001	166.117	166	BLJK	C10	J.C3	K.123	0.0000000	0.5012330	0.5012330	02	
08706	001	166.117	166	BLJK	C10	J.C4	K.124	0.0000000	0.1437714	0.1437714	02	
08706	001	166.117	166	BLJK	C10	J.C5	K.125	0.0000000	0.0000050	0.0000050	02	
08706	001	166.117	166	BLJK	C10	J.C6	K.126	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
08706	001	166.117	166	BLJK	C10	J.C7	K.127	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
08715	001	166.130	160	JUMP	072			0.0000000	0.0000000	0.0000000	02	
50000	001	160.223	160	TOF	C14	C.324*F.4		0.0000000	1.6700037	1.6700037	02	
50200	001	160.240	160	TFZ	CC2	F.1	Z.	0.0000000	0.0000000	0.0000000	02	
50300	001	160.243	160	TFK	C10	F.4	K.244	1.6700037	1.6100456	1.6100456	02	
09800	001	160.254	160	TEK	CC1	E.	K.255	0.0000000	1.6000053	1.6000053	02	
10000	001	160.256	C14	JUMP	141			0.0000000	0.0000000	0.0000000	02	
51700	001	014.420	C14	JUMP	000			0.0000000	0.0000000	0.0000000	02	
51800	001	014.421	C14	TOE	001	C.C22*E.		0.0000000	1.6000053	1.6000053	02	
52000	001	014.423	C14	REPT	C17	C20		0.0000000	0.0000000	0.0000000	02	
52100	001	014.424	C14	TOJ	000	C.C25*J.C5		0.0000000	0.0000050	0.0000050	02	
52100	001	014.425	C14	TOJ	000	C.C26*J.C6		0.0000000	0.0000000	0.0000000	02	
52100	001	014.426	C14	TOJ	000	C.C27*J.C7		0.0000000	0.0000000	0.0000000	02	
52100	001	014.427	C14	TOJ	000	C.C30*J.10		0.0000000	0.0000000	0.0000000	02	
52100	001	014.430	C14	TOJ	000	C.C31*J.11		0.0000000	0.0000000	0.0000000	02	
52100	001	014.431	C14	TOJ	000	C.C32*J.12		0.0000000	0.0000000	0.0000000	02	
52100	001	014.432	C14	TOJ	000	C.C33*J.13		0.0000000	0.0000000	0.0000000	02	
52100	001	014.433	C14	TOJ	000	C.C34*J.14		0.0000000	0.0000000	0.0000000	02	
52100	001	014.434	C14	TOJ	000	C.C35*J.15		0.0000000	0.0000000	0.0000000	02	
52100	001	014.435	C14	TOJ	000	C.C36*J.16		0.0000000	0.0000000	0.0000000	02	
52100	001	014.436	C14	TOJ	000	C.C37*J.17		0.0000000	0.0000000	0.0000000	02	
52100	001	014.437	C14	TOJ	000	C.C40*J.C0		0.0000000	0.2610477	0.2610477	02	
52100	001	014.440	C14	TOJ	000	C.C41*J.C1		0.0000000	0.2004500	0.2004500	02	
52100	001	014.441	C14	TOJ	000	C.C42*J.C2		0.0000000	0.0450103	0.0450103	02	
52100	001	014.442	C14	TOJ	000	C.C43*J.C3		0.0000000	0.5012330	0.5012330	02	
52100	001	014.443	C14	TOJ	000	C.C44*J.C4		0.0000000	0.1437714	0.1437714	02	
52200	001	014.445	C14	REPT	CC7	C10		0.0000000	0.0000000	0.0000000	02	
52300	001	014.446	C14	TOF	000	C.C47*F.7		0.0000000	0.0000000	0.0000000	02	
52300	001	014.447	C14	TOF	000	C.C50*F.0		0.0000000	0.0000000	0.0000000	02	
52300	001	014.450	C14	TOF	000	C.C51*F.1		0.0000000	0.0000000	0.0000000	02	
52300	001	014.451	C14	TOF	000	C.C52*F.2		0.0000000	0.0000200	0.0000200	02	
52300	001	014.452	C14	TOF	000	C.C53*F.3		0.0000000	0.0000004	0.0000004	02	
52300	001	014.453	C14	TOF	000	C.C54*F.4		0.0000000	1.6100456	1.6100456	02	
52300	001	014.454	C14	TOF	000	C.C55*F.5		0.0000000	0.0200000	0.0200000	02	
52300	001	014.455	C14	TOF	000	C.C56*F.6		0.0000000	0.0000000	0.0000000	02	
52400	001	014.457	C14	REPT	CC6	CC7		0.0000000	0.0000000	0.0000000	02	
52500	001	014.460	C14	TOH	000	C.C61*H.01		0.0000000	0.0000000	0.0000000	02	
52500	001	014.461	C14	TOH	000	C.C62*H.02		0.0000000	0.0000000	0.0000000	02	
52500	001	014.462	C14	TOH	000	C.C63*H.03		0.0000000	0.0000000	0.0000000	02	
52500	001	014.463	C14	TOH	000	C.C64*H.04		0.0000000	0.0000000	0.0000000	02	
52500	001	014.464	C14	TOH	000	C.C65*H.05		0.0000000	0.0000000	0.0000000	02	

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52500 001 014.465  014 TCH  CCC   C.C66*H.C6   0.0000000   0.0000000   02
52500 001 014.466  014 TOF  CCC   C.C67*H.07   C.0000000   C.0000000   02
52600 001 014.47C  C14 JUMP CC1               C.0000000   C.0000000   02
52700 001 014.472  C14 REPT 020   021         0.0000000   0.0000000   02
52800 001 014.473  C14 TGX  CCC   G.14  X.    0.0000000   0.0000001   02
52800 001 014.474  C14 TGX  CCC   G.15  X.    C.0000000   0.0000001   02
52800 001 014.475  C14 TGX  CCC   G.16  X.    0.0000000   C.0000001   02
52800 001 014.47E  C14 TGX  CCC   G.17  X.    C.0000000   0.0000001   02
52800 002 014.477  C14 TGX  CCC   G.CC  X.    0.0000000   0.0000001   02
52800 002 014.CCC  014 TGX  CCC   G.C1  X.    0.0000000   0.0000001   02
52800 002 014.C01  C14 TGX  CCC   G.C2  X.    0.0000000   0.0000001   02
52800 002 014.C02  C14 TGX  CCC   G.C3  X.    0.0000000   0.0000001   02
52800 002 014.C03  C14 TGX  CCC   G.C4  X.    0.0000000   0.0000001   02
52800 002 014.C04  C14 TGX  CCC   G.C5  X.    0.0000000   0.0000001   02
52800 002 014.CC5  C14 TGX  CCC   G.C6  X.    0.0000000   0.0000001   02
52800 002 014.C06  014 TGX  CCC   G.C7  X.    0.0000000   0.0000001   02
52800 002 014.C07  014 TGX  CCC   G.1C  X.    0.0000000   0.0000001   02
52800 002 014.C1C  C14 TGX  CCC   G.11  X.    C.0000000   0.0000001   02
52800 002 014.C11  C14 TGX  CCC   G.12  X.    0.0000000   0.0000001   02
52800 002 014.C12  014 TGX  CCC   G.13  X.    0.0000000   0.0000001   02
52800 002 014.C13  014 TGX  CCC   G.14  X.    0.0000001   0.0000001   02
52900 002 014.C15  C14 THX  CCC   H.16  X.    0.0000000   0.0000001   02
53000 002 014.C1E  015 THX  CC2   H.17  X.    0.0000000   0.0000001   02
53100 002 015.C21  014 TCC  CC1   C.    0.022*  0.0000000   1.6000053   02
53200 002 014.C23  014 REPT 017   C2C           0.0000000   0.0000000   02
53300 002 014.C24  014 TJC  CCC   J.C5  C.025*  0.0000050   0.0000050   02
53300 002 014.C25  C14 TJC  CCC   J.C6  C.026*  0.0000000   0.0000000   02
53300 002 014.C2E  C14 TJC  CCC   J.C7  C.C27*  0.0000000   0.0000000   02
53300 002 014.C27  C14 TJC  CCC   J.1C  0.030*  0.0000000   0.0000000   02
53300 002 014.C3C  C14 TJC  CCC   J.11  0.031*  C.0000000   0.0000000   02
53300 002 014.C31  C14 TJC  CCC   J.12  C.C32*  0.0000000   0.0000000   02
53300 002 014.C32  C14 TJC  CCC   J.13  C.033*  0.0000000   0.0000000   02
53300 002 014.C33  C14 TJC  CCC   J.14  0.C34*  0.0000000   0.0000000   02
53300 002 014.C34  C14 TJC  CCC   J.15  C.C35*  0.0000000   0.0000000   02
53300 002 014.C35  014 TJC  CCC   J.16  C.036*  0.0000000   0.0000000   02
53300 002 014.C36  C14 TJC  CCC   J.17  0.037*  0.0000000   0.0000000   02
53300 002 014.C37  014 TJC  CCC   J.CC  C.C4C*  0.2610477   0.2610477   02
53300 002 014.C4C  014 TJC  CCC   J.C1  C.041*  0.2004500   0.2004500   02
53300 002 014.C41  C14 TJC  CCC   J.C2  C.042*  0.0450103   0.0450103   02
53300 002 014.C42  C14 TJC  CCC   J.C3  0.043*  0.5012330   0.5012330   02
53300 002 014.C43  014 TJC  CCC   J.C4          C.1437714   0.1437714   02
53400 002 014.C45  C14 JUMP CCC               0.0000000   0.0000000   02
53500 002 014.C4E  C14 BLFC C1C   F.7   C.C47*  0.0000000   0.0000000   02
53500 002 014.C4E  C14 BLFC C1C   F.C   C.C5C*  0.0000000   0.0000000   02
53500 002 014.C4E  C14 BLFO C10   F.1   C.C51*  0.0000000   0.0000000   02
53500 002 014.C4E  C14 BLFO C10   F.2   C.C52*  0.0000200   0.0000200   02
53500 002 014.C4E  014 BLFO C10   F.3   C.C53*  0.0000004   0.0000004   02
53500 002 014.C4E  C14 BLFO C10   F.4   C.C54*  1.6100456   1.6100456   02
53500 002 014.C4E  C14 BLFO C10   F.5   0.055*  0.0200000   0.0200000   02
53500 002 014.C4E  C14 BLFO C10   F.6   C.056*  0.0000000   0.0000000   02
53600 002 014.C57  014 J[redacted] C1C           0.0000000   0.0000000   02
53700 002 014.C6C  C14 THC  CCC   H.C1  C.061*  0.0000000   0.0000000   02
53800 002 014.C61  C14 THC  CCC   H.C2  C.      0.0000000   1.6000053   02
53900 002 014.C62  C14 THC  CCC   H.C3  C.063*  0.0000000   0.0000000   02
54000 002 014.C63  C14 THC  CCC   H.C4  C.064*  C.0000000   0.0000000   02
54100 002 014.C64  014 THC  CCC   H.C5  C.C65*  0.0000000   0.0000000   02
54200 002 014.C65  014 THC  CCC   H.C6  C.C66*  0.0000000   0.0000000   02
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54300 002 014.066   C14 THC  CCC   H.C7  C.067* 0.0000000  0.0000000  0.0000000  02
54400 002 014.067   C14 JUMP CCC                 0.0000000  0.0000000  0.0000000  02
54500 002 014.070   C14 THX  CCC   H.11  X.     0.0000000  0.0000001  0.0000001  02
54600 002 014.071   C14 THX  CCC   H.12  X.     0.0000000  0.0000001  0.0000001  02
54700 002 014.072   C14 THX  CCC   H.13  X.     0.0000000  0.0000001  0.0000001  02
54800 002 014.073   C14 THX  CCC   H.14  X.     0.0000000  0.0000001  0.0000001  02
54900 002 014.074   C14 THX  CCC   H.15  X.     0.0000000  0.0000001  0.0000001  02
55000 002 014.075   C14 TBC  CCC   B.    C.     3.7777777  1.6000053  1.6000053  02
55100 002 014.076   C14 TDC  CCC   D.,   C.     0.0000000  1.6000053  1.6000053  02
55200 002 014.077   174 TEX  CCC   E.    X.     1.6000053  0.0000001  0.0000001  02
00000 002 174.100   160 JUMP C53                0.0000000  0.0000000  0.0000000  77
10300 002 160.154   16C TPK  CC1   P.124 K.155  0.0000000  0.1610124  0.1610124  02
10500 002 160.156   160 REPT CC7   C1C          0.0000000  0.0000000  0.0000000  02
10600 002 160.157   160 TCF  CCO   C.26C*F.C    0.0000000  0.0000000  0.0000000  02
10600 002 160.160   160 TCF  CCO   C.261*F.1    0.0000000  0.0000000  0.0000000  02
10600 002 160.161   160 TCF  CCO   C.262*F.2    0.0000000  0.0000200  0.0000200  02
10600 002 160.162   160 TCF  CCO   C.263*F.3    0.0000000  0.0000004  0.0000004  02
10600 002 160.163   160 TCF  CCO   C.264*F.4    0.0000000  1.6100456  1.6100456  02
10600 002 160.164   160 TCF  CCO   C.265*F.5    0.0000000  0.0200000  0.0200000  02
10600 002 160.165   160 TCF  CCC   C.266*F.6    0.0000000  0.0000000  0.0000000  02
10600 002 160.166   160 TCF  CCO   C.267*F.7    0.0000000  0.0000000  0.0000000  02
10700 002 160.170   160 JUMP C45                0.0000000  0.0000000  0.0000000  02
10800 002 160.236   160 REPT C17   C2C          0.0000000  0.0000000  0.0000000  02
10900 002 160.237   160 TCJ  CCO   C.340*J.CO   0.2610477  0.2610477  0.2610477  02
10900 002 160.240   160 TCJ  CCO   C.341*J.01   0.2004500  0.2004500  0.2004500  02
10900 002 160.241   160 TCJ  CCC   C.342*J.02   0.0450103  0.0450103  0.0450103  02
10900 002 160.242   160 TCJ  CCO   C.343*J.03   0.5012330  0.5012330  0.5012330  02
10900 002 160.243   160 TCJ  CCO   C.344*J.04   0.1437714  0.1437714  0.1437714  02
10900 002 160.244   160 TCJ  CCC   C.345*J.C5   0.0000050  0.0000050  0.0000050  02
10900 002 160.245   160 TCJ  CCC   C.346*J.C6   0.0000000  0.0000000  0.0000000  02
10900 002 160.246   160 TCJ  CCO   C.347*J.C7   0.0000000  0.0000000  0.0000000  02
10900 002 160.247   160 TCJ  CCC   C.350*J.10   0.0000000  0.0000000  0.0000000  02
10900 002 160.250   160 TCJ  CCC   C.351*J.11   0.0000000  0.0000000  0.0000000  02
10900 002 160.251   160 TCJ  CCO   C.352*J.12   0.0000000  0.0000000  0.0000000  02
10900 002 160.252   160 TCJ  CCC   C.353*J.13   0.0000000  0.0000000  0.0000000  02
10900 002 160.253   160 TCJ  CCC   C.354*J.14   0.0000000  0.0000000  0.0000000  02
10900 002 160.254   160 TCJ  CCC   C.355*J.15   0.0000000  0.0000000  0.0000000  02
10900 002 160.255   160 TCJ  CCC   C.356*J.16   0.0000000  0.0000000  0.0000000  02
10900 002 160.256   160 TCJ  CCC   C.357*J.17   0.0000000  0.0000000  0.0000000  02
11000 002 160.260   160 JUMP 113                0.0000000  0.0000000  0.0000000  02
11300 002 160.374   160 TPK  CC1   P.135 K.375  0.0000000  0.7550135  0.7550135  02
11500 002 160.376   160 TPK  CC1   P.131 K.377  0.0000000  1.3770131  1.3770131  02
11700 002 160.400   160 TEK  CC1   E.    K.401  0.0000001  1.6000017  1.6000017  02
11900 002 160.402   160 TPK  CC4   P.132 K.403  0.0000000  0.2600132  0.2600132  02
12100 002 160.407   160 TPK  CC1   P.136 K.41C  0.0000000  0.0000136  0.0000136  02
12300 002 160.411   C14 JUMP CC6                0.0000000  0.0000000  0.0000000  02
51700 002 014.420   C14 JUMP CC0                0.0000000  0.0000000  0.0000000  02
51800 002 014.421   014 TCE  CC1   C.C22*E.     0.0000000  1.6000017  1.6000017  02
52000 002 014.423   C14 REPT C17   C2C          0.0000000  0.0000000  0.0000000  02
52100 002 014.424   C14 TCJ  CCC   C.C25*J.C5   0.0000000  0.0000050  0.0000050  02
52100 002 014.425   C14 TCJ  CCC   C.C26*J.C6   0.0000000  0.0000000  0.0000000  02
52100 002 014.426   C14 TCJ  CCO   C.C27*J.07   0.0000000  0.0000000  0.0000000  02
52100 002 014.427   C14 TCJ  CCO   C.C3C*J.10   0.0000000  0.0000000  0.0000000  02
52100 002 014.430   014 TCJ  CCO   C.C31*J.11   0.0000000  0.0000000  0.0000000  02
52100 002 014.431   014 TCJ  CCO   C.C32*J.12   0.0000000  0.0000000  0.0000000  02
52100 002 014.432   014 TCJ  CCO   C.C33*J.13   0.0000000  0.0000000  0.0000000  02
52100 002 014.433   014 TCJ  CCC   C.C34*J.14   0.0000000  0.0000000  0.0000000  02
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52100 002 014.434  014 TCJ  CCC   C.C35*J.15   0.0000000   0.0000000   0.0000000   02
52100 002 014.435  014 TCJ  CCC   C.C36*J.16   0.0000000   0.0000000   0.0000000   02
52100 002 014.436  014 TCJ  CCC   C.C37*J.17   0.0000000   0.0000000   0.0000000   02
52100 002 014.437  014 TCJ  CCC   C.C40*J.00   0.0000000   0.2610477   0.2610477   02
52100 002 014.44C  014 TCJ  CCC   C.C41*J.C1   0.0000000   0.2004500   0.2004500   02
52100 002 014.441  014 TCJ  CCC   C.C42*J.C2   0.0000000   0.0450103   0.0450103   02
52100 002 014.442  014 TCJ  CCC   C.C43*J.C3   0.0000000   0.5012330   0.5012330   02
52100 002 014.443  014 TCJ  CCC   C.C44*J.04   0.0000000   0.1437714   0.1437714   02
52200 002 014.445  014 REPT CC7   C1C           0.0000000   0.0000000   0.0000000   02
52300 002 014.446  014 TCF  CCC   C.C47*F.7    0.0000000   0.0000000   0.0000000   02
52300 002 014.447  014 TCF  CCC   C.C50*F.C    0.0000000   0.0000000   0.0000000   02
52300 002 014.45C  014 TCF  CCC   C.C51*F.1    0.0000000   0.0000000   0.0000000   02
52300 002 014.451  014 TCF  CCC   C.C52*F.2    0.0000000   0.0000200   0.0000200   02
52300 002 014.452  014 TCF  CCC   C.C53*F.3    0.0000000   0.0000004   0.0000004   02
52300 002 014.453  014 TCF  CCC   C.C54*F.4    0.0000000   1.6100456   1.6100456   02
52300 002 014.454  014 TCF  CCC   C.C55*F.5    0.0000000   0.0200500   0.0200500   02
52300 002 014.455  014 TCF  CCC   C.C56*F.6    0.0000000   0.0000000   0.0000000   02
52400 002 014.457  014 REPT CC6   CC7           0.0000000   0.0000000   0.0000000   02
52500 002 014.46C  014 TCH  CCC   C.C61*H.01   0.0000000   0.0000000   0.0000000   02
52500 002 014.461  014 TCH  CCC   C.C62*H.02   0.0000000   1.6000053   1.6000053   02
52500 002 014.462  014 TCH  CCC   C.C63*H.03   0.0000000   0.0000000   0.0000000   02
52500 002 014.463  014 TCH  CCC   C.C64*H.04   0.0000000   0.0000000   0.0000000   02
52500 002 014.464  014 TCH  CCC   C.C65*H.05   0.0000000   0.0000000   0.0000000   02
52500 002 014.465  014 TCH  CCC   C.C66*H.06   0.0000000   0.0000000   0.0000000   02
52500 002 014.466  014 TCH  CCC   C.C67*H.07   0.0000000   0.0000000   0.0000000   02
52600 002 014.47C  014 JUMP CC1               0.0000000   0.0000000   0.0000000   02
5270C 002 014.472  014 REPT C2C   C21          0.0000000   0.0000000   0.0000000   02
52800 002 014.473  014 TGX  CCC   G.14  X.     0.0000001   0.0000001   0.0000001   02
52800 002 014.474  014 TGX  CCC   G.15  X.     0.0000001   0.0000001   0.0000001   02
52800 002 014.475  014 TGX  CCC   G.16  X.     0.0000001   0.0000001   0.0000001   02
52800 002 014.476  014 TGX  CCC   G.17  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.477  014 TGX  CCC   G.CC  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.0CC  014 TGX  CCC   G.C1  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.CC1  014 TGX  CCC   G.C2  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.C02  014 TGX  CCC   G.C3  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.C03  014 TGX  CCC   G.C4  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.CC4  014 TGX  CCC   G.C5  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.C05  014 TGX  CCC   G.C6  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.CC6  014 TGX  CCC   G.C7  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.CC7  014 TGX  CCC   G.C1C X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.C1C  014 TGX  CCC   G.11  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.C11  014 TGX  CCC   G.12  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.C12  014 TGX  CCC   G.13  X.     0.0000001   0.0000001   0.0000001   02
52800 003 014.C13  014 TGX  CCC   G.14  X.     0.0000001   0.0000001   0.0000001   02
52900 003 014.C15  014 THX  CCC   H.16  X.     0.0000001   0.0000001   0.0000001   02
53C00 003 014.C16  C15 THX  CC2   H.17  X.     0.0000001   0.0000001   0.0000001   02
53100 003 015.C21  014 TCC  CC1   C.     C.022* 1.6000053   1.6000017   1.6000017   02
53200 003 014.C23  014 REPT C17   C2C           0.0000000   0.0000000   0.0000000   02
53300 003 014.C24  014 TJC  CCC   J.C5  C.025* 0.0000000   0.0000050   0.0000050   02
53300 003 014.C25  014 TJC  CCC   J.C6  C.026* 0.0000000   0.0000030   0.0000030   02
53300 003 014.C26  014 TJC  CCC   J.C7  C.027* 0.0000000   0.0000000   0.0000000   02
53300 003 014.C27  014 TJC  CCC   J.C1C C.C3C* 0.0000000   0.0000000   0.0000000   02
53300 003 014.C3C  014 TJC  CCC   J.11  0.C31* 0.0000000   0.0000000   0.0000000   02
53300 003 014.C31  014 TJC  CCC   J.12  C.032* 0.0000000   0.0000000   0.0000000   02
53300 C03 014.C32  014 TJC  00C   J.13  0.033* 0.0000000   0.0000000   0.0000000   02
53300 003 014.C33  014 TJC  CCC   J.14  C.034* 0.0000000   0.0000000   0.0000000   02
53300 003 014.C34  014 TJC  CCC   J.15  0.035* 0.0000000   0.0000000   0.0000000   02
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53300	003	014.035	014	TJC	000	J.16	C.036*	0.0000000	0.0000000	0.0000000	02		
53300	003	014.036	014	TJC	000	J.17	C.037*	0.0000000	0.0000000	0.0000000	02		
53300	003	014.037	014	TJC	000	J.00	C.040*	0.2610477	0.2610477	0.2610477	02		
53300	003	014.040	014	TJC	000	J.01	C.041*	0.2004500	0.2004500	0.2004500	02		
53300	003	014.041	014	TJC	000	J.02	C.042*	0.0450103	0.0450103	0.0450103	02		
53300	003	014.042	014	TJC	000	J.03	C.043*	0.5012330	0.5012330	0.5012330	02		
53300	003	014.043	014	TJC	000	J.04	C.044*	0.1437714	0.1437714	0.1437714	02		
53400	003	014.045	014	JUMP	000			0.0000000	0.0000000	0.0000000	02		
53500	003	014.046	014	BLFC	010	F.7	C.047*	0.0000000	0.0000000	0.0000000	02		
53500	003	014.046	014	BLFC	010	F.0	C.050*	0.0000000	0.0000000	0.0000000	02		
53500	003	014.046	014	BLFC	010	F.1	C.051*	0.0000000	0.0000000	0.0000000	02		
53500	003	014.046	014	BLFC	010	F.2	C.052*	0.0000200	0.0000200	0.0000200	02		
53500	003	014.046	014	BLFC	010	F.3	C.053*	0.0000004	0.0000004	0.0000004	02		
53500	003	014.046	014	BLFC	010	F.4	C.054*	1.6100456	1.6100456	1.6100456	02		
53500	003	014.046	014	BLFC	010	F.5	C.055*	0.0200000	0.0200000	0.0200000	02		
53500	003	014.046	014	BLFC	010	F.6	C.056*	0.0000000	0.0000000	0.0000000	02		
53600	003	014.057	014	JUMP	000			0.0000000	0.0000000	0.0000000	02		
53700	003	014.060	014	THC	000	H.01	C.061*	0.0000000	0.0000000	0.0000000	02		
53800	003	014.061	014	THC	000	H.02	C.	1.6000053	1.6000017	1.6000017	02		
53900	003	014.062	014	THC	000	H.03	C.063*	0.0000000	0.0000000	0.0000000	02		
54000	003	014.063	014	THC	000	H.04	C.064*	0.0000000	0.0000000	0.0000000	02		
54100	003	014.064	014	THC	000	H.05	C.065*	0.0000000	0.0000000	0.0000000	02		
54200	003	014.065	014	THC	000	H.06	C.066*	0.0000000	0.0000000	0.0000000	02		
54300	003	014.066	014	THC	000	H.07	C.067*	0.0000000	0.0000000	0.0000000	02		
54400	003	014.067	014	JUMP	000			0.0000000	0.0000000	0.0000000	02		
54500	003	014.070	014	THX	000	H.11	X.	0.0000001	0.0000001	0.0000001	02		
54600	003	014.071	014	THX	000	H.12	X.	0.0000001	0.0000001	0.0000001	02		
54700	003	014.072	014	THX	000	H.13	X.	0.0000001	0.0000001	0.0000001	02		
54800	003	014.073	014	THX	000	H.14	X.	0.0000001	0.0000001	0.0000001	02		
54900	003	014.074	014	THX	000	H.15	X.	0.0000001	0.0000001	0.0000001	02		
55000	003	014.075	014	TBC	000	B.	C.	3.7777777	1.6000017	1.6000017	02		
55100	003	014.076	014	TDC	000	D.	C.	1.6000053	1.6000017	1.6000017	02		
55200	003	014.077	174	TEX	000	E.	X.	1.6000017	0.0000001	0.0000001	02		
00000	003	174.100	160	JUMP	017			0.0000000	0.0000000	0.0000000	77		
12500	003	160.120	160	XTRP	010	K.123	P.012	0.4000000	0.0000000	0.0000000	02		
13100	003	160.131	160	TPK	001	P.136	K.132	0.0000000	1.0000136	1.0000136	02		
13300	004	160.133	160	JUMP	434			0.0000000	0.0000000	0.0000000	02		
13400	004	160.070	160	XTRP	004	K.073	P.010	0.0001000	0.0000000	0.0000000	02		
13800	004	160.075	160	TSK	003	S.	K.076	0.0000000	1.7400000	1.7400000	02		
14200	004	160.101	160	JUMP	077			0.0000000	0.0000000	0.0000000	02		
14300	004	160.201	160	TDK	005	D.	K.202	1.6000017	1.5000000	1.5000000	02		
14700	004	160.207	160	BLJK	017	J.10	K.210	0.0000000	0.0000006	0.0000006	02		
14700	004	160.207	160	BLJK	017	J.11	K.211	0.0000000	0.0000000	0.0000000	02	ERR	41 00 00 00
14700	004	160.207	160	BLJK	017	J.12	K.212	0.0000000	1.6100307	1.6100307	02		
14700	004	160.207	160	BLJK	017	J.13	K.213	0.0000000	0.0000000	0.0000000	02	ERR	41 00 00 00
14700	004	160.207	160	BLJK	017	J.14	K.214	0.0000000	0.0000000	0.0000000	02	ERR	41 00 00 00
14700	004	160.207	160	BLJK	017	J.15	K.215	0.0000000	0.0000000	0.0000000	02	ERR	41 00 00 00
14700	004	160.207	160	BLJK	017	J.16	K.216	0.0000000	0.0000000	0.0000000	02	ERR	41 00 00 00
14700	004	160.207	160	BLJK	017	J.17	K.217	0.0000000	0.0000010	0.0000010	02		
14700	004	160.207	160	BLJK	017	J.00	K.220	0.2610477	0.0000000	0.0000000	02	ERR	41 00 00 00
14700	004	160.207	160	BLJK	017	J.01	K.221	0.2004500	1.4000000	1.4000000	02		
14700	004	160.207	160	BLJK	017	J.02	K.222	0.0450103	0.0000002	0.0000002	02		
14700	004	160.207	160	BLJK	017	J.03	K.223	0.5012330	1.6030114	1.6030114	02		
14700	004	160.207	160	BLJK	017	J.04	K.224	0.1437714	1.6273000	1.6273000	02		
14700	004	160.207	160	BLJK	017	J.05	K.225	0.0000050	0.0000000	0.0000000	02	ERR	41 00 00 00
14700	004	160.207	160	BLJK	017	J.06	K.226	0.0000000	0.0000000	0.0000000	02		
15400	004	160.227	161	BLFK	010	F.0	K.230	0.0000000	1.7573161	1.7573161	02		

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15400   004 160.227   161 BLFK  C10   F.1     K.231   0.0000000   0.0000000   0.0000000   02  ERR   41 CC CC CC
15400   004 160.227   161 BLFK  C10   F.2     K.232   0.0000200   1.7727061   1.7727061   02
15400   004 160.227   161 BLFK  C10   F.3     K.233   0.0000004   0.0000000   0.0000000   02  ERR   41 CC CC CC
15400   004 160.227   161 BLFK  C10   F.4     K.234   1.6100456   1.6050437   1.6050437   02
15400   004 160.227   161 BLFK  C10   F.5     K.235   0.0200000   1.7400001   1.7400001   02
15400   004 160.227   161 BLFK  C10   F.6     K.236   0.0000000   1.7552161   1.7552161   02
15400   004 160.227   161 BLFK  C10   F.7     K.237   0.0000000   0.0000000   0.0000000   02  ERR   41 CC CC CC
16000   004 161.240   160 TFD   000   F.1     D.      0.0000000   1.5000000   1.5000000   02
16050   004 160.241   160 JUMP  020                   0.0000000   0.0000000   0.0000000   02
16100   004 160.262   160 TBC   000   B.      0.263*  0.0000000   0.0000004   0.0000004   02
16200   004 160.263   160 ABX   002   B.      X.      0.0000004   0.0000001   0.0000005   02
16300   004 160.266   160 READ  015   E.      K.300   0.0000005   0.0000000   1.6044077   02
17600   004 160.304   160 XTRE  001   K.305   E.      1.7600777   1.6044077   1.6000077   02
17800   004 160.306   160 TJB   000   J.07    B.      0.0000000   1.6000077   1.6000077   02
17900   004 160.307   160 SEB   000   E.      B.      1.6044077   1.6000077   0.0044000   02
18000   004 160.310   160 TSF   000   S.      F.1     0.0000000   1.5000000   1.5000000   02
18030   004 160.311   160 TDZ   000   D.      Z.      1.5000000   0.0000000   0.0000000   02
18070   004 160.312   160 TBE   000   B.      E.      1.6000077   0.0044000   0.0044000   02
18100   004 160.313   160 RGHT  010   B.              0.0044000   0.0000011   0.0000044   02
18400   004 160.324   160 TJB   006   J.05    B.      0.0000000   0.0000044   0.0000044   02
18500   004 160.333   175 TCF   001   C.      F.4     1.6000017   1.6050437   1.6050437   02
00000   004 175.335   174 JUMP  001                   0.0000000   0.0000000   0.0000000   77
00000   004 174.337   160 TBC   017   B.      0.340*  0.0000044   0.2610477   0.2610477   77
19100   004 160.357   160 JUMP  012                   0.0000000   0.0000000   0.0000000   02
19200   004 160.372   160 TFH   000   F.3     B.      0.0000000   0.2610477   0.2610477   02
19300   004 160.373   161 TEK   003   E.      K.374   0.0044000   1.6100000   1.6100000   02
19500   004 161.377   161 TJD   014   J.00    D.      0.0000000   0.0000000   0.0000000   02
19550   004 161.414   014 JUMP  003                   0.0000000   0.0000000   0.0000000   02
51700   004 014.420   014 JUMP  000                   0.0000000   0.0000000   0.0000000   02
51800   004 014.421   014 TCE   001   0.022*E.        0.0000000   1.6100000   1.6100000   02
52000   004 014.423   014 REPT  017   020             0.0000000   0.0000000   0.0000000   02
52100   004 014.424   014 TCJ   000   0.025*J.05      0.0000000   0.0000044   0.0000044   02
52100   004 014.425   014 TCJ   000   0.026*J.06      0.0000000   0.0000000   0.0000000   02
52100   004 014.426   014 TCJ   000   0.027*J.07      0.0000000   1.6000077   1.6000077   02
52100   004 014.427   014 TCJ   000   0.030*J.10      0.0000000   0.0000006   0.0000006   02
52100   004 014.430   014 TCJ   000   0.031*J.11      0.0000000   0.0000000   0.0000000   02
52100   004 014.431   014 TCJ   000   0.032*J.12      0.0000000   1.6100307   1.6100307   02
52100   004 014.432   014 TCJ   000   0.033*J.13      0.0000000   0.0000000   0.0000000   02
52100   004 014.433   014 TCJ   000   0.034*J.14      0.0000000   0.0000000   0.0000000   02
52100   004 014.434   014 TCJ   000   0.035*J.15      0.0000000   0.0000000   0.0000000   02
52100   004 014.435   014 TCJ   000   0.036*J.16      0.0000000   0.0000000   0.0000000   02
52100   004 014.436   014 TCJ   000   0.037*J.17      0.0000000   0.0000010   0.0000010   02
52100   004 014.437   014 TCJ   000   0.040*J.00      0.0000000   0.0000000   0.0000000   02
52100   004 014.440   014 TCJ   000   0.041*J.01      0.0000000   1.4000000   1.4000000   02
52100   004 014.441   014 TCJ   000   0.042*J.02      0.0000000   0.0000002   0.0000002   02
52100   004 014.442   014 TCJ   000   0.043*J.03      0.0000000   1.6030114   1.6030114   02
52100   004 014.443   014 TCJ   000   0.044*J.04      0.0000000   1.6273000   1.6273000   02
52200   004 014.445   014 REPT  007   010             0.0000000   0.0000000   0.0000000   02
52300   004 014.446   014 TOF   000   0.047*F.7       0.0000000   0.0000000   0.0000000   02
52300   004 014.447   014 TOF   000   0.050*F.0       0.0000000   1.7573161   1.7573161   02
52300   004 014.450   014 TOF   000   0.051*F.1       0.0000000   1.5000000   1.5000000   02
52300   004 014.451   014 TOF   000   0.052*F.2       0.0000000   1.7727061   1.7727061   02
52300   004 014.452   014 TOF   000   0.053*F.3       0.0000000   0.2610477   0.2610477   02
52300   004 014.453   014 TOF   000   0.054*F.4       0.0000000   1.6050437   1.6050437   02
52300   004 014.454   014 TOF   000   0.055*F.5       0.0000000   1.7400001   1.7400001   02
52300   004 014.455   014 TOF   000   0.056*F.6       0.0000000   1.7552161   1.7552161   02
52400   004 014.457   014 REPT  006   007             0.0000000   0.0000000   0.0000000   02
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52500 004 014.46C 014 TCH CCC C.C61*H.01 0.0000000 0.0000000 0.0000000 02
52500 004 014.461 014 TCH CCC 0.C62*H.02 0.0000003 0.0000017 1.6000017 02
52500 004 014.462 014 TCH CCC C.C63*H.03 0.0000000 0.0000000 0.0000000 02
52500 004 014.463 014 TCH CCC 0.C64*H.04 0.0000000 0.0000000 0.0000000 02
52500 004 014.464 014 TCH CCC 0.C65*H.05 0.0000000 0.0000000 0.0000000 02
52500 004 014.465 014 TCH CCC 0.C66*H.06 0.0000000 0.0000000 0.0000000 02
52500 004 014.466 014 TCH CCC C.C67*H.C7 0.0000000 0.0000000 0.0000000 02
52600 004 014.47G 014 JUMP CC1 0.0000000 0.0000000 0.0000000 02
52700 004 014.472 014 REPT 020 021 0.0000000 0.0000000 0.0000000 02
52800 004 014.473 014 TGX CCC G.14 X. 0.0000001 0.0000001 0.0000001 02
52800 004 014.474 014 TGX CCC G.15 X. 0.0000001 0.0000001 0.0000001 02
52800 004 014.475 014 TGX CCC G.16 X. 0.0000001 0.0000001 0.0000001 02
52800 004 014.476 014 TGX CCC G.17 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.477 014 TGX CCC G.C0 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.000 014 TGX CCC G.C1 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.GC1 014 TGX CCC G.C2 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.GC2 014 TGX CCC G.C3 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.GC3 014 TGX CCC G.C4 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.GC4 014 TGX CCC G.C5 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.GC5 014 TGX CCC G.C6 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.GC6 014 TGX CCC G.C7 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.GC7 014 TGX CCC G.1C X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.C1C 014 TGX CCC G.11 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.C11 014 TGX CCC G.12 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.C12 014 TGX CCC G.13 X. 0.0000001 0.0000001 0.0000001 02
52800 005 014.C13 014 TGX CCC G.14 X. 0.0000001 0.0000001 0.0000001 02
52900 005 014.C15 014 THX CCC H.16 X. 0.0000001 0.0000001 0.0000001 02
53000 005 014.C1E 014 THX CC2 H.17 X. 0.0000001 0.0000001 0.0000001 02
53100 005 015.C21 014 TCC GC1 C. C.C22* 1.6050437 1.6100000 1.6100000 02
53200 005 014.C23 014 REPT C17 C2C 0.0000000 0.0000000 0.0000000 02
53300 005 014.C24 014 TJC CCC J.C5 0.025* 0.0000044 0.0000044 0.0000044 02
53300 005 014.C25 014 TJC CCC J.C6 0.C26* 0.0000000 0.0000000 0.0000000 02
53300 005 014.C26 014 TJC CCC J.C7 0.C27* 1.6000077 1.6000077 1.6000077 02
53300 005 014.C27 014 TJC CCC J.1C 0.03C* 0.0000006 0.0000006 0.0000006 02
53300 005 014.C3C 014 TJC CCC J.11 0.C31* 0.0000000 0.0000000 0.0000000 02
53300 005 014.C31 014 TJC CCC J.12 0.032* 1.6100307 1.6100307 1.6100307 02
53300 005 014.C32 014 TJC CCC J.13 0.C33* 0.0000000 0.0000000 0.0000000 02
53300 005 014.C33 014 TJC CCC J.14 0.C34* 0.0000000 0.0000000 0.0000000 02
53300 005 014.C34 014 TJC CCC J.15 0.035* 0.0000000 0.0000000 0.0000000 02
53300 005 014.C35 014 TJC CCC J.16 0.036* 0.0000000 0.0000000 0.0000000 02
53300 005 014.C36 014 TJC CCC J.17 0.C37* 0.000001C 0.0000010 0.0000010 02
53300 005 014.C37 014 TJC CCC J.CC 0.C4C* 0.0000000 0.0000000 0.0000000 02
53300 005 014.C4C 014 TJC CCC J.C1 0.041* 1.4000000 1.4000000 1.4000000 02
53300 005 014.C41 014 TJC CCC J.C2 0.C42* 0.0000002 0.0000002 0.0000002 02
53300 005 014.C42 014 TJC CCC J.03 0.C43* 1.6030114 1.6030114 1.6030114 02
53300 005 014.C43 014 TJC CCC J.C4 0.C44* 1.6273000 1.6273000 1.6273000 02
53400 005 014.C45 014 JUMP CCC 0.C0C0000 0.0000000 0.0000000 02
53500 005 014.C46 014 BLFC C1C F.7 0.C47* 0.0000000 0.0000000 0.0000000 02
53500 005 014.C46 014 BLFC 01C F.C 0.050* 1.7573161 1.7573161 1.7573161 02
53500 005 014.C46 014 BLFC 010 F.1 0.051* 1.5000000 1.5000000 1.5000000 02
53500 005 014.C46 014 BLFC 010 F.2 0.052* 1.7727061 1.7727061 1.7727061 02
53500 005 014.C46 014 BLFC 010 F.3 0.053* 0.2610477 0.2610477 0.2610477 02
53500 005 014.C46 014 BLFC 010 F.4 0.054* 1.6050437 1.6050437 1.6050437 02
53500 005 014.C46 014 BLFC C10 F.5 0.055* 1.7400001 1.7400001 1.7400001 02
53500 005 014.C46 014 BLFC 010 F.6 0.056* 1.7552161 1.7552161 1.7552161 02
53600 005 014.C57 014 JUMP CCC 0.0000000 0.0000000 0.0000000 02
53700 005 014.C6C 014 TPC CCC H.C1 C.C61* 0.0000000 0.0000000 0.0000000 02
```

```
53800 005 014.C61 C14 THC  CCC  H.C2  C.     1.6000017  1.6100000  02
53900 005 014.C62 C14 THC  CCC  H.C3  C.C63*  0.0000000  0.0000000  02
54000 005 014.C63 C14 THC  CCC  H.C4  C.064*  0.0000000  0.0000000  02
54100 005 014.C64 C14 THC  CCC  H.C5  C.065*  0.0000000  0.0000000  02
54200 005 014.C65 C14 THC  CCC  H.C6  C.C66*  0.0000000  0.0000000  02
54300 005 014.C66 C14 THC  CCC  H.C7  C.067*  0.0000000  0.0000000  02
54400 005 014.C67 C14 JUMP CCC                0.0000000  0.0000000  02
54500 005 014.C7C C14 THX  CCC  H.11  X.      0.0000001  0.0000001  02
54600 005 014.C71 C14 THX  CCC  H.12  X.      0.0000001  0.0000001  02
54700 005 014.C72 C14 THX  CCC  H.13  X.      0.0000001  0.0000001  02
54800 005 014.C73 C14 THX  CCC  H.14  X.      0.0000001  0.0000001  02
54900 005 014.C74 C14 THX  CCC  H.15  X.      0.0000001  0.0000001  02
55000 005 014.C75 C14 TBC  CCC  B.    C.      3.7777777  1.6100000  02
55100 005 014.C76 C14 TDC  CCC  D.    C.      1.6100000  1.6100000  02
55200 005 014.C77 174 TEX  CCC  E.    X.      1.6100000  0.0000001  02
00000 005 174.10C 161 JUMP CCC                0.0000000  0.0000000  77
19700 005 161.1C1 161 REPT C17  C2C           0.0000000  0.0000000  02  ERR  41 CC CC CC
19800 005 161.1C2 161 TGK  CCC  G.C3  K.103   0.0000001  0.0000000  02
19800 005 161.1C3 161 TGK  CCC  G.C4  K.104   0.0000001  0.3400000  02
19800 005 161.1C4 161 TGK  CCC  G.C5  K.105   0.0000001  1.3000000  02
19800 005 161.1C5 161 TGK  CCC  G.C6  K.106   0.0000001  1.2400000  02
19800 005 161.1C6 161 TGK  CCC  G.C7  K.107   0.0000001  0.2000000  02
19800 005 161.1C7 161 TGK  CCC  G.1C  K.11C   0.0000001  1.1400000  02
19800 005 161.11C 161 TGK  CCC  G.11  K.111   0.0000001  0.1000000  02
19800 005 161.111 161 TGK  CCC  G.12  K.112   0.0000001  0.0400000  02
19800 005 161.112 161 TGK  CCC  G.13  K.113   0.0000000  1.0000000  02
19800 005 161.113 161 TGK  CCC  G.14  K.114   0.0000001  1.7562625  02  ERR  41 CC CC CC
19800 005 161.114 161 TGK  CCC  G.15  K.115   0.0000001  0.0000000  02
19800 005 161.115 161 TGK  CCC  G.16  K.116   0.0000001  0.0000000  02  ERR  41 CC CC CC
19800 005 161.116 161 TGK  CCC  G.17  K.117   0.0000001  1.7642021  02
19800 005 161.117 161 TGK  CCC  G.CC  K.120   0.0000001  0.0000007  02
19800 005 161.12C 161 TGK  CCC  G.C1  K.121   0.0000001  1.7670160  02
19800 005 161.121 161 TGK  CCC  3.C2  K.122   0.0000001  1.7602011  02
21200 005 161.123 161 REPT C11  C12           0.0000000  0.0000000  02
21300 005 161.124 161 THK  CCC  H.C5  K.125   0.0000000  0.0000000  02  ERR  41 CC CC CC
21300 005 161.125 161 THK  CCC  H.C6  K.126   0.0000000  1.7451161  02
21300 005 161.126 161 THK  CCC  H.C7  K.127   0.0000000  1.7767622  02
21300 005 161.127 161 THK  CCC  H.10  K.130   0.0000000  0.0000000  02  ERR  41 CC CC CC
21300 005 161.13C 161 THK  CCC  H.11  K.131   0.0000001  1.7451161  02
21300 005 161.131 161 THK  CCC  H.12  K.132   0.0000001  1.7750020  02
21300 005 161.132 161 THK  CCC  H.13  K.133   0.0000001  1.7702242  02
21300 005 161.133 161 THK  CCC  H.14  K.134   0.0000001  0.0000700  02
21300 005 161.134 161 THK  CCC  H.15  K.135   0.0000001  1.6102353  02
21300 005 161.135 161 THK  CCC  H.16  K.136   0.0000001  1.7651000  02
22000 005 161.137 161 TDJ  CC2  D.    J.03    1.6100000  0.0000000  02
22100 005 161.142 161 TCF  CC0  C.    F.3     1.6100000  0.2610477  02
22200 005 161.143 161 THK  CC1  H.C4  K.144   0.0000000  1.7767622  02
22300 005 161.145 176 JUMP C11                0.0000000  0.0000000  02
00000 005 176.157 176 XTRC CC1  K.16C C.      0.0000007  0.2610477  77
00000 005 176.161 176 ABJ  CCC  B.    J.02    0.0000007  0.0000002  77
00000 005 176.162 176 READ C11  E.    K.164   0.0000011  0.0000011  77
00000 005 176.174 175 SDX  CC5  D.    X.      0.0000000  0.3400000  77
00000 005 175.176 175 TDJ  CC1  D.    J.17    1.7777777  1.7777777  77
00000 005 175.200 175 AEJ  CC1  E.    J.01    0.3400000  0.0000010  77
00000 005 175.202 177 TSE  CC1  S.    E.      0.0000000  1.7400000  77
00000 005 177.204 177 SJX  CC2  J.C5  X.      0.0000044  0.0000001  77
00000 005 177.207 177 SJX  CC2  J.1C  X.      0.0000006  0.0000001  77
```

00000	005	177.212	177	TBC	CCC	B.	C.	0.0000011	0.2610477	0.2610477	77
00000	005	177.213	177	RGHT	C02	B.		0.2610477	0.0000003	0.0261047	77
00000	005	177.216	176	TCB	CC0	C.	B.	0.2610477	0.0261047	0.0261047	77
00000	005	176.217	176	XTRC	CC1	K.22C	C.	0.0000007	0.0261047	0.0000007	77
00000	005	176.221	176	ABJ	CC0	B.	J.02	0.0000007	0.0000002	0.0000011	77
00000	005	176.222	176	READ	C11	E.	K.224	0.0000011	0.0000000	0.3400000	77
00000	005	176.234	175	SDX	CC5	D.	X.	0.0000C1C	0.0000001	0.0000007	77
00000	005	175.242	177	TSE	C01	S.	E.	0.0000000	0.3400000	0.3400000	77
00000	005	177.244	177	SJX	C02	J.C5	X.	0.0000043	0.0000001	0.0000042	77
00000	005	177.247	177	SJX	C02	J.1C	X.	0.0000005	0.0000001	0.0000004	77
00000	005	177.252	177	TBC	C00	B.	C.	0.0000011	0.0261047	0.0261047	77
00000	005	177.253	177	RGHT	C02	B.		0.0261047	0.0000003	0.0026104	77
00000	005	177.256	176	TCB	CCC	C.	B.	0.0261047	0.0026104	0.0026104	77
00000	005	176.257	176	XTRC	CC1	K.26C	C.	0.0000007	0.0026104	0.0000000	77
00000	005	176.261	176	ABJ	CC0	B.	J.02	0.0000004	0.0000002	0.0000006	77
00000	005	176.262	176	READ	C11	E.	K.267	0.0000006	0.0000000	0.2000000	77
00000	005	176.274	175	SDX	CC5	D.	X.	0.0000007	0.0000001	0.0000006	77
00000	005	175.302	177	TSE	C01	S.	E.	0.0000000	0.2000000	0.2000000	77
00000	005	177.304	177	SJX	C02	J.C5	X.	0.0000042	0.0000001	0.0000041	77
00000	005	177.307	177	SJX	C02	J.1C	X.	0.0000004	0.0000001	0.0000003	77
00000	005	177.312	177	TBC	CC0	B.	C.	0.0000006	0.0026104	0.0026104	77
00000	005	177.313	177	RGHT	C02	B.		0.0026104	0.0000003	0.0002610	77
00000	005	177.316	176	TCB	CCC	C.	B.	0.0026104	0.0002610	0.0002610	77
00000	005	176.317	176	XTRC	CC1	K.32C	C.	0.0000007	0.0002610	0.0000000	77
00000	005	176.321	176	ABJ	CC0	B.	J.02	0.0000000	0.0000000	0.0000002	77
00000	005	176.322	176	READ	C11	E.	K.333	0.0000002	0.0000000	1.0000000	77
00000	005	176.334	175	SDX	CC5	D.	X.	0.0000006	0.0000001	0.0000005	77
00000	005	175.342	177	TSE	C01	S.	E.	0.0000000	1.0000000	1.0000000	77
00000	005	177.344	177	SJX	C02	J.C5	X.	0.0000041	0.0000001	0.0000040	77
00000	005	177.347	177	SJX	C02	J.1C	X.	0.0000003	0.0000001	0.0000002	77
00000	005	177.352	177	TBC	CCC	B.	C.	0.0000002	0.0000000	0.0000002	77
00000	005	177.353	177	RGHT	C02	B.		0.0000261C	0.0000003	0.0000261	77
00000	005	177.356	176	TCB	CC0	C.	B.	0.0002610	0.0000261	0.0000261	77
00000	005	176.357	176	XTRC	CC1	K.36C	C.	0.0000007	0.0000261	0.0000001	77
00000	005	176.361	176	ABJ	CC0	B.	J.02	0.0000001	0.0000002	0.0000003	77
00000	005	176.362	176	READ	C11	E.	K.372	0.0000003	0.0000000	0.3400000	77
00000	005	176.374	175	SDX	CC5	D.	X.	0.0000005	0.0000001	0.0000004	77
00000	005	175.402	177	TSE	C01	S.	E.	0.0000000	0.3400000	0.3400000	77
00000	005	177.404	177	SJX	C02	J.C5	X.	0.0000040	0.0000001	0.0000037	77
00000	005	177.407	177	SJX	C02	J.1C	X.	0.0000002	0.0000001	0.0000001	77
00000	005	177.412	177	TBC	CCC	B.	C.	0.0000003	0.0000261	0.0000261	77
00000	005	177.413	177	RGHT	C02	B.		0.0000261	0.0000003	0.0000026	77
00000	005	177.416	176	TCB	CCC	C.	B.	0.0000261	0.0000026	0.0000026	77
00000	005	176.417	176	XTRC	CC1	K.42C	C.	0.0000007	0.0000026	0.0000006	77
00000	005	176.421	176	ABJ	CC0	B.	J.02	0.0000006	0.0000002	0.0000010	77
00000	005	176.422	176	READ	C11	E.	K.425	0.0000010	0.0000000	1.3000000	77
00000	005	176.434	175	SDX	CC5	D.	X.	0.0000004	0.0000001	0.0000003	77
00000	005	175.442	177	TSE	C01	S.	E.	0.0000000	1.3000000	1.3000000	77
00000	005	177.444	177	SJX	C02	J.C5	X.	0.0000037	0.0000001	0.0000036	77
00000	005	177.447	177	SJX	C02	J.1C	X.	0.0000001	0.0000001	0.0000000	77
00000	005	177.452	177	TBC	CCC	B.	C.	0.0000010	0.0000026	0.0000026	77
00000	005	177.453	177	RGHT	C02	B.		0.0000026	0.0000003	0.0000002	77
00000	005	177.456	176	TCB	CC0	C.	B.	0.0000026	0.0000002	0.0000002	77
00000	005	176.457	176	XTRC	CC1	K.46C	C.	0.0000007	0.0000002	0.0000002	77
00000	005	176.461	176	ABJ	CC0	B.	J.02	0.0000002	0.0000000	0.0000004	77
00000	005	176.462	176	READ	C11	E.	K.471	0.0000004	0.0000000	0.1000000	77
00000	006	176.474	175	SDX	CC5	D.	X.	0.0000003	0.0000001	0.0000002	77

```
00000   006 175.002   177 TSE  001   S.     E.      0.0000000   0.1000000   0.1000000   77
00000   006 177.004   177 SJX  002   J.05   X.      0.0000036   0.0000001   0.0000035   77
00000   006 177.007   177 SJX  002   J.10   X.      0.0000000   0.0000001   1.7777777   77
00000   006 177.011   174 TCJ  001   C.     J.12    0.0000002   1.6100307   1.6100307   77
00000   006 174.013   161 JUMP 307                   0.0000000   0.0000000   0.0000000   77
18200   006 161.323   161 SFX  000   F.4    X.      1.6050437   0.0000001   1.6050436   02
18300   006 161.324   160 SFX  006   F.5    X.      1.7400001   0.0000001   1.7400000   02
18430   006 160.326   160 JUMP 000                   0.0000000   0.0000000   0.0000000   02
18440   006 160.327   160 TJK  003   J.10   K.330   1.7777777   0.0000006   0.0000006   02
18500   006 160.333   175 TCF  001   C.     F.4     1.6100307   1.6050436   1.6050436   02
00000   006 175.335   174 JUMP 000                   0.0000000   0.0000000   0.0000000   77
00000   006 174.336   160 TBC  016   B.     0.337*  0.0000004   0.0000000   0.0000000   77
23200   006 160.355   160 TEK  002   E.     K.356   0.1000000   1.6000102   1.6000102   02
23320   006 160.360   160 TSK  001   S.     K.361   0.0000000   0.7000000   0.7000000   02
23340   006 160.362   160 TSK  001   S.     K.363   0.0000000   1.4400000   1.4400000   02
23360   006 160.364   161 JUMP 010                   0.0000000   0.0000000   0.0000000   02

00000           161.375                                                         ERR   00 00 00 02


100             ERROR 000002      CARD
```

C. COMPUTER RUN WITH HARDWARE PRECEDENCES AND CONNECTIONS SATISFIED

A run was made with a hardware precedence matrix and a connection matrix which were satisfied by the order of execution of automatic checkout program steps and by the requested connections. The precedence matrix and precedence link matrices were the following:

	MATRIX						KFIRST	KSEC
	COLUMN							
	1	2	3	4	5	6		
1	0	1	0	0	0	0	000001610124	000001610124
2	0	0	1	0	0	0	000007550135	000007550135
3	0	0	0	1	0	0	000013770131	000013770131
4	0	0	0	0	1	0	000002600132	000002600132
5	0	0	0	0	0	1	000000000136	000000000136
6	0	0	0	0	0	0	000010000136	000010000136

ROW

The connection and connection link matrices were the following:

	CONMAT						ACON	BCON
	PRIME EQUIPMENT							
	1	2	3	4	5	6		
1	0	1	0	0	0	0	000001610102	000001610102
2	1	0	0	0	0	0	000007550103	000007550103
3	1	0	0	0	0	0	000013770201	000013770201
4	0	0	1	1	0	0	000002600205	000002600205
5	0	1	0	0	0	0	000000000304	000000000304
6	0	0	0	0	0	0	000010000404	000010000404

During the execution of the automatic checkout program, comments were written for precedences and connections satisfied, and the program terminated normally. The run is listed on the following pages.

```
     *      XEC

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
     (FPT)       EXIT        (TSHM)      (RTN)       (STHM)      (FIL)       DUMP

  PREPROCESSING TIME = 000.28 MIN.

        EXECUTION
   6
        000001610124        000007550135        000013770131        000002600132
        000000000136        000010000136
        000001610124        000007550135        000013770131        000002600132
        000000000136        000010000136
0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0
0 1 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
        000000000000        000000000000        000000000000        000000000000
        000000000000        000000000000
        000001610102        000007550103        000013770201        000002600205
        000000000304        000010000404
   2
  CONSISTENT MATRIX
```

LABEL 1	REV	CHN SEC	NC	OP	W/R	DEST	SRC	OLD DEST	SOURCE	NEW DEST	TN	ERRORS
08700	001	166.111	166	BLFK	C05	F.2	K.112	0.0000000	0.0000200	0.0000200	02	
08700	001	166.111	166	BLFK	C05	F.3	K.113	0.0000000	0.0000004	0.0000004	02	
08700	001	166.111	166	BLFK	C05	F.4	K.114	0.0000000	1.6700037	1.6700037	02	
08700	001	166.111	166	BLFK	C05	F.5	K.115	0.0000000	0.0200000	0.0200000	02	
08700	001	166.111	166	BLFK	C05	F.6	K.116	0.0000000	0.0000000	0.0000000	02	
08706	001	166.117	166	BLJK	C10	J.C0	K.120	0.0000000	0.2610477	0.2610477	02	
08706	001	166.117	166	BLJK	C10	J.C1	K.121	0.0000000	0.2004500	0.2004500	02	
08706	001	166.117	166	BLJK	C10	J.C2	K.122	0.0000000	0.0450103	0.0450103	02	
08706	001	166.117	166	BLJK	C10	J.C3	K.123	0.0000000	0.5012330	0.5012330	02	
08706	001	166.117	166	BLJK	C10	J.C4	K.124	0.0000000	0.1437714	0.1437714	02	
08706	001	166.117	166	BLJK	C10	J.C5	K.125	0.0000000	0.0000050	0.0000050	02	
08706	001	166.117	166	BLJK	C10	J.C6	K.126	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
08706	001	166.117	166	BLJK	C10	J.C7	K.127	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
08715	001	166.130	160	JUMP	C72			0.0000000	0.0000000	0.0000000	02	
50000	001	160.223	160	TCF	C14	C.324*F.4		0.0000000	1.6700037	1.6700037	02	
50200	001	160.240	160	TFZ	C02	F.1	Z.	0.0000000	0.0000000	0.0000000	02	
50300	001	160.243	160	TFK	C10	F.4	K.244	1.6700037	1.6100456	1.6100456	02	
09800	001	160.254	160	TEK	CC1	E.	K.255	0.0000000	1.6000053	1.6000053	02	
10000	001	160.256	C14	JUMP	141			0.0000000	0.0000000	0.0000000	02	
51700	001	014.420	C14	JUMP	000			0.0000000	0.0000000	0.0000000	02	
51800	001	014.421	014	TOE	CC1	C.C22*E.		0.0000000	1.6000053	1.6000053	02	
52000	001	014.423	C14	REPT	017	C2C		0.0000000	0.0000000	0.0000000	02	
52100	001	014.424	014	TOJ	000	C.C25*J.05		0.0000000	0.0000050	0.0000050	02	
52100	001	014.425	C14	TOJ	000	C.C26*J.06		0.0000000	0.0000000	0.0000000	02	
52100	001	014.426	014	TOJ	000	C.C27*J.07		0.0000000	0.0000000	0.0000000	02	
52100	001	014.427	C14	TOJ	000	C.C30*J.10		0.0000000	0.0000000	0.0000000	02	
52100	001	014.430	C14	TOJ	000	C.C31*J.11		0.0000000	0.0000000	0.0000000	02	
52100	001	014.431	014	TOJ	000	C.C32*J.12		0.0000000	0.0000000	0.0000000	02	
52100	001	014.432	014	TOJ	000	C.C33*J.13		0.0000000	0.0000000	0.0000000	02	
52100	001	014.433	014	TOJ	000	C.C34*J.14		0.0000000	0.0000000	0.0000000	02	
52100	001	014.434	014	TOJ	000	C.C35*J.15		0.0000000	0.0000000	0.0000000	02	
52100	001	014.435	C14	TOJ	000	C.C36*J.16		0.0000000	0.0000000	0.0000000	02	
52100	001	014.436	C14	TOJ	000	C.C37*J.17		0.0000000	0.0000000	0.0000000	02	
52100	001	014.437	014	TOJ	000	C.C40*J.00		0.0000000	0.2610477	0.2610477	02	
52100	001	014.440	C14	TOJ	000	C.C41*J.01		0.0000000	0.2004500	0.2004500	02	
52100	001	014.441	014	TOJ	000	C.C42*J.02		0.0000000	0.0450103	0.0450103	02	
52100	001	014.442	014	TOJ	000	C.C43*J.03		0.0000000	0.5012330	0.5012330	02	
52100	001	014.443	014	TOJ	000	C.C44*J.04		0.0000000	0.1437714	0.1437714	02	
52200	001	014.445	014	REPT	007	C1C		0.0000000	0.0000000	0.0000000	02	
52300	001	014.446	014	TCF	000	C.C47*F.7		0.0000000	0.0000000	0.0000000	02	
52300	001	014.447	C14	TCF	000	C.C50*F.0		0.0000000	0.0000000	0.0000000	02	
52300	001	014.450	C14	TCF	000	C.C51*F.1		0.0000000	0.0000000	0.0000000	02	
52300	001	014.451	014	TCF	000	C.C52*F.2		0.0000000	0.0000200	0.0000200	02	
52300	001	014.452	C14	TCF	000	C.C53*F.3		0.0000000	0.0000004	0.0000004	02	
52300	001	014.453	014	TCF	000	C.C54*F.4		0.0000000	1.6100456	1.6100456	02	
52300	001	014.454	C14	TCF	000	C.C55*F.5		0.0000000	0.0200000	0.0200000	02	
52300	001	014.455	014	TCF	000	C.C56*F.6		0.0000000	0.0000000	0.0000000	02	
52400	001	014.457	C14	REPT	006	CC7		0.0000000	0.0000000	0.0000000	02	
52500	001	014.460	014	TOH	000	0.C61*H.01		0.0000000	0.0000000	0.0000000	02	
52500	001	014.461	C14	TOH	000	0.C62*H.02		0.0000000	0.0000000	0.0000000	02	
52500	001	014.462	C14	TOH	000	C.C63*H.03		0.0000000	0.0000000	0.0000000	02	
52500	001	014.463	014	TOH	000	0.C64*H.04		0.0000000	0.0000000	0.0000000	02	
52500	001	014.464	C14	TOH	000	0.C65*H.05		0.0000000	0.0000000	0.0000000	02	

```
52500  001 014.465  C14 TCH  CCC  C.C66*H.C6  0.CCCCCCC  0.0000000  0.0000000  02
52500  001 014.466  C14 TCH  CCO  C.C67*H.C7  C.CCCCCCC  C.CCCCCCC  0.0000000  02
52600  001 014.47C  C14 JUMP 0C1              0.CCCCCCC  0.CCCCCCC  0.0000000  02
52700  001 014.472  C14 REPT 02C  C21         0.CCCCCCC  0.0000000  0.0000000  02
52800  001 014.473  C14 TGX  CCO  G.14  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  001 014.474  C14 TGX  CCC  G.15  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  001 014.475  C14 TGX  CCC  G.16  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  001 014.476  C14 TGX  CCO  G.17  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.477  C14 TGX  CCC  G.CC  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.CGC  C14 TGX  CCC  G.C1  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.CC1  C14 TGX  CCC  G.C2  X.    0.CCC3000  0.0000001  0.0000001  02
52800  002 014.CG2  C14 TGX  CCO  G.C3  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.CG3  C14 TGX  CCC  G.C4  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.CC4  C14 TGX  CCC  G.C5  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.CC5  C14 TGX  CCO  G.C6  X.    0.CCC3000  0.0000001  0.0000001  02
52800  002 014.CC6  C14 TGX  CCC  G.C7  X.    0.CCC6000  0.0000001  0.0000001  02
52800  002 014.C07  C14 TGX  CCC  G.1C  X.    0.CCC3000  0.0000001  0.0000001  02
52800  002 014.C1C  C14 TGX  CCC  G.11  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.C11  C14 TGX  CCC  G.12  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.C12  C14 TGX  CCC  G.13  X.    0.CCCCCCC  0.0000001  0.0000001  02
52800  002 014.C13  C14 TGX  CCO  G.14  X.    0.CCCCCCC  0.0000001  0.0000001  02
52900  002 014.C15  C14 THX  CCO  H.16  X.    0.CCC3000  0.0000001  0.0000001  02
53000  002 014.C16  C15 THX  C02  H.17  X.    0.CCCCCCC  0.0000001  0.0000001  02
53100  002 015.021  C14 TCC  C01  C.    C.022* 0.CCCCCCC  1.6000053  1.6000053  02
53200  002 014.C23  C14 REPT 017  C2C         0.CCCCCCC  0.0000000  0.0000000  02
53300  002 014.C24  C14 TJC  CCC  J.C5  C.025* 0.CCC3C50  0.0000050  0.0000050  02
53300  002 014.025  C14 TJC  CCC  J.C6  C.026* 0.CCCCCCC  0.0000000  0.0000000  02
53300  002 014.C26  C14 TJC  CCC  J.C7  C.027* 0.CCCCCCC  0.0000000  0.0000000  02
53300  002 014.C27  C14 TJC  CCC  J.1C  C.C3C* 0.CCC3C0C  0.0000000  0.0000000  02
53300  002 014.C3C  C14 TJC  CCC  J.11  C.031* 0.CCC3C00  0.0000000  0.0000000  02
53300  002 014.C31  C14 TJC  CCC  J.12  C.032* 0.CCC3C00  0.0000000  0.0000000  02
53300  002 014.C32  C14 TJC  CCC  J.13  C.033* 0.CCCCCCC  0.0000000  0.0000000  02
53300  002 014.C33  C14 TJC  CCC  J.14  C.034* 0.CCCCCCC  0.0000000  0.0000000  02
53300  002 014.C34  C14 TJC  CCC  J.15  C.035* 0.CCCCCCC  0.0000000  0.0000000  02
53300  002 014.C35  C14 TJC  CCC  J.16  C.036* 0.CCCCCCC  0.0000000  0.0000000  02
53300  002 014.C36  C14 TJC  CCC  J.17  C.037* 0.CCCCCCC  0.0000000  0.0000000  02
53300  002 014.C37  C14 TJC  CCC  J.CC  C.04C* 0.2610477  0.2610477  0.2610477  02
53300  002 014.C4C  C14 TJC  CCC  J.C1  C.041* 0.2004500  0.2004500  0.2004500  02
53300  002 014.041  C14 TJC  CCC  J.C2  C.042* 0.2450103  0.2450103  0.2450103  02
53300  002 014.C42  C14 TJC  CCC  J.C3  C.043* 0.5012330  0.5012330  0.5012330  02
53300  002 014.C43  C14 TJC  CCC  J.C4  C.044* 0.1437714  0.1437714  0.1437714  02
53400  002 014.C45  C14 JUMP CCC              0.CCCCCCC  0.0000000  0.0000000  02
53500  002 014.C46  C14 BLFC C10  F.7   C.047* 0.CCC3C00  0.0000000  0.0000000  02
53500  002 014.C46  C14 BLFC C10  F.C   C.05C* 0.CCCCCCC  0.0000000  0.0000000  02
53500  002 014.C46  C14 BLFC C10  F.1   C.051* 0.CCCCCCC  0.0000000  0.0000000  02
53500  002 014.C46  C14 BLFC C10  F.2   C.052* 0.CCCC2C0  0.0000200  0.0000200  02
53500  002 014.C46  C14 BLFC C10  F.3   C.053* 0.CCCCCC4  0.0000004  0.0000004  02
53500  002 014.C46  C14 BLFC C10  F.4   C.C54* 1.6100456  1.6100456  1.6100456  02
53500  002 014.C46  C14 BLFC C10  F.5   C.055* 0.02CCCCC  0.0200000  0.0200000  02
53500  002 014.C46  C14 BLFC C10  F.6   C.056* 0.CCC3C00  0.0000000  0.0000000  02
53600  002 014.C57  C14 JUMP CCC              0.CCC6C0C  0.0000000  0.0000000  02
53700  002 014.C6C  C14 THC  CCC  H.C1  C.061* 0.CCCCCCC  0.0000000  0.0000000  02
53800  002 014.C61  C14 THC  CCC  H.C2  C.     C.CCCCCCC  1.6000053  1.6000053  02
53900  002 014.C62  C14 THC  CCC  H.C3  C.063* 0.0000000  0.0000000  0.0000000  02
54000  002 014.C63  C14 THC  CCC  H.C4  C.064* 0.000C00C  0.0000000  0.0000000  02
54100  002 014.C64  C14 THC  CCC  H.C5  C.065* 0.0000C00  0.0000000  0.0000000  02
54200  002 014.C65  C14 THC  CCC  H.C6  C.066* 0.0000C00  0.0000000  0.0000000  02
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          54300   002 014.066   014 THC  000   H.07  0.067* 0.0000000   0.0000000   0.0000000   02
          54400   002 014.067   014 JUMP CCC                 0.0000000   0.0000000   0.0000000   02
          54500   002 014.070   014 THX  000   H.11  X.     0.0000000   0.0000001   0.0000001   02
          54600   002 014.071   014 THX  000   H.12  X.     0.0000000   0.0000001   0.0000001   02
          54700   002 014.072   014 THX  000   H.13  X.     0.0000000   0.0000001   0.0000001   02
          54800   002 014.073   014 THX  000   H.14  X.     0.0000000   0.0000001   0.0000001   02
          54900   002 014.074   014 THX  000   H.15  X.     0.0000000   0.0000001   0.0000001   02
          55000   002 014.075   014 TBC  000   B.    C.     3.7777777   1.6000053   1.6000053   02
          55100   002 014.076   014 TDC  000   D.    C.     0.0000000   1.6000053   1.6000053   02
          55200   002 014.077   174 TEX  000   E.    X.     1.6000053   0.0000001   0.0000001   02
          00000   002 174.100   160 JUMP 053               0.0000000   0.0000000   0.0000000   77
160.154         160.155
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.154         160.155
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          10300   002 160.154   160 TPK  001   P.124 K.155  0.0000000   0.1610124   0.1610124   02
          10500   002 160.156   160 REPT 007   010         0.0000000   0.0000000   0.0000000   02
          10600   002 160.157   160 TOF  000   0.260*F.0   0.0000000   0.0000000   0.0000000   02
          10600   002 160.160   160 TOF  000   0.261*F.1   0.0000000   0.0000000   0.0000000   02
          10600   002 160.161   160 TOF  000   0.262*F.2   0.0000000   0.0000200   0.0000200   02
          10600   002 160.162   160 TOF  000   0.263*F.3   0.0000000   0.0000004   0.0000004   02
          10600   002 160.163   160 TOF  000   0.264*F.4   0.0000000   1.6100456   1.6100456   02
          10600   002 160.164   160 TOF  000   0.265*F.5   0.0000000   0.0200000   0.0200000   02
          10600   002 160.165   160 TOF  000   0.266*F.6   0.0000000   0.0000000   0.0000000   02
          10600   002 160.166   160 TOF  000   0.267*F.7   0.0000000   0.0000000   0.0000000   02
          10700   002 160.170   160 JUMP 045               0.0000000   0.0000000   0.0000000   02
          10800   002 160.236   160 REPT 017   020         0.0000000   0.0000000   0.0000000   02
          10900   002 160.237   160 TOJ  000   0.340*J.00  0.0000000   0.2610477   0.2610477   02
          10900   002 160.240   160 TOJ  000   0.341*J.01  0.0000000   0.2004500   0.2004500   02
          10900   002 160.241   160 TOJ  000   0.342*J.02  0.0000000   0.0450103   0.0450103   02
          10900   002 160.242   160 TOJ  000   0.343*J.03  0.0000000   0.5012330   0.5012330   02
          10900   002 160.243   160 TOJ  000   0.344*J.04  0.0000000   0.1437714   0.1437714   02
          10900   002 160.244   160 TOJ  000   0.345*J.05  0.0000000   0.0000050   0.0000050   02
          10900   002 160.245   160 TOJ  000   0.346*J.06  0.0000000   0.0000000   0.0000000   02
          10900   002 160.246   160 TOJ  000   0.347*J.07  0.0000000   0.0000000   0.0000000   02
          10900   002 160.247   160 TOJ  000   0.350*J.10  0.0000000   0.0000000   0.0000000   02
          10900   002 160.250   160 TOJ  000   0.351*J.11  0.0000000   0.0000000   0.0000000   02
          10900   002 160.251   160 TOJ  000   0.352*J.12  0.0000000   0.0000000   0.0000000   02
          10900   002 160.252   160 TOJ  000   0.353*J.13  0.0000000   0.0000000   0.0000000   02
          10900   002 160.253   160 TOJ  000   0.354*J.14  0.0000000   0.0000000   0.0000000   02
          10900   002 160.254   160 TOJ  000   0.355*J.15  0.0000000   0.0000000   0.0000000   02
          10900   002 160.255   160 TOJ  000   0.356*J.16  0.0000000   0.0000000   0.0000000   02
          10900   002 160.256   160 TOJ  000   0.357*J.17  0.0000000   0.0000000   0.0000000   02
          11000   002 160.260   160 JUMP 113               0.0000000   0.0000000   0.0000000   02
160.374         160.375
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.374         160.375
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          11300   002 160.374   160 TPK  001   P.135 K.375  0.0000000   0.7550135   0.7550135   02
160.376         160.377
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.376         160.377
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PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          11500    002 160.376   160 TPK  001   P.131 K.377  0.0000000   1.3770131   1.3770131    02
          11700    002 160.400   160 TEK  001   E.    K.401  0.0000001   1.6000017   1.6000017    02
160.402           160.403
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.402           160.403
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          11900    002 160.402   160 TPK  004   P.132 K.403  0.0000000   0.2600132   0.2600132    02
160.407           160.410
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.407           160.410
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          12100    002 160.407   160 TPK  001   P.136 K.410  0.0000000   0.0000136   0.0000136    02
          12300    002 160.411   014 JUMP 006                0.0000000   0.0000000   0.0000000    02
          51700    002 014.420   014 JUMP 000                0.0000000   0.0000000   0.0000000    02
          51800    002 014.421   014 TCE  001   0.022*E.      0.0000000   1.6000017   1.6000017    02
          52000    002 014.423   014 REPT 017   020          0.0000000   0.0000000   0.0000000    02
          52100    002 014.424   014 TOJ  000   0.025*J.05   0.0000000   0.0000050   0.0000050    02
          52100    002 014.425   014 TOJ  000   0.026*J.06   0.0000000   0.0000000   0.0000000    02
          52100    002 014.426   014 TOJ  000   0.027*J.07   0.0000000   0.0000000   0.0000000    02
          52100    002 014.427   014 TOJ  000   0.030*J.10   0.0000000   0.0000000   0.0000000    02
          52100    002 014.430   014 TOJ  000   0.031*J.11   0.0000000   0.0000000   0.0000000    02
          52100    002 014.431   014 TOJ  000   0.032*J.12   0.0000000   0.0000000   0.0000000    02
          52100    002 014.432   014 TOJ  000   0.033*J.13   0.0000000   0.0000000   0.0000000    02
          52100    002 014.433   014 TOJ  000   0.034*J.14   0.0000000   0.0000000   0.0000000    02
          52100    002 014.434   014 TOJ  000   0.035*J.15   0.0000000   0.0000000   0.0000000    02
          52100    002 014.435   014 TOJ  000   0.036*J.16   0.0000000   0.0000000   0.0000000    02
          52100    002 014.436   014 TOJ  000   0.037*J.17   0.0000000   0.0000000   0.0000000    02
          52100    002 014.437   014 TOJ  000   0.040*J.00   0.0000000   0.2610477   0.2610477    02
          52100    002 014.440   014 TOJ  000   0.041*J.01   0.0000000   0.2004500   0.2004500    02
          52100    002 014.441   014 TOJ  000   0.042*J.02   0.0000000   0.0450103   0.0450103    02
          52100    002 014.442   014 TOJ  000   0.043*J.03   0.0000000   0.5012330   0.5012330    02
          52100    002 014.443   014 TOJ  000   0.044*J.04   0.0000000   0.1437714   0.1437714    02
          52200    002 014.445   014 REPT 007   010          0.0000000   0.0000000   0.0000000    02
          52300    002 014.446   014 TOF  000   0.047*F.7    0.0000000   0.0000000   0.0000000    02
          52300    002 014.447   014 TOF  000   0.050*F.0    0.0000000   0.0000000   0.0000000    02
          52300    002 014.450   014 TOF  000   0.051*F.1    0.0000000   0.0000000   0.0000000    02
          52300    002 014.451   014 TOF  000   0.052*F.2    0.0000000   0.0000200   0.0000200    02
          52300    002 014.452   014 TOF  000   0.053*F.3    0.0000000   0.0000004   0.0000004    02
          52300    002 014.453   014 TOF  000   0.054*F.4    0.0000000   1.6100456   1.6100456    02
          52300    002 014.454   014 TOF  000   0.055*F.5    0.0000000   0.0200000   0.0200000    02
          52300    002 014.455   014 TOF  000   0.056*F.6    0.0000000   0.0000000   0.0000000    02
          52400    002 014.457   014 REPT 006   007          0.0000000   0.0000000   0.0000000    02
          52500    002 014.460   014 TOH  000   0.061*H.01   0.0000000   0.0000000   0.0000000    02
          52500    002 014.461   014 TOH  000   0.062*H.02   0.0000000   1.6000053   1.6000053    02
          52500    002 014.462   014 TOH  000   0.063*H.03   0.0000000   0.0000000   0.0000000    02
          52500    002 014.463   014 TOH  000   0.064*H.04   0.0000000   0.0000000   0.0000000    02
          52500    002 014.464   014 TOH  000   0.065*H.05   0.0000000   0.0000000   0.0000000    02
          52500    002 014.465   014 TOH  000   0.066*H.06   0.0000000   0.0000000   0.0000000    02
          52500    002 014.466   014 TOH  000   0.067*H.07   0.0000000   0.0000000   0.0000000    02
          52600    002 014.470   014 JUMP 001                0.0000000   0.0000000   0.0000000    02
          52700    002 014.472   014 REPT 020   021          0.0000000   0.0000000   0.0000000    02
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52800	002	014.473	014	TGX	CCC	G.14	X.	0.0000001	0.0000001	0.0000001	02
52800	002	014.474	014	TGX	CCC	G.15	X.	0.0000001	0.0000001	0.0000001	02
52800	002	014.475	014	TGX	CCC	G.16	X.	0.0000001	0.0000001	0.0000001	02
52800	002	014.476	014	TGX	CCC	G.17	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.477	014	TGX	CCC	G.C0	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.CCC	014	TGX	CCC	G.C1	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C01	014	TGX	CCC	G.C2	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C02	014	TGX	CCC	G.C3	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C03	014	TGX	CCC	G.C4	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.CC4	014	TGX	CCC	G.C5	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C05	014	TGX	CCC	G.C6	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C06	014	TGX	CCC	G.C7	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C07	014	TGX	CCC	G.C8	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C1C	014	TGX	CCC	G.11	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C11	014	TGX	CCC	G.12	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C12	014	TGX	CCC	G.13	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.C13	014	TGX	CCC	G.14	X.	0.0000001	0.0000001	0.0000001	02
52900	003	014.C15	014	THX	CCC	H.16	X.	0.0000001	0.0000001	0.0000001	02
53000	003	014.C16	015	THX	CC2	H.17	X.	0.0000001	0.0000001	0.0000001	02
53100	003	015.021	014	TCC	GC1	C.	C.022*	1.6000053	1.6000017	1.6000017	02
53200	003	014.023	014	REPT	G17	02C	C.	0.0000000	0.0000000	0.0000000	02
53300	003	014.024	014	TJC	GCC	J.C5	C.025*	0.0000050	0.0000050	0.0000050	02
53300	003	014.025	014	TJC	GCC	J.C6	C.026*	0.0000000	0.0000000	0.0000000	02
53300	003	014.C26	014	TJC	GCC	J.C7	C.027*	0.0000000	0.0000000	0.0000000	02
53300	003	014.C27	014	TJC	GCC	J.1C	C.030*	0.0000000	0.0000000	0.0000000	02
53300	003	014.C3C	014	TJC	GCC	J.11	C.031*	0.0000000	0.0000000	0.0000000	02
53300	003	014.C31	014	TJC	GCC	J.12	C.032*	0.0000000	0.0000000	0.0000000	02
53300	003	014.C32	014	TJC	GCC	J.13	C.033*	0.0000000	0.0000000	0.0000000	02
53300	003	014.033	014	TJC	GCC	J.14	C.034*	0.0000000	0.0000000	0.0000000	02
53300	002	014.034	014	TJC	GCC	J.15	C.035*	0.0000000	0.0000000	0.0000000	02
53300	003	014.C35	014	TJC	GCC	J.16	C.036*	0.0000000	0.0000000	0.0000000	02
53300	003	014.036	014	TJC	GCC	J.17	C.037*	0.0000000	0.0000000	0.0000000	02
53300	003	014.037	014	TJC	GCC	J.C0	C.040*	0.2610477	0.2610477	0.2610477	02
53300	003	014.C4C	014	TJC	CCC	J.C1	C.041*	0.2004500	0.2004500	0.2004500	02
53300	003	014.041	014	TJC	CCC	J.C2	C.042*	0.0450103	0.0450103	0.0450103	02
53300	003	014.042	014	TJC	CCC	J.C3	C.043*	0.5012330	0.5012330	0.5012330	02
53300	003	014.C43	014	TJC	CCC	J.C4	C.044*	0.1437714	0.1437714	0.1437714	02
53400	003	014.045	014	JUMP	CC0			0.0000000	0.0000000	0.0000000	02
53500	003	014.046	014	BLFC	C1C	F.7	C.047*	0.0000000	0.0000000	0.0000000	02
53500	003	014.046	014	BLFC	C1C	F.C	C.050*	0.0000000	0.0000000	0.0000000	02
53500	003	014.046	014	BLFC	C1C	F.1	C.051*	0.0000000	0.0000000	0.0000000	02
53500	003	014.046	014	BLFO	C1C	F.2	C.052*	0.0000200	0.0000200	0.0000200	02
53500	003	014.046	014	BLFC	C1C	F.3	C.053*	0.0000004	0.0000004	0.0000004	02
53500	003	014.046	014	BLFC	C1C	F.4	C.054*	1.6100456	1.6100456	1.6100456	02
53500	003	014.046	014	BLFO	C1C	F.5	C.055*	0.0220000	0.0220000	0.0220000	02
53500	003	014.046	014	BLFO	C1C	F.6	C.056*	0.0000000	0.0000000	0.0000000	02
53600	003	014.C57	014	JUMP	CC0			0.0000000	0.0000000	0.0000000	02
53700	003	014.06C	014	THC	CC0	H.C1	0.061*	0.0000000	0.0000000	0.0000000	02
53800	003	014.061	014	THC	C3C	H.C2	C.	1.6000053	1.6000017	1.6000017	02
53900	003	014.C62	014	THC	CC0	H.C3	0.063*	0.0000000	0.0000000	0.0000000	02
54000	003	014.063	014	THC	CC0	H.C4	C.064*	0.0000000	0.0000000	0.0000000	02
54100	003	014.064	014	THC	CC0	H.C5	0.065*	0.0000000	0.0000000	0.0000000	02
54200	003	014.065	014	THC	CC0	H.C6	0.066*	0.0000000	0.0000000	0.0000000	02
54300	003	014.066	014	THC	CC0	H.C7	0.067*	0.0000000	0.0000000	0.0000000	02
54400	003	014.067	014	JUMP	CC0			0.0000000	0.0000000	0.0000000	02
54500	003	014.C7C	014	THX	CC0	H.11	X.	0.0000001	0.0000001	0.0000001	02
54600	003	014.071	014	THX	GC0	H.12	X.	0.0000001	0.0000001	0.0000001	02

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          54700    003 014.072    014 THX   000    H.13   X.      0.0000001   0.0000001   0.0000001   02
          54800    003 014.073    014 THX   000    H.14   X.      0.0000001   0.0000001   0.0000001   02
          54900    003 014.074    014 THX   000    H.15   X.      0.0000001   0.0000001   0.0000001   02
          55000    003 014.075    014 TBC   000    B.     C.      3.7777777   1.6000017   1.6000017   02
          55100    003 014.076    014 TDC   000    D.     C.      1.6000053   1.6000017   1.6000017   02
          55200    003 014.077    174 TEX   000    E.     X.      1.6000017   0.0000001   0.0000001   02
          00000    003 174.100    160 JUMP  017                   0.0000000   0.0000000   0.0000000   77
          12500    003 160.120    160 XTRP  010    K.123  P.012   0.4000000   0.0000000   0.0000000   02
160.131          160.132
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.131          160.132
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          13100    003 160.131    160 TPK   001    P.136  K.132   0.0000000   1.0000136   1.0000136   02
          13300    004 160.133    160 JUMP  434                   0.0000000   0.0000000   0.0000000   02
          13400    004 160.070    160 XTRP  004    K.073  P.010   0.0001000   0.0000000   0.0000000   02
          13800    004 160.075    160 TSK   003    S.     K.076   0.0000000   1.7400000   1.7400000   02
          14200    004 160.101    160 JUMP  077                   0.0000000   0.0000000   0.0000000   02
          14300    004 160.201    160 TDK   005    D.     K.202   1.6000017   1.5000000   1.5000000   02
          14700    004 160.207    160 BLJK  017    J.10   K.210   0.0000000   0.0000006   0.0000006   02
          14700    004 160.207    160 BLJK  017    J.11   K.211   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017    J.12   K.212   0.0000000   1.6100307   1.6100307   02
          14700    004 160.207    160 BLJK  017    J.13   K.213   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017    J.14   K.214   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017    J.15   K.215   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017    J.16   K.216   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017    J.17   K.217   0.0000000   0.0000010   0.0000010   02
          14700    004 160.207    160 BLJK  017    J.00   K.220   0.2610477   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017    J.01   K.221   0.2004500   1.4000000   1.4000000   02
          14700    004 160.207    160 BLJK  017    J.02   K.222   0.0450103   0.0000002   0.0000002   02
          14700    004 160.207    160 BLJK  017    J.03   K.223   0.5012330   1.6030114   1.6030114   02
          14700    004 160.207    160 BLJK  017    J.04   K.224   0.1437714   1.6273000   1.6273000   02
          14700    004 160.207    160 BLJK  017    J.05   K.225   0.0000050   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017    J.06   K.226   0.0000000   0.0000000   0.0000000   02
          15400    004 160.227    161 BLFK  010    F.0    K.230   0.0000000   1.7573161   1.7573161   02
          15400    004 160.227    161 BLFK  010    F.1    K.231   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          15400    004 160.227    161 BLFK  010    F.2    K.232   0.0000200   1.7727061   1.7727061   02
          15400    004 160.227    161 BLFK  010    F.3    K.233   0.0000004   0.0000000   0.0000000   02  ERR   41 00 00 00
          15400    004 160.227    161 BLFK  010    F.4    K.234   1.6100456   1.6050437   1.6050437   02
          15400    004 160.227    161 BLFK  010    F.5    K.235   0.0200000   1.7400001   1.7400001   02
          15400    004 160.227    161 BLFK  010    F.6    K.236   0.0000000   1.7552161   1.7552161   02
          15400    004 160.227    161 BLFK  010    F.7    K.237   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          16000    004 161.240    160 TFD   000    F.1    D.      0.0000000   1.5000000   1.5000000   02
          16050    004 160.241    160 JUMP  020                   0.0000000   0.0000000   0.0000000   02
          16100    004 160.262    160 TBC   000    B.     C.263*  0.0000000   0.0000004   0.0000004   02
          16200    004 160.263    160 ABX   002    B.     X.      0.0000004   0.0000001   0.0000005   02
          16300    004 160.266    160 READ  015    E.     K.300   0.0000005   0.0000000   1.6044077   02
          17600    004 160.304    160 XTRE  001    K.305  E.      1.7600777   1.6044077   1.6000077   02
          17800    004 160.306    160 TJB   000    J.07   B.      0.0000000   1.6000077   1.6000077   02
          17900    004 160.307    160 SEB   000    E.     B.      1.6044077   1.6000077   0.0044000   02
          18000    004 160.310    160 TSF   000    S.     F.1     0.0000000   1.5000000   1.5000000   02
          18030    004 160.311    160 TDZ   000    D.     Z.      1.5000000   0.0000000   0.0000000   02
          18070    004 160.312    160 TBE   000    B.     E.      1.6000077   0.0044000   0.0044000   02
          18100    004 160.313    160 RGHT  010    B.             0.0044000   0.0000011   0.0000044   02
          18400    004 160.324    160 TJB   006    J.05   B.      0.0000000   0.0000044   0.0000044   02
          18500    004 160.333    175 TCF   001    C.     F.4     1.6000017   1.6050437   1.6050437   02
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00000  004 175.335  174 JUMP  CC1                0.0000000  0.0000000  77
00000  004 174.337  160 TBC   017  B.    C.340*  0.0000044  0.2610477  77
19100  004 160.357  160 JUMP  012                0.0000000  0.0000000  02
19200  004 160.372  160 TFB   CCC  F.3   8.     0.0044000  0.2610477  02
19300  004 160.372  161 TEK   003  E.    K.374  0.0000000  1.6100000  02
19500  004 161.377  161 TJC   014  J.CC  D.     0.0000000  0.0000000  02
19550  004 161.414  014 JUMP  003                0.0000000  0.0000000  02
51700  004 014.420  014 JUMP  000                0.0000000  0.0000000  02
51800  004 014.421  014 TCE   001  C.022*E.      0.0000000  1.6100000  02
52000  004 014.423  014 REPT  017  C2C           0.0000000  0.0000000  02
52100  004 014.424  014 TCJ   CCC  C.025*J.05    0.0000000  0.0000044  02
52100  004 014.425  014 TCJ   CCC  C.026*J.06    0.0000000  0.0000000  02
52100  004 014.426  014 TCJ   CCC  C.027*J.07    0.0000000  1.6000077  02
52100  004 014.427  014 TCJ   CCC  C.03C*J.10    0.0000000  0.0000006  02
52100  004 014.430  014 TCJ   CCC  C.031*J.11    0.0000000  0.0000000  02
52100  004 014.431  014 TCJ   CCC  C.032*J.12    0.0000000  1.6100307  02
52100  004 014.432  014 TCJ   CCC  C.033*J.13    0.0000000  0.0000000  02
52100  004 014.433  014 TCJ   CCC  C.034*J.14    0.0000000  0.0000000  02
52100  004 014.434  014 TCJ   CCC  C.035*J.15    0.0000000  0.0000000  02
52100  004 014.435  014 TCJ   CCC  C.036*J.16    0.0000000  0.0000000  02
52100  004 014.436  014 TCJ   CCC  C.037*J.17    0.0000000  0.0000010  02
52100  004 014.437  014 TCJ   CCC  C.040*J.00    0.0000000  0.0000000  02
52100  004 014.44C  014 TCJ   CCC  C.041*J.01    0.0000000  1.4000000  02
52100  004 014.441  014 TCJ   CCC  C.042*J.02    0.0000000  0.0000002  02
52100  004 014.442  014 TCJ   CCC  C.043*J.03    0.0000000  1.6030114  02
52100  004 014.443  014 TCJ   CCC  C.044*J.04    0.0000000  1.6273000  02
52200  004 014.445  014 REPT  007  C1C           0.0000000  0.0000000  02
52300  004 014.446  014 TOF   000  C.047*F.7     0.0000000  0.0000000  02
52300  004 014.447  014 TOF   CCC  C.050*F.C     0.0000000  1.7573161  02
52300  004 014.450  014 TOF   CCC  C.051*F.1     0.0000000  1.5000000  02
52300  004 014.451  014 TOF   CCC  C.052*F.2     0.0000000  1.7727061  02
52300  004 014.452  014 TOF   CCC  C.053*F.3     0.0000000  0.2610477  02
52300  004 014.453  014 TOF   CCC  C.054*F.4     0.0000000  1.6050437  02
52300  004 014.454  014 TOF   CCC  C.055*F.5     0.0000000  1.7400001  02
52300  004 014.455  014 TOF   CCC  C.056*F.6     0.0000000  1.7552161  02
52400  004 014.457  014 REPT  CC6  0C7           0.0000000  0.0000000  02
52500  004 014.460  014 TCH   000  C.061*H.01    0.0000000  0.0000000  02
52500  004 014.461  014 TCH   CCC  C.062*H.02    0.0000000  1.6000017  02
52500  004 014.462  014 TCH   CCC  C.063*H.03    0.0000000  0.0000000  02
52500  004 014.463  014 TCH   CCC  C.064*H.04    0.0000000  0.0000000  02
52500  004 014.464  014 TCH   CCC  C.065*H.05    0.0000000  0.0000000  02
52500  004 014.465  014 TCH   CCC  C.066*H.06    0.0000000  0.0000000  02
52500  004 014.466  014 TCH   CCC  C.067*H.07    0.0000000  0.0000000  02
52600  004 014.47C  014 JUMP  001                0.0000000  0.0000000  02
52700  004 014.472  014 REPT  020  021           0.0000000  0.0000000  02
52800  004 014.473  014 TGX   CCC  G.14  X.      0.0000001  0.0000001  02
52800  004 014.474  014 TGX   CCC  G.15  X.      0.0000001  0.0000001  02
52800  004 014.475  014 TGX   CCC  G.16  X.      0.0000001  0.0000001  02
52800  004 014.476  014 TGX   CCC  G.17  X.      0.0000001  0.0000001  02
52800  004 014.477  014 TGX   CCC  G.CC  X.      0.0000001  0.0000001  02
52800  005 014.CCC  014 TGX   CCC  G.C1  X.      0.0000001  0.0000001  02
52800  005 014.C01  014 TGX   000  G.C2  X.      0.0000001  0.0000001  02
52800  005 014.C02  014 TGX   CCC  G.C3  X.      0.0000001  0.0000001  02
52800  005 014.C03  014 TGX   CCC  G.C4  X.      0.0000001  0.0000001  02
52800  005 014.C04  014 TGX   CCC  G.C5  X.      0.0000001  0.0000001  02
52800  005 014.C05  014 TGX   000  G.C6  X.      0.0000001  0.0000001  02
52800  005 014.C06  014 TGX   CCC  G.C7  X.      0.0000001  0.0000001  02
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19800  005 161.106  161 TGK  CCC  G.C7  K.1C7  0.0000001  0.2000000  0.2000000  C2
19800  005 161.107  161 TGK  CCC  G.1C  K.110  0.0000001  1.1400000  1.1400000  C2
19800  005 161.11C  161 TGK  CCC  G.11  K.111  0.0000001  0.1000000  0.1000000  C2
19800  005 161.111  161 TGK  CCC  G.12  K.112  0.0000001  0.0400000  0.0400000  C2
19800  005 161.112  161 TGK  CCC  G.13  K.113  0.0000001  1.0000000  1.0000000  C2
19800  005 161.113  161 TGK  CCC  G.14  K.114  0.0000001  1.7562625  1.7562625  C2  ERR  41 00 00 00
19800  005 161.114  161 TGK  CCC  G.15  K.115  0.0000001  0.3000000  0.3000000  C2  ERR  41 00 00 00
19800  005 161.115  161 TGK  CCC  G.16  K.116  0.0000001  0.0000000  0.0000000  C2
19800  005 161.116  161 TGK  CCC  G.17  K.117  0.0000001  1.7642021  1.7642021  C2
19800  005 161.117  161 TGK  CCC  G.CC  K.120  0.0000001  0.0000007  0.0000007  C2
19800  005 161.12C  161 TGK  CCC  G.C1  K.121  0.0000001  1.7670160  1.7670160  C2
19800  005 161.121  161 TGK  CCC  G.C2  K.122  0.0000001  1.7602011  1.7602011  C2
21200  005 161.123  161 REPT C11  C12          0.0000000  0.0000000  0.0000000  C2
21300  005 161.124  161 THK  CCC  H.C5  K.125  0.0000000  0.0000000  0.0000000  C2  ERR  41 00 00 00
21300  005 161.125  161 THK  CCC  H.C6  K.126  0.0000000  1.7451161  1.7451161  C2
21300  005 161.126  161 THK  CCC  H.C7  K.127  0.0000000  1.7767622  1.7767622  C2
21300  005 161.127  161 THK  CCC  H.1C  K.13C  0.0000000  0.0000000  0.0000000  C2  ERR  41 00 00 00
21300  005 161.13C  161 THK  CCC  H.11  K.131  0.0000001  1.7451161  1.7451161  C2
21300  005 161.131  161 THK  CCC  H.12  K.132  0.0000001  1.7750020  1.7750020  C2
21300  005 161.132  161 THK  CCC  H.13  K.133  0.0000001  1.7702242  1.7702242  C2
21300  005 161.133  161 THK  CCC  H.14  K.134  0.0000001  0.0000700  0.0000700  C2
21300  005 161.134  161 THK  CCC  H.15  K.135  0.0000001  1.6102353  1.6102353  C2
21300  005 161.135  161 THK  CCC  H.16  K.136  0.0000001  1.7651000  1.7651000  C2
22000  005 161.137  161 TDJ  CC2  D.    J.CC   1.6100000  0.0000000  0.0000000  C2
22100  005 161.142  161 TCF  CCC  C.    F.3    1.6100000  0.2610477  0.2610477  C2
22200  005 161.143  161 THK  CC1  H.C4  K.144  0.0000000  1.7767622  1.7767622  C2
22300  005 161.145  176 JUMP C11           K.16C 0.0000000  0.0000000  0.0000000  C2
00000  005 176.157  176 XTRC CC1  K.16C C.          0.2610477  0.2610477  C7
00000  005 176.161  176 ABJ  CCC  B.    J.C2   0.0000007  0.0000011  0.0000011  C7
00000  005 176.162  176 READ C11  E.    K.164  0.0000011  0.3460000  0.3460000  C7
00000  005 176.174  175 SDX  CC5  D.    X.     0.0000000  1.7777777  1.7777777  C7
00000  005 175.176  175 TDJ  CC1  D.    J.17   1.7777777  0.0000010  0.0000010  C7
00000  005 175.2CC  175 AEJ  CC1  E.    J.01   0.3460000  1.4000000  1.4000000  C7
00000  005 175.2C2  177 TSE  CC1  S.    E.     0.0000000  1.7460000  1.7460000  C7
00000  005 177.2C4  177 SJX  CC2  J.C5  X.     0.0000044  0.0000043  0.0000043  C7
00000  005 177.2C7  177 SJX  CC2  J.1C  X.     0.0000006  0.0000035  0.0000035  C7
00000  005 177.212  177 TBC  CC0  B.    C.     0.0000011  0.2610477  0.2610477  C7
00000  005 177.213  177 RGHT CC2  B.           0.2610477  0.0000003  0.0000003  C7
00000  005 177.216  176 TCB  CC0  C.    B.     0.2610477  0.0261047  0.0261047  C7
00000  005 176.217  176 XTRC CC1  K.22C C.     0.0000007  0.0026107  0.0026107  C7
00000  005 176.221  176 ABJ  CCC  B.    J.02   0.0000011  0.0000011  0.0000011  C7
00000  005 176.222  176 READ C11  E.    K.224  0.0000011  0.3460000  0.3460000  C7
00000  005 176.234  175 SDX  CC5  D.    X.     0.0000010  0.0000001  0.0000001  C7
00000  005 175.242  177 TSE  CC1  S.    E.     0.0000000  0.3460000  0.3460000  C7
00000  005 177.244  177 SJX  CC2  J.C5  X.     0.0000043  0.0000001  0.0000001  C7
00000  005 177.247  177 SJX  CC2  J.1C  X.     0.0000005  0.0000001  0.0000001  C7
00000  005 177.252  177 TBC  CC0  B.    C.     0.0000011  0.0026107  0.0026107  C7
00000  005 177.253  177 RGHT CC2  B.           0.0026107  0.0000003  0.0000003  C7
00000  005 177.256  176 TCB  CC0  C.    B.     0.0026107  0.0026104  0.0026104  C7
00000  005 176.257  176 XTRC CC1  K.26C C.     0.0000007  0.0000004  0.0000004  C7
00000  005 176.261  176 ABJ  CCC  B.    J.02   0.0000002  0.0000006  0.0000006  C7
00000  005 176.262  176 READ C11  E.    K.267  0.0000006  0.2000000  0.2000000  C7
00000  005 176.274  175 SDX  CC5  D.    X.     0.0000007  0.0000001  0.0000006  C7
00000  005 175.3C2  177 TSE  CC1  S.    E.     0.0000000  0.2000000  0.2000000  C7
00000  005 177.3C4  177 SJX  CC2  J.C5  X.     0.0000042  0.0000001  0.0000041  C7
00000  005 177.3C7  177 SJX  CC2  J.1C  X.     0.0000006  0.0000001  0.0000003  C7
00000  005 177.312  177 THC  CCC  B.    C.     0.0000006  0.0026104  0.0026104  C7
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00000   005 177.313   177 RGHT  002   B.              0.0026104   0.0000003   0.0002610   77
00000   005 177.316   176 TCB   000   C.      B.      0.0026104   0.0002610   0.0002610   77
00000   005 176.317   176 XTRC  001   K.320   C.      0.0000007   0.0002610   0.0000003   77
00000   005 176.321   176 ABJ   000   B.      J.02    0.0000000   0.0000002   0.0000002   77
00000   005 176.322   176 READ  011   E.      K.333   0.0000002   0.0000000   1.0000000   77
00000   005 176.334   175 SDX   005   D.      X.      0.0000006   0.0000001   0.0000005   77
00000   005 175.342   177 TSE   001   S.      E.      0.0000000   1.0000000   1.0000000   77
00000   005 177.344   177 SJX   002   J.05    X.      0.0000041   0.0000001   0.0000040   77
00000   005 177.347   177 SJX   002   J.10    X.      0.0000003   0.0000001   0.0000002   77
00000   005 177.352   177 TBC   000   B.      C.      0.0000002   0.0002610   0.0002610   77
00000   005 177.353   177 RGHT  002   B.              0.0002610   0.0000003   0.0000261   77
00000   005 177.356   176 TCB   000   C.      B.      0.0002610   0.0000261   0.0000261   77
00000   005 176.357   176 XTRC  001   K.360   C.      0.0000007   0.0000261   0.0000001   77
00000   005 176.361   176 ABJ   000   B.      J.02    0.0000001   0.0000002   0.0000003   77
00000   005 176.362   176 READ  011   E.      K.372   0.0000003   0.0000000   0.0400000   77
00000   005 176.374   175 SDX   005   D.      X.      0.0000005   0.0000001   0.0000004   77
00000   005 175.402   177 TSE   001   S.      E.      0.0000000   0.0400000   0.0400000   77
00000   005 177.404   177 SJX   002   J.05    X.      0.0000040   0.0000001   0.0000037   77
00000   005 177.407   177 SJX   002   J.10    X.      0.0000002   0.0000001   0.0000001   77
00000   005 177.412   177 TBC   000   B.      C.      0.0000003   0.0000261   0.0000261   77
00000   005 177.413   177 RGHT  002   B.              0.0000261   0.0000003   0.0000026   77
00000   005 177.416   176 TCB   000   C.      B.      0.0000261   0.0000026   0.0000026   77
00000   005 176.417   176 XTRC  001   K.420   C.      0.0000007   0.0000026   0.0000006   77
00000   005 176.421   176 ABJ   000   B.      J.02    0.0000006   0.0000002   0.0000010   77
00000   005 176.422   176 READ  011   E.      K.425   0.0000010   0.0000000   1.3000000   77
00000   005 176.434   175 SDX   005   D.      X.      0.0000004   0.0000001   0.0000003   77
00000   005 175.442   177 TSE   001   S.      E.      0.0000000   1.3000000   1.3000000   77
00000   005 177.444   177 SJX   002   J.05    X.      0.0000037   0.0000001   0.0000036   77
00000   005 177.447   177 SJX   002   J.10    X.      0.0000001   0.0000001   0.0000000   77
00000   005 177.452   177 TBC   000   B.      C.      0.0000010   0.0000026   0.0000026   77
00000   005 177.453   177 RGHT  002   B.              0.0000026   0.0000003   0.0000002   77
00000   005 177.456   176 TCB   000   C.      B.      0.0000026   0.0000002   0.0000002   77
00000   005 176.457   176 XTRC  001   K.460   C.      0.0000007   0.0000002   0.0000002   77
00000   005 176.461   176 ABJ   000   B.      J.02    0.0000002   0.0000002   0.0000004   77
00000   005 176.462   176 READ  011   E.      K.471   0.0000004   0.0000000   0.1000000   77
00000   006 176.474   175 SDX   005   D.      X.      0.0000003   0.0000001   0.0000002   77
00000   006 175.502   177 TSE   001   S.      E.      0.0000000   0.1000000   0.1000000   77
00000   006 177.504   177 SJX   002   J.05    X.      0.0000036   0.0000001   0.0000035   77
00000   006 177.507   177 SJX   002   J.10    X.      0.0000000   0.0000001   1.7777777   77
00000   006 177.511   174 TCJ   001   C.      J.12    0.0000002   1.6100307   1.6100307   77
00000   006 174.513   161 JUMP  307                   0.0000000   0.0000000   0.0000000   77
18200   006 161.323   161 SFX   000   F.4     X.      1.6050437   0.0000001   1.6050436   02
18300   006 161.324   160 SFX   006   F.5     X.      1.7400001   0.0000001   1.7400000   02
18430   006 160.326   160 JUMP  000                   0.0000000   0.0000000   0.0000000   02
18440   006 160.327   160 TJK   003   J.10    K.330   1.7777777   0.0000006   0.0000006   02
18500   006 160.333   175 TCF   001   C.      F.4     1.6100307   1.6050436   1.6050436   02
00000   006 175.335   174 JUMP  000                   0.0000000   0.0000000   0.0000000   77
00000   006 174.336   160 TBC   016   B.      0.337*  0.0000004   0.0000000   0.0000000   77
23200   006 160.355   160 TEK   002   E.      K.356   0.1000000   1.6000102   1.6000102   02
23320   006 160.360   160 TSK   001   S.      K.361   0.0000000   0.7000000   0.7000000   02
23340   006 160.362   160 TSK   001   S.      K.363   0.0001000   1.4400000   1.4400000   02
23360   006 160.364   161 JUMP  010                   0.0000000   0.0000000   0.0000000   02

00000           161.375                                                       ERR   00 00 00 02
```

D. COMPUTER RUN WITH HARDWARE PRECEDENCES VIOLATED

A run was made with a hardware precedence matrix for which the order of execution of automatic checkout program steps violated the specified precedences. The precedence matrix and precedence link matrices were the following:

	MATRIX						KFIRST	KSEC
	COLUMN							
	1	2	3	4	5	6		
1	0	1	0	0	0	0	000001610124	000001610124
2	0	0	0	1	0	0	000007550135	000007550135
3	0	0	0	0	1	0	000013770131	000013770131
4	0	0	1	0	0	0	000002600132	000002600132
5	0	0	0	0	0	1	000000000136	000000000136
6	0	0	0	0	0	0	000010000136	000010000136

ROW

The connection and connection link matrices were the following:

	CONMAT						ACON	BCON
	PRIME EQUIPMENT							
	1	2	3	4	5	6		
1	0	1	0	0	0	0	000001610102	000001610102
2	1	0	0	0	0	0	000007550103	000007550103
3	1	0	0	0	0	0	000013770201	000013770201
4	0	0	1	1	0	0	000002600205	000002600205
5	0	1	0	0	0	0	000000000304	000000000304
6	0	0	0	0	0	0	000010000404	000010000404

AUTOMATIC CHECKOUT EQUIPMENT

The precedence constraint that step 4 must precede step 3 was violated by the attempted execution of step 3 before step 4. At that point in the execution of the program, the diagnostic, "ERROR NUMBER 4" (precedences violated), was written, and the program terminated. The run is listed on the following pages.

```
     *     XEC

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.
     (FPT)       EXIT        (TSHM)      (RTN)       (STHM)      (FIL)       DUMP

  PREPROCESSING TIME = 000.28 MIN.

        EXECUTION
   6
        000001610124        000007550135        000013770131        000002600132
        000000000136        000010000136
        000001610124        000007550135        000013770131        000002600132
        000000000136        000010000136
0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0
0 1 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
        000000000000        000000000000        000000000000        000000000000
        000000000000        000000000000
        000001610102        000007550103        000013770201        000002600205
        000000000304        000010000404
   2
  CONSISTENT MATRIX
```

LABEL 1	REV	CHA SEC	NC	OP	k/w	DEST	SRC	OLD DEST	SOURCE	NEW DEST	TN	ERRORS
08700	001	166.111	166	BLFK	CC5	F.2	K.112	0.0000000	0.0000200	0.0000200	02	
08700	001	166.111	166	BLFK	CC5	F.3	K.113	0.0000000	0.0000004	0.0000004	02	
08700	001	166.111	166	BLFK	CC5	F.4	K.114	0.0000000	1.6700037	1.6700037	02	
08700	001	166.111	166	BLFK	CC5	F.5	K.115	0.0000000	0.0200000	0.0200000	02	
08700	001	166.111	166	BLFK	CC5	F.6	K.116	0.0000000	0.0000000	0.0000000	02	
08706	001	166.117	166	BLJK	C10	J.C0	K.120	0.0000000	0.2610477	0.2610477	02	
08706	001	166.117	166	BLJK	C10	J.C1	K.121	0.0000000	0.2004500	0.2004500	02	
08706	001	166.117	166	BLJK	C10	J.C2	K.122	0.0000000	0.0450103	0.0450103	02	
08706	001	166.117	166	BLJK	C10	J.C3	K.123	0.0000000	0.5012330	0.5012330	02	
08706	001	166.117	166	BLJK	C10	J.C4	K.124	0.0000000	0.1437714	0.1437714	02	
08706	001	166.117	166	BLJK	C10	J.C5	K.125	0.0000000	0.0000050	0.0000050	02	
08706	001	166.117	166	BLJK	C10	J.C6	K.126	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
08706	001	166.117	166	BLJK	C10	J.C7	K.127	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
08715	001	166.130	160	JUMP	072			0.0000000	0.0000000	0.0000000	02	
50000	001	160.223	160	TCF	C14	C.324*F.4		0.0000000	1.6700037	1.6700037	02	
50200	001	160.240	160	TFZ	CC2	F.1	Z.	0.0000000	0.0000000	0.0000000	02	
50300	001	160.243	160	TFK	C1C	F.4	K.244	1.6700037	1.6100456	1.6100456	02	
09800	001	160.254	160	TEK	0C1	E.	K.255	0.0000000	1.6000053	1.6000053	02	
10000	001	160.256	C14	JUMP	141			0.0000000	0.0000000	0.0000000	02	
51700	001	014.420	C14	JUMP	000			0.0000000	0.0000000	0.0000000	02	
51800	001	014.421	C14	TCE	001	C.C22*E.		0.0000000	1.6000053	1.6000053	02	
52000	001	014.423	014	REPT	017	C2C		0.0000000	0.0000000	0.0000000	02	
52100	001	014.424	014	TCJ	000	0.C25*J.05		0.0000000	0.0000050	0.0000050	02	
52100	001	014.425	014	TCJ	000	C.C26*J.06		0.0000000	0.0000000	0.0000000	02	
52100	001	014.426	C14	TCJ	000	C.C27*J.07		0.0000000	0.0000000	0.0000000	02	
52100	001	014.427	C14	TCJ	000	C.C30*J.10		0.0000000	0.0000000	0.0000000	02	
52100	001	014.430	C14	TCJ	000	C.C31*J.11		0.0000000	0.0000000	0.0000000	02	
52100	001	014.431	C14	TCJ	000	C.C32*J.12		0.0000000	0.0000000	0.0000000	02	
52100	001	014.432	014	TCJ	000	C.C33*J.13		0.0000000	0.0000000	0.0000000	02	
52100	001	014.433	014	TCJ	000	C.C34*J.14		0.0000000	0.0000000	0.0000000	02	
52100	001	014.434	C14	TCJ	000	C.C35*J.15		0.0000000	0.0000000	0.0000000	02	
52100	001	014.435	C14	TCJ	000	C.C36*J.16		0.0000000	0.0000000	0.0000000	02	
52100	001	014.436	C14	TCJ	000	C.C37*J.17		0.0000000	0.0000000	0.0000000	02	
52100	001	014.437	C14	TCJ	000	C.C40*J.00		0.0000000	0.2610477	0.2610477	02	
52100	001	014.440	C14	TCJ	000	C.C41*J.01		0.0000000	0.2004500	0.2004500	02	
52100	001	014.441	C14	TCJ	000	C.C42*J.02		0.0000000	0.0450103	0.0450103	02	
52100	001	014.442	C14	TCJ	000	C.C43*J.03		0.0000000	0.5012330	0.5012330	02	
52100	001	014.443	C14	TCJ	000	C.C44*J.04		0.0000000	0.1437714	0.1437714	02	
52200	001	014.445	014	REPT	0C7	C1C		0.0000000	0.0000000	0.0000000	02	
52300	001	014.446	C14	TCF	000	0.C47*F.7		0.0000000	0.0000000	0.0000000	02	
52300	001	014.447	C14	TCF	000	0.C50*F.0		0.0000000	0.0000000	0.0000000	02	
52300	001	014.450	C14	TCF	000	0.C51*F.1		0.0000000	0.0000000	0.0000000	02	
52300	001	014.451	014	TCF	000	C.C52*F.2		0.0000000	0.0000200	0.0000200	02	
52300	001	014.452	C14	TCF	000	C.C53*F.3		0.0000000	0.0000004	0.0000004	02	
52300	001	014.453	C14	TCF	000	0.C54*F.4		0.0000000	1.6100456	1.6100456	02	
52300	001	014.454	C14	TCF	000	C.C55*F.5		0.0000000	0.0200000	0.0200000	02	
52300	001	014.455	C14	TCF	000	C.C56*F.6		0.0000000	0.0000000	0.0000000	02	
52400	001	014.457	C14	REPT	0C6	0C7		0.0000000	0.0000000	0.0000000	02	
52500	001	014.460	014	TCH	000	C.C61*H.01		0.0000000	0.0000000	0.0000000	02	
52500	001	014.461	014	TCH	000	C.C62*H.02		0.0000000	0.0000000	0.0000000	02	
52500	001	014.462	014	TCH	000	C.C63*H.03		0.0000000	0.0000000	0.0000000	02	
52500	001	014.463	014	TCH	000	C.C64*H.04		0.0000000	0.0000000	0.0000000	02	
52500	001	014.464	014	TCH	000	C.C65*H.05		0.0000000	0.0000000	0.0000000	02	

```
52500 001 014.465  C14 TGF  CCC  C.C66*H.C6   0.0000000   0.0000000   0.0000000   02
52500 001 014.466  C14 TGF  CCC  C.C67*H.C7   0.0000000   0.0000000   0.0000000   02
52600 001 014.47C  C14 JUMP CC1  221           0.0000000   0.0000000   0.0000000   02
52700 001 014.472  C14 TGX  CCC  G.14  X.      0.0000000   0.0000000   0.0000001   02
52800 001 014.473  C14 TGX  CCC  G.15  X.      0.0000000   0.0000001   0.0000001   02
52800 001 014.474  C14 TGX  CCC  G.16  X.      0.0000000   0.0000001   0.0000001   02
52800 001 014.475  C14 TGX  CCC  G.17  X.      0.0000000   0.0000001   0.0000001   02
52800 001 014.476  C14 TGX  CCC  G.CC  X.      0.0000000   0.0000001   0.0000001   02
52800 002 C14.477  C14 TGX  CCC  G.C1  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.CCC  C14 TGX  CCC  G.C2  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.CC1  C14 TGX  CCC  G.C3  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.CC2  C14 TGX  CCC  G.C4  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.CC3  C14 TGX  CCC  G.C5  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.CC4  C14 TGX  CCC  G.C6  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.CC5  C14 TGX  CCC  G.C7  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.CC6  C14 TGX  CCC  G.1C  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.CC7  C14 TGX  CCC  G.11  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.C1C  C14 TGX  CCC  G.12  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.C11  C14 TGX  CCC  G.13  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.C12  C14 TGX  CCC  G.14  X.      0.0000000   0.0000001   0.0000001   02
52800 002 014.C13  C14 TGX  CCC  G.15  X.      0.0000000   0.0000001   0.0000001   02
52900 002 014.C15  C14 THX  CC2  H.16  X.      0.0000000   0.0000001   0.0000001   02
53000 002 014.C16  C15 THX  CC2  H.17  X.      0.0000000   0.0000001   0.0000001   02
53100 002 015.C21  C14 TCC  CC1  C.    C.22*    0.0000000   1.6000053   1.6000053   02
53200 002 014.C23  C14 KEPT C17  C2C           0.3600000   0.3600000   0.3600000   02
53300 002 014.C24  C14 TJC  CCC  J.C5  C.025*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C25  C14 TJC  CCC  J.C6  C.026*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C26  C14 TJC  CCC  J.C7  C.027*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C27  C14 TJC  CCC  J.1C  C.03C*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C3C  C14 TJC  CCC  J.11  C.031*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C31  C14 TJC  CCC  J.12  C.032*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C32  C14 TJC  CCC  J.13  C.033*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C33  C14 TJC  CCC  J.14  C.034*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C34  C14 TJC  CCC  J.15  C.035*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C35  C14 TJC  CCC  J.16  C.036*   0.0000000   0.0000000   0.0000000   02
53300 002 014.C36  C14 TJC  CCC  J.17  C.037*   0.0000000   0.0000000   0.0000000   02
53300 C02 014.C37  C14 TJC  CCC  J.CC  C.C4C*   0.2610477   0.2610477   0.2610477   02
53300 002 014.C4C  C14 TJC  CCC  J.C1  C.041*   0.2004500   0.2004500   0.2004500   02
53300 002 014.C41  C14 TJC  CCC  J.C2  C.042*   0.0450103   0.0450103   0.0450103   02
53300 002 014.C42  C14 TJC  CCC  J.C3  C.043*   0.5012330   0.5012330   0.5012330   02
53300 002 014.C43  C14 TJC  CCC  J.C4  C.044*   0.1437714   0.1437714   0.1437714   02
53400 002 014.C45  C14 JUMP CCC                 0.0000000   0.0000000   0.0000000   02
53500 002 014.C46  C14 BLFC C1C  F.7   C.047*   0.0000000   0.0000000   0.0000000   02
53500 002 014.C46  C14 BLFC C1C  F.C   C.05C*   0.0000000   0.0000000   0.0000000   02
53500 002 014.C46  C14 BLFC C1C  F.1   C.051*   0.0000000   0.0000000   0.0000000   02
53500 002 014.C46  C14 BLFC C1C  F.2   C.052*   0.0002200   0.0002200   0.0002200   02
53500 002 014.C46  C14 BLFC C1C  F.3   C.053*   0.0000004   0.0000004   0.0000004   02
53500 002 014.C46  C14 BLFC C1C  F.4   C.054*   1.4100456   1.4100456   1.6100456   02
53500 002 014.C46  C14 BLFC C1C  F.5   C.055*   0.0220000   0.0220000   0.0220000   02
53500 002 014.C46  C14 BLFC C1C  F.6   C.056*   0.0000000   0.0000000   0.0000000   02
53500 002 014.C46  C14 JUMP CCC                 0.0000000   0.0000000   0.0000000   02
53700 002 014.C57  C14 THC  CCC  H.C1  C.061*   0.0000000   0.0000000   0.0000000   02
53800 002 014.C61  C14 THC  CCC  H.C2  C.       0.0000000   1.4000053   1.6000053   02
53900 002 014.C62  C14 THC  CCC  H.C3  C.063*   0.0000000   0.0000000   0.0000000   02
54000 002 014.C63  C14 THC  CCC  H.C4  C.064*   0.0000000   0.0000000   0.0000000   02
54100 002 014.C64  C14 THC  CCC  H.C5  C.065*   0.0000000   0.0000000   0.0000000   02
54200 002 014.C65  C14 THC  CCC  H.C6  C.066*   0.0000000   0.0000000   0.0000000   02
```

```
          54300   002 014.066   014 THC  000   H.07  C.067* 0.0000000  0.0000000  0.0000000  02
          54400   002 014.067   014 JUMP 000              0.0000000  0.0000000  0.0000000  02
          54500   002 014.070   014 THX  000   H.11  X.     0.0000000  0.0000001  0.0000001  02
          54600   002 014.071   014 THX  000   H.12  X.     0.0000000  0.0000001  0.0000001  02
          54700   002 014.072   014 THX  000   H.13  X.     0.0000000  0.0000001  0.0000001  02
          54800   002 014.073   014 THX  000   H.14  X.     0.0000000  0.0000001  0.0000001  02
          54900   002 014.074   014 THX  000   H.15  X.     0.0000000  0.0000001  0.0000001  02
          55000   002 014.075   014 TBC  000   B.    C.     3.7777777  1.6000053  1.6000053  02
          55100   002 014.076   014 TDC  000   D.    C.     0.0000000  1.6000053  1.6000053  02
          55200   002 014.077   174 TEX  000   E.    X.     1.6000053  0.0000001  0.0000001  02
          00000   002 174.100   160 JUMP 053              0.0000000  0.0000000  0.0000000  77
160.154         160.155
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.154         160.155
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          10300   002 160.154   160 TPK  001   P.124 K.155  0.0000000  0.1610124  0.1610124  02
          10500   002 160.156   160 REPT 007   010         0.0000000  0.0000000  0.0000000  02
          10600   002 160.157   160 TOF  000   0.260*F.0   0.0000000  0.0000000  0.0000000  02
          10600   002 160.160   160 TOF  000   0.261*F.1   0.0000000  0.0000000  0.0000000  02
          10600   002 160.161   160 TOF  000   0.262*F.2   0.0000000  0.0000200  0.0000200  02
          10600   002 160.162   160 TOF  000   0.263*F.3   0.0000000  0.0000004  0.0000004  02
          10600   002 160.163   160 TOF  000   0.264*F.4   0.0000000  1.6100456  1.6100456  02
          10600   002 160.164   160 TOF  000   0.265*F.5   0.0000000  0.0200000  0.0200000  02
          10600   002 160.165   160 TOF  000   0.266*F.6   0.0000000  0.0000000  0.0000000  02
          10600   002 160.166   160 TOF  000   0.267*F.7   0.0000000  0.0000000  0.0000000  02
          10700   002 160.170   160 JUMP 045              0.0000000  0.0000000  0.0000000  02
          10800   002 160.236   160 REPT 017   020         0.0000000  0.0000000  0.0000000  02
          10900   002 160.237   160 TOJ  000   0.340*J.00  0.0000000  0.2610477  0.2610477  02
          10900   002 160.240   160 TOJ  000   0.341*J.01  0.0000000  0.2004500  0.2004500  02
          10900   002 160.241   160 TOJ  000   0.342*J.02  0.0000000  0.0450103  0.0450103  02
          10900   002 160.242   160 TOJ  000   0.343*J.03  0.0000000  0.5012330  0.5012330  02
          10900   002 160.243   160 TOJ  000   0.344*J.04  0.0000000  0.1437714  0.1437714  02
          10900   002 160.244   160 TOJ  000   0.345*J.05  0.0000000  0.0000050  0.0000050  02
          10900   002 160.245   160 TOJ  000   0.346*J.06  0.0000000  0.0000000  0.0000000  02
          10900   002 160.246   160 TOJ  000   0.347*J.07  0.0000000  0.0000000  0.0000000  02
          10900   002 160.247   160 TOJ  000   0.350*J.10  0.0000000  0.0000000  0.0000000  02
          10900   002 160.250   160 TOJ  000   0.351*J.11  0.0000000  0.0000000  0.0000000  02
          10900   002 160.251   160 TOJ  000   0.352*J.12  0.0000000  0.0000000  0.0000000  02
          10900   002 160.252   160 TOJ  000   0.353*J.13  0.0000000  0.0000000  0.0000000  02
          10900   002 160.253   160 TOJ  000   0.354*J.14  0.0000000  0.0000000  0.0000000  02
          10900   002 160.254   160 TOJ  000   0.355*J.15  0.0000000  0.0100000  0.0100000  02
          10900   002 160.255   160 TOJ  000   0.356*J.16  0.0000000  0.0000000  0.0000000  02
          10900   002 160.256   160 TOJ  000   0.357*J.17  0.0000000  0.0000000  0.0000000  02
          11000   002 160.260   160 JUMP 113              0.0000000  0.0000000  0.0000000  02
160.374         160.375
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.374         160.375
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          11300   002 160.374   160 TPK  001   P.135 K.375  0.0000000  0.7550135  0.7550135  02
160.376         160.377
ERROR NUMBER   4
```

E. COMPUTER RUN WITH INVALID CONNECTIONS

A run was made with a connection matrix for which the requested connections were invalid. The precedence matrix and precedence link matrices were the following:

	MATRIX COLUMN						KFIRST	KSEC
	1	2	3	4	5	6		
1		1					000001610124	000001610124
2			1				000007550135	000007550135
3				1			000013770131	000013770131
4					1		000002600132	000002600132
5						1	000000000136	000000000136
6							000010000136	000010000136

ROW

The connection and connection link matrices were the following:

	CONMAT PRIME EQUIPMENT						ACON	BCON
	1	2	3	4	5	6		
1	0	1	0	0	0	0	000001610102	000001610102
2	1	0	0	0	0	0	000007550103	000007550103
3	1	0	0	0	0	0	000013770201	000013770201
4	0	0	1	1	0	0	000002600205	000002600205
5	0	1	0	0	0	0	000000000604	000000000604
6	0	0	0	0	0	0	000010000404	000010000404

AUTOMATIC CHECKOUT EQUIPMENT

The connection 4-6, requested by the automatic checkout program, had a zero entry in the connection matrix, indicating that no connection existed. At that point in the execution of the program, the diagnostic, "ERROR NUMBER 1!" (invalid connection), was written, and the program terminated. The run is listed on the following pages.

```
          XEC

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.
     (FPT)       EXIT        (TSAM)      (RTN)       (STAM)      (FIL)       DUMP

  PREPROCESSING TIME = 000.28 MIN.

        EXECUTION
   6
        000001610124        000007550135        000013770131        000002600132
        000000000136        000010000136
        000001610124        000007550135        000013770131        000002600132
        000000000136        000010000136
0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0
0 1 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0
        000000000000        000000000000        000000000000        000000000000
        000000000000        000000000000
        000001610102        000007550102        000013770201        000002600205
        000000000604        000010000404
   2
CONSISTENT MATRIX
```

LABEL 1	REV	CHN SEC	NC	OP	WYW	DEST	SRC	OLD DEST	SOURCE	NEW DEST	TN	ERRORS
08700	001	166.111	166	BLFK	005	F.2	K.112	0.0000000	0.0000200	0.0000200	02	
08700	001	166.111	166	BLFK	005	F.3	K.113	0.0000000	0.0000004	0.0000004	02	
08700	001	166.111	166	BLFK	005	F.4	K.114	0.0000000	1.6700037	1.6700037	02	
08700	001	166.111	166	BLFK	005	F.5	K.115	0.0000000	0.0200000	0.0200000	02	
08700	001	166.111	166	BLFK	005	F.6	K.116	0.0000000	0.0000000	0.0000000	02	
08706	001	166.117	166	BLJK	010	J.00	K.120	0.0000000	0.2610477	0.2610477	02	
08706	001	166.117	166	BLJK	010	J.01	K.121	0.0000000	0.2004500	0.2004500	02	
08706	001	166.117	166	BLJK	010	J.02	K.122	0.0000000	0.0450103	0.0450103	02	
08706	001	166.117	166	BLJK	010	J.03	K.123	0.0000000	0.5012330	0.5012330	02	
08706	001	166.117	166	BLJK	010	J.04	K.124	0.0000000	0.1437714	0.1437714	02	
08706	001	166.117	166	BLJK	010	J.05	K.125	0.0000000	0.0000050	0.0000050	02	
08706	001	166.117	166	BLJK	010	J.06	K.126	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
08706	001	166.117	166	BLJK	010	J.07	K.127	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
08715	001	166.130	160	JUMP	072			0.0000000	0.0000000	0.0000000	02	
50000	001	160.223	160	TCF	014	0.324*F.4		0.0000000	1.6700037	1.6700037	02	
50200	001	160.240	160	TFZ	002	F.1	Z.	0.0000000	0.0000000	0.0000000	02	
50300	001	160.243	160	TFK	010	F.4	K.244	1.6700037	1.6100456	1.6100456	02	
09800	001	160.254	160	TEK	001	E.	K.255	0.0000000	1.6000053	1.6000053	02	
10000	001	160.256	014	JUMP	141			0.0000000	0.0000000	0.0000000	02	
51700	001	014.420	014	JUMP	000			0.0000000	0.0000000	0.0000000	02	
51800	001	014.421	014	TCE	001	0.022*E.		0.0000000	1.6000053	1.6000053	02	
52000	001	014.423	014	REPT	017	020		0.0000000	0.0000000	0.0000000	02	
52100	001	014.424	014	TCJ	000	0.025*J.05		0.0000000	0.0000050	0.0000050	02	
52100	001	014.425	014	TCJ	000	0.026*J.06		0.0000000	0.0000000	0.0000000	02	
52100	001	014.426	014	TCJ	000	0.027*J.07		0.0000000	0.0000000	0.0000000	02	
52100	001	014.427	014	TCJ	000	0.030*J.10		0.0000000	0.0000000	0.0000000	02	
52100	001	014.430	014	TCJ	000	0.031*J.11		0.0000000	0.0000000	0.0000000	02	
52100	001	014.431	014	TCJ	000	0.032*J.12		0.0000000	0.0000000	0.0000000	02	
52100	001	014.432	014	TCJ	000	0.033*J.13		0.0000000	0.0000000	0.0000000	02	
52100	001	014.433	014	TCJ	000	0.034*J.14		0.0000000	0.0000000	0.0000000	02	
52100	001	014.434	014	TCJ	000	0.035*J.15		0.0000000	0.0000000	0.0000000	02	
52100	001	014.435	014	TCJ	000	0.036*J.16		0.0000000	0.0000000	0.0000000	02	
52100	001	014.436	014	TCJ	000	0.037*J.17		0.0000000	0.0000000	0.0000000	02	
52100	001	014.437	014	TCJ	000	0.040*J.00		0.0000000	0.2610477	0.2610477	02	
52100	001	014.440	014	TCJ	000	0.041*J.01		0.0000000	0.2004500	0.2004500	02	
52100	001	014.441	014	TCJ	000	0.042*J.02		0.0000000	0.0450103	0.0450103	02	
52100	001	014.442	014	TCJ	000	0.043*J.03		0.0000000	0.5012330	0.5012330	02	
52100	001	014.443	014	TCJ	000	0.044*J.04		0.0000000	0.1437714	0.1437714	02	
52200	001	014.445	014	REPT	007	010		0.0000000	0.0000000	0.0000000	02	
52300	001	014.446	014	TCF	000	0.047*F.7		0.0000000	0.0000000	0.0000000	02	
52300	001	014.447	014	TCF	000	0.050*F.0		0.0000000	0.0000000	0.0000000	02	
52300	001	014.450	014	TCF	000	0.051*F.1		0.0000000	0.0000000	0.0000000	02	
52300	001	014.451	014	TCF	000	0.052*F.2		0.0000000	0.0000200	0.0000200	02	
52300	001	014.452	014	TCF	000	0.053*F.3		0.0000000	0.0000004	0.0000004	02	
52300	001	014.453	014	TCF	000	0.054*F.4		0.0000000	1.6100456	1.6100456	02	
52300	001	014.454	014	TCF	000	0.055*F.5		0.0000000	0.0200000	0.0200000	02	
52300	001	014.455	014	TCF	000	0.056*F.6		0.0000000	0.0000000	0.0000000	02	
52400	001	014.457	014	REPT	006	007		0.0000000	0.0000000	0.0000000	02	
52500	001	014.460	014	TCH	000	0.061*H.01		0.0000000	0.0000000	0.0000000	02	
52500	001	014.461	014	TCH	000	0.062*H.02		0.0000000	0.0000000	0.0000000	02	
52500	001	014.462	014	TCH	000	0.063*H.03		0.0000000	0.0000000	0.0000000	02	
52500	001	014.463	014	TCH	000	0.064*H.04		0.0000000	0.0000000	0.0000000	02	
52500	001	014.464	014	TCH	000	0.065*H.05		0.0000000	0.0000000	0.0000000	02	

```
52500 001 014.465 C14 TCH CCC C.C66*H.C6 0.0000000 0.0000000 0.0000000 02
52500 001 014.466 C14 TCH CCC C.C67*H.C7 0.0000000 0.0000000 0.0000000 02
52600 001 014.47C C14 JUMP 001 0.0000000 0.0000000 0.0000000 02
52700 001 014.472 C14 REPT 020 021 X. 0.0000000 0.0000000 0.0000000 02
52800 001 014.473 C14 TGX CCC G.14 X. 0.0000001 0.0000001 0.0000001 02
52800 001 014.474 C14 TGX CCC G.15 X. 0.0000001 0.0000001 0.0000001 02
52800 001 014.475 C14 TGX CCC G.16 X. 0.0000000 0.0000001 0.0000001 02
52800 001 014.476 C14 TGX CCC G.17 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.477 C14 TGX CCC G.CC X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.CCC C14 TGX CCC G.C1 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.CC1 C14 TGX CCC G.C2 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.CC2 C14 TGX CCC G.C3 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.CC3 C14 TGX CCC G.C4 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.CC4 C14 TGX CCC G.C5 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.CC5 C14 TGX CCC G.C6 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.CC6 C14 TGX CCC G.C7 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.CC7 C14 TGX CCC G.1C X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.C1C C14 TGX CCC G.11 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.C11 C14 TGX CCC G.12 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.C12 C14 TGX CCC G.13 X. 0.0000000 0.0000001 0.0000001 02
52800 002 014.C13 C14 TGX CCC G.14 X. 0.0000001 0.0000001 0.0000001 02
52900 002 014.C15 C14 THX CCC H.16 X. 0.0000000 0.0000001 0.0000001 02
53000 002 014.C16 C15 THX C02 H.17 X. 0.0000000 0.0000001 0.0000001 02
53100 002 015.C21 C14 TCC CC1 C. C.022* 0.0000000 1.6000053 02
53200 002 014.C23 C14 REPT C17 C2C 0.0000000 0.0000000 0.0000000 02
53300 002 014.C24 C14 TJC CCC J.C5 C.025* 0.0000050 0.0000050 0.0000050 02
53300 002 014.C25 C14 TJC CCC J.C6 C.026* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C26 C14 TJC CCC J.C7 C.027* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C27 C14 TJC CCC J.1C C.030* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C3C C14 TJC CCC J.11 C.031* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C31 C14 TJC CCC J.12 C.032* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C32 C14 TJC CCC J.13 C.033* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C33 C14 TJC CCC J.14 C.034* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C34 C14 TJC CCC J.15 C.035* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C35 C14 TJC CCC J.16 C.036* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C36 C14 TJC CCC J.17 C.037* 0.0000000 0.0000000 0.0000000 02
53300 002 014.C37 C14 TJC CCC J.CC C.04C* 0.2610477 0.2610477 0.2610477 02
53300 002 014.C4C C14 TJC CCC J.C1 C.041* 0.2004500 0.2004500 0.2004500 02
53300 002 014.C41 C14 TJC CCC J.C2 C.042* 0.0450103 0.0450103 0.0450103 02
53300 002 014.C42 C14 TJC CCC J.C3 C.043* 0.5012330 0.5012330 0.5012330 02
53300 002 014.C43 C14 TJC CCC J.C4 C.044* 0.1437714 0.1437714 0.1437714 02
53400 002 014.C45 C14 JUMP CCC 0.0000000 0.0000000 0.0000000 02
53500 002 014.C46 C14 BLFC C1C F.7 C.047* 0.0000000 0.0000000 0.0000000 02
53500 002 014.C46 C14 BLFC C1C F.C C.050* 0.0000000 0.0000000 0.0000000 02
53500 002 014.C46 C14 BLFC C1C F.1 C.051* 0.0000000 0.0000000 0.0000000 02
53500 002 014.C46 C14 BLFC C1C F.2 C.052* 0.0000200 0.0000200 0.0000200 02
53500 002 014.C46 C14 BLFC C1C F.3 C.053* 0.0000004 0.0000004 0.0000004 02
53500 002 014.C46 C14 BLFC C1C F.4 C.054* 1.6100456 1.6100456 1.6100456 02
53500 002 014.C46 C14 BLFC C1C F.5 C.055* 0.0200000 0.0200000 0.0200000 02
53500 002 014.C46 C14 BLFC C1C F.6 C.056* 0.0000000 0.0000000 0.0000000 02
53600 002 014.C57 C14 JUMP CCC 0.0000000 0.0000000 0.0000000 02
53700 002 014.C6C C14 THC CCC H.C1 C.061* 0.0000000 0.0000000 0.0000000 02
53800 002 014.C61 C14 THC CCC H.C2 C. 0.0000000 1.6000053 1.6000053 02
53900 002 014.C62 C14 THC CCC H.C3 C.063* 0.0000000 0.0000000 0.0000000 02
54000 002 014.C63 C14 THC CCC H.C4 C.064* 0.0000000 0.0000000 0.0000000 02
54100 002 014.C64 C14 THC CCC H.C5 C.065* 0.0000000 0.0000000 0.0000000 02
54200 002 014.C65 C14 THC CCC H.C6 C.066* 0.0000000 0.0000000 0.0000000 02
```

```
          54300   002 014.066   014 THC  CCC   H.07   C.067*  0.0000000   0.0000000   0.0000000   02
          54400   002 014.067   014 JUMP CCC                  0.0000000   0.0000000   0.0000000   02
          54500   002 014.070   014 THX  CCC   H.11   X.      0.0000000   0.0000001   0.0000001   02
          54600   002 014.071   014 THX  CCC   H.12   X.      0.0000000   0.0000001   0.0000001   02
          54700   002 014.072   014 THX  CCC   H.13   X.      0.0000000   0.0000001   0.0000001   02
          54800   002 014.073   014 THX  CCC   H.14   X.      0.0000000   0.0000001   0.0000001   02
          54900   002 014.074   014 THX  CCC   H.15   X.      0.0000000   0.0000001   0.0000001   02
          55000   002 014.075   014 TBC  CCC   B.     C.      3.7777777   1.6000053   1.6000053   02
          55100   002 014.076   014 TDC  CCC   D.     C.      0.0000000   1.6000053   1.6000053   02
          55200   002 014.077   174 TEX  CCC   E.     X.      1.6000053   0.0000001   0.0000001   02
          00000   002 174.100   160 JUMP C53                  0.0000000   0.0000000   0.0000000   77
160.154           160.155
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.154           160.155
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          10300   002 160.154   160 TPK  CC1   P.124 K.155  0.0000000   0.1610124   0.1610124   02
          10500   002 160.156   160 REPT CC7   C1C          0.0000000   0.0000000   0.0000000   02
          10600   002 160.157   160 TCF  CCC   C.260*F.0    0.0000000   0.0000000   0.0000000   02
          10600   002 160.160   160 TCF  CCC   C.261*F.1    0.0000000   0.0000000   0.0000000   02
          10600   002 160.161   160 TCF  CCC   C.262*F.2    0.0000000   0.0000200   0.0000200   02
          10600   002 160.162   160 TCF  CCC   C.263*F.3    0.0000000   0.0000004   0.0000004   02
          10600   002 160.163   160 TCF  CCC   C.264*F.4    0.0000000   1.6100456   1.6100456   02
          10600   002 160.164   160 TCF  CCC   C.265*F.5    0.0000000   0.0200000   0.0200000   02
          10600   002 160.165   160 TCF  CCC   C.266*F.6    0.0000000   0.0000000   0.0000000   02
          10600   002 160.166   160 TCF  CCC   C.267*F.7    0.0000000   0.0000000   0.0000000   02
          10700   002 160.170   160 JUMP C45                  0.0000000   0.0000000   0.0000000   02
          10800   002 160.236   160 REPT C17   C2C          0.0000000   0.0000000   0.0000000   02
          10900   002 160.237   160 TCJ  CCC   C.340*J.00    0.0000000   0.2610477   0.2610477   02
          10900   002 160.240   160 TCJ  CCC   C.341*J.01    0.0000000   0.2004500   0.2004500   02
          10900   002 160.241   160 TCJ  CCC   C.342*J.02    0.0000000   0.0450103   0.0450103   02
          10900   002 160.242   160 TCJ  CCC   C.343*J.03    0.0000000   0.5012330   0.5012330   02
          10900   002 160.243   160 TCJ  CCC   C.344*J.04    0.0000000   0.1437714   0.1437714   02
          10900   002 160.244   160 TCJ  CCC   C.345*J.05    0.0000000   0.0000050   0.0000050   02
          10900   002 160.245   160 TCJ  CCC   C.346*J.06    0.0000000   0.0000000   0.0000000   02
          10900   002 160.246   160 TCJ  CCC   C.347*J.07    0.0000000   0.0000000   0.0000000   02
          10900   002 160.247   160 TCJ  CCC   C.350*J.10    0.0000000   0.0000000   0.0000000   02
          10900   002 160.250   160 TCJ  CCC   C.351*J.11    0.0000000   0.0000000   0.0000000   02
          10900   002 160.251   160 TCJ  CCC   C.352*J.12    0.0000000   0.0000000   0.0000000   02
          10900   002 160.252   160 TCJ  CCC   C.353*J.13    0.0000000   0.0000000   0.0000000   02
          10900   002 160.253   160 TCJ  CCC   C.354*J.14    0.0000000   0.0000000   0.0000000   02
          10900   002 160.254   160 TCJ  CCC   C.355*J.15    0.0000000   0.0000000   0.0000000   02
          10900   002 160.255   160 TCJ  CCC   C.356*J.16    0.0000000   0.0000000   0.0000000   02
          10900   002 160.256   160 TCJ  CCC   C.357*J.17    0.0000000   0.0000000   0.0000000   02
          11000   002 160.260   160 JUMP C13                  0.0000000   0.0000000   0.0000000   02
160.374           160.375
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.374           160.375
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          11300   002 160.374   160 TPK  CC1   P.135 K.375  0.0000000   0.7550135   0.7550135   02
160.376           160.377
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.376           160.377
```

```
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          11500    002 160.376    160 TPK  CC1    P.131 K.377  C.0000000    1.3770131    1.3770131     02
          11700    002 160.400    160 TEK  CC1    E.    K.401  C.0000001    1.6000017    1.6000017     02
160.402           160.403
PRECEDENCE CK FOR START OF STEP
CONNECTIONS CK
160.402           160.403
PRECEDENCE CK FOR END OF STEP
CONNECTIONS CK
          11900    002 160.402    160 TPK  CC4    P.132 K.403  C.0000000    0.2600132    0.2600132     02
160.407           160.410
PRECEDENCE CK FOR START OF STEP
ERROR NUMBER  11
```

F. COMPUTER RUN WITH FLOW DIAGRAM PRECEDENCES SATISFIED

A run was made with a flow diagram precedence matrix which was satisfied by the order of execution of automatic checkout program steps. The precedence matrix and precedence link matrices were the following:

		MATRIX							KFIRST	KSEC
		COLUMN								
		1	2	3	4	5	6	7		
	1	0	1	0	0	0	0	0	000000166111	000000166111
	2	0	0	1	0	0	0	0	000000014420	000000014420
ROW	3	0	0	0	1	1	1	0	000000174100	000000174100
	4	0	-1	0	0	0	0	0	000000160154	000000160154
	5	0	-1	0	0	0	0	0	000000160120	000000150120
	6	0	0	0	0	0	0	1	000000161101	000000161101
	7	0	0	0	0	0	0	0	000000176157	000000176157

During execution of the automatic checkout program, comments were written for the precedences satisfied, and the program terminated normally. The run is listed on the following pages.

```
     *     XEC

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
     (FPT)       EXIT        (TSHM)      (RTN)       (STHM)      (FIL)       DUMP

  PREPROCESSING TIME = 000.28 MIN.

       EXECUTION
   7
        000000166111        000000014420        000000174100        000000160154
        000000160120        000000161101        000000176157
        000000166111        000000014420        000000174100        000000160154
        000000160120        000000161101        000000176157
0 0 0 0 0 0 0 1 0 0-1-1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 1 0

0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0

0-0-0-0-0-0-0-0-0
       000000000000        000000000000        000000000000        000000000000
       000000000000        000000000000        000000000000
       000000000000        000000000000        000000000000        000000000000
       000000000000        000000000000        000000000000
 1
CONSISTENT MATRIX
```

```
52300 001 014.454 C14 TQF CC0 C.C55*F.5 C.CCCCCCC C.0220000 0.0220000 02
52300 001 014.455 C14 TQF CC0 C.C56*F.6 C.0000000 0.0000000 0.0000000 02
52400 001 014.457 C14 REPT CC6 CC7 C.CCCCCCC 0.0000000 0.0000000 02
52500 001 014.46C C14 TQH CC0 C.C61*H.01 C.CCCCCCC 0.0000000 0.0000000 02
52500 001 014.461 C14 TQH CCC C.C62*H.02 C.CCCCCCC 0.0000000 0.0000000 02
52500 001 014.462 C14 TQH CCC C.C63*H.03 C.CCCCCCC 0.0000000 0.0000000 02
52500 001 014.463 C14 TQH CCC C.C64*H.04 C.CCCCCCC 0.0000000 0.0000000 02
52500 001 014.464 C14 TQH CCC C.C65*H.05 C.CCCCCCC 0.0000000 0.0000000 02
52500 001 014.465 C14 TQH CCC C.C66*H.06 C.CCCCCCC 0.0000000 0.0000000 02
52500 001 014.466 C14 TQH CCC C.C67*H.07 C.CCCCCCC 0.0000000 0.0000000 02
52600 001 014.470 C14 JUMP CC1 C.CCCCCCC 0.0000000 0.0000000 02
52700 001 014.472 C14 REPT C2C C21 C.CCCCCCC 0.0000000 0.0000000 02
52800 001 014.472 C14 TGX CC0 G.14 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 001 014.474 C14 TGX CC0 G.15 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 001 014.475 C14 TGX CC0 G.16 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 001 014.476 C14 TGX CC0 G.17 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.477 C14 TGX CC0 G.CC X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.CCC C14 TGX CCC G.C1 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.CC1 C14 TGX CCC G.C2 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.C02 C14 TGX CC0 G.C3 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.C03 C14 TGX CC0 G.C4 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.C04 C14 TGX CCC G.C5 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.CC5 C14 TGX CC0 G.C6 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.CC6 C14 TGX CCC G.C7 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.CC7 C14 TGX CC0 G.1C X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.CC8 C14 TGX CCC G.11 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.CC9 C14 TGX CC0 G.12 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.C1C C14 TGX CC0 G.13 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.C11 C14 TGX CCC G.14 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.C12 C14 TGX CCC H.16 X. C.CCCCCCC 0.0000001 0.0000001 02
52800 002 014.C13 C14 TGX CCC H.17 X. C.CCCCCCC 0.0000001 0.0000001 02
52900 002 014.C15 C15 THX CC0 C. C.CCCCCCC 0.0000001 0.0000001 02
53000 002 014.C16 C15 THX CC2 C21 C.CCCCCCC 0.0000001 0.0000001 02
53100 002 015.C21 C14 TCC CC1 C2C C.C22* 0.0000000 1.6000053 02
53200 002 014.C22 C14 REPT C17 C.C23* 0.0000000 0.0000000 02
53300 002 014.C24 C14 TJC CC0 J.C5 C.C25* C.CCCCCCC 0.0000000 02
53300 002 014.C25 C14 TJC CCC J.C6 C.C26* C.CCCCCCC 0.0000000 02
53300 002 014.C26 C14 TJC CC0 J.C7 C.C27* C.CCCCCCC 0.0000000 02
53300 002 014.C27 C14 TJC CC0 J.1C C.C3C* C.CCCCCCC 0.0000000 02
53300 002 014.C3C C14 TJC CCC J.11 C.C31* C.CCCCCCC 0.0000000 02
53300 002 014.C31 C14 TJC CC0 J.12 C.C32* C.CCCCCCC 0.0000000 02
53300 002 014.C32 C14 TJC CCC J.13 C.C33* C.CCCCCCC 0.0000000 02
53300 002 014.C33 C14 TJC CCC J.14 C.C34* C.CCCCCCC 0.0000000 02
53300 002 014.C34 C14 TJC CCC J.15 C.C35* C.CCCCCCC 0.0000000 02
53300 002 014.C35 C14 TJC CCC J.16 C.C36* C.CCCCCCC 0.0000000 02
53300 002 014.C36 C14 TJC CCC J.17 C.C37* C.CCCCCCC 0.0000000 02
53300 002 014.C37 C14 TJC CCC J.CC C.C40* 0.2610477 0.2610477 02
53300 002 014.C40 C14 TJC CCC J.C1 C.C41* 0.2004500 0.2004500 02
53300 002 014.C41 C14 TJC CCC J.C2 C.C42* 0.0450103 0.0450103 02
53300 002 014.C42 C14 TJC CCC J.C3 C.C43* 0.5012330 0.5012330 02
53300 002 014.C43 C14 TJC CC0 J.C4 C.C44* 0.1437714 0.1437714 02
53400 002 014.C45 C14 JUMP CC0 0.0000000 0.0000000 02
53500 002 014.C46 C14 BLFC C1C F.7 C.C47* 0.0000000 0.0000000 02
53500 002 014.C46 C14 BLFC C1C F.C C.C5C* 0.0000000 0.0000000 02
53500 002 014.C46 C14 BLFC C1C F.1 C.C51* C.CCCCCC0 0.0000000 02
53500 002 014.C46 C14 BLFC C1C F.2 C.C52* 0.0000200 0.0000200 02
53500 002 014.C46 C14 BLFC C1C F.3 C.C53* C.CCCCC04 0.0000004 02
53500 002 014.C46 C14 BLFC C1C F.4 C.C54* 1.6100456 1.6100456 02
53500 002 014.C46 C14 BLFC C1C F.5 C.C55* C.CCCCCCC 0.0000000 02
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          53500   002 014.046   C14 BLFC C10   F.6    C.056*  0.0000000   0.0000000   0.0000000   02
          53600   002 014.057   014 JUMP CC0                   0.0000000   0.0000000   0.0000000   02
          53700   002 014.060   C14 THC  CC0   H.C1   C.061*  0.0000000   0.0000000   0.0000000   02
          53800   002 014.061   C14 THC  CCC   H.C2   C.      0.0000000   1.6000053   1.6000053   02
          53900   002 014.062   C14 THC  CCC   H.C3   C.063*  0.0000000   0.0000000   0.0000000   02
          54000   002 014.063   014 THC  CCC   H.C4   C.064*  0.0000000   0.0000000   0.0000000   02
          54100   002 014.064   C14 THC  CCC   H.C5   C.065*  0.0000000   0.0000000   0.0000000   02
          54200   002 014.065   C14 THC  CCC   H.C6   C.066*  0.0000000   0.0000000   0.0000000   02
          54300   002 014.066   C14 THC  CCC   H.C7   C.067*  0.0000000   0.0000000   0.0000000   02
          54400   002 014.067   C14 JUMP CCC                   0.0000000   0.0000000   0.0000000   02
          54500   002 014.070   C14 THX  CCC   H.11   X.      0.0000000   0.0000001   0.0000001   02
          54600   002 014.071   C14 THX  CCC   H.12   X.      0.0000000   0.0000001   0.0000001   02
          54700   002 014.072   C14 THX  CCC   H.13   X.      0.0000000   0.0000001   0.0000001   02
          54800   002 014.073   C14 THX  CCC   H.14   X.      0.0000000   0.0000001   0.0000001   02
          54900   002 014.074   C14 THX  CCC   H.15   X.      0.0000000   0.0000001   0.0000001   02
          55000   002 014.075   C14 TBC  CCC   B.     C.      3.7777777   1.6000053   1.6000053   02
          55100   002 014.076   C14 TDC  CCC   D.     C.      0.0000000   1.6000053   1.6000053   02
          55200   002 014.077   174 TEX  CCC   E.     X.      1.6000053   0.0000001   0.0000001   02
174.100           174.100
PRECEDENCE CK FOR START OF STEP
174.100           174.100
PRECEDENCE CK FOR END OF STEP
          00000   002 174.100   160 JUMP 053                   0.0000000   0.0000000   0.0000000   77
160.154           160.100
PRECEDENCE CK FOR START OF STEP
160.154           160.100
PRECEDENCE CK FOR END OF STEP
          10300   002 160.154   160 TPK  001   P.124 K.155     0.0000000   0.1610124   0.1610124   02
          10500   002 160.156   160 REPT C07   010             0.0000000   0.0000000   0.0000000   02
          10600   002 160.157   160 TOF  CCC   0.260*F.0       0.0000000   0.0000000   0.0000000   02
          10600   002 160.160   160 TOF  CCC   0.261*F.1       0.0000000   0.0000000   0.0000000   02
          10600   002 160.161   160 TOF  CCC   0.262*F.2       0.0000000   0.0000200   0.0000200   02
          10600   002 160.162   160 TOF  CCC   0.263*F.3       0.0000000   0.0000004   0.0000004   02
          10600   002 160.163   160 TOF  CCC   0.264*F.4       0.0000000   1.6100456   1.6100456   02
          10600   002 160.164   160 TOF  CCC   0.265*F.5       0.0000000   0.0200000   0.0200000   02
          10600   002 160.165   160 TOF  CCC   0.266*F.6       0.0000000   0.0000000   0.0000000   02
          10600   002 160.166   160 TOF  CCC   0.267*F.7       0.0000000   0.0000000   0.0000000   02
          10700   002 160.170   160 JUMP 045                   0.0000000   0.0000000   0.0000000   02
          10800   002 160.236   160 REPT C17   020             0.0000000   0.0000000   0.0000000   02
          10900   002 160.237   160 TOJ  CCC   0.340*J.00      0.0000000   0.2610477   0.2610477   02
          10900   002 160.240   160 TOJ  CCC   0.341*J.01      0.0000000   0.2004500   0.2004500   02
          10900   002 160.241   160 TOJ  CCC   0.342*J.02      0.0000000   0.0450103   0.0450103   02
          10900   002 160.242   160 TOJ  CCC   0.343*J.03      0.0000000   0.5012330   0.5012330   02
          10900   002 160.243   160 TOJ  CCC   0.344*J.04      0.0000000   0.1437714   0.1437714   02
          10900   002 160.244   160 TOJ  CCC   0.345*J.05      0.0000000   0.0000050   0.0000050   02
          10900   002 160.245   160 TOJ  CCC   0.346*J.06      0.0000000   0.0000000   0.0000000   02
          10900   002 160.246   160 TOJ  CCC   0.347*J.07      0.0000000   0.0000000   0.0000000   02
          10900   002 160.247   160 TOJ  CCC   0.350*J.10      0.0000000   0.0000000   0.0000000   02
          10900   002 160.250   160 TOJ  CCC   0.351*J.11      0.0000000   0.0000000   0.0000000   02
          10900   002 160.251   160 TOJ  CCC   0.352*J.12      0.0000000   0.0000000   0.0000000   02
          10900   002 160.252   160 TOJ  CCC   0.353*J.13      0.0000000   0.0000000   0.0000000   02
          10900   002 160.253   160 TOJ  CCC   0.354*J.14      0.0000000   0.0000000   0.0000000   02
          10900   002 160.254   160 TOJ  CCC   0.355*J.15      0.0000000   0.0000000   0.0000000   02
          10900   002 160.255   160 TOJ  CCC   0.356*J.16      0.0000000   0.0000000   0.0000000   02
          10900   002 160.256   160 TOJ  CCC   0.357*J.17      0.0000000   0.0000000   0.0000000   02
          11000   002 160.260   160 JUMP 113                   0.0000000   0.0000000   0.0000000   02
          11300   002 160.374   160 TPK  001   P.135 K.375     0.0000000   0.7550135   0.7550135   02
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          11500   002 160.376   160 TPK   001   P.131 K.377   0.0000000   1.3770131   1.3770131   02
          11700   002 160.400   160 TEK   001   E.    K.401   0.0000001   1.6000017   1.6000017   02
          11900   002 160.402   160 TPK   004   P.132 K.403   0.0000000   0.2600132   0.2600132   02
          12100   002 160.407   160 TPK   001   P.136 K.410   0.0000000   0.0000136   0.0000136   02
          12300   002 160.411   014 JUMP  006                 0.0000000   0.0000000   0.0000000   02
 14.420           14.410
PRECEDENCE CK FCR START OF STEP
 14.420           14.410
PRECEDENCE CK FCR END OF STEP
          51700   002 014.420   014 JUMP  000                 0.0000000   0.0000000   0.0000000   02
          51800   002 014.421   014 TCE   001   0.022*E.      0.0000000   1.6000017   1.6000017   02
          52000   002 014.423   014 REPT  017   020           0.0000000   0.0000000   0.0000000   02
          52100   002 014.424   014 TOJ   000   0.025*J.05    0.0000000   0.0000050   0.0000050   02
          52100   002 014.425   014 TOJ   000   0.026*J.06    0.0000000   0.0000000   0.0000000   02
          52100   002 014.426   014 TOJ   000   0.027*J.07    0.0000000   0.0000000   0.0000000   02
          52100   002 014.427   014 TOJ   000   0.030*J.10    0.0000000   0.0000000   0.0000000   02
          52100   002 014.430   014 TOJ   000   0.031*J.11    0.0000000   0.0000000   0.0000000   02
          52100   002 014.431   014 TOJ   000   0.032*J.12    0.0000000   0.0000000   0.0000000   02
          52100   002 014.432   014 TOJ   000   0.033*J.13    0.0000000   0.0000000   0.0000000   02
          52100   002 014.433   014 TOJ   000   0.034*J.14    0.0000000   0.0000000   0.0000000   02
          52100   002 014.434   014 TOJ   000   0.035*J.15    0.0000000   0.0000000   0.0000000   02
          52100   002 014.435   014 TOJ   000   0.036*J.16    0.0000000   0.0000000   0.0000000   02
          52100   002 014.436   014 TOJ   000   0.037*J.17    0.0000000   0.0000000   0.0000000   02
          52100   002 014.437   014 TOJ   000   0.040*J.00    0.0000000   0.2610477   0.2610477   02
          52100   002 014.440   014 TOJ   000   0.041*J.01    0.0000000   0.2004500   0.2004500   02
          52100   002 014.441   014 TOJ   000   0.042*J.02    0.0000000   0.0450103   0.0450103   02
          52100   002 014.442   014 TOJ   000   0.043*J.03    0.0000000   0.5012330   0.5012330   02
          52100   002 014.443   014 TOJ   000   0.044*J.04    0.0000000   0.1437714   0.1437714   02
          52200   002 014.445   014 REPT  007   010           0.0000000   0.0000000   0.0000000   02
          52300   002 014.446   014 TCF   000   0.047*F.7     0.0000000   0.0000000   0.0000000   02
          52300   002 014.447   014 TCF   000   0.050*F.0     0.0000000   0.0000000   0.0000000   02
          52300   002 014.450   014 TCF   000   0.051*F.1     0.0000000   0.0000000   0.0000000   02
          52300   002 014.451   014 TCF   000   0.052*F.2     0.0000000   0.0000200   0.0000200   02
          52300   002 014.452   014 TCF   000   0.053*F.3     0.0000000   0.0000004   0.0000004   02
          52300   002 014.453   014 TCF   000   0.054*F.4     0.0000000   1.6100456   1.6100456   02
          52300   002 014.454   014 TCF   000   0.055*F.5     0.0000000   0.0200000   0.0200000   02
          52300   002 014.455   014 TCF   000   0.056*F.6     0.0000000   0.0000000   0.0000000   02
          52400   002 014.457   014 REPT  006   007           0.0000000   0.0000000   0.0000000   02
          52500   002 014.460   014 TCH   000   0.061*H.01    0.0000000   0.0000000   0.0000000   02
          52500   002 014.461   014 TCH   000   0.062*H.02    0.0000000   1.6000053   1.6000053   02
          52500   002 014.462   014 TCH   000   0.063*H.03    0.0000000   0.0000000   0.0000000   02
          52500   002 014.463   014 TCH   000   0.064*H.04    0.0000000   0.0000000   0.0000000   02
          52500   002 014.464   014 TCH   000   0.065*H.05    0.0000000   0.0000000   0.0000000   02
          52500   002 014.465   014 TCH   000   0.066*H.06    0.0000000   0.0000000   0.0000000   02
          52500   002 014.466   014 TCH   000   0.067*H.07    0.0000000   0.0000000   0.0000000   02
          52600   002 014.470   014 JUMP  001                 0.0000000   0.0000000   0.0000000   02
          52700   002 014.472   014 REPT  020   021           0.0000000   0.0000000   0.0000000   02
          52800   002 014.473   014 TGX   000   G.14  x.      0.0000001   0.0000001   0.0000001   02
          52800   002 014.474   014 TGX   000   G.15  x.      0.0000001   0.0000001   0.0000001   02
          52800   002 014.475   014 TGX   000   G.16  x.      0.0000001   0.0000001   0.0000001   02
          52800   002 014.476   014 TGX   000   G.17  x.      0.0000001   0.0000001   0.0000001   02
          52800   003 014.477   014 TGX   000   G.00  x.      0.0000001   0.0000001   0.0000001   02
          52800   003 014.000   014 TGX   000   G.01  x.      0.0000001   0.0000001   0.0000001   02
          52800   003 014.001   014 TGX   000   G.02  x.      0.0000001   0.0000001   0.0000001   02
          52800   003 014.002   014 TGX   000   G.03  x.      0.0000001   0.0000001   0.0000001   02
          52800   003 014.003   014 TGX   000   G.04  x.      0.0000001   0.0000001   0.0000001   02
          52800   003 014.004   014 TGX   000   G.05  x.      0.0000001   0.0000001   0.0000001   02
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52800	003	014.005	014	TGX	000	G.06	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.006	014	TGX	000	G.07	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.007	014	TGX	000	G.10	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.010	014	TGX	000	G.11	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.011	014	TGX	000	G.12	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.012	014	TGX	000	G.13	X.	0.0000001	0.0000001	0.0000001	02
52800	003	014.013	014	TGX	000	G.14	X.	0.0000001	0.0000001	0.0000001	02
52900	003	014.015	014	THX	000	H.16	X.	0.0000001	0.0000001	0.0000001	02
53000	003	014.016	015	THX	002	H.17	X.	0.0000001	0.0000001	0.0000001	02
53100	003	015.021	014	TCC	001	C.	C.022*	1.6000053	1.6000017	1.6000017	02
53200	003	014.023	014	REPT	017	020		0.0000000	0.0000000	0.0000000	02
53300	003	014.024	014	TJC	000	J.05	0.025*	0.0000050	0.0000050	0.0000050	02
53300	003	014.025	014	TJC	000	J.06	0.026*	0.0000000	0.0000000	0.0000000	02
53300	003	014.026	014	TJC	000	J.07	0.027*	0.0000000	0.0000000	0.0000000	02
53300	003	014.027	014	TJC	000	J.10	0.030*	0.0000000	0.0000000	0.0000000	02
53300	003	014.030	014	TJC	000	J.11	0.031*	0.0000000	0.0000000	0.0000000	02
53300	003	014.031	014	TJC	000	J.12	0.032*	0.0000000	0.0000000	0.0000000	02
53300	003	014.032	014	TJC	000	J.13	0.033*	0.0000000	0.0000000	0.0000000	02
53300	003	014.033	014	TJC	000	J.14	0.034*	0.0000000	0.0000000	0.0000000	02
53300	003	014.034	014	TJC	000	J.15	0.035*	0.0000000	0.0000000	0.0000000	02
53300	003	014.035	014	TJC	000	J.16	0.036*	0.0000000	0.0000000	0.0000000	02
53300	003	014.036	014	TJC	000	J.17	0.037*	0.0000000	0.0000000	0.0000000	02
53300	003	014.037	014	TJC	000	J.00	0.040*	0.2610477	0.2610477	0.2610477	02
53300	003	014.040	014	TJC	000	J.01	0.041*	0.2004500	0.2004500	0.2004500	02
53300	003	014.041	014	TJC	000	J.02	0.042*	0.0450103	0.0450103	0.0450103	02
53300	003	014.042	014	TJC	000	J.03	0.043*	0.5012330	0.5012330	0.5012330	02
53300	003	014.043	014	TJC	000	J.04	0.044*	0.1437714	0.1437714	0.1437714	02
53400	003	014.045	014	JUMP	000			0.0000000	0.0000000	0.0000000	02
53500	003	014.046	014	BLFO	010	F.7	0.047*	0.0000000	0.0000000	0.0000000	02
53500	003	014.046	014	BLFO	010	F.0	0.050*	0.0000000	0.0000000	0.0000000	02
53500	003	014.046	014	BLFO	010	F.1	0.051*	0.0000000	0.0000000	0.0000000	02
53500	003	014.046	014	BLFO	010	F.2	0.052*	0.0000200	0.0000200	0.0000200	02
53500	003	014.046	014	BLFO	010	F.3	0.053*	0.0000004	0.0000004	0.0000004	02
53500	003	014.046	014	BLFO	010	F.4	0.054*	1.6100456	1.6100456	1.6100456	02
53500	003	014.046	014	BLFO	010	F.5	0.055*	0.0200000	0.0200000	0.0200000	02
53500	003	014.046	014	BLFO	010	F.6	0.056*	0.0000000	0.0000000	0.0000000	02
53600	003	014.057	014	JUMP	000			0.0000000	0.0000000	0.0000000	02
53700	003	014.060	014	THC	000	H.01	0.061*	0.0000000	0.0000000	0.0000000	02
53800	003	014.061	014	THC	000	H.02	C.	1.6000053	1.6000017	1.6000017	02
53900	003	014.062	014	THC	000	H.03	0.063*	0.0000000	0.0000000	0.0000000	02
54000	003	014.063	014	THC	000	H.04	0.064*	0.0000000	0.0000000	0.0000000	02
54100	003	014.064	014	THC	000	H.05	0.065*	0.0000000	0.0000000	0.0000000	02
54200	003	014.065	014	THC	000	H.06	0.066*	0.0000000	0.0000000	0.0000000	02
54300	003	014.066	014	THC	000	H.07	0.067*	0.0000000	0.0000000	0.0000000	02
54400	003	014.067	014	JUMP	000			0.0000000	0.0000000	0.0000000	02
54500	003	014.070	014	THX	000	H.11	X.	0.0000001	0.0000001	0.0000001	02
54600	003	014.071	014	THX	000	H.12	X.	0.0000001	0.0000001	0.0000001	02
54700	003	014.072	014	THX	000	H.13	X.	0.0000001	0.0000001	0.0000001	02
54800	003	014.073	014	THX	000	H.14	X.	0.0000001	0.0000001	0.0000001	02
54900	003	014.074	014	THX	000	H.15	X.	0.0000001	0.0000001	0.0000001	02
55000	003	014.075	014	TBC	000	B.	C.	3.7777777	1.6000017	1.6000017	02
55100	003	014.076	014	TDC	000	D.	C.	1.6000053	1.6000017	1.6000017	02
55200	003	014.077	174	TEX	000	E.	X.	1.6000017	0.0000001	0.0000001	02

174.100 174.100
PRECEDENCE CK FOR START OF STEP
174.100 174.100
PRECEDENCE CK FOR END OF STEP

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          00000   003 174.100   160 JUMP 017                    0.0000000   0.0000000   0.0000000   77
160.120           160.100
PRECEDENCE CK FOR START OF STEP
160.120           160.100
PRECEDENCE CK FOR END OF STEP
          12500   003 160.120   160 XTRP 010   K.123 P.012   0.4000000   0.0000000   0.0000000   02
          13100   003 160.131   160 TPK  001   P.136 K.132   0.0000000   1.0000136   1.0000136   02
          13300   004 160.133   160 JUMP 434                  0.0000000   0.0000000   0.0000000   02
          13400   004 160.070   160 XTRP 004   K.073 P.010   0.0001000   0.0000000   0.0000000   02
          13800   004 160.075   160 TSK  003   S.    K.076   0.0000000   1.7400000   1.7400000   02
          14200   004 160.101   160 JUMP 077                  0.0000000   0.0000000   0.0000000   02
          14300   004 160.201   160 TDK  005   D.    K.202   1.6000017   1.5000000   1.5000000   02
          14700   004 160.207   160 BLJK 017   J.10  K.210   0.0000000   0.0000006   0.0000006   02
          14700   004 160.207   160 BLJK 017   J.11  K.211   0.0000000   0.0000000   0.0000000   02  ERR  41 00 00 00
          14700   004 160.207   160 BLJK 017   J.12  K.212   0.0000000   1.6100307   1.6100307   02
          14700   004 160.207   160 BLJK 017   J.13  K.213   0.0000000   0.0000000   0.0000000   02  ERR  41 00 00 00
          14700   004 160.207   160 BLJK 017   J.14  K.214   0.0000000   0.0000000   0.0000000   02  ERR  41 00 00 00
          14700   004 160.207   160 BLJK 017   J.15  K.215   0.0000000   0.0000000   0.0000000   02  ERR  41 00 00 00
          14700   004 160.207   160 BLJK 017   J.16  K.216   0.0000000   0.0000000   0.0000000   02  ERR  41 00 00 00
          14700   004 160.207   160 BLJK 017   J.17  K.217   0.0000000   0.0000010   0.0000010   02
          14700   004 160.207   160 BLJK 017   J.00  K.220   0.2610477   0.0000000   0.0000000   02  ERR  41 00 00 00
          14700   004 160.207   160 BLJK 017   J.01  K.221   0.2004500   1.4000000   1.4000000   02
          14700   004 160.207   160 BLJK 017   J.02  K.222   0.0450103   0.0000002   0.0000002   02
          14700   004 160.207   160 BLJK 017   J.03  K.223   0.5012330   1.6030114   1.6030114   02
          14700   004 160.207   160 BLJK 017   J.04  K.224   0.1437714   1.6273000   1.6273000   02
          14700   004 160.207   160 BLJK 017   J.05  K.225   0.0000050   0.0000000   0.0000000   02  ERR  41 00 00 00
          14700   004 160.207   160 BLJK 017   J.06  K.226   0.0000000   0.0000000   0.0000000   02
          15400   004 160.227   161 BLFK 010   F.0   K.230   0.0000000   1.7573161   1.7573161   02
          15400   004 160.227   161 BLFK 010   F.1   K.231   0.0000000   0.0000000   0.0000000   02  ERR  41 00 00 00
          15400   004 160.227   161 BLFK 010   F.2   K.232   0.0000200   1.7727061   1.7727061   02
          15400   004 160.227   161 BLFK 010   F.3   K.233   0.0000004   0.0000000   0.0000000   02  ERR  41 00 00 00
          15400   004 160.227   161 BLFK 010   F.4   K.234   1.6100456   1.6050437   1.6050437   02
          15400   004 160.227   161 BLFK 010   F.5   K.235   0.0200000   1.7400001   1.7400001   02
          15400   004 160.227   161 BLFK 010   F.6   K.236   0.0000000   1.7552161   1.7552161   02
          15400   004 160.227   161 BLFK 010   F.7   K.237   0.0000000   0.0000000   0.0000000   02  ERR  41 00 00 00
          16000   004 161.240   160 TFD  000   F.1   D.      0.0000000   1.5000000   1.5000000   02
          16050   004 160.241   160 JUMP 020                  0.0000000   0.0000000   0.0000000   02
          16100   004 160.262   160 TBC  000   B.    0.263*  0.0000000   0.0000004   0.0000004   02
          16200   004 160.263   160 ABX  002   B.    X.      0.0000004   0.0000001   0.0000005   02
          16300   004 160.266   160 READ 015   E.    K.300   0.0000005   0.0000000   1.6044077   02
          17600   004 160.304   160 XTRE 001   K.305 E.      1.7600777   1.6044077   1.6000077   02
          17800   004 160.306   160 TJB  000   J.07  B.      0.0000000   1.6000077   1.6000077   02
          17900   004 160.307   160 SEB  000   E.    B.      1.6044077   1.6000077   0.0044000   02
          18000   004 160.310   160 TSF  000   S.    F.1     0.0000000   1.5000000   1.5000000   02
          18030   004 160.311   160 TDZ  000   D.    Z.      1.5000000   0.0000000   0.0000000   02
          18070   004 160.312   160 TBE  000   B.    E.      1.6000077   0.0044000   0.0044000   02
          18100   004 160.313   160 RGHT 010   B.            0.0044000   0.0000011   0.0000044   02
          18400   004 160.324   160 TJB  006   J.05  B.      0.0000000   0.0000044   0.0000044   02
          18500   004 160.333   175 TCF  001   C.    F.4     1.6000017   1.6050437   1.6050437   02
          00000   004 175.335   174 JUMP 001                  0.0000000   0.0000000   0.0000000   77
          00000   004 174.337   160 TBC  017   B.    0.340*  0.0000044   0.2610477   0.2610477   77
          19100   004 160.357   160 JUMP 012                  0.0000000   0.0000000   0.0000000   02
          19200   004 160.372   160 TFB  000   F.3   D.      0.0000000   0.2610477   0.2610477   02
          19300   004 160.373   161 TEK  003   E.    K.374   0.0044000   1.6100000   1.6100000   02
          19500   004 161.377   161 TJB  014   J.00  B.      0.0000000   0.0000000   0.0000000   02
          19550   004 161.414   014 JUMP 003                  0.0000000   0.0000000   0.0000000   02
14.420            14.400
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PRECEDENCE CK FCR START OF STEP
14.420 14.400
PRECEDENCE CK FCR END OF STEP

51700	004 014.420	C14	JUMP	CCC		0.0000000	0.0000000	0.0000000	02
51800	004 014.421	C14	TCE	CC1	0.022*E.	0.0000000	1.6100000	1.6100000	02
52000	004 014.423	C14	REPT	017	C20	0.0000000	0.0000000	0.0000000	02
52100	004 014.424	C14	TCJ	CCC	0.025*J.05	0.0000000	0.0000044	0.0000044	02
52100	004 014.425	C14	TCJ	CCC	0.026*J.06	0.0000000	0.0000000	0.0000000	02
52100	004 014.426	C14	TCJ	CCC	0.027*J.07	0.0000000	1.6000077	1.6000077	02
52100	004 014.427	C14	TCJ	CCC	0.030*J.10	0.0000000	0.0000006	0.0000006	02
52100	004 014.430	C14	TCJ	CCC	0.031*J.11	0.0000000	0.0000005	0.0000005	02
52100	004 014.431	C14	TCJ	CCC	0.032*J.12	0.0000000	1.6100307	1.6100307	02
52100	004 014.432	C14	TCJ	CCC	0.033*J.13	0.0000000	0.0000000	0.0000000	02
52100	004 014.433	C14	TCJ	CCC	0.034*J.14	0.0000000	0.0000000	0.0000000	02
52100	004 014.434	C14	TCJ	CCC	0.035*J.15	0.0000000	0.0000000	0.0000000	02
52100	004 014.435	C14	TCJ	CCC	0.036*J.16	0.0000000	0.0000000	0.0000000	02
52100	004 014.436	C14	TCJ	CCC	0.037*J.17	0.0000000	0.0000010	0.0000010	02
52100	004 014.437	C14	TCJ	CCC	0.040*J.00	0.0000000	0.0000000	0.0000000	02
52100	004 014.440	C14	TCJ	CCC	0.041*J.01	0.0000000	1.4000000	1.4000000	02
52100	004 014.441	C14	TCJ	CCC	0.042*J.02	0.0000000	0.0000002	0.0000002	02
52100	004 014.442	C14	TCJ	CCC	0.043*J.03	0.0000000	1.6030114	1.6030114	02
52100	004 014.443	C14	TCJ	CCC	0.044*J.04	0.0000000	1.6273000	1.6273000	02
52200	004 014.445	C14	REPT	007	C10	0.0000000	0.0000000	0.0000000	02
52300	004 014.446	C14	TCF	CCC	0.047*F.7	0.0000000	0.0000000	0.0000000	02
52300	004 014.447	C14	TCF	CCC	0.050*F.0	0.0000000	1.7573161	1.7573161	02
52300	004 014.450	C14	TCF	CCC	0.051*F.1	0.0000000	1.5000000	1.5000000	02
52300	004 014.451	C14	TCF	CCC	0.052*F.2	0.0000000	1.7727061	1.7727061	02
52300	004 014.452	C14	TCF	CCC	0.053*F.3	0.0000000	0.2610477	0.2610477	02
52300	004 014.453	C14	TCF	CCC	0.054*F.4	0.0000000	1.6050437	1.6050437	02
52300	004 014.454	C14	TCF	CCC	0.055*F.5	0.0000000	1.7400001	1.7400001	02
52300	004 014.455	C14	TCF	CCC	0.056*F.6	0.0000000	1.7552161	1.7552161	02
52400	004 014.457	C14	REPT	006	CC7	0.0000000	0.0000000	0.0000000	02
52500	004 014.460	C14	TCH	CCC	0.061*H.01	0.0000000	0.0000000	0.0000000	02
52500	004 014.461	C14	TCH	CCC	0.062*H.02	0.0000000	1.6000017	1.6000017	02
52500	004 014.462	C14	TCH	CCC	0.063*H.03	0.0000000	0.0000000	0.0000000	02
52500	004 014.463	C14	TCH	CCC	0.064*H.04	0.0000000	0.0000000	0.0000000	02
52500	004 014.464	C14	TCH	CCC	0.065*H.05	0.0000000	0.0000000	0.0000000	02
52500	004 014.465	C14	TCH	CCC	0.066*H.06	0.0000000	0.0000000	0.0000000	02
52500	004 014.466	C14	TCH	CCC	0.067*H.07	0.0000000	0.0000000	0.0000000	02
52600	004 014.470	C14	JUMP	CC1		0.0000000	0.0000000	0.0000000	02
52700	004 014.472	C14	REPT	020	C21	0.0000000	0.0000000	0.0000000	02
52800	004 014.473	C14	TGX	CCC	G.14 X.	0.0000001	0.0000001	0.0000001	02
52800	004 014.474	C14	TGX	CCC	G.15 X.	0.0000001	0.0000001	0.0000001	02
52800	004 014.475	C14	TGX	CCC	G.16 X.	0.0000001	0.0000001	0.0000001	02
52800	004 014.476	C14	TGX	CCC	G.17 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.477	C14	TGX	CCC	G.00 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.000	C14	TGX	CCC	G.01 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.001	C14	TGX	CCC	G.02 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.002	C14	TGX	CCC	G.03 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.003	C14	TGX	CCC	G.04 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.004	C14	TGX	CCC	G.05 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.005	C14	TGX	CCC	G.06 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.006	C14	TGX	CCC	G.07 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.007	C14	TGX	CCC	G.10 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.010	C14	TGX	CCC	G.11 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.011	C14	TGX	CCC	G.12 X.	0.0000001	0.0000001	0.0000001	02
52800	005 014.012	C14	TGX	CCC	G.13 X.	0.0000001	0.0000001	0.0000001	02

52800	005 014.C13	C14	TGX	CCC	G.14	X.	0.0000001	0.0000001	0.0000001	02
52900	005 014.C15	C14	THX	CC2	H.16	X.	0.0000001	0.0000001	0.0000001	02
53000	005 014.C16	C15	THX	CC2	H.17	X.	0.0000001	0.0000001	0.0000001	02
53100	005 015.C21	C14	TCC	CC1	C.	C.C22*	1.6050437	1.6100000	1.6100000	02
53200	005 014.C23	C14	REPT	C17	C2C		0.0000000	0.0000000	0.0000000	02
53300	005 014.C24	C14	TJC	CCO	J.C5	C.025*	0.0000044	0.0000044	0.0000044	02
53300	005 014.C25	C14	TJC	CCC	J.C6	C.026*	0.0000000	0.0000000	0.0000000	02
53300	005 014.C26	C14	TJC	CCO	J.C7	C.027*	1.6000077	1.6000077	1.6000077	02
53300	005 014.C27	C14	TJC	CCO	J.10	C.030*	0.0000006	0.0000006	0.0000006	02
53300	005 014.C3C	C14	TJC	CCC	J.11	C.031*	0.0000000	0.0000000	0.0000000	02
53300	005 014.C31	C14	TJC	CCO	J.12	C.032*	1.6100307	1.6100307	1.6100307	02
53300	005 014.C32	C14	TJC	CCC	J.13	C.033*	0.0000000	0.0000000	0.0000000	02
53300	005 014.C33	C14	TJC	CCC	J.14	C.034*	0.0000000	0.0000000	0.0000000	02
53300	005 014.C34	C14	TJC	CCO	J.15	C.035*	0.0000000	0.0000000	0.0000000	02
53300	005 014.C35	C14	TJC	CCC	J.16	C.036*	0.0000000	0.0000000	0.0000000	02
53300	005 014.C36	C14	TJC	CCC	J.17	C.037*	0.0000010	0.0000010	0.0000010	02
53300	005 014.C37	C14	TJC	CCO	J.CC	C.040*	0.0000000	0.0000000	0.0000000	02
53300	005 014.C4C	C14	TJC	CCC	J.C1	C.041*	1.4000000	1.4000000	1.4000000	02
53300	005 014.C41	C14	TJC	CCC	J.C2	C.042*	0.0000002	0.0000002	0.0000002	02
53300	005 014.C42	C14	TJC	CCC	J.C3	C.043*	1.6030114	1.6030114	1.6030114	02
53300	005 014.C43	C14	TJC	CCC	J.C4	C.044*	1.6273000	1.6273000	1.6273000	02
53400	005 014.C45	C14	JUMP	CCC			0.0000000	0.0000000	0.0000000	02
53500	005 014.C46	C14	BLFC	C10	F.7	C.047*	0.0000000	0.0000000	0.0000000	02
53500	005 014.C46	C14	BLFC	C10	F.C	C.050*	1.7573161	1.7573161	1.7573161	02
53500	005 014.C46	C14	BLFC	C10	F.1	C.051*	1.5000000	1.5000000	1.5000000	02
53500	005 014.C46	C14	BLFC	C1C	F.2	C.052*	1.7727061	1.7727061	1.7727061	02
53500	005 014.C46	C14	BLFC	C1C	F.3	C.053*	0.2610477	0.2610477	0.2610477	02
53500	005 014.C46	C14	BLFC	C1C	F.4	C.054*	1.6050437	1.6050437	1.6050437	02
53500	005 014.C46	C14	BLFC	C1C	F.5	C.055*	1.7400001	1.7400001	1.7400001	02
53500	005 014.C46	C14	BLFC	C10	F.6	C.056*	1.7552161	1.7552161	1.7552161	02
53600	005 014.C57	C14	JUMP	CCO			0.0000000	0.0000000	0.0000000	02
53700	005 014.C6C	C14	THC	CCC	H.C1	C.061*	0.0000000	0.0000000	0.0000000	02
53800	005 014.061	C14	THC	CCO	H.C2	C.	1.6000017	1.6100000	1.6100000	02
53900	005 014.C62	C14	THC	CCC	H.C3	C.063*	0.0000000	0.0000000	0.0000000	02
54000	005 014.063	C14	THC	CCC	H.C4	C.064*	0.0000000	0.0000000	0.0000000	02
54100	005 014.C64	C14	THC	CCC	H.C5	C.065*	0.0000000	0.0000000	0.0000000	02
54200	005 014.C65	C14	THC	CCC	H.C6	C.066*	0.0000000	0.0000000	0.0000000	02
54300	005 014.C66	C14	THC	CCC	H.C7	C.067*	0.0000000	0.0000000	0.0000000	02
54400	005 014.C67	C14	JUMP	CCC			0.0000000	0.0000000	0.0000000	02
54500	005 014.C7C	C14	THX	CCC	H.11	X.	0.0000001	0.0000001	0.0000001	02
54600	005 014.C71	C14	THX	CCO	H.12	X.	0.0000001	0.0000001	0.0000001	02
54700	005 014.C72	C14	THX	CCC	H.13	X.	0.0000001	0.0000001	0.0000001	02
54800	005 014.C73	C14	THX	CCO	H.14	X.	0.0000001	0.0000001	0.0000001	02
54900	005 014.C74	C14	THX	CCO	H.15	X.	0.0000001	0.0000001	0.0000001	02
55000	005 014.C75	C14	TBC	CCC	B.	C.	3.7777777	1.6100000	1.6100000	02
55100	005 014.C76	C14	TDC	CCO	D.	C.	0.0000000	1.6100000	1.6100000	02
55200	005 014.C77	174	TEX	CCC	E.	X.	1.6100000	0.0000001	0.0000001	02

174.100 174.100
PRECEDENCE CK FOR START OF STEP
174.100 174.100
PRECEDENCE CK FOR END OF STEP

00000	005 174.1CC	161	JUMP	CCC			0.0000000	0.0000000	0.0000000	77

161.101 161.100
PRECEDENCE CK FOR START OF STEP
161.101 161.100
PRECEDENCE CK FOR END OF STEP

19700	005 161.101	161	REPT	017	C2C		0.0000000	0.0000000	0.0000000	02

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          19800    005 161.102   161 TGK   000   G.03   K.103   0.0000001   0.0000000   0.0000000   02  ERR   41 00 00 00
          19800    005 161.103   161 TGK   000   G.04   K.104   0.0000001   0.3400000   0.3400000   02
          19800    005 161.104   161 TGK   000   G.05   K.105   0.0000001   1.3000000   1.3000000   02
          19800    005 161.105   161 TGK   000   G.06   K.106   0.0000001   1.2400000   1.2400000   02
          19800    005 161.106   161 TGK   000   G.07   K.107   0.0000001   0.2000000   0.2000000   02
          19800    005 161.107   161 TGK   000   G.10   K.110   0.0000001   1.1400000   1.1400000   02
          19800    005 161.110   161 TGK   000   G.11   K.111   0.0000001   0.1000000   0.1000000   02
          19800    005 161.111   161 TGK   000   G.12   K.112   0.0000001   0.0400000   0.0400000   02
          19800    005 161.112   161 TGK   000   G.13   K.113   0.0000001   1.0000000   1.0000000   02
          19800    005 161.113   161 TGK   000   G.14   K.114   0.0000001   1.7562625   1.7562625   02
          19800    005 161.114   161 TGK   000   G.15   K.115   0.0000001   0.0000000   0.0000000   02  ERR   41 00 00 00
          19800    005 161.115   161 TGK   000   G.16   K.116   0.0000001   0.0000000   0.0000000   02  ERR   41 00 00 00
          19800    005 161.116   161 TGK   000   G.17   K.117   0.0000001   1.7642021   1.7642021   02
          19800    005 161.117   161 TGK   000   G.00   K.120   0.0000001   0.0000007   0.0000007   02
          19800    005 161.120   161 TGK   000   G.01   K.121   0.0000001   1.7670160   1.7670160   02
          19800    005 161.121   161 TGK   000   G.02   K.122   0.0000001   1.7602011   1.7602011   02
          21200    005 161.123   161 REPT  011   012            0.0000000   0.0000000   0.0000000   02
          21300    005 161.124   161 THK   000   H.05   K.125   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          21300    005 161.125   161 THK   000   H.06   K.126   0.0000000   1.7451161   1.7451161   02
          21300    005 161.126   161 THK   000   H.07   K.127   0.0000000   1.7767622   1.7767622   02
          21300    005 161.127   161 THK   000   H.10   K.130   0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          21300    005 161.130   161 THK   000   H.11   K.131   0.0000001   1.7451161   1.7451161   02
          21300    005 161.131   161 THK   000   H.12   K.132   0.0000001   1.7750020   1.7750020   02
          21300    005 161.132   161 THK   000   H.13   K.133   0.0000001   1.7702242   1.7702242   02
          21300    005 161.133   161 THK   000   H.14   K.134   0.0000001   0.0000700   0.0000700   02
          21300    005 161.134   161 THK   000   H.15   K.135   0.0000001   1.6102353   1.6102353   02
          21300    005 161.135   161 THK   000   H.16   K.136   0.0000001   1.7651000   1.7651000   02
          22000    005 161.137   161 TDJ   002   D.     J.00    1.6100000   0.0000000   0.0000000   02
          22100    005 161.142   161 TCF   000   C.     F.3     1.6100000   0.2610477   0.2610477   02
          22200    005 161.143   161 THK   001   H.04   K.144   0.0000000   1.7767622   1.7767622   02
          22300    005 161.145   176 JUMP  011                  0.0000000   0.0000000   0.0000000   02
176.157           176.144
PRECEDENCE CK FOR START OF STEP
176.157           176.144
PRECEDENCE CK FOR END OF STEP
          00000    005 176.157   176 XTRC  001   K.100  C.      0.0000007   0.2610477   0.0000007   77
          00000    005 176.161   176 ABJ   000   B.     J.02    0.0000007   0.0000002   0.0000011   77
          00000    005 176.162   176 READ  011   E.     K.164   0.0000011   0.0000000   0.3400000   77
          00000    005 176.174   175 SDX   005   D.     X.      0.0000000   0.0000001   1.7777777   77
          00000    005 175.176   175 TDJ   001   D.     J.17    1.7777777   0.0000010   0.0000010   77
          00000    005 175.200   175 AEJ   001   E.     J.01    0.3400000   1.4000000   1.7400000   77
          00000    005 175.202   177 TSE   001   S.     E.      0.0000000   1.7400000   1.7400000   77
          00000    005 177.204   177 SJX   002   J.05   X.      0.0000044   0.0000001   0.0000043   77
          00000    005 177.207   177 SJX   002   J.10   X.      0.0000006   0.0000001   0.0000005   77
          00000    005 177.212   177 TBC   000   B.     C.      0.0000011   0.2610477   0.2610477   77
          00000    005 177.213   177 RGHT  002   B.             0.2610477   0.0000003   0.0261047   77
          00000    005 177.216   176 TCB   000   C.     B.      0.2610477   0.0261047   0.0261047   77
          00000    005 176.217   176 XTRC  001   K.220  C.      0.0000007   0.0261047   0.0000007   77
          00000    005 176.221   176 ABJ   000   B.     J.02    0.0000007   0.0000002   0.0000011   77
          00000    005 176.222   176 READ  011   E.     K.224   0.0000011   0.0000000   0.3400000   77
          00000    005 176.234   175 SDX   005   D.     X.      0.0000010   0.0000001   0.0000007   77
          00000    005 175.242   177 TSE   001   S.     E.      0.0000000   0.3400000   0.3400000   77
          00000    005 177.244   177 SJX   002   J.05   X.      0.0000043   0.0000001   0.0000042   77
          00000    005 177.247   177 SJX   002   J.10   X.      0.0000005   0.0000001   0.0000004   77
          00000    005 177.252   177 TBC   000   B.     C.      0.0000011   0.0261047   0.0261047   77
          00000    005 177.253   177 RGHT  002   B.             0.0261047   0.0000003   0.0026104   77
          00000    005 177.256   176 TCB   000   C.     B.      0.0261047   0.0026104   0.0026104   77
```

```
00000  005 176.257  176 XTRC CC1  K.26C C.     0.0000007  0.0026104  0.0000004  77
00000  005 176.261  176 ABJ  CC0  B.   J.02    0.0000004  0.0000002  0.0000006  77
00000  005 176.262  176 READ C11  E.   K.267   0.0000006  0.0000000  0.2000000  77
00000  005 176.274  175 SDX  CC5  D.   X.      0.0000007  0.0000001  0.0000006  77
00000  005 175.3C2  177 TSE  CC1  S.   E.      0.0000000  0.2000000  0.2000003  77
00000  005 177.304  177 SJX  CC2  J.C5 X.      0.0000042  0.0000001  0.0000341  77
00000  005 177.307  177 SJX  CC2  J.1C X.      0.0000004  0.0000001  0.0000003  77
00000  005 177.312  177 TBC  CC0  B.   C.      0.0000006  0.0026104  0.0026104  77
00000  005 177.313  177 RGHT CC2  B.   B.      0.0026104  0.0000003  0.0026104  77
00000  005 177.316  176 TCB  CC0  C.   B.      0.0026104  0.0002610  0.0026104  77
00000  005 176.317  176 XTRC CC1  K.32C C.     0.0000007  0.0002610  0.0000003  77
00000  005 176.321  176 ABJ  CC0  B.   J.02    0.0000000  0.0000002  0.0000002  77
00000  005 176.322  176 READ C11  E.   K.333   0.0000002  0.0000000  1.0000000  77
00000  005 176.334  175 SDX  CC5  D.   X.      0.0000006  0.0000001  0.0000005  77
00000  005 175.342  177 TSE  CC1  S.   E.      0.0000000  1.0000000  1.0000000  77
00000  005 177.344  177 SJX  CC2  J.C5 X.      0.0000041  0.0000001  0.0000040  77
00000  005 177.347  177 SJX  CC2  J.1C X.      0.0000003  0.0000001  0.0000002  77
00000  005 177.352  177 TBC  CC0  B.   C.      0.0000002  0.0002610  0.0002610  77
00000  005 177.353  177 RGHT CC2  B.   B.      0.0002610  0.0000003  0.0000261  77
00000  005 177.356  176 TCB  CC0  C.   B.      0.0002610  0.0000261  0.0000261  77
00000  005 176.357  176 XTRC CC1  K.36C C.     0.0000007  0.0000261  0.0000031  77
00000  005 176.361  176 ABJ  CC0  B.   J.02    0.0000001  0.0000002  0.0000003  77
00000  005 176.362  176 READ C11  E.   K.372   0.0000003  0.0000000  0.0400000  77
00000  005 176.374  175 SDX  CC5  D.   X.      0.0000005  0.0000001  0.0000004  77
00000  005 175.402  177 TSE  CC1  S.   E.      0.0000000  0.0400000  0.0400000  77
00000  005 177.4C4  177 SJX  CC2  J.C5 X.      0.0000040  0.0000001  0.0000037  77
00000  005 177.4C7  177 SJX  CC2  J.1C X.      0.0000002  0.0000001  0.0000001  77
00000  005 177.412  177 TBC  C00  B.   C.      0.0000003  0.0002261  0.0000261  77
00000  005 177.413  177 RGHT CC2  B.   B.      0.0000261  0.0000026  0.0000026  77
00000  005 177.416  176 TCB  CC0  C.   B.      0.0000261  0.0000026  0.0000026  77
00000  005 176.417  176 XTRC 001  K.42C C.     0.0000007  0.0000026  0.0000036  77
00000  005 176.421  176 ABJ  CC0  B.   J.02    0.0000006  0.0000002  0.0000010  77
00000  005 176.422  176 READ C11  E.   K.425   0.0000010  0.0000000  1.3000000  77
00000  005 176.434  175 SDX  CC5  D.   X.      0.0000004  0.0000001  0.0000003  77
00000  005 175.442  177 TSE  CC1  S.   E.      0.0000000  1.3000000  1.3000000  77
00000  005 177.444  177 SJX  CC2  J.C5 X.      0.0000037  0.0000001  0.0000036  77
00000  005 177.447  177 SJX  CC2  J.1C X.      0.0000001  0.0000001  0.0000000  77
00000  005 177.452  177 TBC  CCC  B.   C.      0.0000010  0.0000026  0.0000026  77
00000  005 177.453  177 RGHT CC2  B.   B.      0.0000026  0.0000003  0.0000032  77
00000  005 177.456  176 TCB  CC0  C.   B.      0.0000026  0.0000002  0.0000002  77
00000  005 177.457  176 XTRC CC1  K.46C C.     0.0000007  0.0000002  0.0000002  77
00000  005 176.461  176 ABJ  CC0  B.   J.02    0.0000002  0.0000000  0.0000004  77
00000  005 176.462  176 READ C11  E.   K.471   0.0000004  0.0000000  0.1000000  77
00000  006 176.474  175 SDX  CC5  D.   X.      0.0000003  0.0000001  0.0000032  77
00000  006 175.CC2  177 TSE  CC1  S.   E.      0.0000000  0.1000000  0.1000000  77
00000  006 177.CC4  177 SJX  CC2  J.C5 X.      0.0000036  0.0000001  0.0000035  77
00000  006 177.CC7  177 SJX  CC2  J.1C X.      0.0000000  0.0000001  1.7777777  77
00000  006 177.C11  174 TCJ  CC1  C.   J.12    0.0000002  1.6100307  1.6100307  77
00000  006 174.C13  161 JUMP 3C7  0.0000000C  0.0000000  0.0000000  0.0000000  77
18200  006 161.323  161 SFX  CC0  F.4  X.      1.6050437  0.0000001  1.6050436  32
18300  006 161.324  160 SFX  CC6  F.5  X.      1.7400001  0.0000001  1.7400000  32
18430  006 16C.326  160 JUMP CCC  0.0000000C  0.0000000  0.0000000  0.0000000  02
18440  006 16C.327  160 TJK  003  J.1C K.330   1.7777777  0.0000006  0.0000006  02
18500  006 16C.333  175 TCF  CC1  C.   F.4     1.6100307  1.6050436  1.6050436  02
00000  006 175.335  174 JUMP CCC  0.0000000C  0.0000000  0.0000000  0.0000000  77
00000  006 174.336  160 TBC  016  B.   0.337*  0.0000004  0.0000000  0.0000000  77
23200  006 16C.355  160 TEK  CC2  E.   K.356   0.1000000  1.6000102  1.6000102  02
```

```
          23320   006 160.360   160 TSK   001    S.     K.361   0.0000000   0.7000000   0.7000000    02
          23340   006 160.362   160 TSK   001    S.     K.363   0.0000000   1.4400000   1.4400000    02
          23360   006 160.364   161 JUMP  01C                   0.0000000   0.0000000   0.0000000    02

00000                 161.375                                                                    ERR    00 00 00 02


                ERROR 000002      CARD
```

G. COMPUTER RUN WITH FLOW DIAGRAM PRECEDENCES VIOLATED

A run was made with a flow diagram precedence matrix for which the order of execution of automatic checkout program steps violated the specified precedences. The precedence matrix and precedence link matrices were the following:

		MATRIX COLUMN							KFIRST	KSEC
		1	2	3	4	5	6	7		
	1	0	1	0	0	0	0	0	000000166111	000000166111
	2	0	0	1	0	0	0	0	000000014420	000000014420
	3	0	0	0	1	1	1	0	000000174100	000000174100
ROW	4	0	-1	0	0	0	0	0	000000160154	000000160154
	5	0	-1	0	0	0	0	0	000000160120	000000160120
	6	0	0	0	0	0	0	0	000000161101	000000161101
	7	0	0	0	0	0	1	0	000000176157	000000176157

The precedence constraint that step 7 must precede step 6 was violated by the attempted execution of step 6 before step 7. At that point in the execution of the program, the diagnostic, "ERROR NUMBER 4" (precedences violated), was written, and the program was terminated. The run is listed on the following pages.

```
    *     XEQ

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
     (FPT)        EXIT         (TSHM)       (RTN)        (STHM)       (FIL)        DUMP

  PREPROCESSING TIME = 000.25 MIN.

        EXECUTION
  7
       000000166111         CCC000014420         000000174100         00CC00160154
       000000160120         00C000161101         000000176157
       00C000166111         00C00001442C         000000174100         000000160154
       000000160120         0C00CC161101         C00000176157
0 C 0 0 0 0 0 1 0 0-1-1 0 C 0 1 0 0 0 C C 0 0 1 0 0 0 0 0 C 1 0 0 0 0 0 0 1 0 0
C 1 0 C 0 0 0 0 0


0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-C-C-0-C-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0


0-0-0-0-0-0-0-0-0
       00000000C000         00000000000C         00000000000C         000000000000
       000000000000         0C000000000C         00C000000000
       000000000000         0C000000C0C0         C0C000000000         000000000000
       00C000000000         00C000000000         00000000000C
 1
CONSISTENT MATRIX
```

LABEL	REV CHN SEC	NC	OP	W/W	DEST	SRC	OLD DEST	SOURCE	NEW DEST	TN	ERRORS
1											
166.111	166. 0										
PRECEDENCE CK FOR START OF STEP											
166.111	166. C										
PRECEDENCE CK FOR END OF STEP											
	08700 001 166.111	166	BLFK	005	F.2	K.112	0.0000000	0.0000200	0.0000200	02	
	08700 001 166.111	166	BLFK	005	F.3	K.113	0.0000000	0.0000004	0.0000004	02	
	08700 001 166.111	166	BLFK	005	F.4	K.114	0.0000000	1.6700037	1.6700037	02	
	08700 001 166.111	166	BLFK	005	F.5	K.115	0.0000000	0.0200000	0.0200000	02	
	08700 001 166.111	166	BLFK	005	F.6	K.116	0.0000000	0.0000000	0.0000000	02	
	08706 001 166.117	166	BLJK	010	J.00	K.120	0.0000000	0.2610477	0.2610477	02	
	08706 001 166.117	166	BLJK	010	J.01	K.121	0.0000000	0.2004500	0.2004500	02	
	08706 001 166.117	166	BLJK	010	J.02	K.122	0.0000000	0.0450103	0.0450103	02	
	08706 001 166.117	166	BLJK	010	J.03	K.123	0.0000000	0.5012330	0.5012330	02	
	08706 001 166.117	166	BLJK	010	J.04	K.124	0.0000000	0.1437714	0.1437714	02	
	08706 001 166.117	166	BLJK	010	J.05	K.125	0.0000000	0.0000050	0.0000050	02	
	08706 001 166.117	166	BLJK	010	J.06	K.126	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
	08706 001 166.117	166	BLJK	010	J.07	K.127	0.0000000	0.0000000	0.0000000	02	ERR 41 00 00 00
	08715 001 166.130	160	JUMP	072			0.0000000	0.0000000	0.0000000	02	
	50000 001 160.223	160	TOF	014	0.324*F.4		0.0000000	1.6700037	1.6700037	02	
	50200 001 160.240	160	TFZ	002	F.1	Z.	0.0000000	0.0000000	0.0000000	02	
	50300 001 160.243	160	TFK	010	F.4	K.244	1.6700037	1.6100456	1.6100456	02	
	09800 001 160.254	160	TEK	001	E.	K.255	0.0000000	1.6000053	1.6000053	02	
	10000 001 160.256	014	JUMP	141			0.0000000	0.0000000	0.0000000	02	
14.420	14.255										
PRECEDENCE CK FOR START OF STEP											
14.420	14.255										
PRECEDENCE CK FOR END OF STEP											
	51700 001 014.420	014	JUMP	000			0.0000000	0.0000000	0.0000000	02	
	51800 001 014.421	014	TOE	001	0.022*E.		0.0000000	1.6000053	1.6000053	02	
	52000 001 014.423	014	REPT	017	020		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.424	014	TOJ	000	0.025*J.05		0.0000000	0.0000050	0.0000050	02	
	52100 001 014.425	014	TOJ	000	0.026*J.06		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.426	014	TOJ	000	0.027*J.07		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.427	014	TOJ	000	0.030*J.10		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.430	014	TOJ	000	0.031*J.11		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.431	014	TOJ	000	0.032*J.12		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.432	014	TOJ	000	0.033*J.13		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.433	014	TOJ	000	0.034*J.14		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.434	014	TOJ	000	0.035*J.15		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.435	014	TOJ	000	0.036*J.16		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.436	014	TOJ	000	0.037*J.17		0.0000000	0.0000000	0.0000000	02	
	52100 001 014.437	014	TOJ	000	0.040*J.00		0.0000000	0.2610477	0.2610477	02	
	52100 001 014.440	014	TOJ	000	0.041*J.01		0.0000000	0.2004500	0.2004500	02	
	52100 001 014.441	014	TOJ	000	0.042*J.02		0.0000000	0.0450103	0.0450103	02	
	52100 001 014.442	014	TOJ	000	0.043*J.03		0.0000000	0.5012330	0.5012330	02	
	52100 001 014.443	014	TOJ	000	0.044*J.04		0.0000000	0.1437714	0.1437714	02	
	52200 001 014.445	014	REPT	007	010		0.0000000	0.0000000	0.0000000	02	
	52300 001 014.446	014	TOF	000	0.047*F.7		0.0000000	0.0000000	0.0000000	02	
	52300 001 014.447	014	TOF	000	0.050*F.0		0.0000000	0.0000000	0.0000000	02	
	52300 001 014.450	014	TOF	000	0.051*F.1		0.0000000	0.0000000	0.0000000	02	
	52300 001 014.451	014	TOF	000	0.052*F.2		0.0000000	0.0000200	0.0000200	02	
	52300 001 014.452	014	TOF	000	0.053*F.3		0.0000000	0.0000004	0.0000004	02	
	52300 001 014.453	014	TOF	000	0.054*F.4		0.0000000	1.6100456	1.6100456	02	

```
52300 001 014.454  C14 TOF  000  0.C55*F.5   0.0000000  0.0200000  0.0200000  02
52300 001 014.455  C14 TOF  000  0.C56*F.6   0.0000000  0.0000000  0.0000000  02
52400 001 014.457  C14 REPT 006  007         0.0000000  0.0000000  0.0000000  02
52500 001 014.46C  C14 TOH  000  0.C61*H.01  0.0000000  0.0000000  0.0000000  02
52500 001 014.461  C14 TOH  000  0.C62*H.02  0.0000000  0.0000000  0.0000000  02
52500 001 014.462  C14 TOH  000  0.063*H.03  0.0000000  0.0000000  0.0000000  02
52500 001 014.463  C14 TOH  000  0.C64*H.04  0.0000000  0.0000000  0.0000000  02
52500 001 014.464  C14 TOH  000  C.C65*H.05  0.0000000  0.0000000  0.0000000  02
52500 001 014.465  C14 TOH  000  C.C66*H.06  0.0000000  0.0000000  0.0000000  02
52500 001 014.466  C14 TOH  000  0.C67*H.07  0.0000000  0.0000000  0.0000000  02
52600 001 014.47C  C14 JUMP 001  021         0.0000000  0.0000000  0.0000000  02
52700 001 014.472  C14 REPT 02C  G.14  X.    0.0000000  0.0000000  0.0000000  02
52800 001 014.473  C14 TGX  000  G.15  X.    0.0000000  0.0000001  0.0000001  02
52800 001 014.474  C14 TGX  000  G.16  X.    0.0000000  0.0000001  0.0000001  02
52800 001 014.475  C14 TGX  000  G.17  X.    0.0000000  0.0000001  0.0000001  02
52800 001 014.476  C14 TGX  000  G.CC  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.477  C14 TGX  000  G.C1  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.COC  C14 TGX  000  G.C2  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.C01  C14 TGX  000  G.C3  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.C02  C14 TGX  000  G.C4  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.C03  C14 TGX  000  G.C5  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.C04  C14 TGX  000  G.C6  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.C05  C14 TGX  000  G.C7  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.C06  C14 TGX  000  G.1C  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.C07  C14 TGX  000  G.11  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.01C  C14 TGX  000  G.12  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.011  C14 TGX  000  G.13  X.    0.0000000  0.0000001  0.0000001  02
52800 002 014.012  C14 TGX  000  G.14  X.    0.0000001  0.0000001  0.0000001  02
52800 002 014.013  C14 THX  000  H.16  X.    0.0000000  0.0000001  0.0000001  02
52900 002 014.C15  C15 THX  CC2  H.17  X.    0.0000000  0.0000001  0.0000001  02
53000 002 014.C16  C14 TCC  001  C.    0.022* 0.0000000  1.6000053  1.6000053  02
53100 002 015.021  C14 REPT 017  C2C         0.0000000  0.0000000  0.0000000  02
53200 002 014.023  C14 TJC  CCC  J.C5  C.025* 0.0000050  0.0000050  0.0000050  02
53300 002 014.024  C14 TJC  000  J.C6  C.026* 0.0000000  0.0000000  0.0000000  02
53300 002 014.025  C14 TJC  000  J.07  C.027* 0.0000000  0.0000000  0.0000000  02
53300 002 014.026  C14 TJC  000  J.1C  C.C30* 0.0000000  0.0000000  0.0000000  02
53300 002 014.027  C14 TJC  000  J.11  0.031* 0.0000000  0.0000000  0.0000000  02
53300 002 014.C3C  C14 TJC  000  J.12  0.032* 0.0000000  0.0000000  0.0000000  02
53300 002 014.031  C14 TJC  000  J.13  C.C33* 0.0000000  0.0000000  0.0000000  02
53300 002 014.032  C14 TJC  000  J.14  0.034* 0.0000000  0.0000000  0.0000000  02
53300 002 014.033  C14 TJC  000  J.15  0.035* 0.0000000  0.0000000  0.0000000  02
53300 002 014.034  C14 TJC  000  J.16  0.036* 0.0000000  0.0000000  0.0000000  02
53300 002 014.035  C14 TJC  000  J.17  C.037* 0.0000000  0.0000000  0.0000000  02
53300 002 014.C36  C14 TJC  000  J.CC  C.040* 0.2610477  0.2610477  0.2610477  02
53300 002 014.037  C14 TJC  000  J.01  C.041* 0.2004500  0.2004500  0.2004500  02
53300 002 014.04C  C14 TJC  000  J.C2  C.042* 0.0450103  0.0450103  0.0450103  02
53300 002 014.041  C14 TJC  000  J.C3  0.043* 0.5012330  0.5012330  0.5012330  02
53300 002 014.042  C14 TJC  000  J.C4  0.C44* 0.1437714  0.1437714  0.1437714  02
53300 002 014.043  C14 TJC  CC0  J.C5  C.045* 0.0000000  0.0000000  0.0000000  02
53400 002 014.045  C14 JUMP CC0  F.7   C.047* 0.0000000  0.0000000  0.0000000  02
53500 002 014.C4E  C14 BLFO 010  F.C   0.05C* C.0000000  0.0000000  0.0000000  02
53500 002 014.C46  C14 BLFO 010  F.1   C.051* 0.0000000  0.0000000  0.0000000  02
53500 002 014.C46  C14 BLFC 010  F.2   0.052* 0.0000200  0.0000200  0.0000200  02
53500 002 014.C46  C14 BLFO 010  F.3   0.053* 0.0000004  0.0000004  0.0000004  02
53500 002 014.C46  C14 BLFO 010  F.4   C.054* 1.6100456  1.6100456  1.6100456  02
53500 002 014.C46  C14 BLFO 010  F.5   0.055* 0.0200000  0.0200000  0.0200000  02
```

```
          53500   002 014.046   014 BLFC 010   F.6     C.056*  0.0000000   0.0000000   0.0000000   02
          53600   002 014.057   014 JUMP 000                   0.0000000   0.0000000   0.0000000   02
          53700   002 014.060   014 THC  000   H.01    0.061*  0.0000000   0.0000000   0.0000000   02
          53800   002 014.061   014 THC  000   H.02    C.      0.0000000   1.6000053   1.6000053   02
          53900   002 014.062   014 THC  000   H.03    0.063*  0.0000000   0.0000000   0.0000000   02
          54000   002 014.063   014 THC  000   H.04    0.064*  0.0000000   0.0000000   0.0000000   02
          54100   002 014.064   014 THC  000   H.05    C.065*  0.0000000   0.0000000   0.0000000   02
          54200   002 014.065   014 THC  000   H.06    0.066*  0.0000000   0.0000000   0.0000000   02
          54300   002 014.066   014 THC  000   H.07    0.067*  0.0000000   0.0000000   0.0000000   02
          54400   002 014.067   014 JUMP 000                   0.0000000   0.0000000   0.0000000   02
          54500   002 014.070   014 THX  000   H.11    X.      0.0000000   0.0000001   0.0000001   02
          54600   002 014.071   014 THX  000   H.12    X.      0.0000000   0.0000001   0.0000001   02
          54700   002 014.072   014 THX  000   H.13    X.      0.0000000   0.0000001   0.0000001   02
          54800   002 014.073   014 THX  000   H.14    X.      0.0000000   0.0000001   0.0000001   02
          54900   002 014.074   014 THX  000   H.15    X.      0.0000000   0.0000001   0.0000001   02
          55000   002 014.075   014 TBC  000   B.      C.      3.7777777   1.6000053   1.6000053   02
          55100   002 014.076   014 TDC  000   D.      C.      0.0000000   1.6000053   1.6000053   02
          55200   002 014.077   174 TEX  000   E.      X.      1.6000053   0.0000001   0.0000001   02
174.100           174.100
PRECEDENCE CK FOR START OF STEP
174.100           174.100
PRECEDENCE CK FOR END OF STEP
          00000   002 174.100   160 JUMP 053                   0.0000000   0.0000000   0.0000000   77
160.154           160.100
PRECEDENCE CK FOR START OF STEP
160.154           160.100
PRECEDENCE CK FOR END OF STEP
          10300   002 160.154   160 TPK  001   P.124 K.155      0.0000000   0.1610124   0.1610124   02
          10500   002 160.156   160 REPT 007   010             0.0000000   0.0000000   0.0000000   02
          10600   002 160.157   160 TOF  000   0.260*F.0       0.0000000   0.0000000   0.0000000   02
          10600   002 160.160   160 TOF  000   0.261*F.1       0.0000000   0.0000000   0.0000000   02
          10600   002 160.161   160 TOF  000   0.262*F.2       0.0000000   0.0000200   0.0000200   02
          10600   002 160.162   160 TOF  000   0.263*F.3       0.0000000   0.0000004   0.0000004   02
          10600   002 160.163   160 TOF  000   0.264*F.4       0.0000000   1.6100456   1.6100456   02
          10600   002 160.164   160 TOF  000   0.265*F.5       0.0000000   0.0200000   0.0200000   02
          10600   002 160.165   160 TOF  000   0.266*F.6       0.0000000   0.0000000   0.0000000   02
          10600   002 160.166   160 TOF  000   0.267*F.7       0.0000000   0.0000000   0.0000000   02
          10700   002 160.170   160 JUMP 045                   0.0000000   0.0000000   0.0000000   02
          10800   002 160.236   160 REPT 017   020             0.0000000   0.0000000   0.0000000   02
          10900   002 160.237   160 TOJ  000   0.340*J.00      0.0000000   0.2610477   0.2610477   02
          10900   002 160.240   160 TOJ  000   0.341*J.01      0.0000000   0.2004500   0.2004500   02
          10900   002 160.241   160 TOJ  000   0.342*J.02      0.0000000   0.0450103   0.0450103   02
          10900   002 160.242   160 TOJ  000   0.343*J.03      0.0000000   0.5012330   0.5012330   02
          10900   002 160.243   160 TOJ  000   0.344*J.04      0.0000000   0.1437714   0.1437714   02
          10900   002 160.244   160 TOJ  000   0.345*J.05      0.0000000   0.0000050   0.0000050   02
          10900   002 160.245   160 TOJ  000   0.346*J.06      0.0000000   0.0000000   0.0000000   02
          10900   002 160.246   160 TOJ  000   0.347*J.07      0.0000000   0.0000000   0.0000000   02
          10900   002 160.247   160 TOJ  000   0.350*J.10      0.0000000   0.0000000   0.0000000   02
          10900   002 160.250   160 TOJ  000   0.351*J.11      0.0000000   0.0000000   0.0000000   02
          10900   002 160.251   160 TOJ  000   0.352*J.12      0.0000000   0.0000000   0.0000000   02
          10900   002 160.252   160 TOJ  000   0.353*J.13      0.0000000   0.0000000   0.0000000   02
          10900   002 160.253   160 TOJ  000   0.354*J.14      0.0000000   0.0000000   0.0000000   02
          10900   002 160.254   160 TOJ  000   0.355*J.15      0.0000000   0.0000000   0.0000000   02
          10900   002 160.255   160 TOJ  000   0.356*J.16      0.0000000   0.0000000   0.0000000   02
          10900   002 160.256   160 TOJ  000   0.357*J.17      0.0000000   0.0000000   0.0000000   02
          11000   002 160.260   160 JUMP 113                   0.0000000   0.0000000   0.0000000   02
          11300   002 160.374   160 TPK  001   P.135 K.375      0.0000000   0.7550135   0.7550135   02
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11500  002 16C.376  16C TPK   0C1  P.131 K.377  0.0000000  1.3770131  1.3770131  02
11700  002 16C.400  16C TEK   0C1  E.    K.401  0.0000001  1.6000017  1.6000017  02
11900  002 16C.402  16C TPK   0G4  P.132 K.403  0.0000000  0.2600132  0.2600132  02
12100  002 16C.407  16C TPK   0C1  P.136 K.410  0.0000000  0.0000136  0.0000136  02
12300  002 16C.411  C14 JUMP  0C6               0.0000000  0.0000000  0.0000000  02
  14.420
PRECEDENCE CK FCR START CF STEP
  14.420
PRECEDENCE CK FCR END OF STEP
 51700  002 14.420  C14 JUMP  0C0               0.0000000  0.0000000  0.0000000  02
 51800  002 14.421  C14 TCE   0C1  C.022*E.     0.0000000  1.6000017  1.6000017  02
 52000  002 14.423  C14 REPT  017  C20          0.0000000  0.0000000  0.0000000  02
 52100  002 14.424  C14 TCJ   000  C.025*J.05   0.0000000  0.0000050  0.0000050  02
 52100  002 14.425  C14 TCJ   0C0  C.026*J.06   0.0000000  0.0000000  0.0000000  02
 52100  002 14.426  C14 TCJ   0C0  C.027*J.07   0.0000000  0.0000000  0.0000000  02
 52100  002 14.427  C14 TCJ   0C0  C.030*J.10   0.0000000  0.0000000  0.0000000  02
 52100  002 14.43C  C14 TCJ   0C0  C.031*J.11   0.0000000  0.0000000  0.0000000  02
 52100  002 14.431  C14 TCJ   0C0  C.032*J.12   0.0000000  0.0000000  0.0000000  02
 52100  002 14.432  C14 TCJ   0C0  C.033*J.13   0.0000000  0.0000000  0.0000000  02
 52100  002 14.433  C14 TCJ   CCC  C.034*J.14   0.0000000  0.0000000  0.0000000  02
 52100  002 14.434  C14 TCJ   0C0  C.035*J.15   0.0000000  0.0000000  0.0000000  02
 52100  002 14.435  C14 TCJ   0C0  C.036*J.16   0.0000000  0.0000000  0.0000000  02
 52100  002 14.436  C14 TCJ   0C0  C.037*J.17   0.0000000  0.0000000  0.0000000  02
 52100  002 14.437  C14 TCJ   CCC  C.040*J.00   0.0000000  0.2610477  0.2610477  02
 52100  002 14.44C  C14 TCJ   0C0  C.041*J.01   0.0000000  0.2004500  0.2004500  02
 52100  002 14.441  C14 TCJ   0C0  C.042*J.02   0.0000000  0.0450103  0.0450103  02
 52100  002 14.442  C14 TCJ   CCC  C.043*J.03   0.0000000  0.5012330  0.5012330  02
 52100  002 14.443  C14 TCJ   0C0  C.044*J.04   0.0000000  0.1437714  0.1437714  02
 52200  002 14.445  C14 REPT  0C7  C1C          0.0000000  0.0000000  0.0000000  02
 52300  002 14.446  C14 TCF   CCC  C.047*F.7    0.0000000  0.0000000  0.0000000  02
 52300  002 14.447  C14 TCF   0C0  C.050*F.0    0.0000000  0.0000000  0.0000000  02
 52300  002 14.45C  C14 TCF   0C0  C.051*F.1    0.0000000  0.0000000  0.0000000  02
 52300  002 14.451  C14 TCF   0C0  C.052*F.2    0.0000000  0.0000200  0.0000200  02
 52300  002 14.452  C14 TCF   0C0  C.053*F.3    0.0000000  0.0000004  0.0000004  02
 52300  002 14.453  C14 TCF   0C0  C.054*F.4    0.0000000  1.6100456  1.6100456  02
 52300  002 14.454  C14 TCF   CCC  C.055*F.5    0.0000000  0.0200000  0.0200000  02
 52300  002 14.455  C14 TCF   0C0  C.056*F.6    0.0000000  0.0000000  0.0000000  02
 52400  002 14.457  C14 REPT  0C6  C07          0.0000000  0.0000000  0.0000000  02
 52500  002 14.46C  C14 TCH   0C0  C.061*H.01   0.0000000  0.0000000  0.0000000  02
 52500  002 14.461  C14 TCH   0C0  C.062*H.02   0.0000000  1.6000053  1.6000053  02
 52500  002 14.462  C14 TCH   0C0  C.063*H.03   0.0000000  0.0000000  0.0000000  02
 52500  002 14.463  C14 TCH   0C0  C.064*H.04   0.0000000  0.0000000  0.0000000  02
 52500  002 14.464  C14 TCH   0C0  C.065*H.05   0.0000000  0.0000000  0.0000000  02
 52500  002 14.465  C14 TCH   0C0  C.066*H.06   0.0000000  0.0000000  0.0000000  02
 52500  002 14.466  C14 TCF   0C0  C.067*H.07   0.0000000  0.0000000  0.0000000  02
 52600  002 14.470  C14 JUMP  0C1               0.0000000  0.0000000  0.0000000  02
 52700  002 14.472  C14 REPT  020  021          0.0000000  0.0000000  0.0000000  02
 52800  002 14.473  C14 TGX   0C0  G.14  X.     0.0000001  0.0000001  0.0000001  02
 52800  002 14.474  C14 TGX   0C0  G.15  X.     0.0000001  0.0000001  0.0000001  02
 52800  002 14.475  C14 TGX   0C0  G.16  X.     0.0000001  0.0000001  0.0000001  02
 52800  002 14.476  C14 TGX   0C0  G.17  X.     0.0000001  0.0000001  0.0000001  02
 52800  003 14.477  C14 TGX   0C0  G.CC  X.     0.0000001  0.0000001  0.0000001  02
 52800  003 14.COC  C14 TGX   0C0  G.01  X.     0.0000001  0.0000001  0.0000001  02
 52800  003 14.CC1  C14 TGX   0C0  G.C2  X.     0.0000001  0.0000001  0.0000001  02
 52800  003 14.CC2  C14 TGX   0C0  G.03  X.     0.0000001  0.0000001  0.0000001  02
 52800  003 14.CC3  C14 TGX   0C0  G.C4  X.     0.0000001  0.0000001  0.0000001  02
 52800  003 14.CC4  C14 TGX   0C0  G.C5  X.     0.0000001  0.0000001  0.0000001  02
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52800   003 014.C05   C14 TGX  0C0   G.C6   X.      0.0000001   0.0000001   0.0000001   02
52900   003 014.C06   C14 TGX  0C0   G.C7   X.      0.0000001   0.0000001   0.0000001   02
52800   003 014.C07   C14 TGX  0C0   G.1C   X.      0.0000001   0.0000001   0.0000001   02
52800   003 014.C1C   C14 TGX  0C0   G.11   X.      0.0000001   0.0000001   0.0000001   02
52800   003 014.C11   C14 TGX  0C0   G.12   X.      0.0000001   0.0000001   0.0000001   02
52800   003 014.C12   C14 TGX  0C0   G.13   X.      0.0000001   0.0000001   0.0000001   02
52800   003 014.C13   C14 TGX  0C0   G.14   X.      0.0000001   0.0000001   0.0000001   02
52900   003 014.C15   C14 THX  0C0   H.16   X.      0.0000001   0.0000001   0.0000001   02
53000   003 014.C16   C15 THX  0C2   H.17   X.      0.0000001   0.0000001   0.0000001   02
53100   003 015.C21   C14 TCC  0C1   C.     C.C22*  1.6000053   1.6000017   1.6000017   02
53200   003 014.C23   C14 REPT 017   C2C             0.0000000   0.0000000   0.0000000   02
53300   003 014.C24   C14 TJC  0C0   J.C5   0.025*  0.0000050   0.0000050   0.0000050   02
53300   003 014.C25   C14 TJC  0C0   J.C6   C.C26*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C26   C14 TJC  0C0   J.C7   0.027*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C27   C14 TJC  0C0   J.1C   0.030*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C3C   C14 TJC  0C0   J.11   C.C31*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C31   C14 TJC  0C0   J.12   0.032*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C32   C14 TJC  0C0   J.13   C.033*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C33   C14 TJC  0C0   J.14   C.034*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C34   C14 TJC  0C0   J.15   0.035*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C35   C14 TJC  0C0   J.16   0.036*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C36   C14 TJC  0C0   J.17   0.037*  0.0000000   0.0000000   0.0000000   02
53300   003 014.C37   C14 TJC  0C0   J.CC   0.040*  0.2610477   0.2610477   0.2610477   02
53300   003 014.C4C   C14 TJC  0C0   J.C1   0.041*  0.2004500   0.2004500   0.2004500   02
53300   003 014.C41   C14 TJC  0C0   J.C2   0.042*  0.0450103   0.0450103   0.0450103   02
53300   003 014.C42   C14 TJC  0C0   J.C3   0.043*  0.5012330   0.5012330   0.5012330   02
53300   003 014.C43   C14 TJC  0C0   J.C4   0.044*  0.1437714   0.1437714   0.1437714   02
53400   003 014.C45   C14 JUMP 0C0                   0.0000000   0.0000000   0.0000000   02
53500   003 014.C46   C14 BLFC 010   F.7    0.047*  0.0000000   0.0000000   0.0000000   02
53500   003 014.C4E   C14 BLFC 010   F.C    0.050*  0.0000000   0.0000000   0.0000000   02
53500   003 014.C4E   C14 BLFC 010   F.1    0.051*  0.0000000   0.0000000   0.0000000   02
53500   003 014.C46   C14 BLFC 010   F.2    0.052*  0.0000200   0.0000200   0.0000200   02
53500   003 014.C4E   C14 BLFC 010   F.3    0.053*  0.0000004   0.0000004   0.0000004   02
53500   003 014.C4E   C14 BLFC 010   F.4    0.054*  1.6100456   1.6100456   1.6100456   02
53500   003 014.C46   C14 BLFC 010   F.5    C.055*  0.0200000   0.0200000   0.0200000   02
53500   003 014.C4E   C14 BLFC 010   F.6    C.056*  0.0000000   0.0000000   0.0000000   02
53600   003 014.C57   C14 JUMP 0CC                   0.0000000   0.0000000   0.0000000   02
53700   003 014.C6C   C14 THC  0C0   H.C1   C.061*  0.0000000   0.0000000   0.0000000   02
53800   003 014.C61   C14 THC  0C0   H.C2   C.      1.6000053   1.6000017   1.6000017   02
53900   003 014.C62   C14 THC  0C0   H.03   C.063*  0.0000000   0.0000000   0.0000000   02
54000   003 014.C63   C14 THC  0C0   H.C4   0.064*  0.0000000   0.0000000   0.0000000   02
54100   003 014.C64   C14 THC  0C0   H.C5   C.065*  0.0000000   0.0000000   0.0000000   02
54200   003 014.C65   C14 THC  0C0   H.C6   0.066*  0.0000000   0.0000000   0.0000000   02
54300   003 014.C66   C14 THC  0C0   H.C7   0.067*  0.0000000   0.0000000   0.0000000   02
54400   003 014.C67   C14 JUMP 0C0                   0.0000000   0.0000000   0.0000000   02
54500   003 014.C7C   C14 THX  0C0   H.11   X.      0.0000001   0.0000001   0.0000001   02
54600   003 014.C71   C14 THX  0C0   H.12   X.      0.0000001   0.0000001   0.0000001   02
54700   003 014.C72   C14 THX  0C0   H.13   X.      0.0000001   0.0000001   0.0000001   02
54800   003 014.C73   C14 THX  0C0   H.14   X.      0.0000001   0.0000001   0.0000001   02
54900   003 014.C74   C14 THX  0C0   H.15   X.      0.0000001   0.0000001   0.0000001   02
55000   003 014.C75   C14 TBC  0C0   B.     C.      3.7777777   1.6000017   1.6000017   02
55100   003 014.C76   C14 TDC  0C0   D.     C.      1.6000053   1.6000017   1.6000017   02
55200   003 014.C77   174 TEX  0C0   E.     X.      1.6000017   0.0000001   0.0000001   02
174.100          174.100
PRECEDENCE CK FOR START OF STEP
174.100          174.100
PRECEDENCE CK FOR END OF STEP
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          00000    003 174.100    160 JUMP  017                    0.0000000   0.0000000   0.0000000   77
160.120            160.100
PRECEDENCE CK FOR START OF STEP
160.120            160.100
PRECEDENCE CK FOR END OF STEP
          12500    003 160.120    160 XTRP  010   K.123  P.012     0.4000000   0.0000000   0.0000000   02
          13100    003 160.131    160 TPK   001   P.136  K.132     0.0000000   1.0000136   1.0000136   02
          13300    004 160.133    160 JUMP  434                    0.0000000   0.0000000   0.0000000   02
          13400    004 160.070    160 XTRP  004   K.073  P.010     0.0001000   0.0000000   0.0000000   02
          13800    004 160.075    160 TSK   003   S.     K.076     0.0000000   1.7400000   1.7400000   02
          14200    004 160.101    160 JUMP  077                    0.0000000   0.0000000   0.0000000   02
          14300    004 160.201    160 TDK   005   D.     K.202     1.6000017   1.5000000   1.5000000   02
          14700    004 160.207    160 BLJK  017   J.10   K.210     0.0000000   0.0000006   0.0000006   02
          14700    004 160.207    160 BLJK  017   J.11   K.211     0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017   J.12   K.212     0.0000000   1.6100307   1.6100307   02
          14700    004 160.207    160 BLJK  017   J.13   K.213     0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017   J.14   K.214     0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017   J.15   K.215     0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017   J.16   K.216     0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017   J.17   K.217     0.0000000   0.0000010   0.0000010   02
          14700    004 160.207    160 BLJK  017   J.00   K.220     0.2610477   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017   J.01   K.221     0.2004500   1.4000000   1.4000000   02
          14700    004 160.207    160 BLJK  017   J.02   K.222     0.0450103   0.0000002   0.0000002   02
          14700    004 160.207    160 BLJK  017   J.03   K.223     0.5012330   1.6030114   1.6030114   02
          14700    004 160.207    160 BLJK  017   J.04   K.224     0.1437714   1.6273000   1.6273000   02
          14700    004 160.207    160 BLJK  017   J.05   K.225     0.0000050   0.0000000   0.0000000   02  ERR   41 00 00 00
          14700    004 160.207    160 BLJK  017   J.06   K.226     0.0000000   0.0000000   0.0000000   02
          15400    004 160.227    161 BLFK  010   F.0    K.230     0.0000000   1.7573161   1.7573161   02
          15400    004 160.227    161 BLFK  010   F.1    K.231     0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          15400    004 160.227    161 BLFK  010   F.2    K.232     0.0000200   1.7727061   1.7727061   02
          15400    004 160.227    161 BLFK  010   F.3    K.233     0.0000004   0.0000000   0.0000000   02  ERR   41 00 00 00
          15400    004 160.227    161 BLFK  010   F.4    K.234     1.6100456   1.6050437   1.6050437   02
          15400    004 160.227    161 BLFK  010   F.5    K.235     0.0200000   1.7400001   1.7400001   02
          15400    004 160.227    161 BLFK  010   F.6    K.236     0.0000000   1.7552161   1.7552161   02
          15400    004 160.227    161 BLFK  010   F.7    K.237     0.0000000   0.0000000   0.0000000   02  ERR   41 00 00 00
          16000    004 161.240    160 TFD   000   F.1    D.        0.0000000   1.5000000   1.5000000   02
          16050    004 160.241    160 JUMP  020                    0.0000000   0.0000000   0.0000000   02
          16100    004 160.262    160 TBC   000   B.     0.263*    0.0000000   0.0000004   0.0000004   02
          16200    004 160.263    160 ABX   002   B.     X.        0.0000004   0.0000001   0.0000005   02
          16300    004 160.266    160 READ  015   E.     K.300     0.0000005   0.0000000   1.6044077   02
          17600    004 160.304    160 XTRE  001   K.305  E.        1.7600777   1.6044077   1.6000077   02
          17800    004 160.306    160 TJB   000   J.07   B.        0.0000000   1.6000077   1.6000077   02
          17900    004 160.307    160 SEB   000   E.     B.        1.6044077   1.6000077   0.0044000   02
          18000    004 160.310    160 TSF   000   S.     F.1       0.0000000   1.5000000   1.5000000   02
          18030    004 160.311    160 TDZ   000   D.     Z.        1.5000000   0.0000000   0.0000000   02
          18070    004 160.312    160 TBE   000   B.     E.        1.6000077   0.0044000   0.0044000   02
          18100    004 160.313    160 RGHT  010   B.               0.0044000   0.0000011   0.0000044   02
          18400    004 160.324    160 TJB   006   J.05   B.        0.0000000   0.0000044   0.0000044   02
          18500    004 160.333    175 TCF   001   C.     F.4       1.6000017   1.6050437   1.6050437   02
          00000    004 175.335    174 JUMP  001                    0.0000000   0.0000000   0.0000000   77
          00000    004 174.337    160 TBC   017   B.     0.340*    0.0000044   0.2610477   0.2610477   77
          19100    004 160.357    160 JUMP  012                    0.0000000   0.0000000   0.0000000   02
          19200    004 160.372    160 TFB   000   F.3    B.        0.0000000   0.2610477   0.2610477   02
          19300    004 160.373    161 TEK   003   E.     K.374     0.0044000   1.6100000   1.6100000   02
          19500    004 161.377    161 TJD   014   J.00   D.        0.0000000   0.0000000   0.0000000   02
          19550    004 161.414    014 JUMP  003                    0.0000000   0.0000000   0.0000000   02
14.420             14.400
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PRECEDENCE CK FOR START OF STEP
 14.420          14.400
PRECEDENCE CK FOR END OF STEP
          51700   004 014.420   014 JUMP  000                    0.0000000   0.0000000   0.0000000   02
          51800   004 014.421   014 TGE   001   C.C22*E.         0.0000000   1.6100000   1.6100000   02
          52000   004 014.423   014 REPT  017   020              0.0000000   0.0000000   0.0000000   02
          52100   004 014.424   014 TGJ   000   G.C25*J.05       0.0000000   0.0000044   0.0000044   02
          52100   004 014.425   014 TGJ   000   G.C26*J.06       0.0000000   0.0000000   0.0000000   02
          52100   004 014.426   014 TGJ   000   G.C27*J.07       0.0000000   1.6000077   1.6000077   02
          52100   004 014.427   014 TGJ   000   G.C30*J.10       0.0000000   0.0000006   0.0000006   02
          52100   004 014.430   014 TGJ   000   G.C31*J.11       0.0000000   0.0000000   0.0000000   02
          52100   004 014.431   014 TGJ   000   G.C32*J.12       0.0000000   1.6100307   1.6100307   02
          52100   004 014.432   014 TGJ   000   G.C33*J.13       0.0000000   0.0000000   0.0000000   02
          52100   004 014.433   014 TGJ   000   G.C34*J.14       0.0000000   0.0000000   0.0000000   02
          52100   004 014.434   014 TGJ   000   G.C35*J.15       0.0000000   0.0000000   0.0000000   02
          52100   004 014.435   014 TGJ   000   G.C36*J.16       0.0000000   0.0000000   0.0000000   02
          52100   004 014.436   014 TGJ   000   G.C37*J.17       0.0000000   0.0000010   0.0000010   02
          52100   004 014.437   014 TGJ   000   G.C40*J.00       0.0000000   0.0000000   0.0000000   02
          52100   004 014.440   014 TGJ   000   G.C41*J.01       0.0000000   1.4000000   1.4000000   02
          52100   004 014.441   014 TGJ   000   G.C42*J.02       0.0000000   0.0000002   0.0000002   02
          52100   004 014.442   014 TGJ   000   G.C43*J.03       0.0000000   1.6030114   1.6030114   02
          52100   004 014.443   014 TGJ   000   G.C44*J.04       0.0000000   1.6273000   1.6273000   02
          52200   004 014.445   014 REPT  007   010              0.0000000   0.0000000   0.0000000   02
          52300   004 014.446   014 TGF   000   G.C47*F.7        0.0000000   0.0000000   0.0000000   02
          52300   004 014.447   014 TGF   000   G.C50*F.0        0.0000000   1.7573161   1.7573161   02
          52300   004 014.450   014 TGF   000   G.C51*F.1        0.0000000   1.5000000   1.5000000   02
          52300   004 014.451   014 TGF   000   G.C52*F.2        0.0000000   1.7727061   1.7727061   02
          52300   004 014.452   014 TGF   000   G.C53*F.3        0.0000000   0.2610477   0.2610477   02
          52300   004 014.453   014 TGF   000   G.C54*F.4        0.0000000   1.6050437   1.6050437   02
          52300   004 014.454   014 TGF   000   G.C55*F.5        0.0000000   1.7400001   1.7400001   02
          52300   004 014.455   014 TGF   000   G.C56*F.6        0.0000000   1.7552161   1.7552161   02
          52400   004 014.457   014 REPT  006   007              0.0000000   0.0000000   0.0000000   02
          52500   004 014.460   014 TGH   000   G.C61*H.01       0.0000000   0.0000000   0.0000000   02
          52500   004 014.461   014 TGH   000   G.C62*H.02       0.0000000   1.6000017   1.6000017   02
          52500   004 014.462   014 TGH   000   G.C63*H.03       0.0000000   0.0000000   0.0000000   02
          52500   004 014.463   014 TGH   000   G.C64*H.04       0.0000000   0.0000000   0.0000000   02
          52500   004 014.464   014 TGH   000   G.C65*H.05       0.0000000   0.0000000   0.0000000   02
          52500   004 014.465   014 TGH   000   G.C66*H.06       0.0000000   0.0000000   0.0000000   02
          52500   004 014.466   014 TGH   000   G.C67*H.07       0.0000000   0.0000000   0.0000000   02
          52600   004 014.470   014 JUMP  001                    0.0000000   0.0000000   0.0000000   02
          52700   004 014.472   014 REPT  020   021              0.0000000   0.0000000   0.0000000   02
          52800   004 014.473   014 TGX   000   G.14  X.         0.0000001   0.0000001   0.0000001   02
          52800   004 014.474   014 TGX   000   G.15  X.         0.0000001   0.0000001   0.0000001   02
          52800   004 014.475   014 TGX   000   G.16  X.         0.0000001   0.0000001   0.0000001   02
          52800   004 014.476   014 TGX   000   G.17  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.477   014 TGX   000   G.00  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.000   014 TGX   000   G.01  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.001   014 TGX   000   G.02  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.002   014 TGX   000   G.03  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.003   014 TGX   000   G.04  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.004   014 TGX   000   G.05  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.005   014 TGX   000   G.06  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.006   014 TGX   000   G.07  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.007   014 TGX   000   G.10  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.010   014 TGX   000   G.11  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.011   014 TGX   000   G.12  X.         0.0000001   0.0000001   0.0000001   02
          52800   005 014.012   014 TGX   000   G.13  X.         0.0000001   0.0000001   0.0000001   02
```

```
          52800   005 014.C13   C14 TGX  CCC   G.14  X.      0.0000001  0.0000001  0.0000001   02
          52900   005 014.C15   C14 THX  CC0   H.16  X.      0.0000001  0.0000001  0.0000001   02
          53000   005 014.C16   C15 THX  0C2   H.17  X.      0.0000001  0.0000001  0.0000001   02
          53100   005 015.C21   014 TCC  0C1   C.    0.022*  1.6050437  1.6100000  1.6100000   02
          53200   005 014.C23   014 REPT C17   020           0.0000000  0.0000000  0.0000000   02
          53300   005 014.C24   014 TJC  000   J.05  0.025*  0.0000044  0.0000044  0.0000044   02
          53300   005 014.C25   014 TJC  CC0   J.06  0.026*  0.0000000  0.0000000  0.0000000   02
          53300   005 014.C26   014 TJC  CCC   J.07  0.027*  1.6000077  1.6000077  1.6000077   02
          53300   005 014.C27   C14 TJC  0C0   J.10  0.030*  0.0000006  0.0000006  0.0000006   02
          53300   005 014.C30   014 TJC  CC0   J.11  0.031*  0.0000000  0.0000000  0.0000000   02
          53300   005 014.C31   014 TJC  CC0   J.12  0.032*  1.6100307  1.6100307  1.6100307   02
          53300   005 014.C32   C14 TJC  000   J.13  0.033*  0.0000000  0.0000000  0.0000000   02
          53300   005 014.C33   C14 TJC  CCC   J.14  0.034*  0.0000000  0.0000000  0.0000000   02
          53300   005 014.C34   014 TJC  CC0   J.15  0.035*  0.0000000  0.0000000  0.0000000   02
          53300   005 014.C35   014 TJC  CC0   J.16  0.036*  0.0000000  0.0000000  0.0000000   02
          53300   005 014.C36   C14 TJC  0C0   J.17  0.037*  0.0000010  0.0000010  0.0000010   02
          53300   005 014.C37   014 TJC  CCC   J.CC  0.040*  0.0000000  0.0000000  0.0000000   02
          53300   005 014.C4C   014 TJC  CC0   J.C1  0.041*  1.4000000  1.4000000  1.4000000   02
          53300   005 014.C41   C14 TJC  0C0   J.C2  0.042*  0.0000002  0.0000002  0.0000002   02
          53300   005 014.C42   014 TJC  CC0   J.C3  0.043*  1.6030114  1.6030114  1.6030114   02
          53300   005 014.C43   C14 TJC  C00   J.C4  0.044*  1.6273000  1.6273000  1.6273000   02
          53400   005 014.C45   C14 JUMP CC0                 0.0000000  0.0000000  0.0000000   02
          53500   005 014.C46   C14 BLFC C10   F.7   0.047*  0.0000000  0.0000000  0.0000000   02
          53500   005 014.C46   C14 BLFC 010   F.0   0.050*  1.7573161  1.7573161  1.7573161   02
          53500   005 014.C46   C14 BLFC 010   F.1   0.051*  1.5000000  1.5000000  1.5000000   02
          53500   005 014.C46   C14 BLFC C10   F.2   0.052*  1.7727061  1.7727061  1.7727061   02
          53500   005 014.C46   C14 BLFC C10   F.3   0.053*  0.2610477  0.2610477  0.2610477   02
          53500   005 014.C46   C14 BLFC 010   F.4   0.054*  1.6050437  1.6050437  1.6050437   02
          53500   005 014.C46   C14 BLFC 010   F.5   0.055*  1.7400001  1.7400001  1.7400001   02
          53500   005 014.C46   C14 BLFC C10   F.6   0.056*  1.7552161  1.7552161  1.7552161   02
          53600   005 014.C57   C14 JUMP 000                 0.0000000  0.0000000  0.0000000   02
          53700   005 014.C6C   G14 THC  CCC   H.C1  0.061*  0.0000000  0.0000000  0.0000000   02
          53800   005 014.C61   014 THC  CC0   H.C2  C.      1.6000017  1.6100000  1.6100000   02
          53900   005 014.C62   C14 THC  0C0   H.C3  0.063*  0.0000000  0.0000000  0.0000000   02
          54000   005 014.C63   C14 THC  CCC   H.C4  0.064*  0.0000000  0.0000000  0.0000000   02
          54100   005 014.C64   014 THC  CC0   H.C5  0.065*  0.0000000  0.0000000  0.0000000   02
          54200   005 014.C65   C14 THC  0C0   H.C6  0.066*  0.0000000  0.0000000  0.0000000   02
          54300   005 014.C66   C14 THC  CC0   H.C7  0.067*  0.0000000  0.0000000  0.0000000   02
          54400   005 014.C67   C14 JUMP CC0                 0.0000000  0.0000000  0.0000000   02
          54500   005 014.C7C   014 THX  CC0   H.11  X.      0.0000001  0.0000001  0.0000001   02
          54600   005 014.C71   C14 THX  000   H.12  X.      0.0000001  0.0000001  0.0000001   02
          54700   005 014.C72   014 THX  CC0   H.13  X.      0.0000001  0.0000001  0.0000001   02
          54800   005 014.C73   C14 THX  CCC   H.14  X.      0.0000001  0.0000001  0.0000001   02
          54900   005 014.C74   C14 THX  CC0   H.15  X.      0.0000001  0.0000001  0.0000001   02
          55000   005 014.C75   C14 TBC  CC0   B.    C.      3.7777777  1.6100000  1.6100000   02
          55100   005 014.C76   C14 TDC  000   D.    C.      0.0000000  1.6100000  1.6100000   02
          55200   005 014.C77   174 TEX  CC0   E.    X.      1.6100000  0.0000001  0.0000001   02
174.100           174.100
PRECEDENCE CK FOR START OF STEP
174.100           174.100
PRECEDENCE CK FOR END OF STEP
          00000   005 174.100   161 JUMP CC0                 0.0000000  0.0000000  0.0000000   77
161.101           161.100
ERROR NUMBER   4
```

H. COMPUTER RUN WITH INCONSISTENT PRECEDENCE MATRIX

A run was made with a flow diagram precedence matrix which contained an inconsistency. The precedence matrix was the following:

MATRIX

		COLUMN						
		1	2	3	4	5	6	7
	1	0	1	0	0	0	0	0
	2	0	0	1	0	0	0	0
	3	0	0	0	1	1	1	0
ROW	4	0	-1	0	0	0	0	0
	5	0	-1	0	0	0	0	0
	6	0	0	0	0	0	0	1
	7	0	0	0	0	0	1	0

The matrix specifies that step 6 must precede step 7 and that step 7 must precede step 6. This is an inconsistency or a loop. At the point in the program at which the consistency of the precedence matrix was checked, the diagnostic, "INCONSISTENT MATRIX," and the arrays, MATRIX and KWUNS, were written. The run is listed on the following page.

```
ENTRY POINTS TC SUBRCUTINES REQUESTED FROM LIBRARY,
     (FPT)       EXIT        (TSHM)      (RTN)       (STHM)      (FIL)       DUMP

  PREPRCCESSING TIME = 000.35 MIN.

        EXECUTICN
   7
        0000009166111        000000014420        000000174100        000000160154
        0000000160120        000000161101        000000176157
        0000000166111        000000014420        000000174100        000000160154
        0000000160120        000000161101        000000176157
0 0 0 0 0 0 0 1 0 0-1-1 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0
0 1 0 0 0 0 0 1 0


0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0

0-0-0-0-0-0-0-0-0
        0000000000000        000000000000        000000000000        000000000000
        0000000000000        000000000000
        0000000000000        000000000000        000000000000        000000000000
        0000000000000        000000000000        000000000000
 1
INCCNSISTENT MATRIX
0 0 0 0 0 0 0 0 0 0 0-1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 1 0
  0   0   0   0   0   1   1
```

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5. AUTHOR(S) (Last name, first name, initial)

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Huebner, Walter J.

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Research conducted in support of Project 8119, which is directed by the Support Techniques Br, A.F. Aero Propulsion Lab.	Aerospace Medical Research Laboratories Wright-Patterson Air Force Base, Ohio

13. ABSTRACT One of the two objectives of this project was the development of error control techniques for the man-computer interface of an automatic checkout system. To minimize human error in man-computer communication in the automatic checkout complex, precedence and connection matrix techniques for use with total and partial simulation methods were developed to detect errors in operational automatic checkout computer programs. Precedence and connection matrix techniques for use with total simulation methods were incorporated into a simulation computer program which comprised a total simulation of the computer which controls an operational automatic checkout system. The modified simulation was then used to process several computer runs of an operational automatic checkout computer program. The basic conclusions drawn from the results of the study of error control methods were that precedence and connection matrix techniques used with total and partial simulation methods can be useful in detecting errors in operational computer-controlled automatic checkout systems, and that further study and development should be made to allow incorporation of the techniques in present and future computer-controlled automatic checkout systems with minimum modification.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Equipment, Simulation Automatic Check-Out Computer Program, Error Detection Human Engineering Simulation, Automatic Check-Out Equipment						

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