AN ABSTRACT OF THE THESIS OF

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This paper addresses the order-picking problem in a warehouse and establishes some criteria for the planning, design, and improvement of a warehouse layout to increase the order-picking efficiency. A simulation model has been developed to study the effect of warehouse layout on the order-picking throughput. Three major design elements of the warehouse layout are considered: crossing aisles, picking aisles orientation, and dock location. The system throughput is measured in terms of the traveling and waiting time of the picking vehicles. The results indicate that the order-picking efficiency can be substantially improved by orienting the picking aisles parallel to the dock, placing or locating the crossing aisles parallel to the dock and by locating the dock on the longitudinal side of the warehouse.

The Effect of Warehouse Layout on Order-picking Efficiency

by

Youssef S. Ben-Mahmud

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Professor of Industrial Engineering in charge of major

Redacted for Privacy

Head of department of Industrial Engineering

Redacted for Privacy
Dean of Graduate School

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DEDICATION

This Thesis

is dedicated in memory of

my brother,

MAHMUD S. MAHMUD

for his care, understanding, encouragement,

and support.

He is to be admired for his strength, endurance, positive attitude, hard work, and intelligence.

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THE EFFECT OF WAREHOUSE LAYOUT ON ORDER-PICKING EFFICIENCY

I. INTRODUCTION

Order-picking is defined as the warehouse activity of performing picking tours throughout the aisles, retrieving the ordered items from their storage locations, and delivering them to the dock. The order-picking process is varied in the way in which it can be performed. A common way is that the operator is scheduled to pick all items of a complete order in one tour. The tour starts from the dock, the operator receives the picking-order ticket, picks the items and ends at the dock for unloading the items of a completed order. This method of order-picking is referred to as "complete orderpicking". In another method, known as "Zone/Batch order-picking," the warehouse is divided into picking zones and the picking orders are batched according to the location of the items in the picking zones. In this method the operator is scheduled to pick all items of multi-orders in a batch located in a picking zone. This method is especially used when different types of material handling equipment are required for items of various sizes, shapes or weights, and/or when the same items are repeated in different picking orders. Α third method is called "pick-and-back" or "out-and-back." This method is mainly applicable in the automated storage and retrieval The crane retrieves a single item or load at a time. systems. In operations, picking is done by the operators most order-picking walking or riding vehicles or carts. The type and capacity of the

vehicles or carts are varied depending on the items' size, shape, weight and the number of items per order.

The assignment of items to storage locations is also accomplished in a variety of ways. One well-known approach is referred to as "the "activity or popularity approach." The items are assigned to the storage locations based on their turnover frequency or activity Items with a higher activity rate are located in storage rate. locations closer to the dock. The advantage of this method is to minimize the traveling distances for order-picking. But a traffic congestion problem can be expected to be created in the active aisles, especially when the number of picking vehicles increases. Another method is called the "random or equally likely approach." In this method the items are randomly assigned to the storage locations. this approach is expected to minimize the congestion problem of the order pickers by "equally likely" distributing the active items throughout the picking aisles. On the other hand, the traveling distances are expected to increase when this method is used. A third method is used by grouping together the items which are complementary based on their function or use and which have a very high chance of being ordered together within an order. Each group is located in a picking zone in the warehouse and zone order-picking is used. This method is expected to minimize the traveling distances.

The order-picking list usually indicates the item number, location and quantity. Items are listed according to their picking sequence. A common method used to determine the picking sequence of items is referred to as the "nearest-neighbor" method. The first item on the list is in the nearest location to the dock followed by the item which is closest to the first item, and so on. Another method that has recently been applied with the use of the computer is to generate the order-picking list and optimize the items sequence for picking by utilizing the "shortest route" or "traveling salesman" technique to minimize the traveling distance.

Warehouse layout has an effect on the order-picking process. If the various functions in the warehouse are not properly relatively located, considerable travling may be required to perform the picking process. There are three major function elements for the warehouse layout. $\overset{\cup}{\mathsf{F}}$ First, the crossing aisles are usually wide enough to permit two-way traffic. They are used to connect the picking aisles and to facilitate the vehicles' movement. The crossing aisles are also used for waiting in front of the picking aisles to prevent the traffic congestion problem from occurriung within the picking aisles. Second, the picking aisles normally are narrow and permit only oneway traffic. They are used for access to the items in their storage locations and for picking and replenishment operations. The picking aisles are usually arranged in either parallel or perpendicular order Third, the dock in the warehouse is considered to be to the dock. the central or focal point where each picking process starts and ends. The dock is also used for orders accumulation and for shipping and receiving goods. Normally the dock is located adjacent to one of the walls of the warehouse building that is close to the receiving and shipping doors.

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The order-picking cost represents the major part of the warehouse overall operating cost and is recognized as an area in which a great savings can be accomplished by increasing the orderpicking efficiency and thereby improving the system performance. There has been much work and a great deal of research done to improve the efficiency of order-picking in the warehouse. Areas such as warehouse automation and product layout have been considered in the search for cost reduction. Although the automated storage system has revolutionized the conventional storage methods, it is not necessarily or always the answer to go from an inefficient conventional system to a sophisticated automatic one. In many cases, it is not justifiable to implement an automated system due to the small capacity and low volume of storage activity relative to the high cost of the automated storage system.

Another important and challenging area has an impact on the order-picking process and is less costly to improve and implement. This is the physical-layout design of the warehouse, and it deals with the relative locations of the various functions contained in the warehouse. Unfortunately, this area has not received enough attention and only a very little literature on this subject is available. All of the research which has been done tries to optimize the system by developing mathematical models rather than analyzing the system's operation and performance under various conditions to study the interaction effect of certain factors and thereby objectively arrive at a satisfactory conclusion.

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The focus of this study is to improve the physical design of the warehouse layout in order to increase the efficiency of the orderpicking process. The function elements of the layout to be considered include the dock location relative to the warehouse building, the picking aisles orientation in relation to the dock location. and the presence of the crossing aisles. The study will be done by developing a simulation model which represents the system's operational characteristics. Through the use of a simulation technique as a tool, an insight into the system is provided which can yield data as to how variables interact, which enables the study of the effects of the considered factors on the system's operation and performance. The system performance is measured in terms of the picking vehicles' traveling and waiting time, which reflect the traveling distance and the traffic congestion of the order-picking operation.

The resulting savings in the vehicle travel and waiting time are of greatest interest to the user, designer and planner of such systems because the traveling and waiting time represent the major part of the picking process and directly effect the order-picking efficiency. This reduction in traveling and waiting time would mean an increase in the productivity of the system and thereby decrease the warehouse operating cost. The savings can be used either in the planning and design of new systems or modification and improvement of the existing ones. Therefore, it is worthwhile to examine this area for further improvement.

II. PROBLEM ANALYSIS

Literature Review

A great deal of research has been done in the area of warehousing and layout, but it seems that no computer simulation assisted study has been developed to analyze the order-picking process in a conventional warehouse. Most of the literature in the field uses some of the traditional mathematical-solution techniques to study some of the factors effecting the warehouse layout. The use of mathematical models is limited to a particular situation or to a narrow area, however, the common objective of the mathematical models is to optimize the system rather than analyze the system's operation and performance under various conditions and to study the interaction effect of certain factors and thereby objectively arrive at a satisfactory conclusion.

Francis (1967) studied some problems of rectangular warehouse design and layout. In his article, he studied the problem related to finding a warehouse layout and design that would minimize the total cost of item movement between the facilities which are the items' storage locations and a known point which is considered to be the dock location.

Francis developed two mathematical models which consider the cost of item movement within the warehouse and the costs due to the warehouse perimeter. He assumed that the warehouse has one dock, and that items with different turnover frequencies are equally likely moved between the dock and storage locations. All item movement is

assumed to be of direct back and forth nature between the storage locations and the dock. Then as he concluded:

A particular type of warehouse layout, called an ordered rectangular layout, is defined, and an ordered rectangular layout is obtained which minimizes the total cost of item movement over all such possible layouts.

Bassan, Roll and Rosenblatt (1980) considered two configurations of shelves. In the first configuration, the shelves are arranged perpendicular to the longitudinal wall of the warehouse building. In the second, the shelves are arranged parallel to the longitudinal wall. Also, two organizational situations are considered. First, the whole warehouse is considered as a single homogeneous unit, while in the second, the warehouse consists of several independent units. The four layout alternatives are shown in Figure II-1.

Bassan and his colleagues assumed that items are delivered to the warehouse through a door (dock) located on one side of the rectangular warehouse and taken out through another door located on the opposite side of the warehouse. Both doors (docks) are considered equivalent to a single door. In the homogeneous alternative, one set of two doors is located at the middle of the longitudinal walls opposite each other, while in the zoned alternative, each zone has its own pair of doors located in the same manner at the middle of the zone. Each zone has its distinct items stored within and also has its own customers, while in the case of the homogeneous warehouse, there is an equal probability for an item to be located in any of the storage spaces in the warehouse.

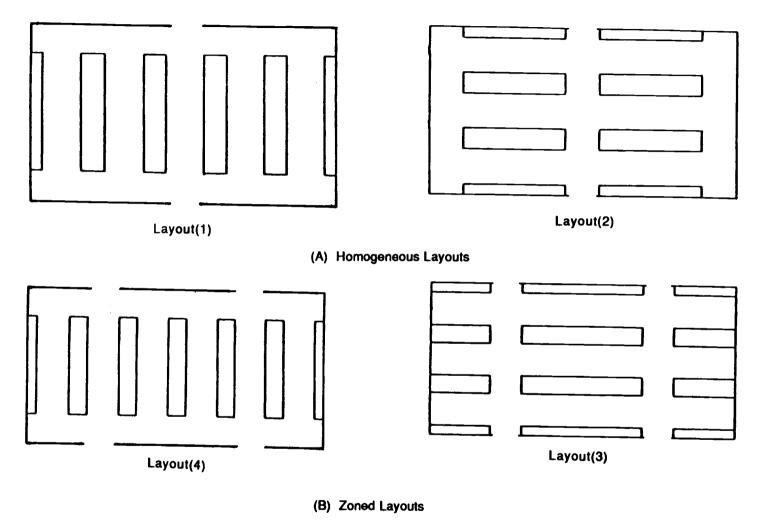


FIGURE II-1 The Different Layouts Considered by Bassan, Roll and Rosenblatt

They developed a mathematical model to compare the overall cost of each alternative. The overall cost considered includes: the material handling cost, the costs connected to the warehouse area, and the costs that are proportional to the building perimeter. In their general comments they write:

> It was found that perimeter costs are of importance and may play (together with the handling costs) a decisive role in the choice between internal layout patterns.

Ballou (1967) developed a linear-programming model to be used as a guideline for more optimal arrangements of products in a typical warehouse, both in the reserve and the assembly sections. He approached the problem by considering that each item in the warehouse has a handling cost associated with it, depending on its particular location. He tried to assess the trade-offs in handling costs among the various stock arrangements by utilizing the linear programming technique to research all the feasible layout arrangements and then suggests the one with the lowest total handling cost.

He concludes:

The largest plan suggested by the linear-programming analysis resulted in total yearly handling costs that ranged from 11% to 23% lower than those encountered when the existing layout methods were applied to the example problem.

Problem Formulation

Consider a typical storage warehouse system with one dock, where the order-picking process is performed by picking vehicles upon requested or scheduled orders. Each picking order consists of multiitems. Each vehicle is assigned a complete picking order in "one picking tour". Starting from the dock, the vehicle receives the picking order, travels through the picking aisles in a sweeping manner starting from one side of the warehouse and continues picking items from aisles closer to the dock first until it finishes picking the last item in the picking order. Then it returns to the dock for unloading the completed picked order, and a new picking order is scheduled. In the order-picking tour, the vehicle selects the shortest path each time it travels from one item location to the next. Each time a picking aisle is occupied by a picking vehicle, the other vehicles have to wait outside the aisle until the aisle is cleared. Once a vehicle has entered the picking aisle, it is required to pick all the ordered items located in that aisle before it leaves for the next aisle. The popularity approach for item location is used; items. with higher turnover frequency are located closer to the dock. γ

By doing so, the layout of the warehouse can have a major impact on the performance of the system. However, an alternative which reduces the vehicles' traveling time and waiting time, and consequently increases the productivity of the system can be found.

One way of doing this is by introducing the crossing aisle first to facilitate the movement of the picking vehicle when it travels through the picking aisles, and second, to divide the one-way traffic picking aisles into two sections. This alternative is expected to reduce the traveling time and waiting time.

The second way is by trying to orient or arrange the picking aisles in two different ways. The first way is to orient the picking aisles perpendicular to the dock, and then, the second way is to arrange the picking aisles parallel to the dock. A study of the two possible ways of aisle orientation systems can reveal how far the aisle-orientation factor can reduce the vehicle traveling time and waiting time, and hence help to increase the efficiency of the system.

The third way is to locate the dock in two alternate locations. First, the dock can be located in the longitudinal side of the warehouse, and then, it can be located in the cross side of the warehouse. A comparison of the two dock location systems can lead to a possible way of decreasing the traveling and waiting time of the picking vehicles and hence improve the performance of the system.

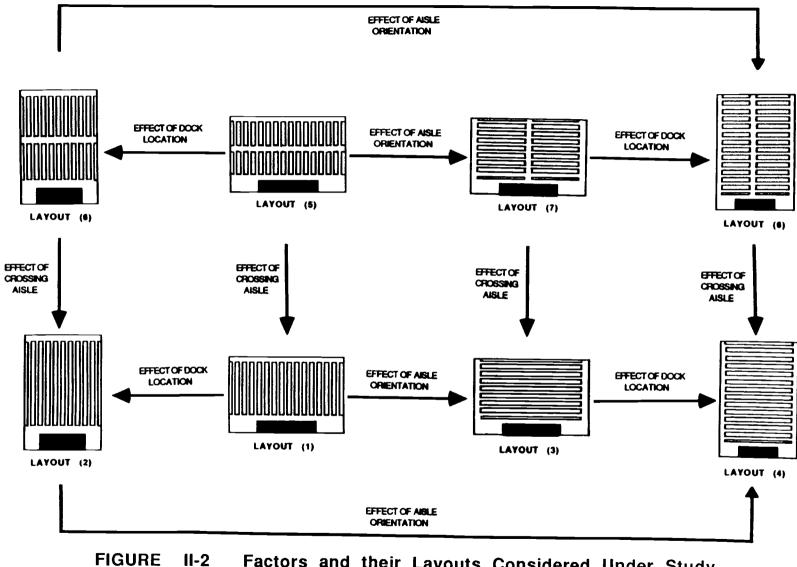
Factors Under Study and Performance Measures

The number of factors which may be analyzed and compared is very large. For this purpose, general assumptions have been made to reduce the magnitude of the problem and to concentrate on some of the factors in this study. The factors considered with their layouts compared are shown in Table II-1 and Figure II-2. As can be seen, for each factor four different pairs of layouts are considered. They are designed in a way to represent and reveal only the effect of each factor by keeping all other factors and variables constant.

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Factors	Pairs of Layouts Compared
Effect of Crossing Aisles	Layouts (1) & (5) Layouts (2) & (6) Layouts (3) & (7) Layouts (4) & (8)
Effect of Aisle Orientation	Layouts (1) & (3) Layouts (2) & (4) Layouts (5) & (7) Layouts (6) & (8)
Effect of Dock Location	Layouts (1) & (2) Layouts (3) & (4) Layouts (5) & (6) Layouts (7) & (8)

TABLEII-1FactorsUnderStudy



Factors and their Layouts Considered Under Study

The first factor deals with the presence of the crossing aisles in the layout of the warehouse. It examines the effect on the picking vehicle movement through the picking aisles and its impact on the traveling time. Also it studies the effect of dividing the one-way traffic of the picking aisles into two separate sections to assess impact on the waiting time of the vehicle for the busy aisles. the presence of the crossing aisles in the warehouse is expected to The result in a considerable reduction in both the traveling and waiting The expected decrease in traveling time is due to the effect time. of the expected short-cut movements the vehicle can make with the presence of crossing aisles. On the other hand, the chances of the vehicle waiting for busy picking aisles are expected to be lower by This is due to the fact that half of the picking fifty percent. aisle is occupied as busy by dividing the picking aisle into two For this reason the waiting time is expected to be reduced sections. too.

The second factor is to study the effect of the picking aisles orientation with relation to the dock. It examines two different alternatives of aisle arrangement. In the first one, the picking aisles are arranged perpendicular to the dock, and in the second, they are arranged parallel to the dock. If the picking aisles are not laid out properly, considerable traveling may be required to go from one location to the next. The way the picking aisles are laid out effects the length and number of these aisles in the warehouse. As the length of picking aisles decreases and their number increases, a reduction in the traveling and waiting time may be expected due to the same reasoning discussed earlier in regard to the effect of the crossing aisles. Of course, this effect is not expected to hold all the time due to the interaction effect with other factors such as the dock location from where all picking cycles start and end.

The third factor considers the effect of the dock location. In regard to this factor, two alternatives of dock location are In the first alternative, the dock is located on examined. the longitudinal side of the warehouse, and in the second alternative the dock is located on the cross side of the warehouse. Obviously. the dock location by itself does not have any effect on the vehicle waiting time, but in relation to the other factors, such as the picking aisles, it would. The dock location is expected to have an effect on the travel time, but it is closely related to the way the picking aisles are arranged in relation to the dock. For example, locating the dock on the longitudinal side of the warehouse may favor traveling time when the picking aisles are arranged perpendicular to the dock, but may not favor in the traveling time other way.

The primary objective of this study is to examine the effect of three elements of the warehouse layout on the order-picking process. In order to select a performance measure for use as a measure to the system throughput, it is necessary to start with the order-picking cycle time (OPCT) definition. The OPCT is defined as the total time required for a vehicle to finish picking a complete order. This includes the time required for traveling to perform the complete order-picking tour, time spent waiting in queues for access to busy aisles, time required for picking items from storage locations,

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unlaoding time of the picked order at the dock, and any idle or delay time required by the operator or vehicle. Due to the variation of the idle or delay time required by the operator or vehicle, it is omitted from consideration in the performance measure of the system. The picking and unloading time may vary. This depends mainly on the total number of units picked per order. It also depends on the means by which the material is handled and picked, which in turn is effected by the size, shape and weight of the items and the height of their storage locations. All these variables are not under consideration for the scope of this study. For this reason picking and unloading times are excluded from the performance measure of the system. $\overset{\bigtriangledown}{}$ However, in this study, the system performance is measured in terms of the vehicle average traveling and waiting time per a complete order-picking cycle. Both measures are the most important parameters effecting the order-picking process in warehouse. The traveling time directly reflects the traveled distance, especially when using constant vehicle speed without any consideration to the rate of acceleration and deceleration. The travel time can be defined as the total time required for the vehicle movement in order to finish a complete order-picking tour, starting from the dock, traveling to the different item locations required for a complete order and finally returning to the dock. On the other hand, waiting time gives an indication of any traffic congestion problem within the system. The waiting time (Wt) is defined as the total time spent by a vehicle in queues waiting for access to busy picking aisles in order to finish a complete picking order.

III. ASSUMPTIONS AND GENERAL APPROACH

<u>Assumptions</u>

In order to access the effect of the crossing aisle, picking aisles orientation and dock location on order-picking process, it is necessary to make certain assumptions regarding the warehouse opera-First, it is assumed that the system under consideration tion. consists of a rectangular warehouse. Its size is constant. It has one dock used for unloading the picked orders. The items are stored The height of these racks and number of shelves on which in racks. the items are stored are excluded from the analysis because they wouldn't have a significant bearing on the results. Usually, storage height is predetermined by the type, shape and size of stored items, as well as by the capacity of handling eugipment. All these factors are outside the scope of this study. Storage racks adjacent to a wall or parallel and next to the dock are single-sided; all other racks are assumed to be double-sided, with access to both sides. The passages between the racks are called picking aisles. They are assumed to permit one-way traffic from either direction at a time. The cross aisles and aisles adjacent to the dock are wide enough to permit two-way traffic.

Each item is stored in one region in the racks. This region can be divided between two racks on both sides of the same aisle, which are considered to have the same traveling distance to the dock. The activity approach is used to locate the items in the warehouse. Items with higher turnover frequency are located closer to the dock.

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The replenishment time for stored items is not considered in the analysis. In other words, the supply or the availability of the stored items is assumed constant and always sufficient to fulfill the orders. The number of items stored in the warehouse is assumed to be constant throughout the analysis.

For picking purposes, it is assumed that an order consists of a quantity of multi-items which are picked in one picking tour by moving through the aisles of the warehouse. The picking process is carried out by a driver in a vehicle. There is no capacity restriction prohibiting the vehicle from finishing picking an order in one complete tour. Each vehicle assigned an order starts picking items located on the right side of the warehouse and moves in a sweeping manner through the aisles. It is assumed that each time a vehicle finishes picking the ordered items in an aisle and wants to move to the next aisle, it selects the shortest path. Finally, after a vehicle finishes picking all the items in the order, it returns to the dock for unloading. Another order is assigned to the vehicle immediately after it finishes unloading. The picking frequency of each item type stored in the warehouse is assumed known, and has а constant rate. The number of items per order and number of units per ordered item are assumed to have Poisson distribution, with a minimum of one item per order and one unit from each ordered item. Also, each item can occur only once in a given order.

By taking all these assumptions into consideration, a computer simulation program has been formulated to fit and precisely describe the systems of the eight layouts under study.

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System Design and Specifications

Layout Design

The following are some general specifications which have been followed in laying down the design of the eight different layouts under study, to make sure that all the layouts are evaluated under similar working conditions. First, the shape and size of the warehouse is held constant with dimensions 420 x 280 feet. Then, the width of single-sided racks is 8 feet, which will make the storage system more flexibile to accommodate other storage types like pallet storage system for further studies. Also, the width of picking aisles (one-way traffic) is 12 feet, and the width of crossing aisles (two-way traffic) are 16 feet, which is considered to be wide enough to permit the use of other types of material-handling equipment. 0n the other hand, the percentage of spaced utilized for storage is kept consistant for all layouts in the range of 43% + 3%. In each layout, the racks' length is divided into levels. Each item location is given a level number as shown in Appendices B-1 to B-8. The middle level is assigned the zero value. The upper half is given positive numbers and the lower half negative numbers. The levels are made to determine the shortest path for the movement of the vehicle from one aisle to another. For instance in layout (1), provided in Appendix B-1, suppose a vehicle finished picking an item located at level (+3)and wants to move to pick the next item located at level (-2) in another aisle. The shortest path will then be determined by adding the two level numbers. If the resulting number is positive, then the

shortest path for the vehicle will be to go up the current aisle and then down through the next picking aisle. In the case that the resulting number is negative, then the opposite is true. If the resulting number is zero, then either way will be the same distance.

Item Location

There are 100 items stored in the warehouse. Their turnover frequency is predetermined by a method which will be discussed later in this section. In each layout the distance from the dock to each storage location is determined. The items with higher order frequency are located closer to the dock, and the numbers of items relative to their order frequency is translated or given different numbers in each layout. This is related to the movement of picking vehicles through the aisles of each layout. The vehicles are assumed to start the picking cycle at the dock, and then move to the far right side and start sweeping through the aisles picking by following the ascending order of the translated item location numbers as shown in Figure III-1.

<u>Vehicles and Order Picking</u>

The type of vehicles assumed to be used for picking are driveroperated picking vehicles, with an average speed of 3 miles per hour (264 feet per min.). The vehicles have no capacity limitation. That is, the vehicle capacity can be extended by attaching carts to it. The operator drives the vehicle through the aisles, and steps down at each ordered item location to pick the number of units required with a picking rate of 12 seconds/unit (0.2 min./unit). The number of

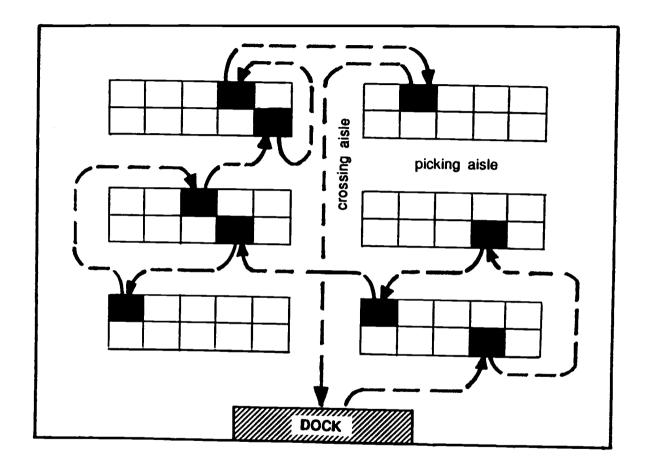


FIGURE III-1 An Example which shows the Movement Path of the Vehicle for a Complete Order-Picking Cycle

picking vehicles used for picking is fixed at two and is kept constant in all the layouts. The number of items scheduled for picking per order is generated from a Poisson distribution with a mean of 10, a minimum of 1 and a maximum of 20 items/order. In addition, the number of units required per ordered item is represented by a Poisson distribution with a mean of 5, a minimum of 1 and maximum of 10 units/ordered item. The minimum number of units and items ordered is restricted to one to prevent scheduling orders of zero units or items.

<u>Simulation Model</u>

Simulation Program Procedure

The simulation language used in this study is GASP IV. The model used to describe the system is classified as the discrete model. This is because time is the only independent variable in the system, and all other variables are dependent and discretely changed specified points in the simulation time. To obtain a complete at simulation of the system under study, some user subprograms have been The listings of these subprograms and their descriptive written. flow charts are shown in Appendices B-9 to B-18. In addition, the definition of all variables, files, and GASP subroutines and functions used are provided in Appendix A. the following section will describe the overall simulation program procedure.

The general simulation procedure is summarized in Figure III-2. As can be seen, there are two main events or dependent variables that describe the operation of the system. The first is scheduling the

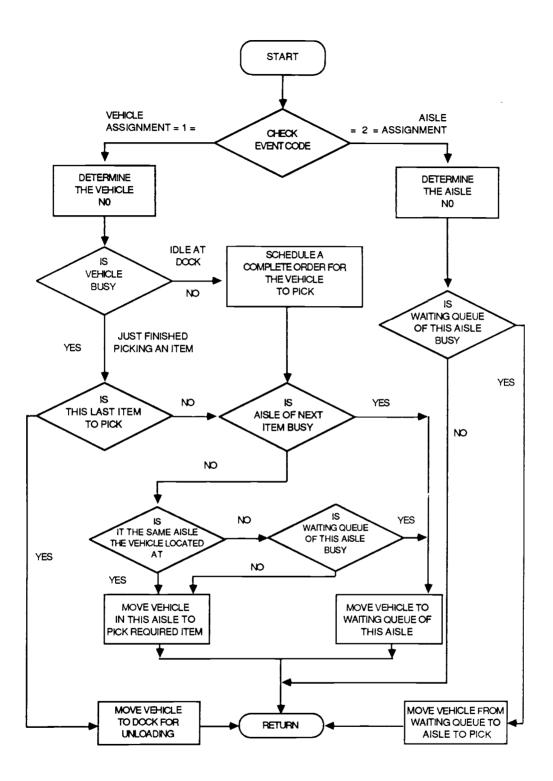


FIGURE III - 2 General Flow Diagram of the Simulation

vehicle assignment when it finishes picking an item or a complete order. The second is scheduling the aisle assignment after it is cleared from a picking vehicle. Subroutine EVENTS mainly transfer control to one of the two events. In the case of first event, it determines the vehicle number and checks whether or not it has completed picking an order. In the case of a vehicle that has finished a complete picking cycle, another picking order is scheduled for the vehicle with the restriction of not repeating the order of an item in the same picking order. If the vehicle has just finished picking an item and still has some more items left to pick, then the vehicle is removed from the aisle file of that item and the entry of the next item to pick is called from the vehicle file. The item number and aisle is determined and the aisle file is checked to determine its whether or not the aisle is busy. If the aisle is busy, then the item entry is stored in the waiting queue file of that aisle, the time the vehicle started waiting is determined, and the vehicle status is set as waiting. If the aisle is empty from picking vehicles, then the waiting queue of that aisle is checked to see if there is a vehicle waiting. If the waiting queue is also empty, the vehicle is moved to that aisle to start picking. The traveling and picking time is calculated, and the vehicle status is set as picking. The number of items left for the vehicle to pick is decreased by one and the end of the picking event is scheduled. When the vehicle finishes picking the last item in the order, it is moved to the dock for unloading. Traveling, unloading, and total picking cycle time is then calculated, and the vehicle status is set as idle. The

vehicle's next assignment event is scheduled.

In the case of the aisle assignment event, the first step is to determine the aisle number; the waiting queue of that aisle is checked. If the aisle has a vehicle waiting, then the vehicle is removed from the waiting queue file and moved to the picking aisle to pick the required item. The vehicle status is set as picking and the number of items left for the vehicle to pick is decreased by one. Time variables of the vehicle, the waiting, traveling and picking time are calculated, and the next vehicle assignment event is scheduled.

Subroutine PICK basically deals with the vehicle movement throughout the aisles of the warehouse. It calculates the traveling, picking and unloading times of the vehicle and updates the vehicle location after each move. Due to the variation in the aisle patterns of the different layouts which effect the vehicle movement differently, subroutine PICK is designed in three different models. Each model is used for layouts with similar aisle patterns.

In regard to the initial condition of the warehouse, it is assumed that the two picking vehicles are located at the dock waiting for an order to be scheduled for them and that all of the aisles and their waiting queues are empty. As can be seen from the typical storage area at time zero, which is given in Appendix C-17, File (1) has two entries as assignment events of the two vehicles. All other files are empty. Subroutine INTLC is used to initialize the location variables of the two vehicles at the dock in the beginning of the simulation.

The final condition of the system at the end of the simulation shown in Appendix C-18. It shows a sample of the file storage is area of the layout (1) at time 3,000 minutes. It is an exmaple of the final situation in the warehouse at the end of the simulation As can be seen in File (1), it has two entries as assignment time. events for vehicles (2) and (1): to pick their next items at time 3,000 and 3,002 minutes, respectively. File (2) shows that vehicle (1) still has eight items to pick. In the same manner File (3) shows vehicle (2) still has two items to pick. The rest of the files are empty except Files (11) and (14). File (11) has an entry which shows that vehicle (1) is picking item (54) from aisle (8). File (14) has an entry for vehicle (2) picking item (68) from aisle (10). It can be seen in File (2) and (3) that the entries have been arranged in ascending order according to the value of item number so that the vehicle will pick items with least value first since the items are numbered in ascending order starting from the front right to the left side of the warehouse. This has been done to meet the assumption that the vehicle will start picking items located in the front right side of the warehouse and continue sweeping through the aisles to pick the rest of the items ordered.

Input Data

The input data can be divided into two main parts. The first part which is given in Appendices C-9 to C-16 and C-19 may be obtained from the layouts shown in the Appendices B-1 to B-8. This data is read in the main program and describes the location of the one hundred items stored in the warehouse as well as the dock location which is considered as number (1) in all layouts. This information is needed to keep track of the picking vehicles' movement in the warehouse. The first variable describes the aisle number of each item location [AISL(I)]. The second variable determines the level of each location in the layout [HLV(I)]. The next two variables describe the X and Y coordinates of each location in the layout [X(I) and Y(I)].

The last variable in this first part of data is concerned with the cumulative turnover frequency of each item [FX(I)]. This frequency is obtained originally from the ABC curve which is drawn to smoothly through the point 20%/80% as it is shown in Figure pass Item numbers related to their frequencies taken from the III-3. curve are located in each layout by using the popularity approach. The items with higher turnover frequency are located closer to the dock. Then the numbers of the items located in each layout are given equivalent numbers to be used as input data in the program. The equivalent numbers are set differently in each layout. These equivalent item numbers are arranged in each layout in a way that allows the vehicle to move throughout the picking aisles in a sweeping manner following the ascending order of the item numbers as discussed earlier in this section. This has been acocmplished in the program by storing the item entries of each order in the vehicle's file and removing them for picking purpose with the priority of the least value first (LVF). By reading in the main program this cumulative frequency (FX(I)) and its corresponding item numbers used in the

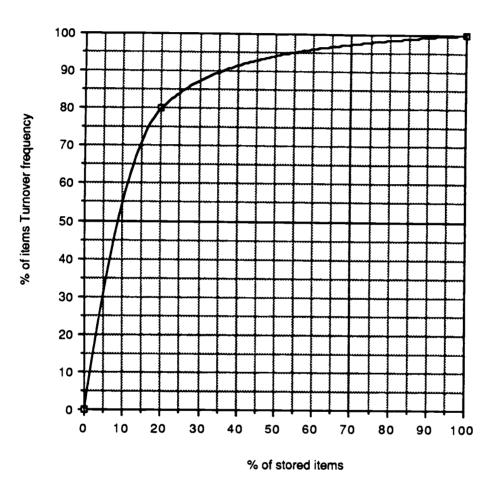


FIGURE III-3

ABC Curve 20/80

program (XIN(I)), the subroutine DPROB can be employed to generate deviates from this given probability mass function.

The second part of the input data for each layout simulation run is given in the Appendices C-1 to C-8. Some cards of this part of input data bear discussion. The first card of the histogram cards (HIS) is set to find the resulted items' turnover frequency generated by subroutine DPROB from the input data of the items' turnover frequency since the output of items' turnover frequency is expected to be different from the original frequency which is derived from ABC curve 20/80. This is due to the restriction used in subroutine EVENTS, which implies that sampling from the input frequency function is to be generated without replacing items to be ordered more than once within the same picking order.

The second set of cards is the priority cards of the filing system (PRI) which are prepared in a certain manner. For instance. in File (1) the event file, the priority to remove the entries from the file is set to follow the rule of the least value first (LVF) of the time event [ATRIB(1)]. It implies that the vehicle first in is first served. In Files (2) and (3) the vehicle files, the priority is also based on (LVF) but according to the item number [ATRIB(3)]. This is done to allow the vehicle to pick items in ascending order based on their number which represents the closeness of item loca-The rest of the files in each layout can be divided into two tion. parts. The first part for the picking aisles and the second for their waiting queues. The priority in all the aisles and their waiting queues follows the rule of first come first served, according to

the vehicle number [ATRIB(5)]. The third set of cards is the parameter cards (PAR). The first card sets the parameters for the NPSSN function to generate from Poisson distribution the number of items to be picked per order with a mean of (10) items, a minimum of (1) item, and a maximum of (20) items per order. The second parameter card is to generate from Poisson distribution the number of units to be picked from each ordered item with a minimum of (1) unit, a mean of (5) units, and maximum of (10) units per item. In the (INI) data card, MSTOP = 1 which specifies that the simulation run of each layout is to end at TTFIN = 3,000 units. It means that the simulation time of the order-picking process in all layout simulation runs is constant and continued for 3,000 minutes (50 hours). On the (ENT) data card, two entries ares scheduled in the event file, each one for a vehicle. This is done to initiate an order to be scheduled for each vehicle at zero simulation time. In other words, it implies that at the beginning of the picking operation the two vehicles are set idle at the dock waiting for an order to be scheduled for them to start picking.

IV. RESULTS

Introduction

To make sure that there is no bias due to the initial conditions in the statistical data collected, a plot for the time of the traveling, picking, waiting, and order-picking cycle of each vehicle against the simulation running time is plotted to provide a feeling for any unsteady period throughout the simulation run. 0ne example provided (Appendix D-9) which shows there is no presence to an is unsteady or transient state throughout the simulation time (3,000 This may be due to the initial conditions the simulation units). model started with. The initial conditions were close or typical to the long-run (stead-state) operational conditions of the simulated Also the pattern and type of activity the system is simusystem. lated to perform was a regular and single-type activity in which the complete order-picking cycles starts and ends at the dock. This assures that the simulation results are being taken from a simulation steady state period and do not have bias.

Due to the assumption that the ordered items are not permitted to be repeated within the same picking order, a restriction in the computer program has been made as discussed in an earlier section. The restriction used is expected to effect the probability function used in the program from generating the required ratio of the items' turnover frequency, which is 20% of the items required to be picked 80% of the time. For this reason, an ABC curve of the resulted turnover frequency is plotted for each layout simulation run to make sure that the turnover frequencies used for all layouts are similar and do not have large variations which may effect the system performance. Figure IV-1 summarizes the resulted ABC curves of all layouts. The results reveal that there is no significant variation in the resultant frequencies used throughout the layout alternatives. As can be seen from the resulted ABC curves, the item frequency ratio is within the range of 20/(72 + 2).

Analysis of Results

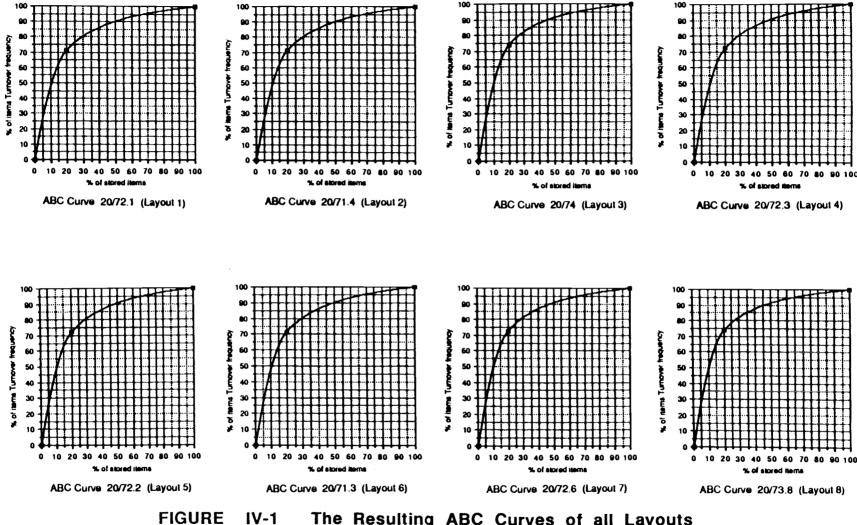
As discussed in the earlier section, the traveling time and waiting time represent the performance measures of the system of the different layout alternatives. The two parameters are considered to give an inside feeling of the system response as well as an indication of the alternatives' throughput.

As a reminder, the travel time is defined as the total time required for a vehicle's movement in order to finish a complete order picking tour, starting from the dock, traveling to the different items' locations required for a picking order and finally returning to the dock. The waiting time is defined as the total time a vehicle spends in queues waiting for access to busy picking aisles in order to finish a complete picking order.

Each pair of layout alternatives for each factor is selected in a way to represent and show only the effect of that factor and to keep all other variables constant.

All of the resultant data are collected from a representative sample of over 100 observations as can be seen from Appendices D-1 to D-8.

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RE IV-1 The Resulting ABC Curves of all Layouts within a Range of 20/ (72 ± 2)

Effect of Crossing Aisle

The system's throughput and the percentage change for the four pairs of layouts are presented in Figures IV-2 and IV-3. Comparing the results of each pair of layouts, it is clear that the presence of the crossing aisle reveals improvement in the throughput. As can be seen from the figures, the four layout pairs are acting in a manner similar to each other. In the first layout pair, layout (5) shows improvement over layout (1) in the traveling time by 3.6%, waiting time by 12.9%, and the sum of traveling and waiting time by 4.2%. In the second pair, layout (6) is improved over layout (2) in the traveling time by 5.3%, waiting time by 33.9% and the sum of traveling and waiting time by 8.4%. As may be seen the third and fourth layout pairs show a much higher rate of improvement. This increase is related to the effect of the parallel orientation of the picking aisles to the dock. In the third pair, layout (7) shows improvement over layout (3) in traveling time by 27.9%, waiting time by 49%, and in the sum of the traveling and waiting time by 30.4%. The fourth pair as well shows a high improvement: layout (8) improved over layout (4) in traveling time by 19.4%, in waiting time by 43.9%, and in the sum of traveling and waiting time by 22.3%.

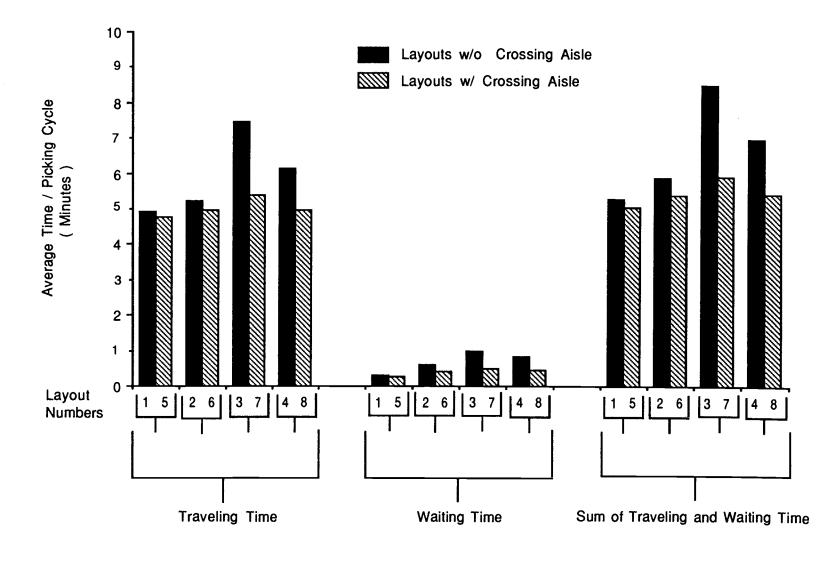
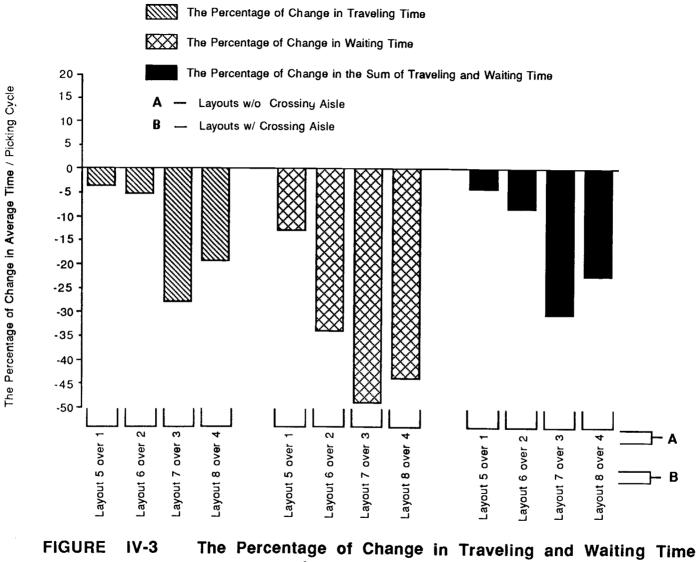
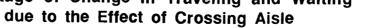


FIGURE IV-2 Effect of Crossing Aisles on Traveling and Waiting Time





Effect of Aisle Orientation

The system responses of the four layout pairs in terms of traveling and waiting times and their percentage change are shown in Figures IV-4 and IV-5. The results of this factor demonstrate an overall improvement in the four pairs of layouts. This comparison shows that when the picking aisles are oriented perpendicular to the dock, the layouts reveal an overall improvement. In the first pair of layouts, layout (1) reveals a significant improvement over layout (3) in traveling time by 34%, in waiting time by 69%, and in the sum of traveling and waiting time by 38.1%. In the second layout pair, layout (2) shows a considerable reduction over layout (4) in traveling time by 14.7%, in waiting time by 24.4%, and in the sum of traveling and waiting time by 15.8%. In the third pair, layout (5) improved over layout (7) in traveling time by 11.7%, in is also waiting time by 47.1%, and in the sum of traveling and waiting time The fourth pair shows a slight overall improvement. Layby 14.8%. out (6) shows a slight increase over layout (8) in traveling time by 0.2%, an improvement in waiting time by 10.9%, and a slightly improved performance in the sum of traveling and waiting time (0.7%).

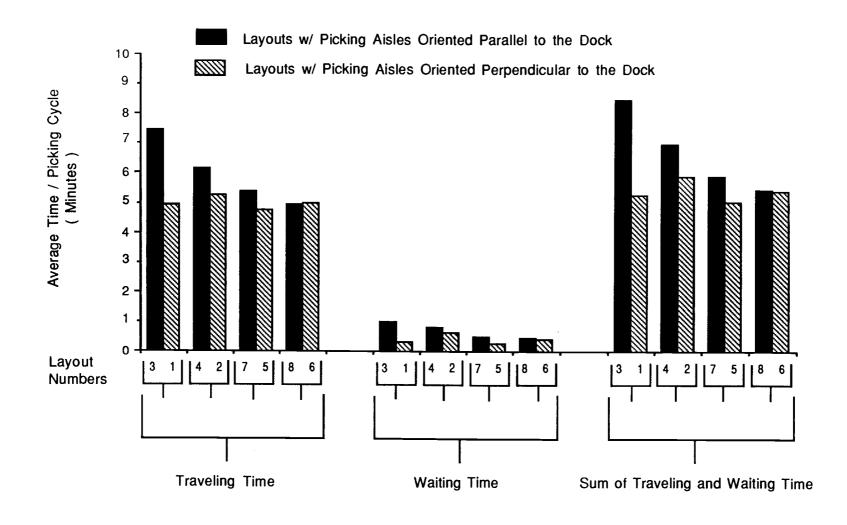


FIGURE IV-4 Effect of Aisles Orientation on Traveling and Waiting Time

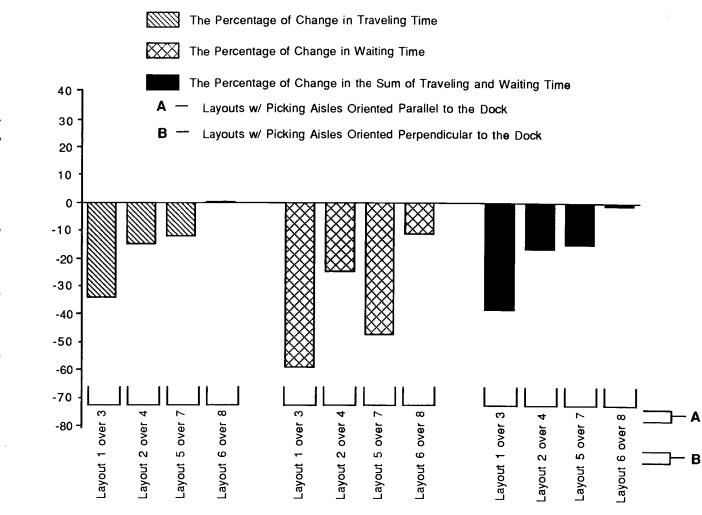


FIGURE IV-5 The Percentage of Change in Traveling and Waiting Time due to the Effect of Aisles Orientation

The Percentage of Change in Average Time / Picking Cycle

<u>Effect of Dock Location</u>

The effect of this factor perhaps is better illustrated by Figures IV-6 and IV-7. As can be seen from the figures, the effect of the dock location can be classified into two categories with relation to the aisle orientation. In the first category, the dock located perpendicular to the picking aisles. is In this case, the results show that a considerable improvement is obtained by locating the dock on the longitudinal side of the warehnouse. This category is represented by layouts (1) and (2) and layouts (5) and (6). Layout (1) reveals a significant improvement over layout (2) in traveling time by 5.7%, in waiting time by 50%, and in the sum of traveling and waiting time by 10.4%. Layout (5) shows an improvement over layout (6) in traveling time by 4%, in waiting time by 34.2%, and in the sum of traveling and waiting time by 6.3%.

The second category illustrates the dock located parallel to the picking aisles. In this case, the effect of locating the dock on the longitudinal side of the warehouse is adversely evident. The traveling and waiting time clearly show an increase. In this category, layouts (3) and (4) and layouts (7) and (8) are compared. Layout (3) shows an overall increase over layout (4) in the traveling time by 21.8%, in waiting time by 22%, and in the sum of the travel-ing and waiting time (21.8%). Layout (7) reveals an increase over layout (8) in traveling time by 8.9%, in waiting time by 10.9% and in the sum of the traveling and waiting time by 8.9%, in waiting time by 9.1%.

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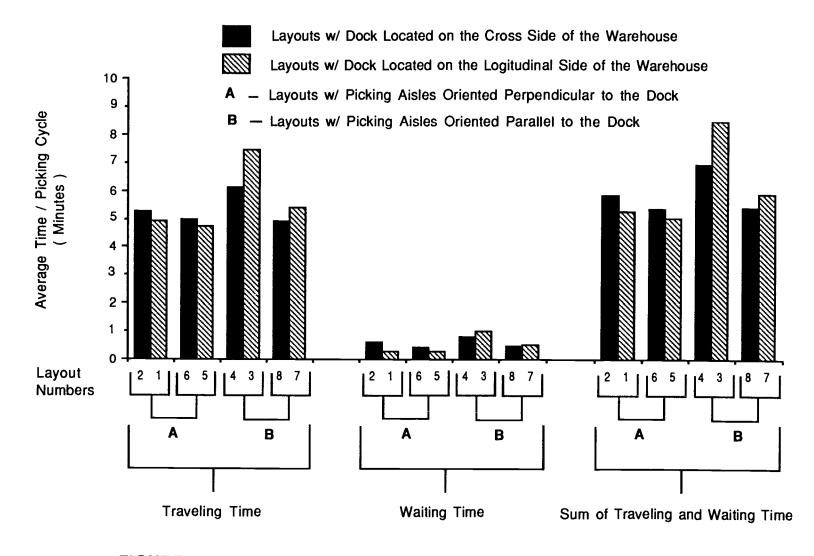


FIGURE IV-6 Effect of Dock Location on Traveling and Waiting Time

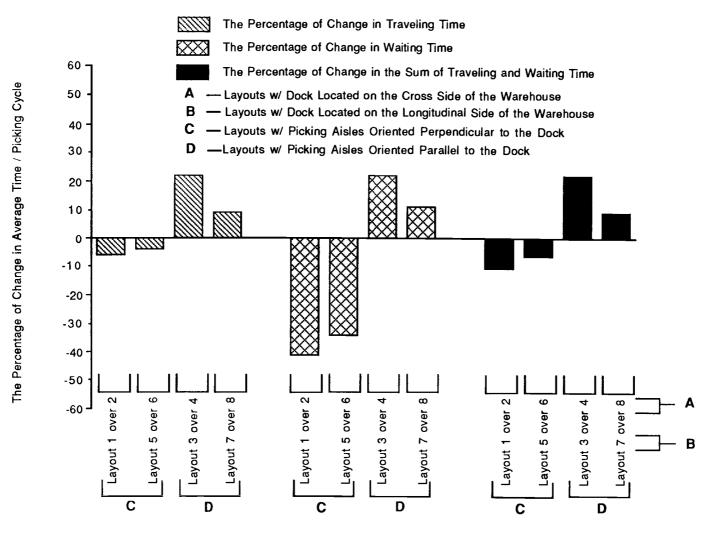


FIGURE IV-7 The Percentage of Change in Traveling and Waiting Time due to the Effect of the Dock Location

Number of Order Picking Cycles Processed

Although the order-picking cycle time is not considered as a measure to the system's performance due to the definition and justification reasons discussed earlier under the system performance measures in Section II, statistical data has been collected on the number of order-picking cycles processed by each of the two picking vehicles. The data is included in the summary report of each layout provided in Appendices D-1 to D-8. The results are summarized and presented in Figures IV-8. As can be seen from the histogram, the results of the total number of order-picking cycles processed reveal and confirm exactly the same indications obtained from the traveling and waiting time measures for the three factors under study as discussed earlier in this section.

It can also be noted from the figure and the appendices that all layouts show a total number of picking cycles processed by the two vehicles to be above 200 cycles. Each vehicle processed over 100 picking cycles, which is considered to be a good sample size from which the observations of the statistical data about the system's performance has been collected.

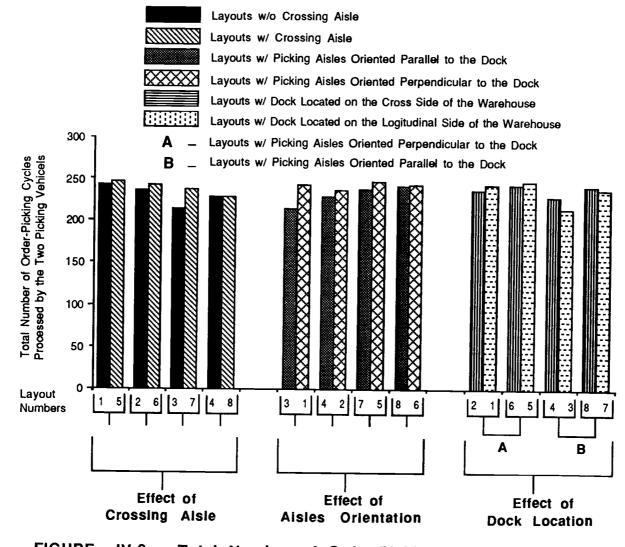


FIGURE IV-8 Total Number of Order-Picking Cycles Processed

V. SUMMARY OF RESULTS AND CONCLUSIONS

<u>Summary of Results</u>

As a reminder, the main objective of this research is to study the effect of different warehouse layouts on the order picking process. Three factors are taken into consideration for this study: the effect of the crossing aisle, the effect of picking aisles orientation, and the effect of dock location. Four different pairs of layouts are considered to study the effect of each factor. By evaluating the effect of each factor considered (as shown in Figure V-1) through the comparison of the relative pairs of the layouts, the following results can be summarized:

The presence of the crossing aisle in the layouts shows improvement in the system performance: a decrease in the traveling time from 3.6% to 27.9%, a decrease in the waiting time from 12.9% to 49%, and a decrease in the sum of both traveling and waiting time from 4.2% to 30.4%.

When the picking aisles are oriented perpendicular to the dock, it improves the layouts by decreasing the traveling time in three layout pairs from 11.7% to 34% and increasing the traveling time in the fourth layout pair by 0.2%; the perpendicular aisles arrangement shows a decrease in the waiting time from 10.9% to 69%, and a decrease in the sum of the traveling and waiting time from 0.7% to 38.1%.

The effect of dock location is related to the picking aisles orientation. If the picking aisles are perpendicular to the dock,

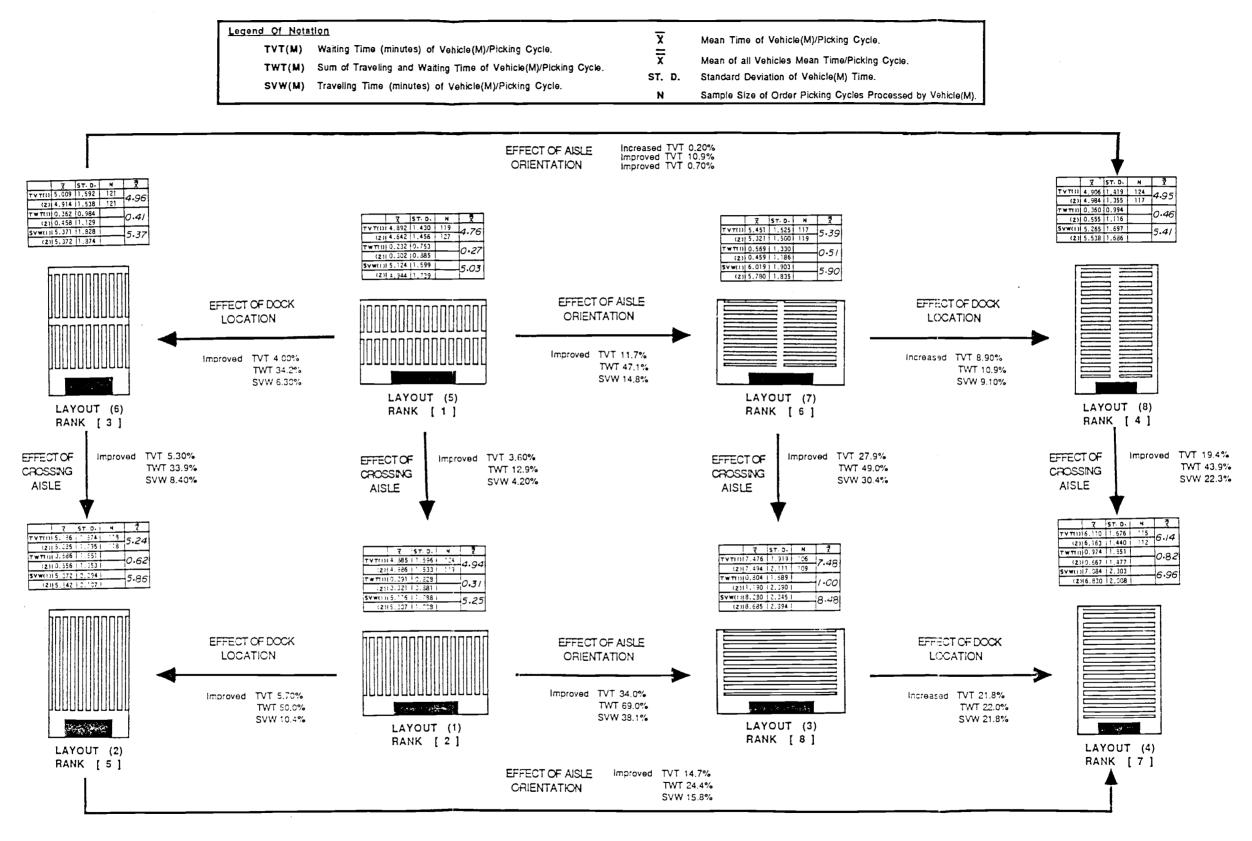


FIGURE V-1 Summary of Results & Conclusions

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then locating the dock on the longitudinal side of the warehouse improves the layouts by decreasing traveling time from 4% to 5.7%, and the waiting time from 34.2% to 50%, as well as decreasing the sum of the traveling and waiting time from 6.3% to 10.4%. But if the picking aisles are parallel to the dock, then locating the dock on the longitudinal side of the warehouse will increase the traveling time from 8.9% to 21.8%, increase the waiting time from 10.9% to 22%, and increase the sum of the traveling and waiting time from 9.1% to 21.8%.

General Conclusions

The general trend of the results obtained from this simulation study concludes that the productivity of the warehouse can be substantially improved through decreasing the traveling and waiting time of the order-picking process. This can be achieved when the picking aisles are oriented perpendicular to the dock, when a crossing aisle is placed or located parallel to the dock and when the dock is located on the longitudinal side of the warehouse., The general outlook of the different layout performances indicates that an improvement in the throughput can be achieved by decreasing the traveling time up to 36%, the waiting time up to 73%, and the sum of the traveling and waiting time up to 41%.

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Recommendations For Further Research

The possibility of extending this study is positive. An extended study could cover a wide variety of factors effecting the order-picking operation in the warehouse. Some general features of the system mentioned in the assumptions under which the order-picking process operates must be taken into consideration. With these features in mind, the system can be operated to study the interaction effect between several variables such as the number of picking vehicles, the number of items stored in the warehouse, the number of items picked per order, the turnover frequency of the items, the items' location approach, the number of docks, the size and shape of the warehouse, space utilization, the number of picking aisles, and the number of items located per aisle.

One of the interesting areas which is recommended for future research is the study of the effect on the order-picking process by using different approaches to item location. The first approach equally distributes the first 20 items with higher turnover frequency throughout the aisles of the warehouse when the item's closeness to the dock is regarded only within each aisle. The second approach concentrates on the location of the first 20 items with higher turnover frequency within the first 4 or 5 closest aisles to the dock. The third approach locates the items with higher turnover frequency closer to the dock. By applying these three approaches with the increase of the number of vehicles picking each time and the use of the first three best layouts obtained from this study, an interesting relationship might be shown in regard to the reaction of each approach with the increase in the number of picking vehicles. This interaction will be represented by the variation in the traveling and waiting time. The traveling time is expected to increase by using the first approach and to decrease by using the second and third approaches. The waiting time is expected to decrease by using the first approach, to increase moderately by using the third approach, and to increase sharpely by using the second approach./ By increasing the number of picking vehicles, this variation will be seen more clearly. This may lead to an improvement in the system by decreasing the sum of traveling and waiting time.

Another interesting research area can be studied by restricting each picking vehicle to pick just the items located in a particular zone of the warehouse. This can be accomplished by dividing the picking aisles into a number of zones equal to the number of picking vehicles and by scheduling each vehicle to pick just the items located within its zone. That means each picking order which consists of multi-items must be divided into sub-picking orders. Each sub-picking order contains items located in a particular zone. Then each sub-picking order will be assigned to a vehicle to pick. After all the sub-orders of a picking order are picked, it will be consolidated on the dock into one picking order. By comparing this picking approach with the complete order picking approach which is used in this study and by keeping the number of picking vehicles constant, an interesting study can be made, especially if it includes the interaction effect of another factor using the different item location approaches mentioned earlier in this section. The effect of the

different combination of the two factors will be reflected in the traveling time only. Obviously, it is expected that there will be no waiting time for each vehicle to pick from its zone. Meanwhile, there will be a considerable variation in the traveling time, especially when the required extra work time to perform the tasks of dividing the picking orders and issuing new sub-orders, and the consolidation-process time of the sub-orders at the dock are included. This study may lead to an improvement in the system by developing a better approach to order-picking and item location.

<u>Comments on the Effect of Some Variables</u> which Change the System Performance

1) Number of Picking Vehicles:

The effect of the increase in the number of picking vehicles is expected primarily to cause a traffic congestion problem in the system which would be reflected mainly on the vehicle's waiting time. This effect will be more intensified, especially when the activity approach is used for item location and a complete order-picking method is applied. The expected increase in number of picking orders processed will reflect the increase in number of order-pickers and is not a result of savings in the vehicles' travel time. On the other by using the random approach for item location, it would help hand. reduce the congestion problem, but it may be expected to increase the travel time. The question would be two-fold: how much saving in waiting time and loss in traveling time will result, and what level of picking-vehicle fleet size would be justifiable to switch from

activity to random approach for item location or visa versa. This can be accomplished by utilizing the simulation model used for this study with some changes to adopt the new assumptions.

2) Number of Items Per Order:

It is true that as the number of items per order increases, it likely that all the picking aisles in the warehouse will is be But there is still some room for savings in the travel visited. time, especially with the presence of the crossing aisles and the selection of the shortest path each time the vehicle moves from one item location to the next. By using the random approach for item location, the traveling time is expected to increase moderately, and the waiting time is expected to substantially reduce. But when the activity approach is used for item location, a moderate savings is expected to result in the traveling time and a considerable increase to result in the waiting time. The increase in waiting time is expected to be seen more clearly by leaving the vehicle in a picking aisle until it finishes picking all of the required items located in the same aisle. Then the question becomes a question of item location approach and order-picking method: what order size or number of items per order would be justifiable to trade off the activity approach with the random approach for item location? The next question would regard order-picking method what method is better - to use the complete order picking approach or zone/batch order picking approach at different levels of order size? These questions can also be studied by using the same simulation model with some modification.

3) ABC Curve Ratio:

Changing the ratio of the ABC curve, which is used to determine the item's activity rate and location, is expected to have some impact on the system's performance. For example, the ratio used in this study was 20/80, which means that 20 percent of the items stored in the warehouse represent 80 percent of the activity and are located closer to the dock. By using a lower ratio such as 20/40, the result expected is an increase in traveling time and reduction in waiting This result is due to the reduction in order frequency of the time. number of items, which is located closer to the dock, which same means the vehicle would have to travel to further aisles to pick the other items more frequently. This effect also would lead to a reduction of the vehicle's chances to wait for the less active closer Suppose a higher ratio is used, such as 10/90. This means aisles. fewer items with higher activity rate are located closer to the dock. In this case, the expected result is a considerable reduction in traveling time and a substantial increase in waiting time due to the concentration of a few very high activity items in the closer aisles. This effect can be studied with relation to other factors by using the same simulation model developed for this study.

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APPENDICES

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APPENDIX A

Variables, Files, and GASP Function Definitions

AISL(I)	Aisle number of location (I).	
AISLE,NA	Number of aisles in the warehouse.	
AN(M)	Aisle number where vehicle (M) is located.	
DX	Distance traveled by vehicle in X-direction.	
DY1	Distance traveled by vehicle in Y-direction through aisle after finished picking.	
DY2	Distance traveled by vehicle in Y-direction through next aisle to start picking from.	
FRQI(I)	Order frequency of item (I).	
FX(I)	Cumulative probability to order item (I).	
HLV(I)	Level number of location (I).	
HMAX	Maximum level in the layout.	
HMIN	Minimum level in the layout.	
HMED	Middle level in the layout.	
HN(M)	Level number where vehicle (M) is located.	
ſ	Location number	
TEM	The item no. which have been ordered to pick.	
)	Aisle number	
1	Vehicle number	
IRL	Middle level of the racks in the layout.	
I,Q(M)	Number of items to be picked by vehicle (M) per order.	
I	The item no. to be ordered.	
CT(M)	Order picking cycle time of vehicle (M).	

A-1 Variable Definitions

PT(M)	Picking time of vehicle (M) for an item.
RT	The arriving time of the vehicle to the waiting queue.
SVWT(M)	Sum of traveling and waiting time of vehicle (M) per order picking cycle.
SWT(M)	Time vehicle (M) started waiting.
TPT(M)	Total picking time of vehicle (M) per order picking cycle.
TT	Total time.
TUN(M)	Total no. of units picked by vehicle (M).
TVT(M)	Total traveling time of vehicle (M) per order pick- ing cycle.
TWT(M)	Total waiting time of vehicle (M) per order picking cycle.
UNT(I)	Number of units to be picked from item (I).
UT(M)	Unloading time of vehicle (M) per order picking cycle.
VBUZ(M)	= 0 = vehicle (M) idle at the dock. = 1 = vehicle (M) finished picking an item = 2 = vehicle (M) is waiting for aisle
VECS,NV	Number of vehicles used for picking in the warehouse.
VT(M)	Traveling time of vehicle (M).
WT(M)	Waiting time of vehicle (M).
X(I)	X-coordinate of location (I).
XIN(I)	Number of item correspondent to FX(I).
XN(M)	X-coordinate of vehicle (M).
Y(I)	Y-coordinate of location (I).

A-1 (Cotinued)

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Variable	Definition			
YMAX	Maximum point in Y-direction the vehicle can move to cross aisle.			
YMIN	Minimum point in Y-direction the vehicle can move to cross aisle.			
YMED	Middle point in Y-direction the vehicle can move to cross aisle.			
YN(M)	Y-coordinate of vehicle (M).			

File No.	Attributes	Code	Definition
1			Event file.
	ATRIB(1)		Event Time (priority: Least Value First (LVF))
	ATRIB(2)	1	Vehicle assignment
		2	Aisle assignment
	ATRIB(3)		Not used.
	ATRIB(4)		Not used.
	ATRIB(5)		Vehicle number if ATRIB(2) = 1. Not used if ATRIB(2) = 2.
	ATRIB(6)		Aisle number if ATRIB(2) = 2. Not used if ATRIB(2) = 1.
M+1			Each file for a vehicle. M = vehicle no.
	ATRIB(1)		Time of order scheduled.
	ATRIB(2)	1	Vehicle assignment.
	ATRIB(3)		Item number. (Priority: Least Value First (LVF))
	ATRIB(4)		Number of units of ordered items
	ATRIB(5)		Vehicle number the order scheduled
	ATRIB(6)		Aisle number where ordered item is located.

A-2 Files and Attributes of Entries

File No.	Attributes	Code	Definition
J+NV+1			Each file for an aisle. J = Aisle number NV = Number of vehicles used for picking in the warehouse.
	ATRIB(1)		Not used.
	ATRIB(2)		Not used.
	ATRIB(3)		Item number the vehicle picking.
	ATRIB(4)		Number of units to be picked.
	ATRIB(5)		Vehicle number which is picking from the aisle. (Priority: First in First Out (FIFO))
	ATRIB(6)		Aisle number from which the vehicle is picking.
J+NA+NV+1			Each file for waiting queue of an aisle. J = Aisle number NA = Number of aisles in the warehouse. NV = Number of vehicles in ware- house
	ATRIB(1)	<u> </u>	Time vehicle started waiting
	ATRIB(2)		Not used.
	ATRIB(3)		Item number to be picked.
	ATRIB(4)		Number of units to be picked.

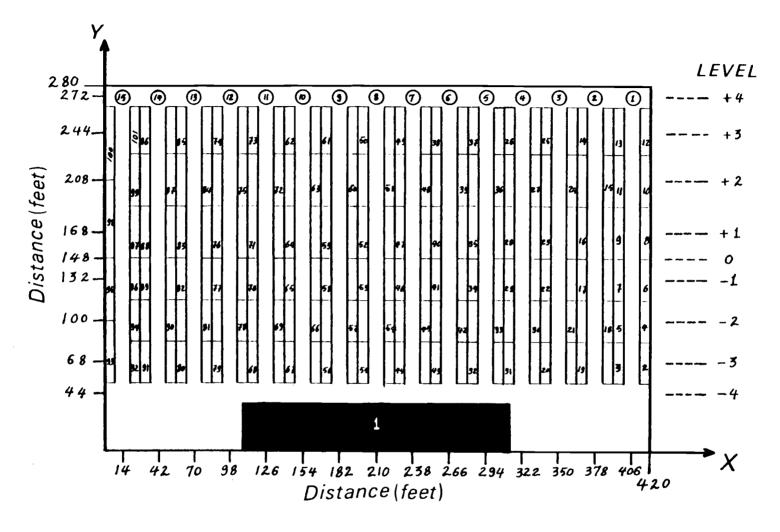
A-2 (Continued)

File No.	Attributes Code	Definition
	ATRIB(5)	Vehicle number which is waiting for the aisle. (Priority: First in First out (FIFO))
	ATRIB(6)	Aisle number for which the vehicle is waiting.

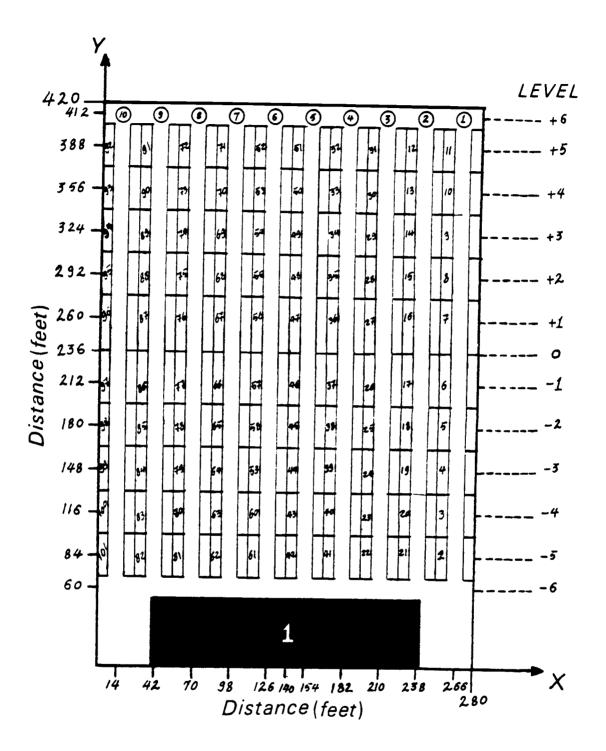
Subroutines or Function	Description
Subroutine GASP	Executive routine for advancing time and status.
Subroutine DATIN	Initializes GASP variables and calls user written functions INTLC and STATE.
Subroutine FILEM(IFILE)	Files on entry into IFILE.
Subroutine RMOVE(NTRY, IFILE)	Removes entry NTRY from file IFILE.
Subroutine COLCT(XX,ICLCT)	Records value XX as an observation on variable number ICLCT.
Subroutine HISTO(XX,T, ISTAT)	Determines the cell number associated with the value XX for variable IHIST and increases the cell content by one.
Subroutine GPLOT (XX,T, IPLOT)	IPLOT is the plot number and GPLOT stores values of the dependent variables XX for a value of the independent variable T.
Function NPSSN(IPAR, ISTRM)	Poisson deviate generator using stream ISTRM and parameters from parameter set IPAR.
Function DPROB(CPROB, VALUE,NVAL)	A deviate generator for obtaining samples from a probability mass function using stream ISTRM; CPROB is a vector of the cumulative probability values for the probability mass function; VALUE contains the possible deviates that can be ob- tained from DPROB; NVAL is the number of values in the vectors CPROB and VALUE.

APPENDIX B

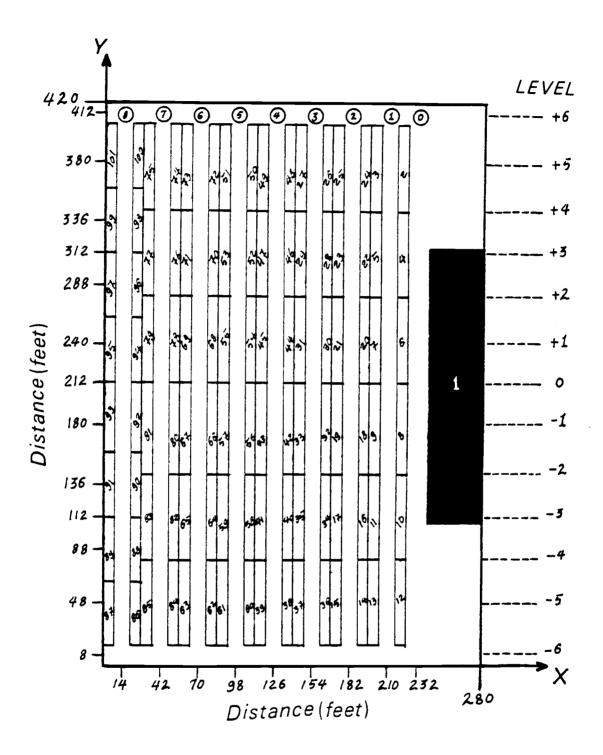
Warehouse Layouts, Flow Charts and Program Listings



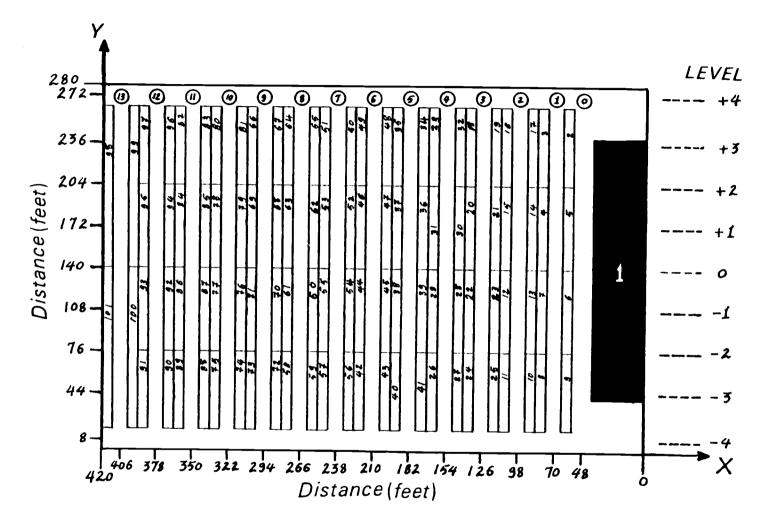
B-1 Layout(1) shows Item Location, Aisle, and Level Numbers, and Distances in X and Y Coordinates



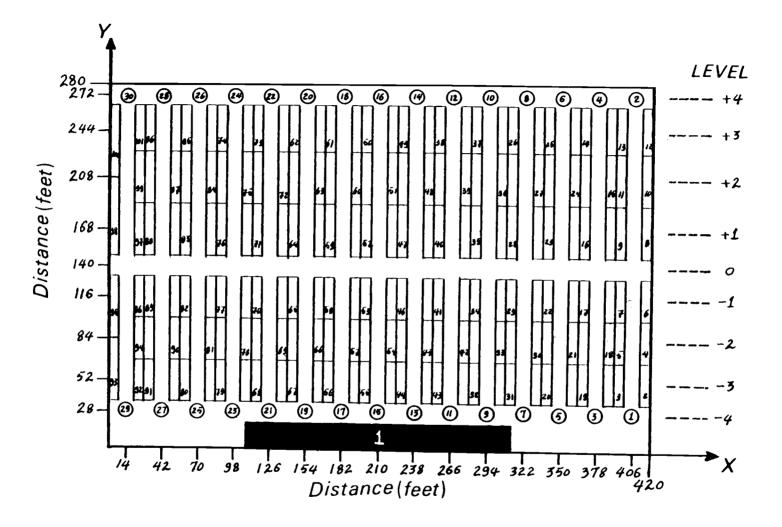
B-2 Layout(2) shows Item Location, Aisle, and Level Numbers, and Distances in X and Y Coordinates



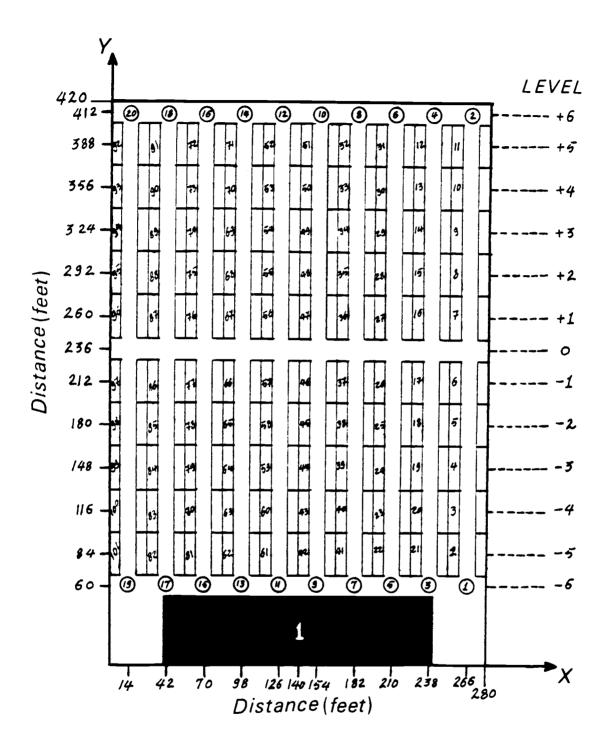
B-3 Layout(3) shows Item Location, Aisle, and Level Numbers, and Distances in X and Y Coordinates



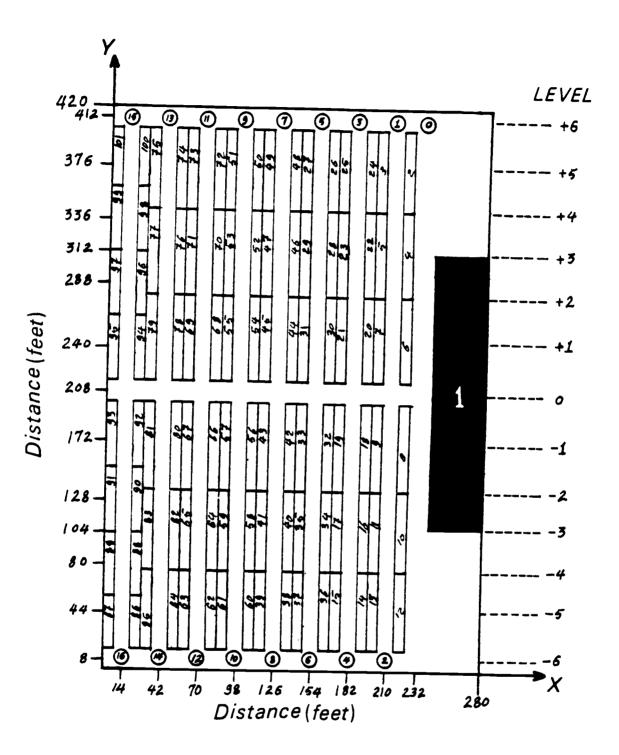
B-4 Layout(4) shows Item Location, Aisle, and Level Numbers, and Distances in X and Y Coordinates



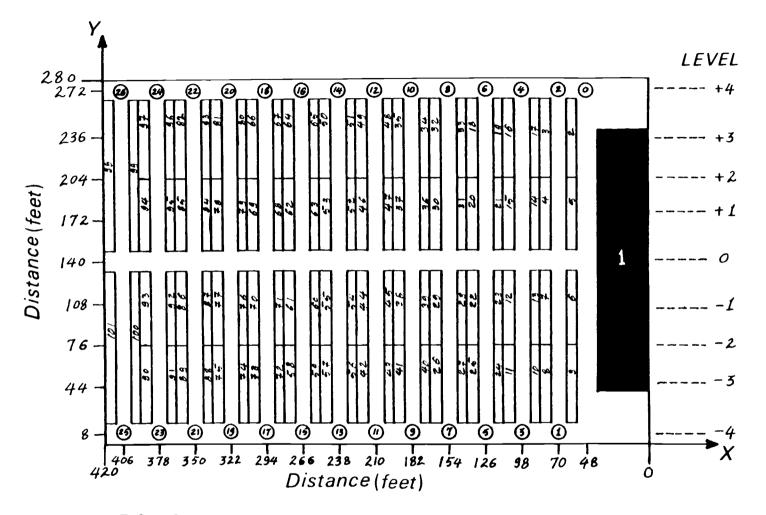
B-5 Layout(5) shows Item Location, Aisle, and Level Numbers, and Distances in X and Y Coordinates



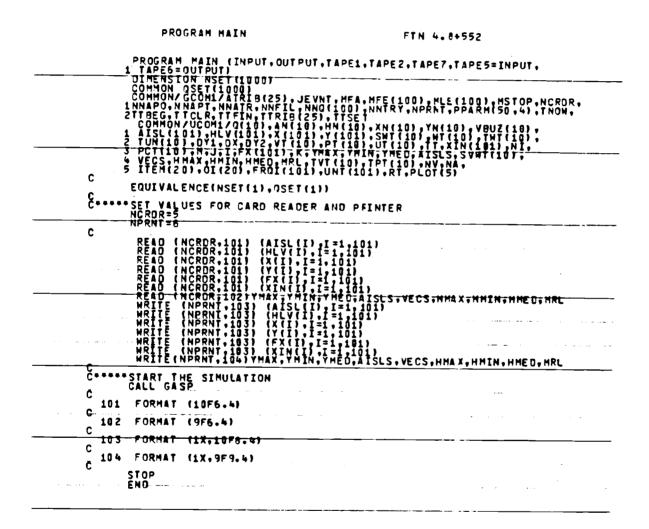
B-6 Layout(6) shows Item Location, Aisle, and Level Numbers, and Distances in X and Y Coordinates



B-7 Layout(7) shows Item Location, Aisle, and Level Numbers, and Distances in X and Y Coordinates

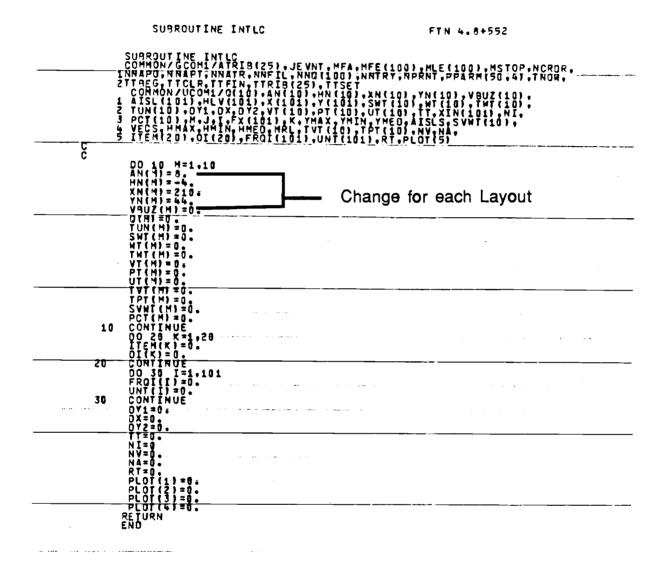


B-8 Layout(8) shows Item Location, Aisle, and Level Numbers, and Distances in X and Y Coordinates



B-9 Listing of Program "MAIN" used for all Layouts

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B-10

Listing of Subroutine "INTLC" used for all Layouts with the necessary chages

72

SUBROUTINE EVNTS

	SUBROUTINE EVNIS(IX) COMMON/GCOMI/ATRIB(25),JEVNI,MFA,MFE(100) LNNAPO,MMAPI,MNATR,MMFIL,MNG(100),MMTRY,MP	HLE (100) . HSTOP . HCRO
	2ftbeg.ttclR.ttfIN.ftRIB(25).ttset	
		YN(10), YBUZ(10),
	Z TJN(10) + DY1 + DX + DY2 + VT (18) + PT (10) + UT (10) +	TT +XIN(101) +NI+
	: AISt(101), HLV(101), X(101), T(101), SWT(10) : TJN(10), DY1, DX, DY2, VT(10), PT(10), UT(10), : TJN(10), H,J,FK(101), X, YMAX, VMIN, YMED, A : VETS, HMAX, HMIN, HMED, MKL, TYT(10), TPT(10), : TEM(20), OI(20), FRQI(101), UNT(101), RT, PL	ISLS,SVHT(10),
	5 ITEN(28),01(28),FRQ1(101),UNT(101),RT,PL	or (5)
<u> </u>		
	63 TO (101.102), IX	
1€1	H=ATRIB(5)	
	NA=VIZT2	
	NV #V ECS NA # A ISLS IF (VBUZ(M).6T.8.8) GO TO 45 OJ 5 L#1.20	
	ITEH(L)=0.	
	OI(L) = 0. 	
-	ŇĪ#MPSŠŇ(1,1) DO_28 K#1,NI	
	ATRIBTLY =TNON	
1.8	ATRIB(2)=1. DI(K)=DPROB(FX_KTH=181.3)	
	00 15 H=1+20	and a second
	IF (ITEM(N).EQ.DI(K)) GO TO 18 Continue	
•	- CONTINUE ITEM(K) = OI(K) ATRIB(3) = ITEM(K)	
	TELTRIAL	
-	FRQI(I)=I CALL HISTO (FRQI(I)-1)	
	ATRIB(+)=NPSSH(2+2)	
	UNT(I)=ATRIB(A) CALL HISTO (UNT(I)+2) ATRIB(2)=M	
	ATRIB(5) =M ATRIB(5) =AISL(I)	
• •	CALL FILENTNALI CONTINUE	
20		
	Q(H) =N I CALL COLCT(Q(H), H) CALL HISTO (Q(H), 3) CALTO SU GO TO SU	
	- CALL HISTO (Q(H) +3)	
C		
45	K= AN (M) CALL - PHOVE (HEE (K +HV+1), (K+HV+1))	
50	CALL RNOVE (HFE (K +4 V +1) + (K + 4 V +1)) IF (9(4) - E0 - A - A - E0 - FO - 7 - 4 FO - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 -	
	CALL RMOVE(HFE(M+1),(M+1)) I=ATRIB(3)	
	J=AISL(1) IF (NNQ(J+NV+1).GT.8.0) 60 TO 60	
	IF (AN(M).EQ.AISL(I)) 60 TO 55	
55	IF [NNQ[]+NA+NV+[].5T.3.0] 60 TO 58 TUN(M)=[UN(M)+ATRIB(4)	
<u> </u>		
	CALL PICK CALL FILEM (J+NV+L)	
	V8UZ4N3=1. Q(N)=Q(N)=1. TVT(N)=TVT(N)+VT(N)	
	ŢŸŢ(H)*TYŢ(Ň)+YŢ(N) TPŢ(N)*TPŢ(N)*PŢ(N)	
	ATRIB(1) = TNOW+TT ATRIB(2) = 1	
	ATRIB(5) #M	
	CALL FILEM (1) -60 to 104	
C		
61	CALL PICK SWT(MJ=TNON+VT(MJ	
	ATRIB(1) = SHT(H) CALL FI FM (1+NA +NV+1)	
	VQ117 (M1 = 2	
	TVT (H) = T VT (H) + VT (H)	

B-11 Listing of Subroutine "EVENTS" used for all Layouts

GO TO 104 C T=1. CALL COLCT (TUN(H),H+NV) CALL PICK TVT(M) = TVT(M) +VT(M) CALL COLCT (TVT(M), M+(2)*(NV)) PLOT(1) = TVT(M) TPT(M) = TVT(M) +UT(M) CALL COLCT (TPT(M), M+(3)*(NV)) PLOT(2) = TPT(M) CALL COLCT (TNT(M), M+(4)*(NV)) PLOT(3) = THT(M) SVWT(M) = TVT(M) +TWT(M) CALL COLCT (SVMT(M), M+(5)*(NV)) PLOT(4) = SVWT(M) CALL COLCT (SVMT(M), M+(5)*(NV)) PLOT(5) = PCT(M) CALL COLCT (PLOT, TNOW, M) VAUZ(M) = 0. TVT(M) = 0. SVWT(M) = 0. SVWT С CALL PICK C J=ATRIB(6) NV=VECS NA=AISLS IF (NNQ(J+NA+NV+1),EQ.Q.Q.Q) GO IC 104 CALL RHOVE(MFE(J+NA+NV+1),(J+NA+NV+1)) RT=ATRIB(1) I=ATRIB(3) H=ATRIB(5) IF (RT.GT.TNOW) GO TO 103 TUN(H)=TUN(H)+ATRIB(4) 102 Ĉ CALL PICK CALL FILEM (J+NV+1) -VBUZ(M)=1. Q(M)=Q(H)-1. MT(M)=TNOWSWT(H)-TWT(M)=TNT(H)+NT(H) ATRIB(1)=INON+TT ATRIB(2)=1. ATRIB(5)=M CALL FILEM (1). GO TO 104 С CALL FILEM-(J+NA+NV+1) ATRIB(1)=RT ATRIB(2)=2. ATRIB(6)=J CALL FILEM (1) 103 C 104 RETURN END

SUBROUTINE EVNTS

FTN 4.8+552

B-11 "EVENTS" (Continued)

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SU	BROUTINE PICK	FTN 4.8	+ 552
SUBROUTIN COMMON/GCO INNAPO,NNAP 2 TTBEG,TTCL COMMON/UC 1 AISL(101) 2 TUN(10),0 3 PCT(10),M 4 VECS,HMAX 5 ITFM200.	E PICK H1/ATRIB(25), JEVNT, HF T.NNATR.NNFIL, NNG(100 R.TTFIN, TTRIB(25), TTS OH1/Q(10), AN(10), HN(1 .HLV(101), X(101), Y(10 .HLV(101), X(101), Y(10 .HLV(101), X(100), HAX, Y .HMIN, HEDO, MRL, TVT(10 .HIN, HEDO,	A, MFE(100), MLE(100), MSTOP, N 1, NHTRY, NPRNT, PPARM(50, 4), T ET (), XN(10), YN(10), VBUZ(10), 1), SWT(10), TN(10), TWT(10), 0), UT(10), TT, XIN(101), NI, NIN, YMED, AISLS, SVWT(10), 0, TPT(10), NV, NA, U1), RT, PLOT(5)	CRDR
1F (V8UZ(H)-1.0) 10.50.180	1017.RI,PLOT(5)	
10 NV=VECS	+NV+1).GT.8.0) GO TO +NA+NV+1).GT.0.0) GO T	50 C 20	
DY2=ABS(Y HN(M)=HLV YN(M)=Y(I)=Y(I) YT(M)=(AT TT=YT(M)+(GOTO 200 GOTO 200	(I) - YN (M)) (I) (A (4)) + (0, 2)	· · · · · · · · · · · · · · · · · · ·	
C 20 AIRIB(1)=1 AIRIB(2)=1 AIRIB(2)= CALL FILE 30 DY1=0: 0X=ABS(X(1)	(1)		
C 60 10 200	+0X+0Y2)/264.		
50 NV=VECS NA=AISLS IF (0(M).G OYI=ABS(TM DX=ABS(X(I DY2=0.	T.0.0) GO TO 60	······	
HN(M)=HLV(YN(M)=Y(I) VT(H)=(DY1 UT(H)=(TUN TT=VT(M)+	+DX+DY2)/264. [M])*(0.2) [(M)	то на селото на селот Селото на селото на с Селото на селото на с	· · · · ·
ATRIB(1)*T ATRIB(2)*2 ATRIB(6)*A CALL FILEH GO TO 200	NÓW+(DY1/264.) N(M) (1)		
60 IF (NN G(J+ IF (AN (M)) IF (NN G(J+ IF (NN G(J+ IF (NN G(J+ IF (HN (M))) DY = ABS (YM DX = ABS (YM DY = ABS (YM DY = ABS (YM	VV+1).GT.0.0) GO TO 10 GAAISL(1) GO TO 10 AANV+1).GT.0.07 GO TO 1V(1).GT.0.0) GO TO IN-YN(M)) -XN(M)) (N-Y(1))		
GO TO 80			
DX=ABSTX(1) DY=ABSTX(1) DY=ABS(1)=1 ATRIB(1)=1 ATRIB(2)=2 ATRIB(6)=4 CALL FILEN HN(M)=H(V(1)) YN(M)=V(1)) VT(M)=(DY1)	=XN(M); XX-Y(I); IOW+(DY1/264.) I(M) 1)		
TT=VT(M)+Pi			

B-12 Listing of Subroutine "PICK" used for Layouts(1) and (2)

	SUBROUTINE FICK	FTN 4.8+552
с	GO TO 200	
90	ATRIB(1)=TNOW ATRIB(2)=2. ATRIB(6)=J CALL FILEM (1) IF (HN(M)+HLV(I).GT.0.0) (DY1=ABS(YHIN-YN(M)) DX=ABS(X(I)-XN(M)) DY2=0.	GO TO 110
C 110	HNTMJ=HMIN YN(M)=YMIN GO TO 120 DY1=ABS(YMAX-YN(M))	
	DX=ABS(X(I)-XN(H)) DY=4D HN(H)=HMAX YN(H)=HMAX	· · · · · · · · · · · ·
120	VT(H) = (DY1+0X+0Y2)/264. ATRIB(1) = TNOM+(DY1/264.) ATRIB(2) = 2. ATRIB(6) = AN(H) CALL FILEM (1) GO TO 200	
<u> </u>	DY1=HBS(YN(H)=Y(1))	
	DX=0. DY2=0. HN(M)=HLV(I) YN(M)=Y(I) VI(M)=(DY1+DY+DY2)/266.	
	PT(H) = (ATR19(4)) * (0.2) TT=VT(H) +PT(H)	стана на селото на с Селото на селото на се
-	RETURN	· · ·

SUBROUTINE PICK

FTN 4. 4+552

B-12 "PICK" (Continued)

2									GNT/0))M	C4CU1								IF LOOX H	017	1) 121		AXV1	N (T)M		101K	2010 .	コシシシャイ		• • • • • • •			IO10M))))]]	• • • N		1(11)	1000	101	;	Y Ŧ I	NI HI SL	0 1 I I) 0 N	;	v		<u> </u>	1	ç)		R] 0 4), 4
3			I۶	-	(V	, .	3 1	IJ	Z	(Ņ	1)	-	1		0	,		1	0	,	5	0	•	1	8 1	0																									
2 10				/=	V 4 () (EIN NN H			SLOOV	5((1 1 1	+++	N	VAG	+ + T	1 N) V	•	Gin	T	•	n	•	n	,	1	5.0	h	G	00	1	3: T	0 C	Z	2 0																		
12				2	=	0	9		S L	5	Y V	M	I	N V	-	۷ ۷	(I /) M)																																	
15				=2((((=	A = M H H H N	84))))T	29 = = = = (() 547((4)			IM())1) A I +		X T	N Y Fi	(M I Y)) 2)))		21	54	• (•																												
20	0	4	Ţ	Ro	ļ	8	ţ	1			=	1	N)	W																																						
36			AFYXY	ί 1=2	16(=4=		(FL05.					J M I I	i		Ť) *')))	ŗ	50)	T	1)	3	5																									
		Y	N	(4)	=	۲	N	ij	ŀ	4																																									
35		0	Y	1	- 1	8 9	Ş	S	; (١											I																																
40		H Y V	Y NNTO		4		=	Y (3		1)	t	•0))	()	HC) Y	' 2	2)	/	2	6	4	•																													
50		NIHOD	VAFFYXY	= /	1 () () ()			L 14 (5	5145	i	ŗ	ij	, I []		• 1	1.)	ı)	5	0	T	0 T	0	6	05	2																										
52		G	Q Y)	3	Ŝ	5()	۷	Ņ	10	U	(-	• 1	'N			ņ)																																	
55		0 H Y V	NI. T	?: (``	: (1) 1) 1)		3:	S H Y ((L(D	V V I Y	1	I		: - i y	• •		I) 2)	,	2	5	4																														
		Y	T = T = T = T = T = T = T = T = T = T =			- 1 - (-) -) -) -) -) -) -) -) -) -)		(H1251	T))))L	U+===E	NU T Z A			M M M)) 4	•	(0	•	2))																												
60		I I I	F	- (4	٩.	Į.	(м)		Ξ	ŋ		4	Ι	S	L	1	I.	١.	1	- 1	G.	C.		٢c	3	1	٩	1 C T			an	1																		

SUBROUTINE PICK

B-13 Listing of Subroutine "PICK" used for Layouts(3) and (4)

FT1 4.3+552

```
FTN 4.8+552
                                IF (HN(M)+HLV(I).GT.0.0) GO TO 70
DY1=A8S(YMIN-YN(M))
DX=A8S(YMIN-YN(M))
DY2=A8S(YMIN-Y(I))
GO TO 80
                              DY1=A9S(YMAX-YV(M))
DX=A9S(YMAX-YV(M))
DY2=A3S(YMAX-Y(I))
ATRIB(1)=TNOW+(DY1/254.)
ATPIB(2)=2.
ATPIB(2)=2.
ATPIB(6)=AN(M)
CALL FILEM(1)
HN(M)=Y(I)
VN(M)=Y(I)
VT(M)=(0Y1+DX+DY2)/264.
PT(M)=(ATRIB(4))+(G.2)
TT=VT(M)+PT(M)
GO TO 200
   С
         70
                80
                            ATRIB(1)=TNOW

ATRIB(2)=2.

ATRIB(6)=J

CALL FILEM (1)

IF (HN(M)+HLV(I).GT.0.0) GO TO 110

DY1=ABS(YMIN-YN(M))

DX=ARS(X(I)-XN(M))

DX=0.

HN(M)=HMIN

YN(M)=YMIN

GO TO 120
 С
              90
           100
 C
         110 DY1=ABS(YMAX-YN(M))
DX=ABS(X(I)-XN(M))
DY2=0.
HN(M)=HMAX
YN(M)=YMAX
120 VT(M)=(DY1+DX+DY2)/264.
ATRIB(1)=TNOM+(DY1/264.)
ATRIB(2)=2.
ATRIB(5)=AN(M)
CALL FILEM (1)
GO TO 200
С
                            DY1=A 9S(YN(H) -Y(I))

DX=0.

DY2=0.

HN(M)=HLV(I)

YN(M)=Y(I)

VT(M)=Y(I)

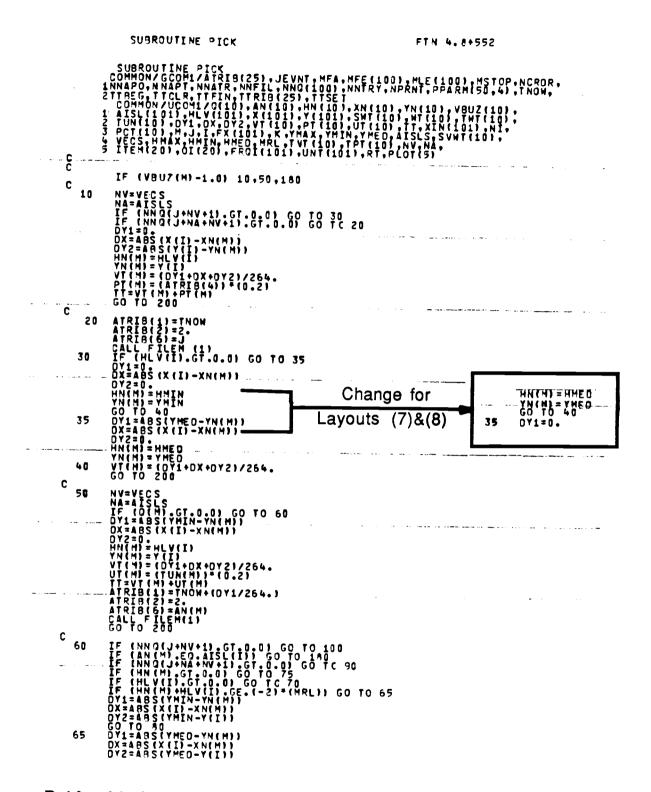
VT(M)=(ATRI9(4))+(0.2)

TT=VT(M)+PT(M)

AN(M)=AISL(I)

XN(M)=X(I)
         180
         200
С
                         PETURN
END
```

SUBROUTINE PICK

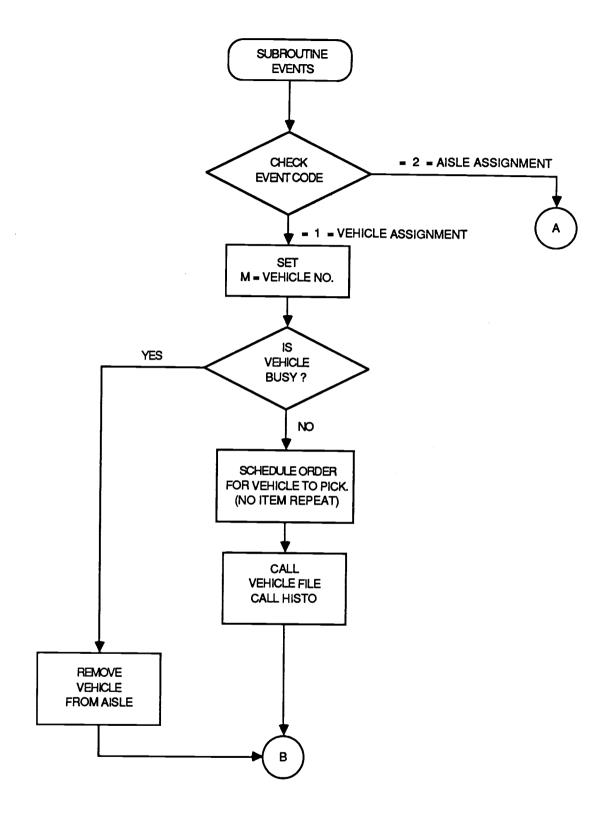


B-14 Listing of Subroutin "PICK" used for Layouts (5)&(6), and with the necessary changes for Layouts (7)&(8)

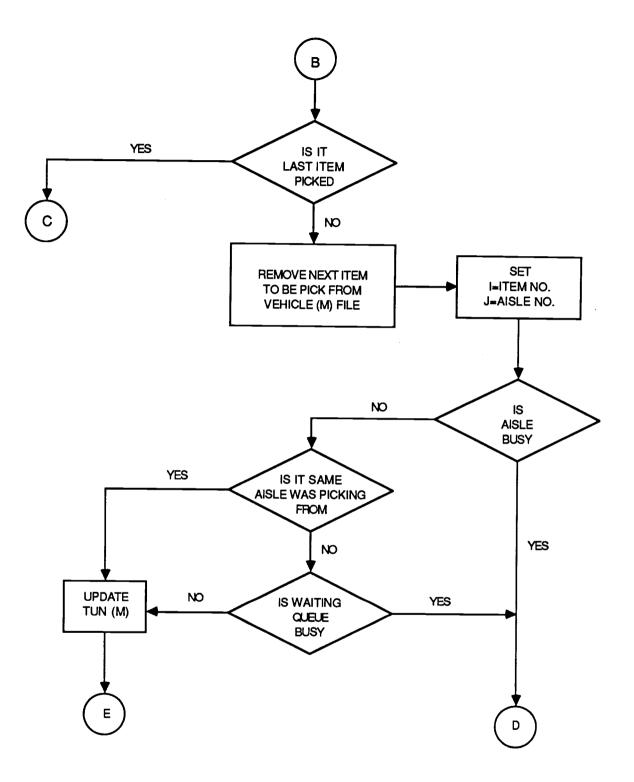
		SUBRO	UTINE	PICK			FTN 4.8+552	
	70	GO TO DV1=AB DX=ABS DV2=0.	50 S(Y(I) (X(I) -	-YN(M) XN(M)))			
	75	GO TO 1 IF (HL) DY1=A95 DX=A85	30 /(I)_G S(Y(I) (X(T)-	T.0.0) - Yn(4) Xn(4))	, GO TO 7	7		
	77	DY2=0. Go to (0 (M)+HL (YMEO (X(I)-) (YMEO	V(I).G -YN(M) KN(M))	E • (2) * (MI)	RL)) GO	TO 79	
	C 79 80) = TNO) =2.) =AN() LEM(1)	+(0Y1	-		· • •	
	• • = ••	VT(M)=(PT(M)=(TT=VT(M)	DY1+DX ATRIB	(4)) + (;	/264. 0.21		an e la como or antipara	
Ċ	90	ATRIB(1 ATRIB(2 ATRIB(6) = TNOV) = Z.) = J		50. TO 110			
	. 100.	IF (HN(DY1=A8S DX=A8S(DY2=0. HN(H)=H YN(H)=Y	H) +HL V (YMIN- X(I) -X MIN	(I) .G	E.(-2) + (H		TO 105	
Ċ	105	DY1=A95 DX=A85(DY2=0.	(YHE0- X(I)-X	YN (M) 1 N(M))		·	····	
-	- 110	DY1=ABS DX=ABS (DY2=0.	MĚĎ 20 (I).LI M)+HLV (YMAX- X(I)-X	(1).Lt YN(H))	GO_TO_11 •(2)*(MR	5 L)) gō 1	0 115	
	115	HN(H) = H YN(H) = Y GO TO 1 DY1=ABS DX=ABS(MAX 20 (YMED-	YN (M)) N(M))				
	120	DY2=0. HN(H)=H YN(H)=(ATRIB(1) ATRIB(1) ATRIB(2) CALL FI GO TO 20	MED DY1+0X = TNOW = 2. = AN(M LEM (1	+(DY1/)	264. 264.)			
с	180	DY1=ABS DX=0. DY2=0. HN(M)=H(YN(H)=Y YN(H)=Y YT(H)=() PT(H)=()	(YN(H) (I) (I) (I) (I)	+DY2)/	264.			
	200 C	TT=VT (M) AN(M)=AI XN(M)=X(RETURN ENO	PT(H) SL(I) ()					
						10-		

B-14 "PICK" (Continued)

80



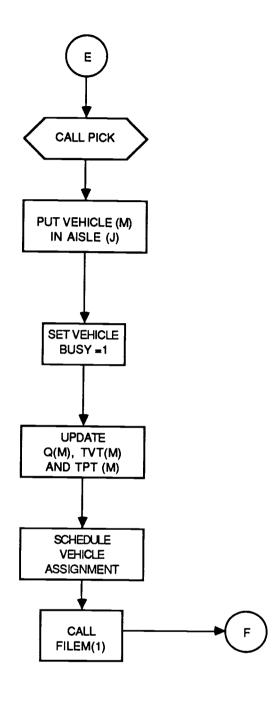
B - 15 Flow chart of subroutine " EVENTS" used for all layouts

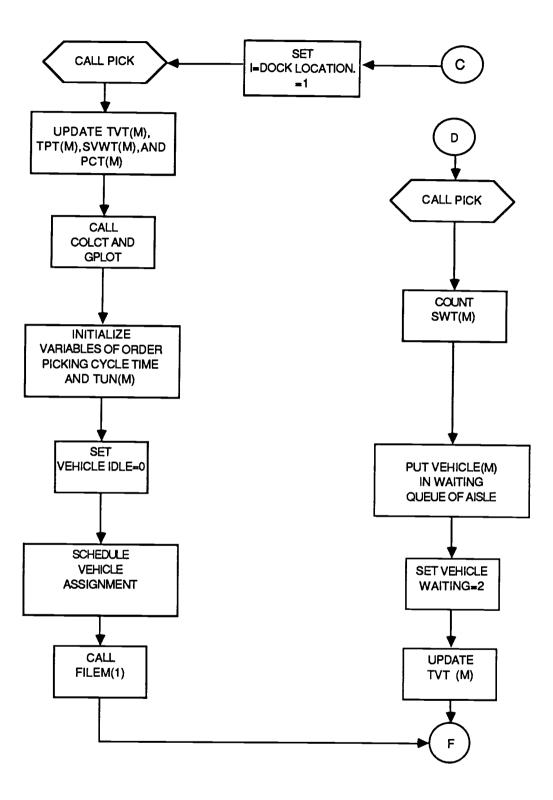


B-15 "EVENTS" (Continued)

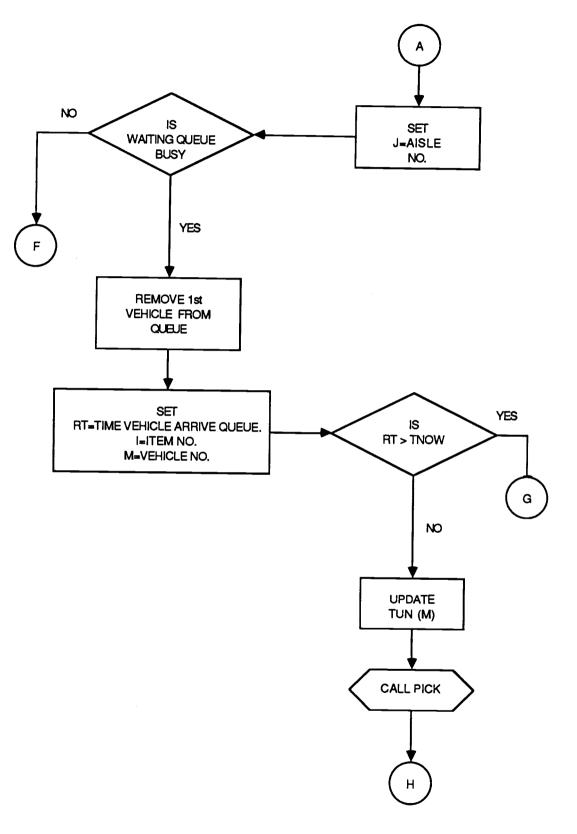
.

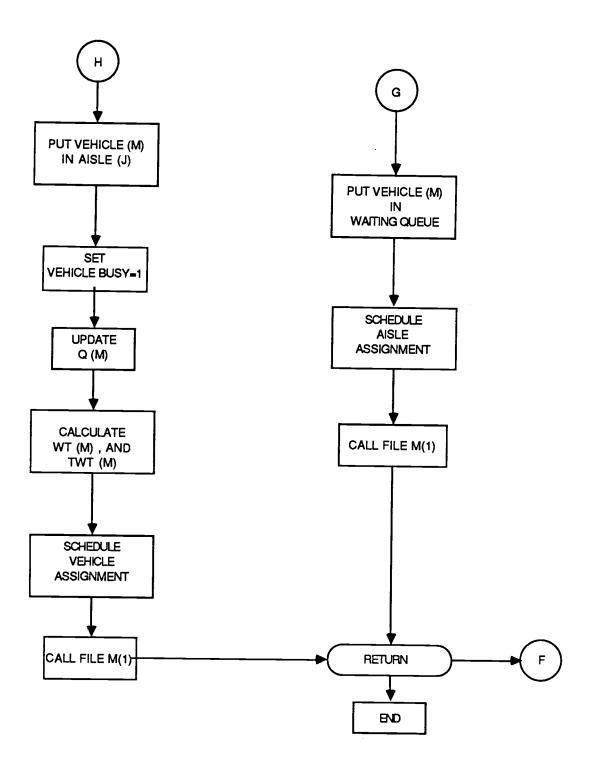
.



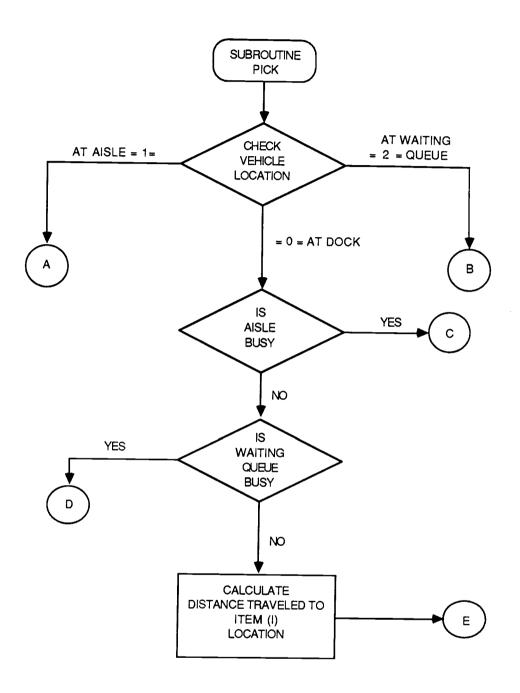


B-15 "EVENTS" (Continued)

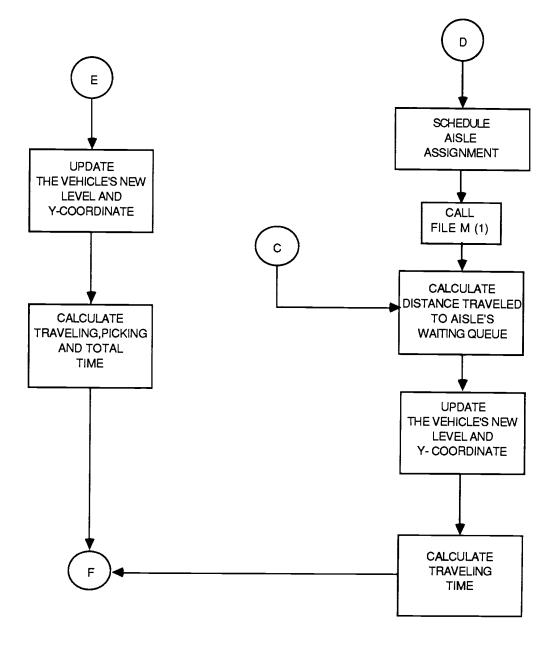


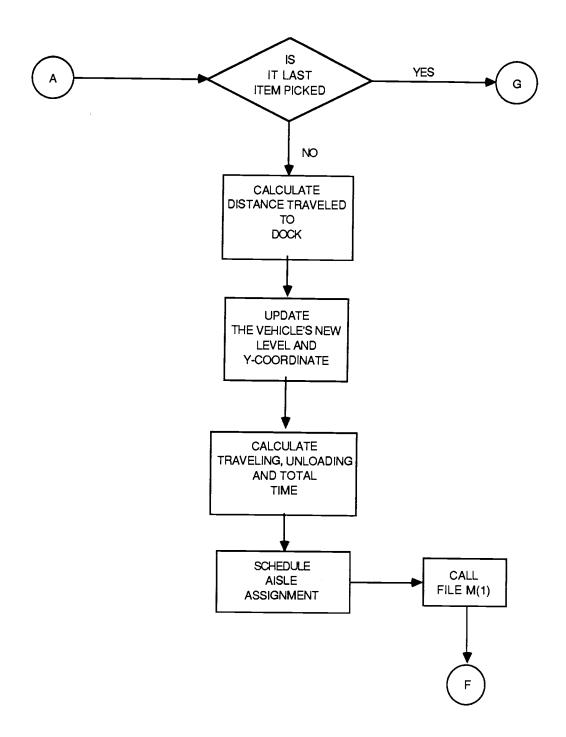


B-15 "EVENTS" (Continued)

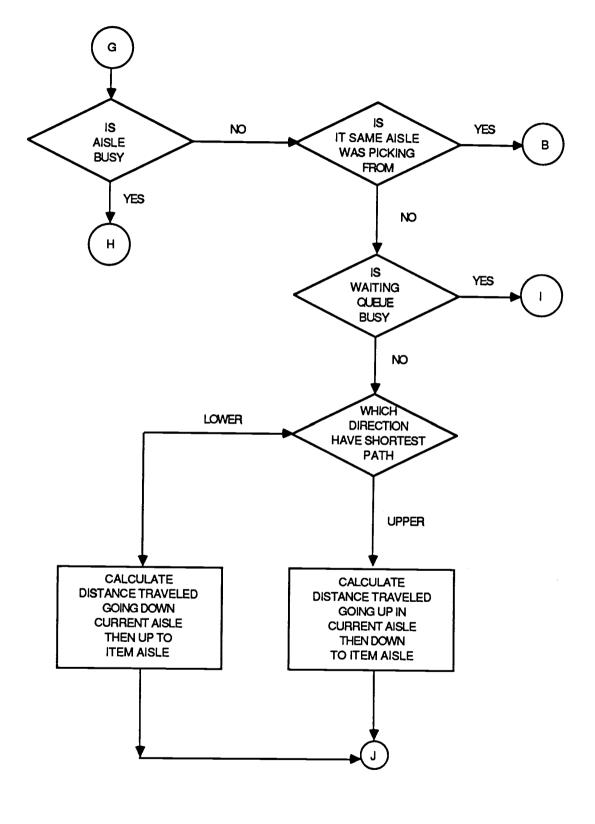


B -16 Flow Chart of Subroutine " PICK" used for Layouts 1and 2

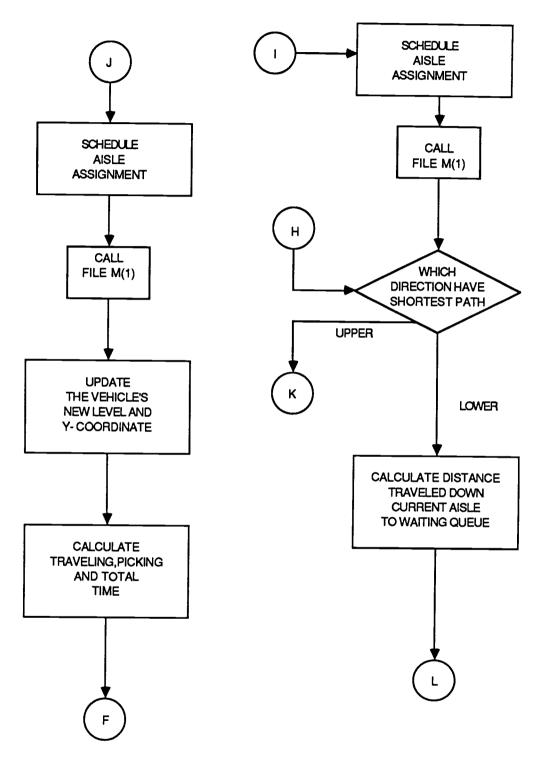


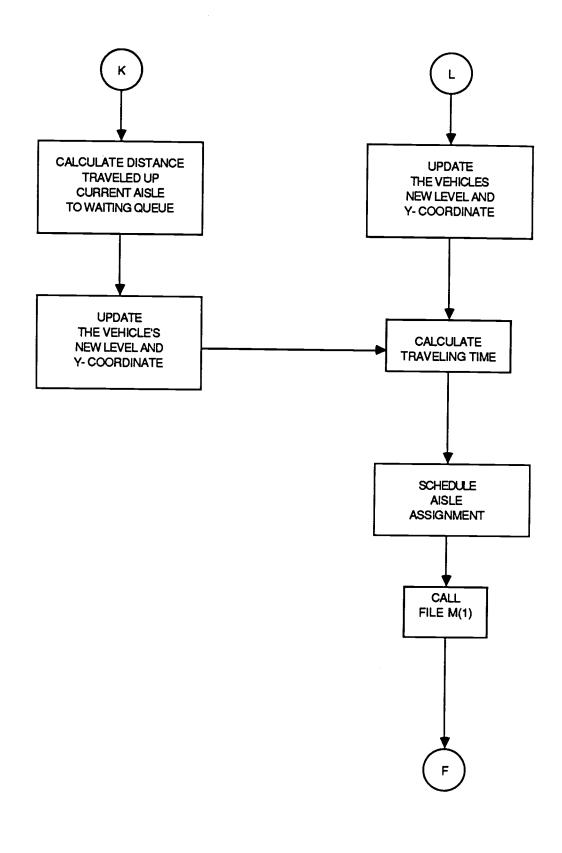


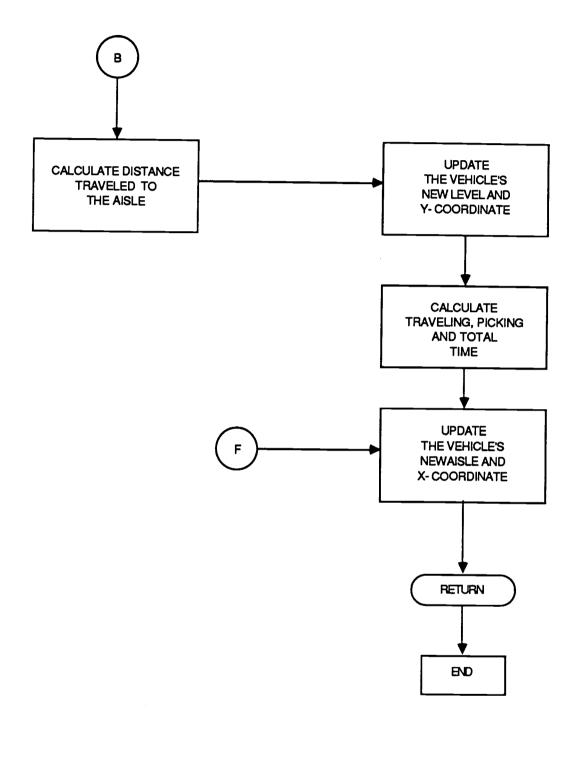
B - 16 "PICK " (Continued)



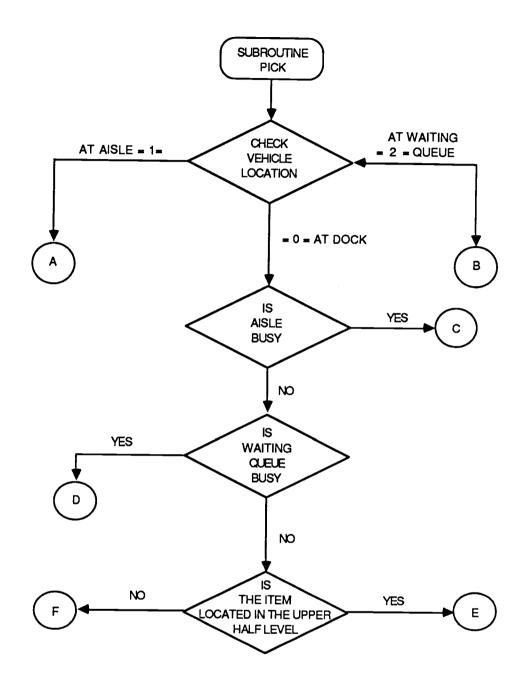
B - 16 "PICK " (Continued)



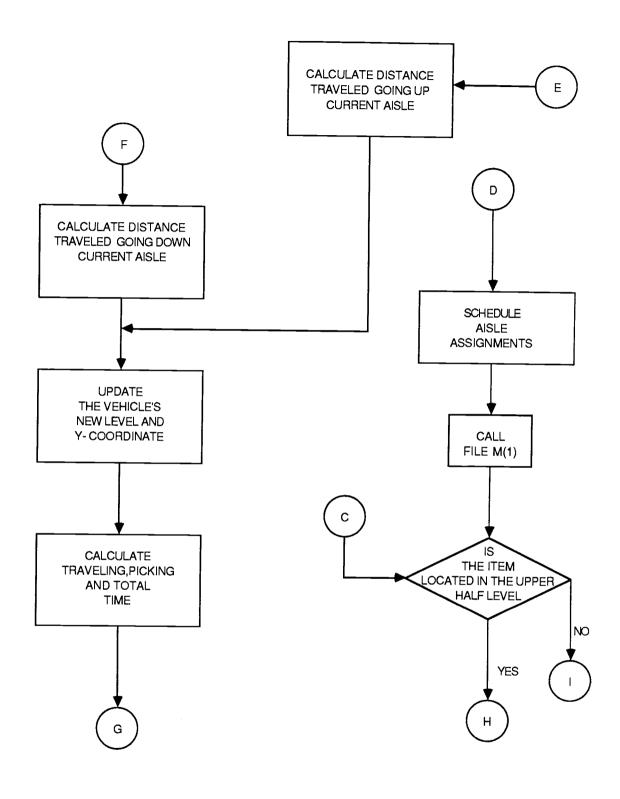




B - 16 "PICK " (Continued)

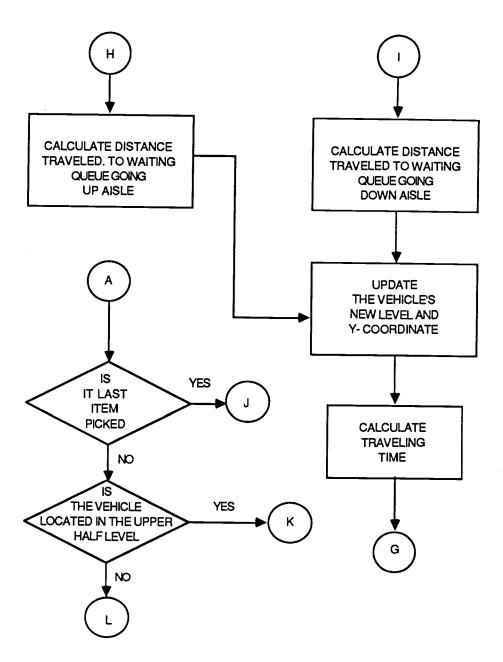


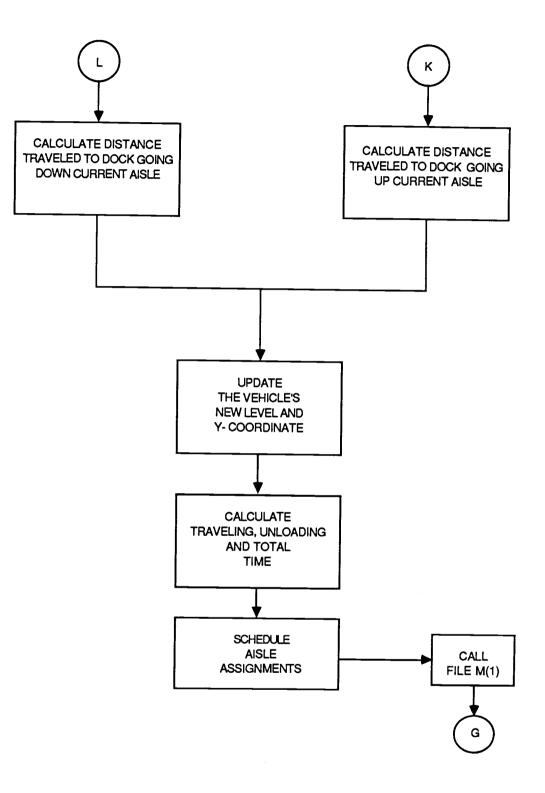
B -17 Flow Chart of Subroutine " PICK" used for Layouts 3and 4



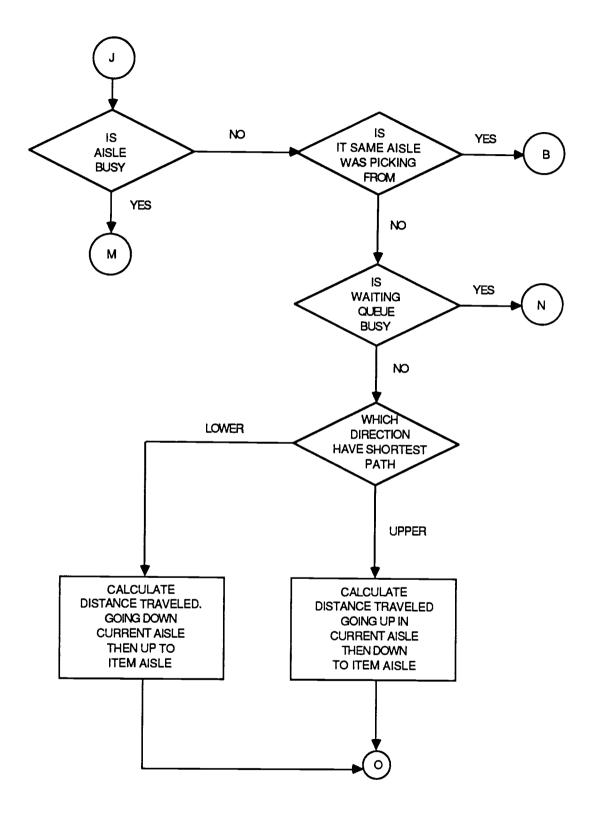
B - 17 "PICK " (Continued)

.

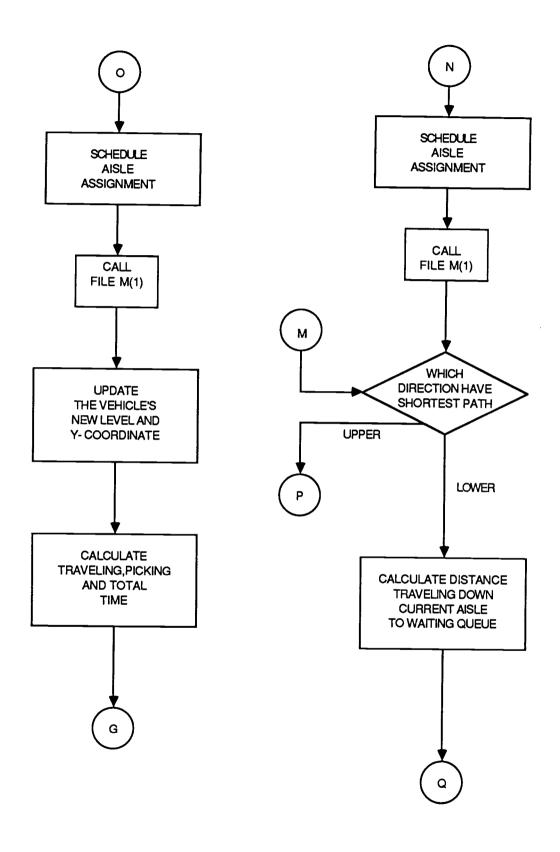




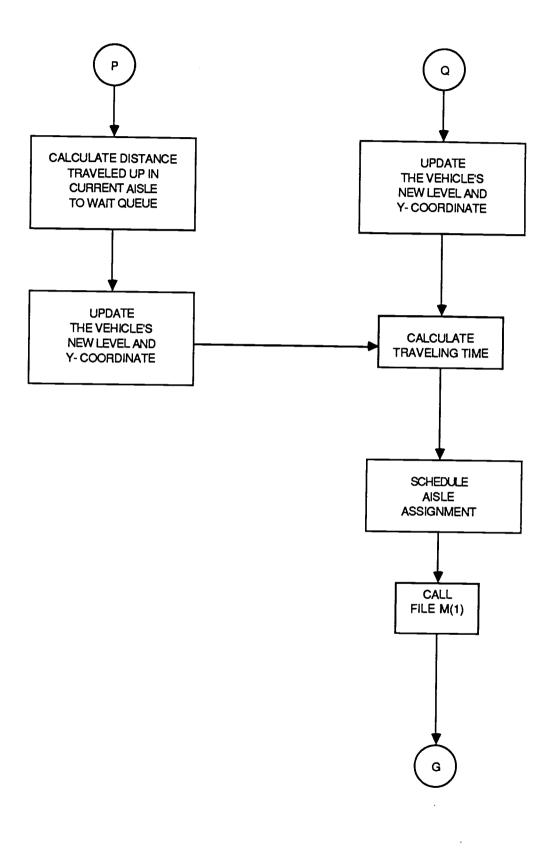
B - 17 "PICK " (Continued)



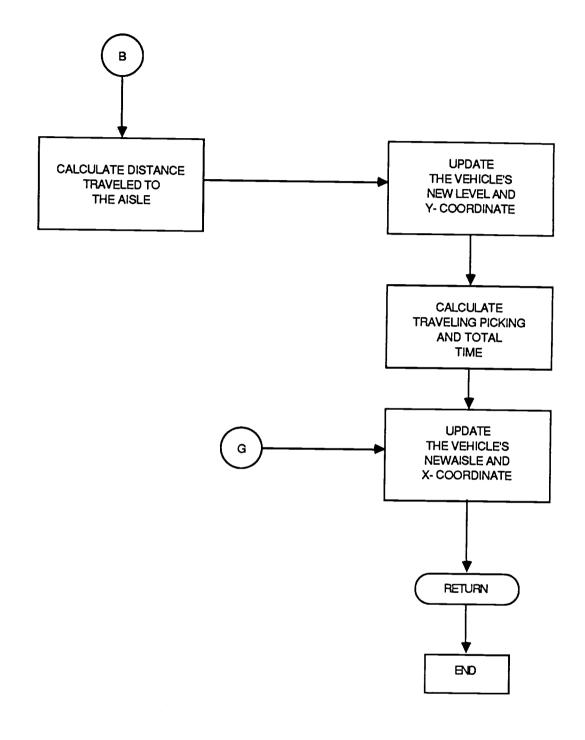
B - 17 "PICK " (Continued)



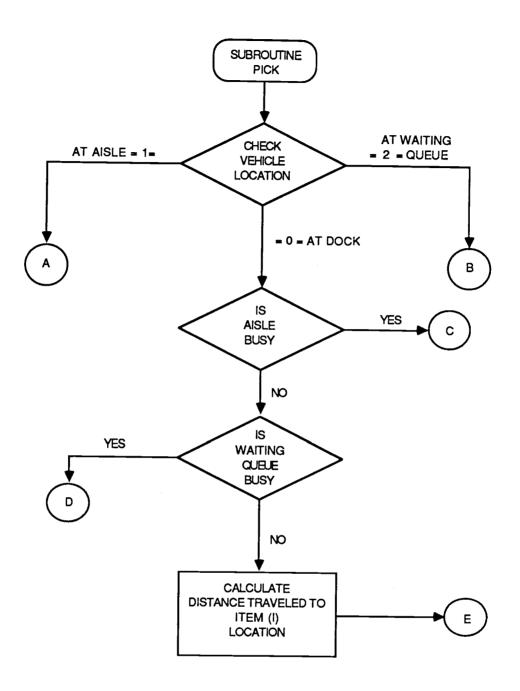
B - 17 "PICK " (Continued)



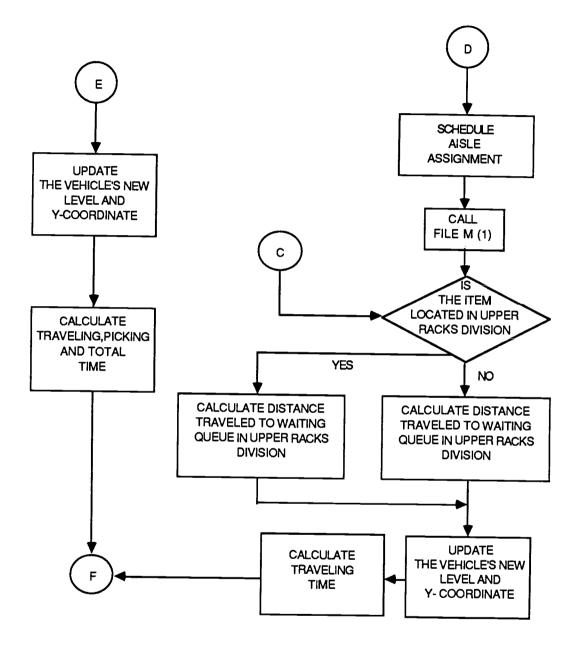
B - 17 "PICK " (Continued)

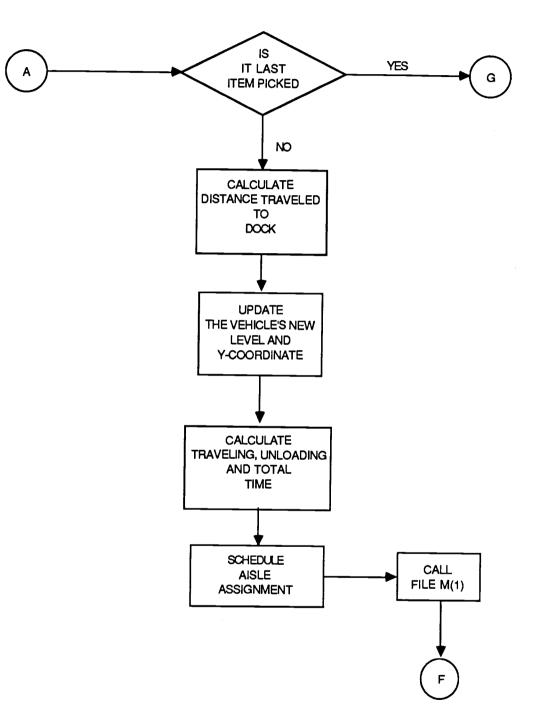


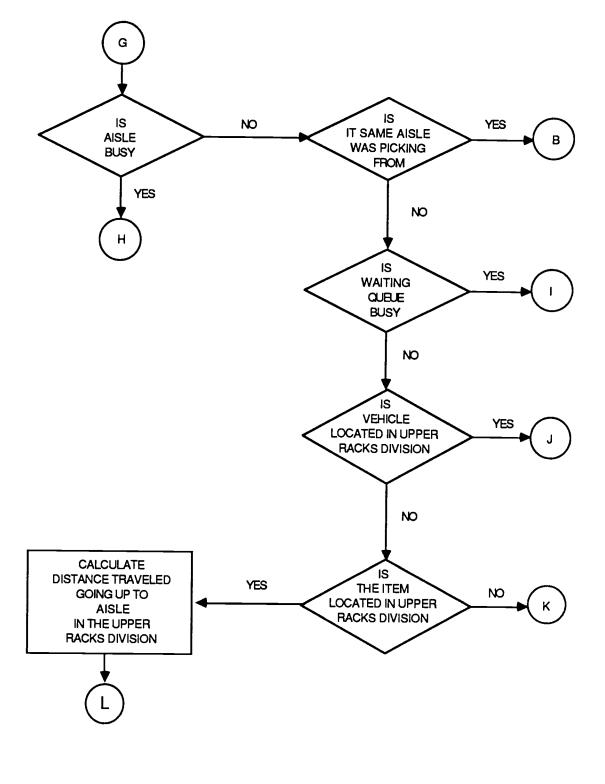
B - 17 "PICK " (Continued)



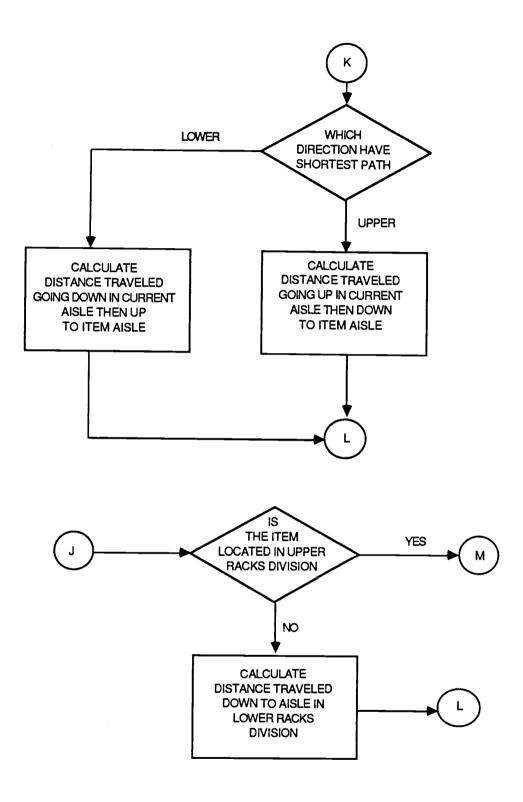
B -18 Flow Chart of Subroutine " PICK" used for Layouts 5,6,7 and 8



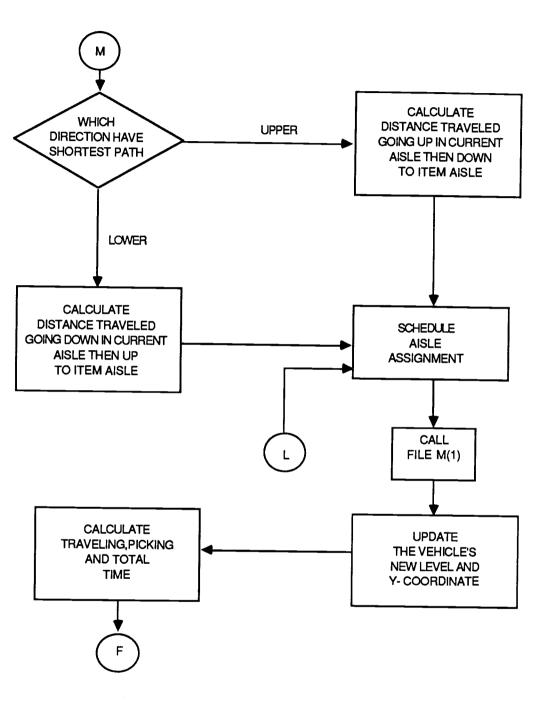


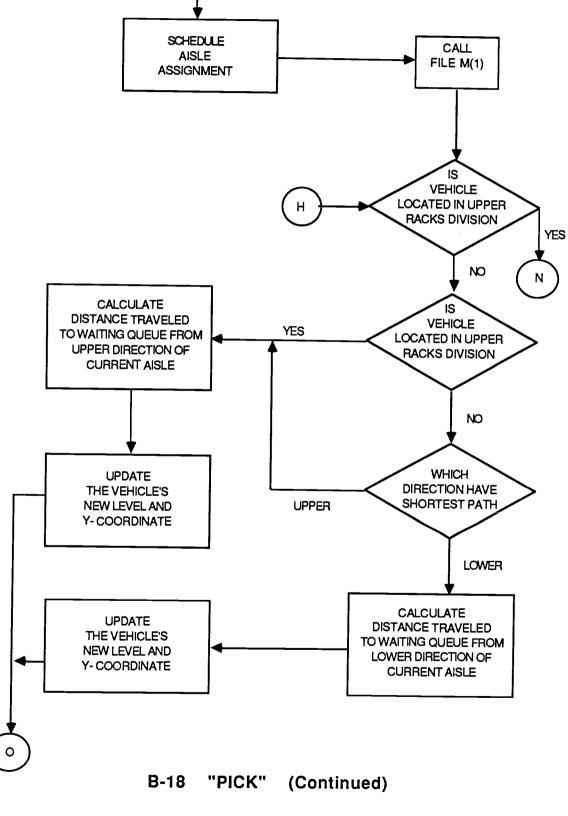


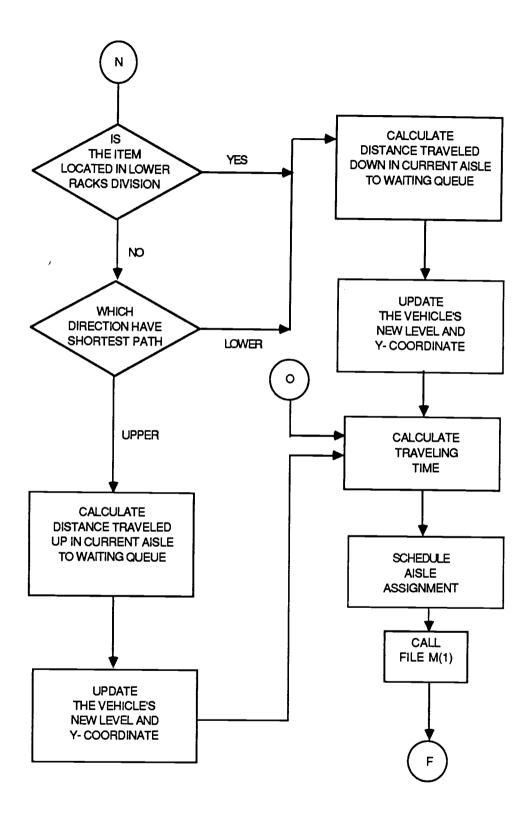
B - 18 "PICK " (Continued)



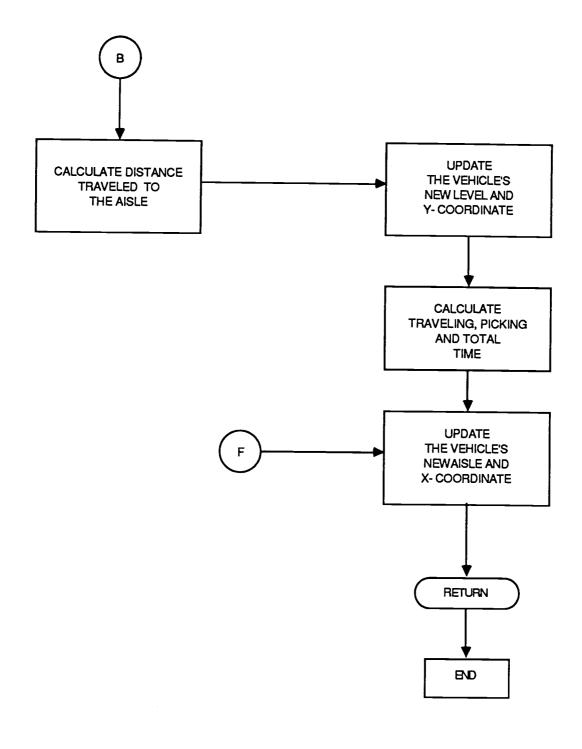
B-18 "PICK" (Continued)





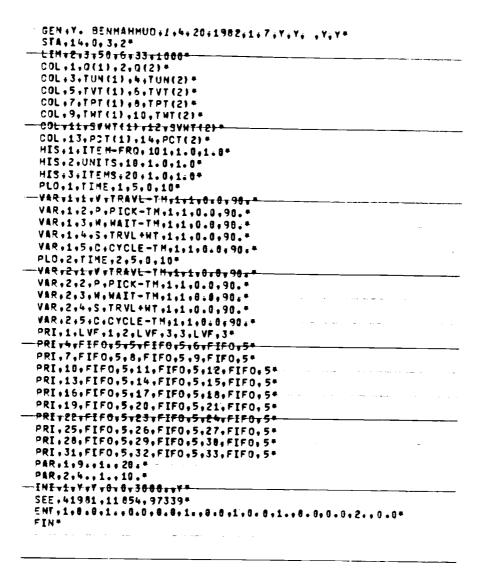


B-18 "PICK" (Continued)



APPENDIX C

Input Data and File Storage



C-1 General Input for Layout (1)

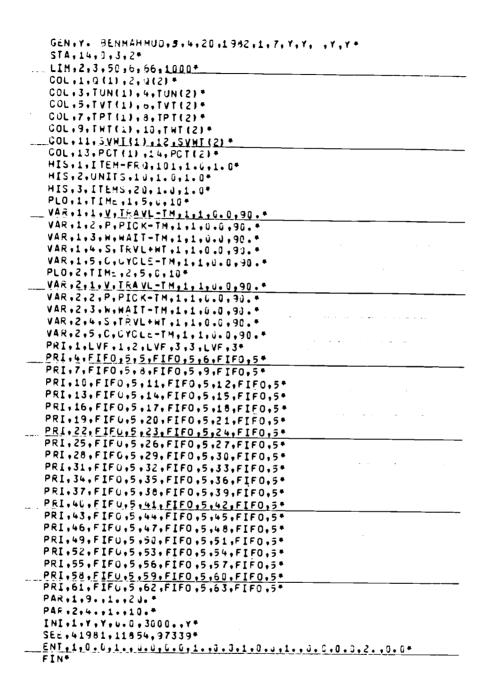
```
SEN.Y. RENMAHMUD, 2.4, 20, 1982, 1.7. Y.Y. . Y.Y.
ST4+14+0+3+2+
LIM+2+3+50+6+23+1000*
001+1+0(1)+2+0(2)+
COL. 3. TUN (1) . 4. TUN (2) .
COL . 5 . T VT (1) . 6 . T VT (2) .
COL . 7 . TPT (1) . 8 . TPT (2) .
COL . 9. THT (1) . 1C . THT (2) .
COL+11+SVWT(1)+12+SVWT(2)*
COL+13+POT(1)+14+POT(2)*
HIS.1.ITE "-FRO. 101.1.0.1.0*
HIS.2.UNITS.10.1.0.1.C*
HIS.3.ITEMS.20.1.0.1.0*
PL0.1.FIME.1.5.0.15*
VAR+1+1+V+TRAVL-TM+1+1+0+0,90.*
VAF .1.2, P.PICY-TM.1.1.6.0,99.*
VAR .1.3. H. WAIT-T M.1.1.C.D. 90. *
VAR.1.4.5.TRVL+WT.1.1.0.0.0.40.*
V49.1.5.C.CYCLE-TM.1.1.0.0.90.*
PL0+2+TIME+2+5+0,10*
VAR+2+1+V+TFAVL-TM+1+1+0.0,90.*
VAR . 2 . 2 . P . P ICK - T H . 1 . 1 . 6 . 0 . 90 . *
VAR.2.3.W.WAIT-TH.1.1.0.0.90.*
VAR + 2 + 4 + 5 + TR VL + WT + 1 + 1 + 0 + 0 + 90 + *
VAR, 2.5.C.CYCLE-TH.1.1.0.0,90.*
PRI+1+LVF+1+2+LVF+3+3+LVF+3*
P91.4.FIF0.5.5.FIF0.5.E.FIF0.5*
PRI.7.FIF0.5.8.FIF0.5.9.FIF0.5*
291.10.FIF0.5.11.FIF0.5.12.FIF0.5*
PPI,13,FIF0,5,14,FIF0,5,15,FIF0,5*
PFI,16.FIF0,5.17.FIF0,5.18.FIF0,5*
PRI+19+FIF0+5+20+FIF0+5+21+FIF0,5*
PRI,22.FIF0.5.23.FIF0.5.
PAP.1.3..1..20.*
PAR.2.4..1..10.*
INI .1.Y.Y.O.0.3300..Y*
SEE+419A1+11854,97339*
ENT,1.0.0.1..C.0.J.C.1.,J.0.1.C.0.1..0.0.0.0.2..0.0*
FIN+
```

C-2 General Input for Layout (2)

```
GEN.Y. BENMAHMUD.3.4.20.1982.1.7.Y.Y. .Y.Y.
STA . 14.0, 3.2*
LI4.2.3.50.6.19.1000*
COL.1.0(1).2.0(2)*
COL +3+TUN(1)+4+TUN(2) =
CDL . 5 . T VT (1) . 5 . T VT (2) .
COL +7 +TPT (1) +8 +TPT (2) *
COL . 9. THT (1) . 10 . THT (2) .
COL . 11 . SV HT (1) . 12 . SVHT (2) .
COL.13.PCT(1).14.PCT(2)*
HIS.1.ITEM-FR0.101.1.0.1.0*
HIS.2.UNITS.13.1.0.1.0.
HIS.3.ITEMS.20.1.0.1.0*
PL0.1.TIME.1.5.0.10*
VAR.1.1.V.TRAVL-TM.1.1.0.0.90.*
VAR+1+2.P.PICK-TH,1,1,0.0.90.*
VAR.1.3.W.WAIT-TM.1.1.0.0.90.*
VAR+1+4+5+TRVL+WT+1+1+0+0,90.*
VAR +1 +5 +C +CYCLE -TM+1+1+0+0+90+*
PL0+2+TIME+2+5+0+10*
VAR.2.1.V.TRAVL-TH.1.1.C.0.90.*
VAR, 2.2. P. PICK-TM, 1.1.0.0.90.*
VAR . 2 . 3 . W . WAIT - T M . 1 . 1 . 0 . 0 . 90 . -
VAR.2.4.5.TC VL+4T.1.1.C.0.90.*
VAR • 2 • 5 • C • C Y C LE = T 4 • 1 • 1 • 0 • 0 • 90 • *
PRI • 1 • L VF • 1 • 2 • L VF • 3 • 3 • L VF • 3 *
PRI,4,FIF0,5,5,FIF0,5,6,FIF0,5*
PRI,7.FIF0,5.8.FIF0,5.9.FIF0,5*
PRI.10.FIF0.5.11.FIF0.5.12.FIF0.5*
PRI+13, FIF0, 5, 14, FIF0, 5, 15, FIF0, 5*
PRI,15,FIF0,5,17,FIF0,5,18,FIF0,5*
PRI,19,FIF0,5*
PAR+1+9++1++20.*
PAP.2.4..1..10.*
INI .1, Y. Y. 0.0, 3300., Y.
SEE + 41981' . 11854 . 97339*
ENT .1.0.0.1..0.0.0.0.1..0.0.1.0.0.1..0.0.0.0.0.0.0.0.0.0.0
FIN.
```

C-3 General Input for Layout (3)

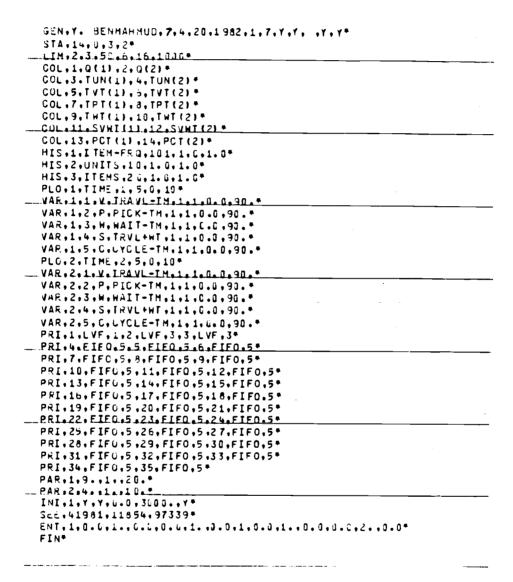
```
GEN.Y. 95NMAHMUD.4.4.20.1982.1.7.Y.Y. .Y.Y.
 STA . 14.0. 3.2*
 LIM.2.3.50.6.29.1000*
 COL . 1.0(1) . 2.0(2) .
 COL + 3 + TUY (1) + 4 + TUH (2) +
 COL . 5. T VT (1) . F. T VT (2) .
 COL +7 +TPT (1) + 9 + TPT (2) =
 COL . 9. TWT (1) . 10 . TWT (2) -
COL. 11. SV WT (1), 12. SVWT (2) -
COL +13 + POT(1) +14 + FOT(2) +
HIS.1.ITEM-FP0.101.1.0.1.0*
415.2.UNITS.10.1.0.1.0*
HIS.3.ITEMS.20.1.0.1.0*
PL0.1.TIME.1.5.0.10*
VAR.1.1.V.TRAVL-TM.1.1.0.0.90.*
VAR+1+2+P+PICK-TM+1+1+0+9+90.*
VAR.1.3.W.WAIT-T4.1.1.0.0.90.*
VAR.1.4.5.TRVL+WT.1.1.6.0.90.*
VAR.1.5.C.CYCLE-TM.1.1.0.0.90.=
PL0.2.TIME.2.5.0.10+
VAR.2.1.V.TRAVL-TM.1.1.0.0.90.*
VAR.2.2.P.PICK-TH.1.1.0.0.90.*
VAP. 2.3. W. WAIT-TM. 1. 1.0.0.90. *
VAR.2.4.5.TRVL+WT.1.1.0.0.90.*
VAR . 2 . 5 . C . CYCLE -T M. 1. 1. 0. 0. 90. *
PFI+1+LVF+1+2+LVF+3+3+LVF+3*
PRI.4.FIF0.5.5.FIF0.5.6.FIF0.5*
PRI .7.FIF0.5.8.FIF0.5.9.FIF0.5*
PRI-10.FIF0.5.11.FIF0.5.12.FIF0.5*
PRI.13.FIF0.5.14.FIF0.5.15.FIF0.5*
PRI+15+FIF0+5+17+FIF0+5+18+FIF0+5*
PRI.19.FIF0.5.20.FIF0.5.21.FIF0.5*
PRI.22.FIF0.5.23.FIF0.5.24.FIF0.5*
PRI.25.FIF0.5.26.FIF0.5.27.FIF0.5*
PRI.28.FIF0.5.29.FIF0.5*
PAR.1.9..1..20..
P1P.2.4..1..10.*
INI,1.Y.Y.G.0.3000..Y*
SEE,41981,11854,97339*
ENT .1.0.0.1.0.0.0.0.1.0.0.1.0.0.1.0.0.1.0.0.0.0.0.0.0.2..0.0.
FIN#
```



C-5 General Input for Layout (5)

```
GEN,Y. BENMAHMUD, 6,4,20,1982,1,7,7,4,4, ,4,4+
 STA, 14.0.3.2*
 LIM,2,3,50,6,43,1000*
                            we want the second s
 COL,1,Q(1),2,Q(2)+
 COL, 3, TUN(1), 4, TUN(2) +
 COL . 5. TVT (1) . 6. TVT (2) *
 COL + 7 + T PT (1) + 8 + T PT (2) +
 COL, 9, TWT (1), 10, TWT (2) =
COL . 11 . SVWT (1) . 12 . SVWT (2) *
                                              COL, 13, PCT(1), 14, PCT(2)+
HIS.1.ITEM-FR0.101.1.0.1.0*
HIS,2,UNITS,10,1.0,1.0.
HIS, 3, ITEMS, 20, 1.0, 1.0*
PL0,1,TIME,1,5,0,10*
VAR,1,1,V,TRAVL-TH,1,1,0.0,90.+
VAR,1.2.P,PICK-TM,1,1.0.0.90.*
VAR.1.3.W.WAIT-TH.1.1.0.0.90.*
VAR, 1, 4, 5, TRVL +WT, 1, 1, 0, 0, 90. +
VAR +1 +5 +C +CYCLE -T M +1 +1 +0 +0 +90 +*
PL0,2,TIME,2,5,0,10*
VAR, 2.1. V, TRAVL-TM, 1, 1, 0.0, 90.*
                                          -----
                                                      . . .
                                                              . . . . . . . .
VAR, 2, 2, P, PICK-TH, 1, 1, 0.0, 90. +
VAR.2.3.W.WAIT-TM.1.1.0.0.90.*
VAR . 2.4.5.TRVL +HT.1.1.0.0.90.*
VAR+2+5+C+CYCLE-TH+1+1+0+0+90+*
PRI+1+LVF+1+2+LVF+3+3+LVF+3*
PRI,4,FIF0,5,5,FIF0,5,6,FIF0,5*
                                               the second se
PRI,7,FIF0,5,8,FIF0,5,9,FIF0,5*
PRI,10,FIF0,5,11,FIF0,5,12,FIF0,5*
PRI,13,FIF0,5,14,FIF0,5,15,FIF0,5*
PRI.16, FIF0, 5, 17, FIF0, 5, 18, FIF0, 5+
PRI,19,FIF0,5,20,FIF0,5,21,FIF0,5*
PRI,22,FIF0,5,23,FIF0,5,24,FIF0,5*
                                               PRI,25,FIF0,5,26,FIF0,5,27,FIF0,5*
PRI,28,FIF0,5,29,FIF0,5,30,FIF0,5*
PRI,31,FIF0,5,32,FIF0,5,33,FIF0,5*
PRI,34,FIF0,5,35,FIF0,5,36,FIF0,5*
PRI, 37, FIF0, 5, 38, FIF0, 5, 39, FIF0, 5*
PRI.40.FIF0.5.41.FIF0.5.42.FIF0.5*
                                                   18 al 17
                                                             ----
PRI,43,FIF0.5=
PAR+1+9++1++ 20.*
PAR.2.4..1...10.*
INI,1,Y,Y,0.0,3000.,Y*
SEE,41981',11854,97339*
FIN+
```

C-6 General Input for Layout (6)



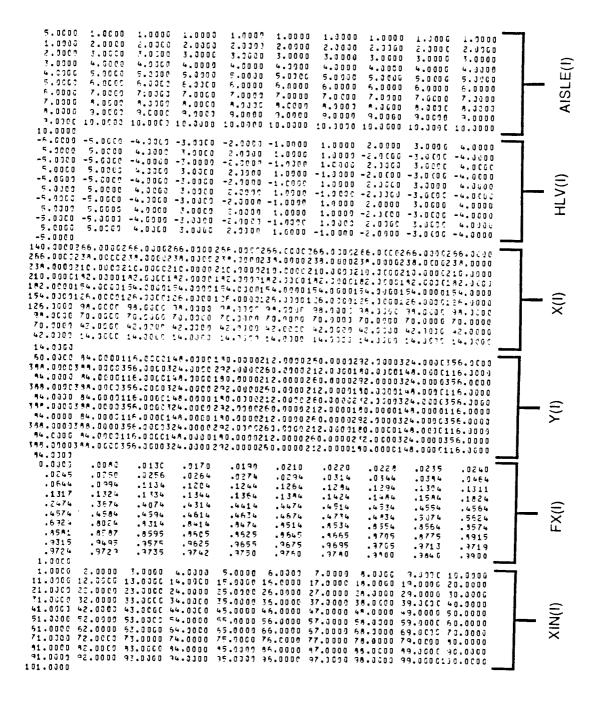
C-7 General Input for Layout (7)

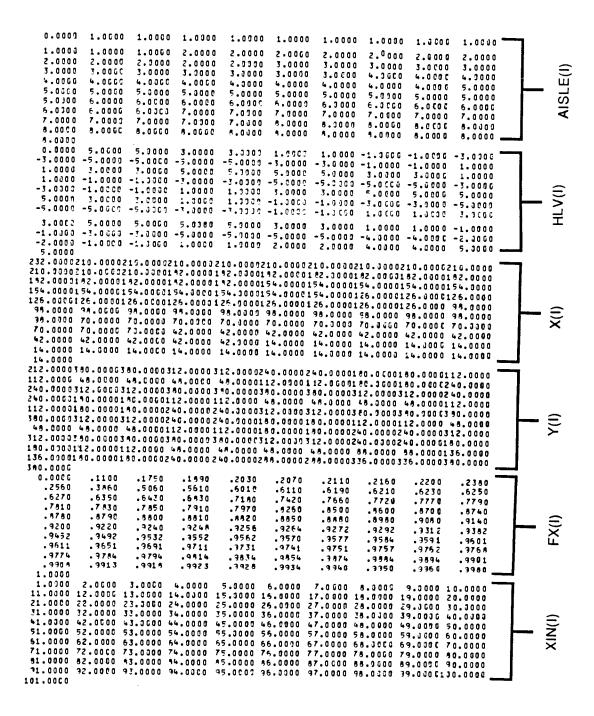
GEN .Y. BENMAHMUD.8,4,20,1982,1,7,	¥,Y, ,Y,Y*
STA,14,0,3,2*	
LIM.2.3.50.6.26.1000*	
COL,1,0(1),2,0(2)*	
COL, 3, TUN (1), 4, TUN (2) *	
COL,5,TVT(1),6,TVT(2)*	· · · · · · · · ·
COL,7,TPT(1),8,TPT(2)*	
COL,9,TWT(1),10,TWT(2)+	· · · -· - ·
COL, 11, SV WT (1), 12, SVWT (2) *	
COL +13, PCT(1) +14, FCT(2) *	
HIS,1,ITE M-FR0,101,1.0,1.0+	
HIS,2,UNITS,10,1.0,1.0*	
HIS,3,ITEMS,20,1.0,1.0*	
PL0,1,TIME,1,5,0,10+	
VAR.1.1.V.TRAVL-TM.1.1.0.0.90.*	
VAR, 1, 2, P, PICK-TH, 1, 1, 0, 0, 90.*	
VAP.1.3.N.HAIT-TH.1.1.0.0.90.*	
VAR+1+4+5+TRVL+WT+1+1+0+0+90.*	· · · · · · · · · · · · · · · · · · ·
VAR . 1 . 5 . C . CYCLE - TM . 1 . 1 . 0 . 0 . 90 . *	
PL0,2,TIME,2,5,0,10*	A second and the second s
VAR . 2 . 1 . V . TRA VL-TH. 1. 1. 0.0.90.*	
VAR+2+2+P+PICK-TH+1+1+0.0,90.*	
VAR, 2, 3, N, WAIT-TM, 1, 1, 0, 0, 90.*	
VAR+2+4+5+TRVL+WT+1,1,0.0,90.*	
VAR .2.5.C.CYCLE -TM.1.1.0.0.90.*	
PRI,1,LVF,1,2,LVF,3,3,LVF.3*	
PRI,4,FIF0,5,5,FIF0,5,6,FIF0,5*	
PRI .7.FIF0.5.8.FIF0.5.9.FIF0.5*	
PRI,10,FIF0,5,11,FIF0,5,12,FIF0,5*	
PRI,13,FIF0,5,14,FIF0,5,15,FIF0,5#	
PRI,16,FIF0,5,17,FIF0,5,18,FIF0,5*	
PRI,19,FIF0,5,20,FIF0,5,21,FIF0,5*	
PRI,22,FIF0,5,23,FIF0,5,24,FIF0,5*	
PRI,25,FIF0,5,26,FIF0,5,27,FIF0,5*	
PRI,28,FIF0,5,29,FIF0,5,30,FIF0,5*	
PRI, 31, FIF0, 5, 32, FIF0, 5, 33, FIF0, 5*	
PRI,34,FIF0,5,35,FIF0,5,36,FIF0,5*	
PR1,37,FIF0,5,38,FIF0,5,39,FIF0,5*	
PRI,40,FIF0,5,41,FIF0,5,42,FIF0,5*	
PRI,43,FIF0,5,44,FIF0,5,45,FIF0,5*	
PRI,46,FIF0,5,47,FIF0,5,48,FIF0,5*	
PRI,49,FIF0,5,50,FIF0,5,51,FIF0,5*	· · · · · · · · · · · · · · · · · · ·
PRI,52,FIF0,5,53,FIF0,5,54,FIF0,5*	
PR1,55,F1F0,5#	
PAR, 1, 9., 1., 20.*	
PAR,2,4.,1.,10.*	
INI +1 +Y + Y + 0 + 0 + 30 00 + + Y +	
SEE, 41981', 11854, 97339*	And an and a second
	1.,0.0,0.0,2.,0.0*

C-8 General Input for Layout (8)

$\begin{array}{c} 1.0000 1 \\ \hline 3.0000 5 \\ 6.0000 6 \\ 8.0000 6 \\ 9.0000 10 \\ 11.0000 10 \\ \hline 1.0000 11 \\ \hline 3.0000 15 \\ 14.0000 15 \\ 15.0000 \end{array}$.0000 5.0008 .0000 6.0000 .0000 8.0000 .0000 11.0000 .0000 11.0000 .0000 15.0000	J.0000 J.0000 J.0000 J.0000 5.0000 5.0000 7.0800 8.0000 10.0000 10.0000 10.0000 10.0000 12.0000 12.0000 10.0000 12.0000 13.0000 15.0000 15.0000	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	AISLE(I)
2.0000 3, -2.0000 -1, -3.0000 -1, -1.0000 -2, 2.0900 1, 3.0000 3, 1.0000 2, -2.0000 -1,	••••••• •••••• •••••• ••••••• ••••••• ••••••• ••••••• •••••• ••••••• ••••••• •••••• •••••• •••••• ••••••• •••••• •••••• •••••• ••••••• ••••••• •••••• •••••• ••••••• ••••••• •••••• •••••• ••••••• ••••••• ••••••• •••••• ••••••• ••••••• •••••• •••••• •••••••• •••••••• ••••••• •••••••••• ••••••••••••••••••••••••• ••••••••••••••••••••••••••••••••••••	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	-1.0000 -1.0000 3.0000 -2.0000 -2.0000 -3.0000 -3.0000 -2.0000 -3.0000 -2.0000 1.0000 -1.0000 3.0000 2.0000	-2.0600 -3.0000 -3.0000 1.0000 -1.0000 -2.0000 -3.0000 -2.0000 -3.0000 2.0000 3.0000 3.0000	(I) HTA(I)
485.0000465. 359.0000350. 322.0000294. -255.0000294. 210.0000210. 162.0000154. 125.0000156. 70.000070.	0000406.0000 8080350.0000 0000294.0000 8000256.0000 8000210.0000 0000154.0000 0000156.0000 0000179.0000	376.0000376.0003 350.0000376.09003 294.0000294.3332 236.0000294.3332 236.0000210.00001 54.0000154.00001 96.000099.0009	378.0000378.0003 322.0008322.0003 294.0000294.0003 238.0080238.0080 182.0000182.0000 154.0000154.00001 98.000099.0000	$\begin{array}{c} 6 6 6 0 0 0 0 0 6 6 0 0 0 0 4 0 6 6 0 0 0 0 3 \\ 3 7 6 0 0 0 0 3 7 3 0 0 0 0 0 3 5 0 0 0 0 0 \\ 5 7 2 0 0 0 0 3 7 2 0 0 0 0 3 7 2 0 0 0 0 \\ 5 7 2 0 0 0 0 0 2 5 6 0 0 0 0 1 5 2 0 0 0 0 \\ 2 3 6 0 0 0 2 5 6 0 0 0 0 1 2 0 0 0 0 \\ 1 2 6 0 0 0 0 1 2 6 0 0 0 0 1 2 6 0 0 0 \\ 1 2 6 0 0 0 0 1 2 6 0 0 0 0 1 2 6 0 0 0 \\ 1 2 6 0 0 0 0 0 1 2 6 0 0 0 0 1 2 6 0 0 0 \\ 1 2 6 0 0 0 0 0 1 2 6 0 0 0 0 1 2 0 0 0 \\ 1 4 0 0 0 0 0 1 4 0 0 0 0 0 0 1 4 0 0 0 0 \\ 1 4 0 0 0 0 0 1 4 0 0 0 0 0 0 0 1 4 0 0 0 0 0 0 0 \\ 1 4 0 0 0 0 0 0 0 0$	(i)X
208.0000244, 	0000244.0000 600 0100.0000 0000668.0000 0000132.0000 0000132.0000 0000288.0000 0000244.0000 5000244.0000	244.0000268.0001 208.4000244.00062 132.0000168.00002 68.0000168.00001 100.000068.00001 68.0000132.00000 244.0000208.00001 244.0000208.00001	166.0000132.00001 244.000620040008 208.0000244.00002 32.0000160.00001 56.0000100.00001 100.0000 68.0000 158.0000132.00001	L68.0000168.0000208.0000 L68.000068.000568.0000 264.0000208.000168.0000 204.0000208.000168.0000 208.000244.0000244.0000 132.0000168.0000248.0000 68.0000168.0000132.0000 68.000068.000058.0008	
.0144 .0391 	0030 .0060 0153 .0158 0411 .0421 4966 .1366 1586 .2136 4236 .4526 9356 .9366 9754 .9764 9910 .9930	.0060 .0100 .0164 .0171 .0431 .0436 .3336 .3736 .5176 .6476 .8256 .6376 .9374 .9384 .9772 .9778	.3916 .3976 .7576 .7926 .8516 .8916 .9404 .3444 .9783 .9790	.4016 .4036 .4076 .8066 .8126 .8166 .9156 .9256 .9316 .9514 .9614 .9694 .9400 .9220 .9840	FX(I)
$\begin{array}{c} 11.0000 & 12.\\ 21.0000 & 22.\\ 31.0000 & 32.\\ & & & & \\ $	$\begin{array}{c} 0 & 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 &$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	38.0100 39.0000 40.0000 48.000-49.0404-50.000 58.0000 59.0000 60.0000 68.0000 69.0000 78.0000 78.0000 79.0000 80.0000	(I)NIX

C-9 Input Data for Layout (1)





C-11 Input Data for Layout (3)

0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	2.0000	-
2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	3.0000	3.0000	3.0000	
3.0000	3.0000	3.0000	3.3000	3.0000	4.0000	4.0000	4.0000	4.0000	4.0000	AISLE(I)
4.0000	4.0000	4.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.3000	5.0000	
5.0000	5.0000	6.0000	5.0000	6.0000	5.0000	6.3000	6.0100	6.300C	7.9600	5
7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	8.0000	3.0000	9.0000	
9.0000	9.0000	5.0000	3000.8	8.3000	9.0000	9.0000	9.0000	9.0000 10.0000	9.0000	
9.0000	9.0000							11.0000		1
								13.000		
13.0000	12.0000	12.0000	12.0000	12.0003	12:0000	12.0050	13.0300	13.000	10.0000	
0.0000	3.0000	3.0000	1.0300	1.0060	-1.0000	-1.0003	-3.0000	-3.000C	-3.0(00	
	-1.0000		1.0000	1.0000	3.0000		3.0000	3.0000	1.0000	
1.0000	-1.0000	-1.0000	-3.0000	-3.0003		-3.0000	-1.3000	-1.0000	1.0000	1
1.0000	3.0000	3.3000	3.0000	3.3000	1.0000	1.0000	-1.0000	-1.0000	-3.0800	
-3.0000	-3.0000	-3.0200	-1.0300	-1.0000	1.0000		3.3060	3.0000	3.0000	
3.0000	1.0000		-1.0000					-3.3030		
-1.0000	1.0000	1.0300	3.3000	3.0000	3.0000	3.3000	1.0000		-1.0000	нг∧(I)
-1.0000	-3.0000	-3.0000	-3.0300	-*.3003	-1.0000	-1.0003	1.3300	1.3000	3.0000	· ·
3.0000	3.0000	3.0000	1.0000	1.0900	-1.0000	-1.0000	-3.0400	-3.0(30	-3.0000	
-3.0000	-1.0000	-1.0000	1.0000	1.0000	3.0000	3.0000	2.0000	2.0000	-2.0000	
÷2.0000										
								70.0000		
98.0000	94.0000	98.0000	34.0000	38.0000	98.0000	98.00001	150.0000	126.00001	26.0000	
126.00001										
154.00001										
1 A 2 . 0 0 G 0 2 2 3 8 . 0 0 0 0 2										
266.00002										×
294.00002										
								350.00003		1
378.00003	7. 0.000									
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	s/m.aaias	575.0000	378.00003	178.00003	378.30004		466.39864	06.0000	
405.000û										
405.0003 140.00C02	236.00002	36.00001	72.0000	172.09001	.05.00001	CO0.0000	44.3000	44.0000	44.0000	
405.0003 140.00C02 44.00001	236.00002 108.00001	36.00001	72.0000	172.09001 172.00002	.05.00001 135.00002	108.0000 236.30032	44.3600 236.0600	44.0000 236.00001	44.0000 72.0006	4
405.0000 140.00002 44.00001 172.00001	236.00002 108.00001	236.00001 198.00001	72.00C0 72.0000 44.0000	172.09001 172.00002 44.0000	05.00001 35.00002 44.0000	10A.0000 236.30002 44.00001	44.3600 236.0600 168.0000	44.0000 236.00001 108.00001	44.0000 72.0000 72.0000	4
405.0000 140.00002 44.00001 172.00001 172.00002	236.00002 108.00001 105.00001 236.00002	236.0000 198.00091 198.0300 236.00002	.72.0000 .72.0000 44.0000 25.0000	172.09001 172.00002 44.0000 236.00001	05.00001 35.00002 44.0000	104.0000 236.0000 44.00001	44.3000 236.0000 108.0000 108.0000	44.0000 236.00001 108.00001 108.0000	44.0000 72.0000 72.0000 44.0000	
405.0000 140.00002 44.00001 172.00001 172.00002 44.0000	236.0000 108.00001 105.00001 236.0000 44.0000	236.0000 198.00001 198.0000 236.00002 44.00001	.72.0000 .72.0000 44.0000 236.0000	172.09001 172.00002 44.0000 236.00001 104.00001	.03.0000 35.00002 44.0000 .72.00001 .72.00001	104.0000 235.30032 44.00001 72.00001	44.3C00 236.0C00 1C8.0000 108.0C00 236.0100	44.0000 236.00001 108.00001 108.0000 236.00002	44.0000 72.0000 72.0000 44.0000 36.0000	
405.0000 140.00002 44.00001 172.00001 172.00002 44.0000 235.00001	236.0000 108.0000 109.0000 236.0000 44.0000 172.0000	236.0000 108.0000 236.0000 44.0000 172.0000	72.0000 72.0000 44.0000 36.0000 08.0000	172.0900 172.0000 44.0000 236.0000 104.0000 108.0000	03.0000 35.0000 44.0000 72.0000 72.0000 44.0000	108.0000 236.30032 44.00001 72.00001 172.0000 44.0000	44.3(00) 236.0(00) 108.0000 236.0100 236.0100 44.0000	44.0000 236.00001 108.00001 108.0000 236.00002 44.00001	44.0000 72.0000 72.0000 44.0000 36.0000 08.0000	
405.0003 140.00002 44.00001 172.00001 172.00002 44.0000 235.00001	236.0000 108.0000 108.0000 236.0000 236.0000 44.0000 172.0000	236.0000 108.0000 236.0000 236.0000 44.0000 172.0000 172.0000	72.0000 72.0000 44.0000 36.0000 08.0000 08.0000 26.0900	172.09001 172.00002 44.0000 236.00001 104.0000 108.0000 236.0000 236.0000	03.00001 35.0000 44.0000 72.00001 72.00001 44.0000 36.00002	L 0 A . 0 0 0 0 2 36 . 3 0 3 32 4 4 . 0 0 0 0 1 7 2 . 0 0 0 0 1 7 2 . 0 0 0 0 1 7 2 . 0 0 0 0 4 4 . 0 0 0 2 36 . 0 0 0 0	44.3600 236.0600 168.0000 108.0000 236.0100 44.0000 172.0000	44.0000 236.00001 108.0000 236.0000 236.00002 44.00001 172.00001	44.0000 72.0000 72.0000 44.0000 36.0000 08.0000 08.0000	
405.0000 140.00002 44.00001 172.00001 172.00002 44.0000 235.00001	236.0000 108.0000 108.0000 236.0000 236.0000 44.0000 172.0000 172.0000 44.0000	236.0000 108.0000 236.0000 44.0000 172.0000 172.0000 44.0000	72.0000 72.0000 44.0000 36.0000 08.0000 08.0000 26.0900 44.0000	172.09001 172.00002 44.0000 236.00001 104.0000 108.0000 236.0000 236.00002	03.0000 35.0000 44.0000 72.0000 72.0000 44.0000 236.0000 09.0000	L 0 A . 0 0 0 0 2 36 . 3 0 3 32 44 . 0 0 0 0 1 7 2 . 0 0 0 0 1 7 2 . 0 0 0 0 44 . 0 0 0 2 36 . 0 0 0 0 1 0 A . 0 0 0 0	44.3000 236.000 108.0000 236.0100 236.0100 44.0000 172.0000	44.0000 236.00001 108.0000 236.0000 236.00002 44.00001 172.00001	44.0000 72.0000 44.0000 36.0000 08.0000 08.0000 36.0000 36.0000	
405.0003 140.0003 172.00003 172.00003 172.00002 44.0000 235.00003 108.0000 235.00003	236.0000 108.0000 236.0000 44.0000 172.0000 172.0000 44.0000 236.0000 236.0000	236.0000 108.0000 236.0000 44.0000 172.0000 172.0000 44.0000 236.0000	72.0000 72.0000 44.0000 36.0000 08.0000 36.0000 44.0000 44.0000	$\begin{array}{c} 1 \ 7 \ 2 \ . \ 0 \ 9 \ 0 \ 0 \ 1 \\ 1 \ 7 \ 2 \ . \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0$.05.0000 35.0000 44.0000 72.00001 72.0000 44.0000 236.0000 236.0000 05.00001	LOA.0000 236.0000 44.0000 72.0000 72.0000 72.0000 72.0000 44.0000 236.00000 108.0000	44.3(00 236.0(00 108.0000 236.0100 236.0100 44.0000 172.0000 172.0000	44.0000 236.00001 108.0000 236.0000 236.00002 44.00001 172.00001	44.0000 72.0000 44.0000 36.0000 38.0000 38.0000 38.0000 38.0000	(i),
405.0003 140.0003 44.00003 172.00003 172.00002 44.00002 235.00003 108.00003 236.00002 44.00003 76.00003	236.0000 109.0000 236.0000 172.0000 172.0000 172.0000 236.0000 236.0000 236.0000 236.0000	236.0000 108.0000 236.0000 44.0000 172.0000 172.0000 44.0000 236.0000 108.0000	72.0000 72.0000 44.0000 36.0000 08.0000 36.0900 36.0900 72.0303 72.0000	172.09001172.00002236.0000104.0000236.0000236.0000236.0000236.0000172.00001172.00002	03.0000 14.0000 72.0000 72.0000 36.0000 03.0000 35.00000 35.00000 35.00000 35.00000 35.00000 35.00000 35.00000 35.000000 35.000000 35.00000 35.00000 35.00000 35.000000 35.000000 35.000000 35.000000 35.000000000 35.000000 35.000000000000000000000000000000000000	10A.0000 236.30336 44.0000 72.0000 72.0000 44.0000 236.0000 08.0000 236.0000 236.0000	44.3000 236.0000 108.0000 236.0100 44.0000 172.0000 44.0000 24.0000 24.0000 20.0000	44.0000 236.00001 108.0000 236.0000 236.0000 244.0000 172.0000 44.0000 24.0000 204.0000	44.0000 72.0000 72.0000 36.0000 08.0000 38.0000 36.0000 76.0000 76.0000	
405.0003 140.0003 140.0003 172.0003 172.0002 44.0002 236.0003 108.0000 236.0003 44.0003 76.0003 0.0000	236.0000 103.0000 236.0000 44.0000 172.0000 172.0000 236.0000 236.0000 236.0000 106.0000 .0650	236.0000 108.000 236.000 244.000 172.000 172.000 236.000 236.000 108.0000 108.0000	72.0000 72.0000 36.0000 36.0000 36.0000 36.0000 72.0000 72.0000 .1990	172.09001 172.00002 44.0000 236.00001 108.0000 236.00002 44.00001 172.00000 172.00000 .2030	03.0000 35.0000 72.0000 72.0000 44.0000 56.0000 05.0000 05.0000 05.0000 235.0000 22210	100.0000 236.30030 72.0000 72.0000 236.0000 236.0000 236.0000 236.0000 236.0000 236.0000 236.0000 236.0000 236.0000 236.00000	44.3000 236.0000 108.0000 236.0100 44.0000 172.0000 172.0000 44.0000 204.0000 204.0000	44.000 236.00001 108.0000 236.0002 236.0002 44.00001 172.0000 44.0000 204.0000 204.0000	44.0000 72.0000 72.0000 36.0000 08.0000 38.0000 36.0000 76.0000 .5290	
405.0003 140.0003 172.00003 172.00003 172.00003 172.00003 108.00003 108.00003 236.00003 44.00003 76.0000 0.0000	236.0000 103.0000 236.0000 44.0000 172.0000 244.0000 236.00000 236.000000 236.000000 236.000000000000000000000000000000000000	236.00001 108.00002 236.00002 44.00002 44.00002 272.00002 236.00001 108.00001 .1750 .5020	72.0000 72.0000 36.0000 08.0000 36.0000 36.0000 72.0303 72.0000 .1890 .5100	172.09001 172.00002 44.0000 236.00001 104.0000 236.00002 36.00002 44.00001 172.00001 172.00002 .2030 .5140	03.0000 35.0000 72.0000 72.0000 36.0000 03.0000 03.0000 35.0000 2210 .5580	100.000 236.303 24.000 72.0000 172.0000 236.0000 236.0000 236.0000 2390 .6930	44.3000 236.0000 108.0000 236.0100 44.0000 172.0000 44.0000 24.0000 24.0000 24.0000 24.0000 20.3590 .7170	44.000 236.00001 108.0000 236.00002 44.00001 172.0000 44.0000 244.0000 244.0000 244.0000	44.0000 72.0000 44.0000 36.0000 38.0000 38.0000 36.3000 76.0000 76.0000 76.7470	
405.0003 140.0003 44.00003 172.00003 172.00003 172.00003 235.00001 108.0000 236.00003 44.00003 76.0000 .5540 .7520	236.0000 108.0000 236.0000 44.0000 172.0000 44.0000 236.0000 108.0000 .055C .534G .7580	236.0000 104.0001 236.0000 44.0000 172.0000 44.0000 236.0000 172.0000 44.0000 1750 .5020 .7640	72.0000 44.0000 36.0000 36.0000 36.0000 36.0000 72.0000 72.0000 .1390 .5100 .7580	172.09001 72.00002 44.0000 236.00001 104.00001 236.00002 34.00002 172.00002 172.00002 .2030 .2030 .9170	03.0000 15.0000 44.0000 72.0000 36.0000 36.0000 36.0000 35.0000 2210 .5560 .8270	2 36. 3 0 3 3 4 4. 0 0 0 0 7 2. 0 0 0 0 7 2. 0 0 0 0 7 4. 0 0 0 0 7 5. 0 0 0 0 2 36. 0 0 0 0 2 36. 0 0 0 0 . 2 3 9 0 . 6 9 3 3 . 8 3 7 0	44.300 236.0000 108.0000 236.0100 236.0100 236.0100 172.0000 172.0000 24.0000 24.0000 24.0000 .72.7170 .8410	44.0000 236.00051 108.0000 236.0002 236.0002 44.0000 172.00051 172.00052 44.0000 204.0000 .4836 .7410 .8455	44.0000 72.0000 44.0000 36.0000 38.0000 38.0000 36.0000 76.0000 .5290 .7470 .8490	
405.0003 140.0003 172.0005 172.0005 172.0005 235.0005 108.0000 235.0000 235.0000 235.0000 235.0000 5940 .7520 .4530	236.0000 108.0000 236.0000 44.0000 172.0000 44.0000 236.0000 44.0000 36.00000 36.00000 36.00000 36.00000 36.00000 36.00000 36.00000000 36.000000000000000000000000000000000000	236.00001 108.0001 236.0000 44.0000 236.0000 44.0000 236.00001 175.0000 1750 .5020 .7640 .7740	72.0000 72.0000 36.0000 36.0000 36.0000 36.0000 72.0000 72.0000 .1890 .5100 .7980 .8790	172.09001 172.0002 44.0000 236.0000 236.0000 234.0000 234.0000 172.00000 .2030 .5140 .5140 .5140 .5140	03.0000 44.0000 72.0000 72.0000 36.0000 03.0000 03.0000 2210 .5580 .8270 .8870	236.3033 44.0000 72.0000 72.0000 76.0000 236.0000 236.0000 236.0000 239.0000 6933 .5370 .5870	44.3000 236.0000 108.0000 236.01000 236.01000 172.00000 24.0000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.000000 25.000000 25.000000 25.000000000000000000000000000000000000	44.0000 236.00001 108.0000 236.0002 236.0002 44.0000 172.00001 172.00002 44.0000 204.0000 204.0000 .4830 .7410 .8450 .8930	44.0000 72.0000 44.0000 36.0000 36.0000 36.0000 76.0000 76.0000 .5290 .7470 .8490 .3000	
405.0003 140.0003 140.0003 172.0005 172.0005 172.0005 236.0005 108.0000 236.0000 236.0000 236.0000 44.0000 5940 .7520 .8530 .9076	236.0000 103.0000 236.0000 44.0000 172.0000 24.0000 236.0000 236.0000 236.0000 236.0000 37.5000 36.0000 37.5000 36.0000 37.5000 36.0000 37.5000 36.0000 37.5000 36.0000 37.5000 36.0000 37.50000 37.50000 37.50000 37.50000 37.50000 37.50000 37.50000 37.500000 37.500000 37.5000000 37.5000000000000000000000000000000000000	236.00001 108.0001 236.0002 44.0000 172.0000 44.0000 44.0000 236.00001 108.00001 .1750 .5020 .7640 .4730 .9160	72.0000 72.0000 44.0000 36.0000 36.0000 36.0000 34.0000 44.0000 372.0000 72.0000 .1890 .5100 .7980 .8790 .9180	172.0900 44.0000 236.0000 236.0000 236.0000 236.0000 44.0000 172.00000 .236.0000 .51A0 .9170 .4450 .9200	03.0000 75.0000 72.0000 72.0000 44.0000 04.0000 05.0000 05.0000 05.580 .2210 .5580 .8870 .9220	236,3033 44,0003 72,0003 72,0003 72,0003 74,0003 236,0003 236,0003 236,0003 236,0003 236,0003 ,2390 ,6933 ,9370 ,9370 ,9240	44.3000 236.0000 108.0000 108.0000 128.0000 44.0000 172.0000 24.00000 24.00000 24.00000 24.00000 24.00000 24.00000 24.000000 24.000000 24.000000 24.000000000000000000000000000000000000	44.0000 236.00001 108.0000 44.0000 172.00002 44.0000 204.0000 204.0000 .4830 .7410 .8450 .8930 .9320	44.0000 72.0000 44.0000 36.0000 08.0000 08.0000 36.0000 76.0000 76.0000 76.0000 74.70 .8490 .3550	
405.0003 140.0003 44.0000 172.0000 172.0000 235.0000 108.0000 235.0000 235.0000 108.0000 235.0000 235.0000 235.0000 235.0000 44.0000 0.0000 .5940 .7520 .9530 .9070 .9330	236.0000 108.0000 236.0000 44.0000 172.0000 236.0000 236.0000 236.0000 236.0000 5346 .5346 .5346 .7580 .8630 .9120	236.00001 108.0000 236.00002 44.0000 172.00002 236.00002 236.00001 175.0000 .1750 .5020 .7640 .8730 .9160	72.0000 44.0000 36.0000 36.0000 36.0000 36.0900 44.0000 72.0000 .1490 .5100 .7980 .8790 .9180	172.09001 172.0000 44.0000 236.00001 104.0000 236.0000 236.0000 236.0000 44.00001 172.00000 .72.00000 .51A0 .9170 .4450 .9200 .7466	03.0000 15.0000 44.0000 72.0000 36.0000 36.0000 08.0000 2210 .5580 .8870 .8870 .920	236.3033 44.0003 72.0003 72.0003 736.0003 236.0003 236.0003 236.0003 .2390 .6933 .9370 .5890 .9240	44.3000 236.0000 236.0000 236.0000 236.0000 172.0000 172.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.000000 25.000000 25.000000 25.000000 25.00000000 25.000000000000000000000000000000000000	44.0000 236.0000 108.0000 236.00002 236.00002 236.00002 44.0000 236.0000 244.0000 204.0000 204.0000 .4830 .7410 .8450 .8930 .9320	44.0000 72.0000 44.0000 36.0000 38.0000 38.0000 36.0000 76.0000 .74.70 .7470 .7470 .7490 .3000 .9590	
405.0003 140.0003 44.00003 172.0005 172.0005 235.0005 108.0000 108.0000 236.00002 44.0000 76.0000 0.0000 0.5940 .7520 .9530 .9350 .9350	236.0000 103.0000 236.0000 44.0000 172.0000 44.0000 236.0000 44.0000 36.0000 5340 .7580 .7580 .8630 .9120 .9610	236.00001 104.0001 236.0000 44.0000 44.0000 236.0000 44.0000 236.00001 172.0000 44.0000 36.00001 .1750 .5020 .7640 .4730 .9160 .9420	72.0000 44.0000 36.0000 36.0000 36.0000 36.0000 36.0000 72.0000 .1890 .5100 .7980 .8790 .9180 .9180 .9150	172.09001 172.00002 44.0000 236.00001 108.0000 234.00002 44.00001 172.00001 172.00001 .2030 .6140 .6140 .9200 .9266 .3660	03.0000 15.0000 15.0000 72.0000 36.0000 36.0000 36.0000 2210 .2210 .520 .8870 .920 .9500 .9680	104.0000 236.3032 44.0000 72.0002 44.0000 236.0000 236.0000 236.0000 236.0000 .2390 .6930 .9370 .9240 .9240 .9700	44.3000 236.0000 108.0000 236.0100 236.0100 172.0000 172.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.0000 25.000000 25.0000000 25.000000 25.000000000000000000000000000000000000	44.0000 236.00001 108.0000 236.0002 24.0000 172.00001 172.00002 44.0000 204.0000 .4870 .7410 .8450 .8930 .9320	44.0000 72.0000 44.0000 36.0000 38.0000 38.0000 36.0000 76.0000 76.0000 .5290 .7470 .8490 .3000 .9350 .9730	FX(I) Y(I)
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405.0003 140.0003 144.00003 172.00003 172.00003 172.00003 235.00003 108.00003 108.00000 236.00000 0.00000 0.00000 0.00000 0.59400 .93400 .9740 .9859 .9951 1.0000	236.0000 108.0000 236.0000 44.0000 172.0000 172.0000 236.0000 44.0000 36.0000 36.0000 36.0000 36.0000 36.0000 36.0000 37.0000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.00000 37.000000 37.000000 37.000000 37.000000 37.0000000 37.000000000000000000000000000000000000	236.00001 108.0001 236.0002 44.00001 172.00002 44.00001 236.00001 1750 5020 .7640 .7730 .9160 .9420 .9780 .9879 .9951	72.0000 44.0000 36.0000 36.0000 36.0000 36.0000 36.0000 72.0000 .1890 .5100 .7800 .5100 .790 .9180 .9180 .3540 .3540 .3740 .3550 .3355	172.09001 172.09002 44.0000 236.0000 236.0000 234.00002 44.00001 172.00001 172.00001 .2030 .6140 .9150 .9200 .3460 .3560 .3560 .3561 .3961	03.0000 44.0000 72.0000 72.0000 36.0000 036.0000 036.0000 2210 .5580 .2210 .5580 .8870 .9220 .9500 .9680 .9417 .9398 .9369	2 36. 3 0 3 3 4 4. 0 0 0 0 3 7 2. 0 0 0 0 1 7 2. 0 0 0 0 2 7 4. 0 0 0 0 0 7 5. 0 0 0 0 0 7 6. 0 0 0 0 0 2 36. 0 0 0 0 0 2 36. 0 0 0 0 0 2 39. 0 0 0 0 5 3 7 0 5 3 7 0 5 3 7 0 5 9 9 7 7 5 9 9 7 7	44.3000 236.0000 108.0000 108.0000 128.0000 172.0000 172.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.00000 25.000000 25.000000 25.0000000 25.000000000000000000000000000000000000	44.0000 236.00001 108.0000 236.0002 236.0002 44.0000 172.00002 44.0000 204.0000 204.0000 .4830 .7410 .8450 .8930 .9320 .9720 .9355 .9358	44.0000 72.0000 44.0000 36.0000 36.0000 36.0000 36.0000 76.0000 .5290 .7470 .8490 .9000 .9350 .9590 .9730 .9349 .9433 .3994	
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405.0003 140.0003 44.00003 172.00003 172.00003 172.00003 235.00001 108.00003 108.00003 44.00000 53400 .53400 .53400 .93400 .00000 1.00000 1.00000 1.00000 1.00000	236.0000 103.0000 236.0000 172.0000 172.0000 172.0000 144.0000 236.0000 236.0000 103.0000 345.0000 345.0000 346.00000 346.000000 346.00000 346.000000 346.000000 346.000000 346.000000000000000000000000000000000000	236.00001 104.0001 236.0000 44.0000 44.0000 44.0000 236.0000 44.0000 34.0000 34.0000 34.0000 34.0000 34.0000 39160 .9780 .9780 .9780 .9780 .9781 3.0000 23.0000	72.0000 44.0000 36.0000 36.0000 36.0000 36.0000 72.0000 .1890 .5100 .7580 .7580 .9180 .9180 .9180 .3540 .37500 .375000 .375000 .375000 .375000 .375000 .375000000000000000000000000000000000000	172.09001 172.00002 44.0000 236.00001 108.0000 234.00002 44.00001 172.00001 172.00001 172.00001 .2030 .6140 .6140 .9200 .9450 .9450 .94511 .94511 .94511 .94511 .94511.9	03.00001 75.0000 72.0000 36.0000 36.0000 36.0000 36.0000 37.0000 36.0000 36.0000 9.0000 9.0000 9.000 9.000 9.000 9.000 9.000 9.000 9.000 9.00000 9.00000 9.00000 9.00000 9.00000000	2 36. 3032 44. 0001 72. 0002 44. 0002 72. 0002 2 36. 0002 2 36. 0002 2 36. 0002 2 390 6 933 3 370 9 340 9 340 9 340 9 340 9 370 9 370 9 370 9 370 9 370 2 390 0 3700 2 36000 2 7. 0000 2 7. 0000	44.3000 236.0000 236.0100 236.0100 236.0100 236.0100 236.0100 236.0100 236.000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 24.0000 25.0000	44.0000 236.00001 108.0000 236.0002 44.0000 172.0000 204.0000 204.0000 .4870 .7410 .7410 .7410 .9380 .9720 .9755 .9720 .9755 .9720 .3735 .9788 9.0000 23.0000 23.0000	44.0000 72.0000 36.0000 36.0000 36.0000 36.0000 76.0000 76.0000 76.0000 .5290 .7470 .7470 .7470 .7470 .7470 .7470 .74590 .9730 .9730 .3749 .9433 .3994 10.0000 36.0000	FX(I)
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405.0003 140.0003 44.00001 172.00003 172.00003 172.00003 108.00003 108.00003 108.00003 44.00001 76.00000 .59400 .7520 .95300 .9070 .97400 .97400 .97400 .97411 1.00000 1.00000 21.00000 41.00000	236.00003 108.0000 236.0000 44.0000 44.0000 236.0000 236.0000 236.0000 236.0000 36570 .5346 .7580 .9400 .9400 .9400 .9460 .9460 .9460 .9460 .9460 .9460 .3869 .9446 .3869 .9446 .3869 .9446 .3869 .9446 .3869 .9446 .20000 .22.0000 .22.000	236.00001 103.0001 236.0002 44.0000 172.0001 172.0000 236.00001 1750 .5020 .7640 .4730 .9160 .9420 .9420 .9420 .9420 .9420 .9420 .9451 3.0000 23.0000 33.0000	72.0000 44.0000 36.0000 36.0000 36.0000 36.0000 36.0000 72.0000 .1390 .5100 .7440 .5100 .7440 .9180 .9440 .3550 .3790 .3885 .3355 4.0000 24.0000 24.0000	172.09001 172.00002 44.0000 236.00001 108.0000 234.00002 24.00002 172.00000 .172.00000 .172.00000 .172.00000 .14500 .9491 .0000 .9491 .0000 .9491 .9491 .0000 .9491 .9491 .0000 .9491 .0000 .9491 .0000 .0000 .9491 .0000 .9491 .0000 .0000 .9491 .0000 .0000 .9491 .0000 .0000 .9491 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000	03.00001 15.0000 44.0000 72.0001 72.0001 36.0000 36.0000 03.0001 35.0000 .2210 .5580 .8870 .9580 .9380 .00000 .00000 .00000 .00000 .0000 .0000 .00000 .0000	2 36.3033 44.0003 72.0003 72.0003 736.0003 736.0003 736.0003 236.0003 236.0003 236.0003 236.0003 .5370 .5390 .9370 .3540 .3750 .3750 .3700 .37.0000 37.0000 37.0000	44.3000 236.0000 236.0100 236.0100 236.0100 172.0000 172.0000 24.0000 24.0000 24.0000 24.0000 25.00000 25.000000 25.000000 25.000000 25.00000 25.000000 25.0000000000 25.000000000000000000000000000000000000	44.0000 236.00001 108.0000 236.0002 44.0000 172.0000 204.0000 204.0000 .4870 .7410 .7410 .7410 .9380 .9720 .9755 .9720 .9755 .9720 .3735 .9788 9.0000 23.0000 23.0000	$\begin{array}{c} 4 \\ 4 \\ 2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0$	FX(I)
405.0003 140.0003 142.0003 172.0005 172.0005 172.0005 172.0005 108.0005 108.0000 236.00002 44.00003 76.0000 .7520 .7520 .9540 .7520 .9540 .9740 .9740 .9740 .9740 .9740 .9740 .9740 .9740 .10000 1.0000 51.0000 51.0000	236.0000 108.0000 236.0000 44.0000 44.0000 44.0000 44.0000 36.0000 36.0000 36.0000 36.0000 36.0000 36.0000 36.0000 9120 .9400 .9400 .9400 .9450 .9450 .9450 .9469 .9469 .9469 .9469 .9460 .9469 .9460 .9469 .9460 .0000 .9200 .0000 .9200 .0000 .92000 .9200 .92000 .92000 .920000 .920000 .9200000 .920	236.00001 109.0001 109.0002 236.0002 44.0000 172.00002 44.0000 236.00001 1750 .5020 .7640 .9160 .9420 .9450 .9420 .9420 .9420 .9450 .9420 .94500 .94500 .94500 .94500 .94500 .94500 .94500 .945000 .945000 .945000000000000000000000000000000000000	72.0000 44.0000 56.0000 36.0000 36.0000 36.0000 36.0000 44.0000 44.0000 51.00 372.0000 3180 3790 3180 3740 3540 37540 3755 4.0000 24.0000 24.0000 54.0000 54.0000	172.09001 172.09002 44.0000 236.00001 104.0000 234.00002 44.00001 172.00001 172.00001 172.00001 172.00001 172.00001 91700 94900 94910 39610 5.00000 25.00000 45.00000 55.00000 65.0000	03.00001 15.0000 15.0000 72.0000 36.0000 35.0000 2210 5580 .2210 .5580 .8270 .9220 .9580 .9417 .9368 .9369 6.0000 26.0000 26.0000 56.0000 56.0000	2 36, 3033 44, 0003 72, 0003 72, 0003 72, 0003 2 36, 0003 3 4, 0003 3 4, 0003 3 7, 0003 4 7, 0003 5 7, 0003	44.3000 236.0000 236.0100 236.0100 236.0100 172.0000 172.0000 244.0000 244.0000 244.0000 244.0000 244.0000 244.0000 255.0000 55.0000	44.0000 236.00001 108.0000 236.00002 236.00002 44.0000 236.00002 44.0000 204.0000 204.0000 204.0000 .4830 .7410 .8450 .8430 .9320 .9580 .9720 .9358 9.0000 23.0000 23.0000 23.0000 23.0000 53.0000	$\begin{array}{c} 4 \\ 4 \\ 2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0$	
405.0003 140.0003 44.00001 172.00003 172.00003 172.00003 108.00003 108.00003 108.00003 44.00001 76.00000 .59400 .7520 .9350 .9750 .9750 .9740 .9740 1.0000 1.0000 1.0000 51.0000 51.0000	236.0000 108.0000 236.0000 44.0000 44.0000 44.0000 44.0000 236.0000 236.0000 236.0000 3655C .5346 .7580 .8630 .9120 .9400 .94600 .9460 .9460 .94600 .94600 .94600 .94600	236.00001 107.0001 108.0002 44.0000 172.0001 172.00002 44.0000 236.00001 1750 .5020 .7640 .4730 .9420 .9420 .9479 .9451 3.0000 13.0000 33.0000 53.0000 63.0000	72.0000 44.0000 36.0000 36.0000 36.0900 44.0000 36.0900 44.0000 72.0000 .1490 .5100 .7480 .8790 .9180 .9440 .9550 .3756 .4385 .3356 4.0000 24.000 34.000 34.000 54.000 54.000 54.000 54.000	172.09001 172.0000 44.0000 236.00001 108.0000 234.00002 34.00000 172.00000 .72.00000 .72.00000 .74.0000 .9170 .9490 .9491 .940	03.00001 15.0000 44.0000 72.0001 72.0001 36.0000 36.0000 03.0001 35.0000 .2210 .5580 .4270 .8870 .9580 .9760 .9560 .9760 .9560 .9760 16.0000 26.0000 35.0000 26.0000 35.0000 26.0000 35.00000 35.00000 35.00000 35.00000 35.000000000000000000000000000000000000	236.3033 44.0003 72.0003 72.0003 736.0003 736.0003 736.0003 236.0003 236.0003 236.0003 236.0003 236.0003 35890 .9370 .9370 .9370 .9425 .9905 .9977 7.0000 37.0000 37.0000 67.0000	44.3000 236.0000 236.0100 236.0100 236.0100 172.0000 172.0000 24.0000 24.0000 24.0000 24.0000 24.0000 25.0000 39.0000 39.0000 55.0000 68.0000	44.0000 236.0000 236.00001 108.0000 236.00002 246.0000 244.0000 244.0000 244.0000 .4830 .7410 .8450 .8930 .9320 .9356 .9720 .9356 .9356 .9720 .9356 .9358 .93500 .93500 .93500 .93500 .93500 .93500 .93500 .93500 .93500 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .937000000000 .937000000000000000000000000000000000000	$\begin{array}{c} 4 \\ 4 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\$	FX(I)
405.0003 140.0003 44.00003 172.00003 172.00003 172.00003 172.00003 108.00003 108.00003 44.00003 44.00003 44.00003 44.00003 44.00003 45300 .9340 .9359 .9340 .9359 .9340 .9359 .9340 .9359 .9340 .9359 .9340 .9359 .9351 1.0000 11.0000 51.0000 51.0000 71.0000 51.0000 .00000 .00000 .00000 .00000 .00000 .00000 .000000 .000000 .00000000	236.0000 103.0000 236.0000 172.0000 172.0000 172.0000 236.0000 236.0000 236.0000 055.000 9120 9400 9410 9760 9440 9410 9760 22.0000 22.0000 12.0000 22.0000 72.0000 62.0000 72.0000 72.0000	236.00001 104.0001 104.0001 236.0000 44.0000 172.0000 44.0000 236.00001 172.0000 44.000 1750 .5020 .7640 .4730 .9420 .9479 .0000 .9479 .0000 .300000 .300000 .300000 .300000 .3000000 .30000000000	72.0000 44.0000 36.0000 36.0900 36.0900 44.0000 72.0000 .1390 .5100 .9180 .9180 .9180 .3540 .3750 .3356 4.0000 24.0000 24.0000 24.0000 24.0000 74.0000 74.0000	172.09001 172.00002 44.0000 236.00000 236.00000 234.00000 234.00000 172.00001 172.00001 172.00001 172.00001 .72.0000 .9450 .9450 .9451.9451.9451.9451.9451.9451.9451.9451	03.00001 15.0000 15.0000 172.0000 26.0000 036.0000 036.0000 036.0000 037.0000 036.0000 037.0000 037.0000 037.0000 037.0000 036.0000 036.0000 05.0000 000	2 36. 3032 44. 0003 72. 0004 72. 0004 73. 0004 75. 0004 75. 0004 75. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 3 370 .5890 .9240 .3540 .37540 .37540 .3740 .3740 .3740 .37. 0004 77. 0000 57. 0000 77. 0000	44.3000 236.0000 236.0100 236.0100 236.0100 236.0100 236.0100 236.0100 24.0000 24.0000 24.0000 24.0000 24.0000 3590 .9710 .9732 .9715 .9783 A.0000 28.0000 28.0000 59.0000 68.0000 5.0000	44.0000 236.00001 108.0000 236.00002 44.0000 172.00002 44.0000 204.0000 .4870 .7410 .8450 .9720 .9786 .9720 .9786 .9720 .9788 9.0000 29.0000 29.0000 29.0000 57.0000 73.0000	44.0000 72.0000 36.0000 36.0000 36.0000 36.0000 36.0000 76.0000 .5290 .7470 .7490 .9730 .9750 .9730 .0000 .9700 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000	FX(I)
405.0003 140.0003 44.00003 172.00003 172.00002 44.0000 235.00001 108.00002 24.00000 236.00000 54.00000 .7520 .9540 .7520 .9540 .97500 .9750 .0000 .97500 .97500 .97500 .97500 .97500	236.0000 103.0000 236.0000 44.0000 172.0000 44.0000 236.0000 236.0000 44.0000 53.0000 9120 9400 9400 9410 9760 9440 9400 9440 12.0000 22.0000 32.0000 62.0000 72.0000 92.0000	236.00001 104.0001 104.0001 236.0000 44.0000 172.0000 44.0000 236.00001 172.0000 44.000 1750 .5020 .7640 .4730 .9420 .9479 .0000 .9479 .0000 .300000 .300000 .300000 .300000 .3000000 .30000000000	72.0000 44.0000 36.0000 36.0900 36.0900 44.0000 72.0000 .1390 .5100 .9180 .9180 .9180 .3540 .3750 .3356 4.0000 24.0000 24.0000 24.0000 24.0000 74.0000 74.0000	172.09001 172.00002 44.0000 236.00000 236.00000 234.00000 234.00000 172.00001 172.00001 172.00001 172.00001 .72.0000 .9450 .9450 .9451.9451.9451.9451.9451.9451.9451.9451	03.00001 15.0000 15.0000 172.0000 26.0000 036.0000 036.0000 036.0000 037.0000 036.0000 037.0000 037.0000 037.0000 037.0000 036.0000 036.0000 05.0000 000	2 36. 3032 44. 0003 72. 0004 72. 0004 73. 0004 75. 0004 75. 0004 75. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 3 370 .5890 .9240 .3540 .37540 .37540 .3740 .3740 .3740 .37. 0004 77. 0000 57. 0000 77. 0000	44.3000 236.0000 236.0100 236.0100 236.0100 236.0100 236.0100 236.0100 24.0000 24.0000 24.0000 24.0000 24.0000 3590 .9710 .9732 .9715 .9783 A.0000 28.0000 28.0000 59.0000 68.0000 5.0000	44.0000 236.0000 236.00001 108.0000 236.00002 246.0000 244.0000 244.0000 244.0000 .4830 .7410 .8450 .8930 .9320 .9356 .9720 .9356 .9356 .9720 .9356 .9358 .93500 .93500 .93500 .93500 .93500 .93500 .93500 .93500 .93500 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .935000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .9350000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .93500000 .937000000000 .937000000000000000000000000000000000000	44.0000 72.0000 36.0000 36.0000 36.0000 36.0000 36.0000 76.0000 .5290 .7470 .7490 .9730 .9750 .9730 .0000 .9700 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000	FX(I)
405.0003 140.0003 44.00003 172.00003 172.00003 172.00003 172.00003 108.00003 108.00003 44.00003 44.00003 44.00003 44.00003 44.00003 45300 .9340 .9359 .9340 .9359 .9340 .9359 .9340 .9359 .9340 .9359 .9340 .9359 .9351 1.0000 11.0000 51.0000 51.0000 71.0000 51.0000 .00000 .00000 .00000 .00000 .00000 .00000 .000000 .000000 .00000000	236.0000 103.0000 236.0000 44.0000 172.0000 44.0000 236.0000 236.0000 44.0000 53.0000 9120 9400 9400 9410 9760 9440 9400 9440 12.0000 22.0000 32.0000 62.0000 72.0000 92.0000	236.00001 104.0001 104.0001 236.0000 44.0000 172.0000 44.0000 236.00001 172.0000 44.000 1750 .5020 .7640 .4730 .9420 .9479 .0000 .9479 .0000 .300000 .300000 .300000 .300000 .3000000 .30000000000	72.0000 44.0000 36.0000 36.0900 36.0900 44.0000 72.0000 .1390 .5100 .9180 .9180 .9180 .3540 .3750 .3356 4.0000 24.0000 24.0000 24.0000 24.0000 74.0000 74.0000	172.09001 172.00002 44.0000 236.00000 236.00000 234.00000 234.00000 172.00001 172.00001 172.00001 172.00001 .72.0000 .9450 .9450 .9451.9451.9451.9451.9451.9451.9451.9451	03.00001 15.0000 15.0000 172.0000 26.0000 036.0000 036.0000 036.0000 037.0000 036.0000 037.0000 037.0000 037.0000 037.0000 036.0000 036.0000 05.0000 000	2 36. 3032 44. 0003 72. 0004 72. 0004 73. 0004 75. 0004 75. 0004 75. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 2 36. 0004 3 370 .5890 .9240 .3540 .37540 .37540 .3740 .3740 .3740 .37. 0004 77. 0000 57. 0000 77. 0000	44.3000 236.0000 236.0100 236.0100 236.0100 236.0100 236.0100 236.0100 24.0000 24.0000 24.0000 24.0000 24.0000 3590 .9710 .9732 .9715 .9783 A.0000 28.0000 28.0000 59.0000 68.0000 5.0000	44.0000 236.00001 108.0000 236.00002 44.0000 172.00002 44.0000 204.0000 .4870 .7410 .8450 .9720 .9780 .9720 .9785 .9720 .9735 9.0000 29.0000 29.0000 59.0000 57.0000 73.0000	44.0000 72.0000 36.0000 36.0000 36.0000 36.0000 36.0000 76.0000 .5290 .7470 .7490 .9730 .9750 .9730 .0000 .9700 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000	FX(I)

C-12 Input Data for Layout (4)

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									_	-
15.0000 2.00u0		1.0000	1.0000	1.JG0J 4.J00J	1.3300 4.3309	1.0000			2.3093	
5.0660			6.0000	6.0000	8.0000		5.0000			_ <u></u>
<u> </u>		9.0000						12.0000 12		AISLE(I)
16.0Cüü	16.000.	15.3000	15.0000	15.0000	17.0000	17.0030	17.0000	18.0000 18	.3000	
		23.0000						21.0000 21		NIS I
								27.0000 27		
<u>94.99.27</u> 1000.ut		29.0000	29.0000	29.3003	29.0000	<u>30.000</u> u	39.0000	30.0000 30	. 3000	
		-3.0000	-2.0000	-2.0000	-1.0000	-1.0000	1.3000	1.0000 2		1
2.0000	3.0000	3.0060	3.0000	2.3600	1.3003	-1.0000	-2.0030	-3.0403 -3		
	-1.0000	1.0000	2.0000	3.0000	3.0000 2.0000	2.0000	1.0000 3.0000		.0000	\sim
-1.0000	-2.0000	-3.0660	-3.0000	-2.0000	-1.0000	1.0000	2.0000	3.0000 3	.0000	(I) HLV(I)
2.0000 3.0000		-1.0000	-2.0000		-3.0000		-1.0000		.0300	
1.0060		3.0040	3.0000	2.3500		-1.0000	-2.0000		.0000	Т
	-1.0000		. 2.0000	3.3000	3.0000	2.0004			.3000	
-3.0000		-3.0000	-2.0000	-1.000	-1.0000	1.3000	1.0000	2.0000 3	. 3 0 0 0	1
210.0000	466.0060							36.0000436		1
								78.0000350 22.0000322		
322.0000	294.0000	294.00002	294.0000	29+.0000	234.0000	294.0000	266.00002	66.0000266	.0000	
								38.0000238		
								26.0000126		×
								98.0060 70		
								42.0003 42		
14.0300										1
								<u>63.0000208</u> 52.0000 52		
84.0000	116.0000	168.00003	208.0006	244.0000	244.0000	208.0000	168.00001	16.0000 34	.J003	
								08.0403168		
								44.0000244 68.0000238		$- \epsilon$
244.0000	244.6000	268.0000	168.00 <u>u</u> 0:	116.3003	84.3033	52.0000	52.0000	84.0000116	.0000	⊢
								52.0000 52 16.0000 54		
								03.000.244		
244.0368 6.6330		.0666	.0080	. 1 100	.Jiio	. 3125	-1123	.013é		
.0148			.0164	.3171	.0181	. 9 26 1	.3221		.)351	
.0391			.0431	.1438	. 34 4 6	.0.56	.0476		. 1535	
•0726 •1346			.1126	.1146	.1166 .3916	•1176 •397 6	.1186 .4016		.1246	Ξ
.4136			.5176	.6476	. 75 7 6	.7926	.9266		.3166	FX(I)
• 8186 • 9336			.8256 .9374	.8336 .3384	.3516 .3404	. 8916 . 9444	.9156 .351		.3316 .3694	Ц <u>.</u>
. 9734		. 9764	.9772	. 377 9	. 37 9 3	. 9790		.9823	. 3843	
.989. 1.000C		.993.	.935)	• 396 3	. 397.	.9377	• 3384	.999J		
1.00.00		3.0360		3.3023	6.111.	7.0000	9-3630	9.0000 10	. 1 3 3 3	
		13.00.0					14.303.			
21.0000	22.0000	23.0000	24.0000	25.0000	26.0000	27.0000	28.0030 38.0034	29.0000 30 39.0000 40	- 1040 - 1040	Ê
41.0000	42.0000	43.0600	44.0000	45.3003	46.0033	47.0000	48.0600	43.0601 50	.0030	— ž
51.0000	52.0000	53.0000	54.0000	55.0600	56.0000	57.0000	58.0000	<u>59.0003 60</u> 69.0000 70	.0000	(I) XIN(I)
71.0000	72.0030	73.0000	74.0000	75.0000	76.3000	77.0000	78.JOJu	73.0000 80	.0000	
81.0000	82.0000	83.0000	84.0000	85.3000	86.0303	87.0000	99.3700	89.000u 90	.0000	
91.0040 101.0000		93.0000	94.0000	32.JUU0	40.100J	31.0000	70.0400	93.0003196		I

C-13 Input Data for Layout (5)

11.0000 13.0000 14.0000 16.0000 15.0000 17.0000 16.0000 20.0000 19.0000	4.0000 4.0000 4.0000 3.0000 <t< th=""><th>AISLE(I)</th></t<>	AISLE(I)
5.0000 $5.0000-5.0000$ $-5.00005.0000$ $-5.0000-5.0000$ $5.0000-5.0000$ $5.00005.0000$ $5.0000-5.0000$ $-5.00005.0000$ $5.0000-5.0000$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	HLV(I)
$\begin{array}{c} 266.0000238.00002\\ 238.0000210.00002\\ 210.0000182.00001\\ 182.0000154.00001\\ 154.0000126.00001\\ 126.000098.00000\\ 98.0000970.0000\\ 70.0000942.0000\end{array}$	$\begin{array}{c} 266.0002266.0000266.0000266.0000266.0000266.0000266.0000266.0000238.0000154.0000154.0000154.0000154.0000154.00000154.00000154.00000154.00000154.00000154.00000154.0000000000$	(I)X
$\begin{array}{c} 388.0000388.00003\\ 84.0000584.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.0000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.000003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.000003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.00000388.00003\\ 84.0000003\\ 84.000003\\ 84.000003\\ 84.000000\\ 84.000003\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.00000\\ 84.0000\\ 84$	$\begin{array}{c} 116.00001^{4}8.0000180.0000212.0000260.0000292.0000324.0000356.0000\\ 356.0000324.0000292.0009260.0009212.0000180.0000148.0000116.0000\\ 116.0000148.0000180.0000212.0000260.0000292.0000324.0000356.0000\\ 356.0000324.0000292.0000260.0009212.0000260.0000292.0000324.0000356.0000\\ 356.0000324.0000292.0000260.0000212.0000260.0000292.0000324.0000356.0000\\ 356.0000324.0000292.0000260.0000212.0000260.0000148.0000116.0000\\ 116.0000148.0000180.0000212.0000260.0000292.0000324.0000356.0000\\ 356.0000324.0000292.0000260.0000212.0000180.0000148.0000116.0000\\ 116.0000148.0000180.0000212.0000260.0000292.0000356.0000\\ 116.0000148.0000180.0000212.0000260.0000292.0000356.0000\\ 356.0000324.0000292.0000260.0000212.0000100.0000148.0000116.0000\\ 356.0000324.0000292.0000260.0000212.0000120.0000148.0000116.0000\\ 356.0000324.00000292.0000200.0000212.0000120.0000000000$	Y(I)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	FX(I)
21.0000 22.0000 31.0000 32.0000 41.0000 42.0000 51.0000 52.0000 61.0000 62.0000 71.0000 72.0000 81.0000 82.0000	43.0000 44.0000 55.0000 45.0000 47.0000 49.0000 50.000 50.000 55.0000 55.0000 57.0000 57.0000 57.0000 57.0000 57.0000 57.0000 59.0000 50.0000 57.0000 57.0000 57.0000 57.0000 57.0000 57.0000 70.0000 70.00000 70.00000 70.0000 70.00000 70.00000000	(I)NIX

14.000 14.000 16.000 15.0000	2.0.000 3.0000 3.0000 3.0000 3.00000 3.00000 12.0000 12.0000 14.0000 .16.0000	2 2 6 6 6 0 3 . 0 7 6 0 5 . 12 . 0 7 0 0 5 . 12 . 0 7 0 0 5 . 14 . 6 5 0 0 . 14 . 6 5 0 0	$\begin{array}{c} 4.0000 & 4\\ 3.0000 & 3\\ \hline 3.0000 & 3\\ \hline 7.0000 & 7\\ 9.0000 & 3\\ 12.0000 & 12\\ 13.0000 & 13\\ 14.0000 & 13 \end{array}$.3000 12.00 .3300 13.03 .0008 16.30	000 4.0000 000 5.0000 100 7.0000 100 7.0000 100 10.0000 100 10.0000 100 10.0000 100 13.0000	2.0040 2.000 4.3000 4.000 5.000 5.000 4.3000 3.030 7.0000 13.000 11.0000 11.000 13.0000 13.000 16.0000 16.000 15.0000 15.000	0 3.0000 0 5.0000 1 4.0001 0 3.0000 1 10.0000 0 11.0000 0 14.0000	AISLE(I)
1.000 1.000 5.000 -5.000 3.000 -1.000 -2.000 5.000	-5.0000 3.0000 -1.0000 3.0000 -1.0000 5.0000 5.0000 -3.0000 -1.0000	-5.0000 3.0000 -1.0000 -1.0000 -5.0000 -5.0000 -3.0000 -1.0000	$\begin{array}{c} +5 \cdot 0 \ 0 \ 0 \ 0 \ -5 \\ 5 \cdot 0 \ 0 \ 0 \ 0 \ 5 \\ +3 \cdot 0 \ 0 \ 0 \ -5 \\ 1 \cdot 0 \ 0 \ 0 \ -1 \\ 1 \cdot 0 \ 0 \ 0 \ 0 \ -3 \\ 5 \cdot 0 \ 0 \ 0 \ -5 \\ -5 \cdot 0 \ 0 \ 0 \ 0 \ -5 \\ 1 \cdot 0 \ 0 \ 0 \ -5 \\ 1 \cdot 0 \ 0 \ 0 \ -5 \\ \end{array}$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{c} 3 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\$	-4.0000 -4.0001 4.0000 4.0001	$\begin{array}{c} 0 & 1.3003 \\ G & 1.0000 \\ J & -3.0000 \\ 0 & -5.3000 \\ 0 & -5.3000 \\ 0 & -1.0300 \\ 0 & -2.3000 \\ 0 & 5.0000 \end{array}$	
182 • 0000 154 • 0000 126 • 0000 98 • 0000 70 • 0000 70 • 0000 42 • 0000 14 • 0000 14 • 0000	182.0000 154.0000 126.0000 70.0000 70.0000 42.0000 14.0000	192.00001 154.00001 126.00001 <u>98.0001</u> 70.066 70.000 42.0000 14.0000	82.0000182 82.0000154 26.0000154 26.0000126 98.0000 38. 70.0000 70 42.0000 42. 42.0030 42. 14.0000 14.	$\begin{array}{c} 0.000182.03\\ 0.000154.00\\ 0.000154.00\\ 0.000126.03\\ 0.000126.03\\ 0.000126.03\\ 0.000126.03\\ 0.000126.03\\ 0.000126.00\\ 0.0000000\\ 0.00000000\\ 0.00000000\\ 0.00000000$	$\begin{array}{c} 0 0 182.00001\\ 0 0 154.00001\\ 0 0 126.00001\\ 0 0 126.00001\\ 0 0 126.00000\\ 0 0 0 14.0000\\ 0 0 42.0000\\ 0 0 14.0000\\ 0 0 14.0000\\ 0 0 14.0000\\ 0 0 14.0000\\ 0 0 0 14.0000\\ 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0$	$\begin{array}{c} 10.00000000000000000000000000000000000$	0192.0000 154.3003 0126.3003 930.0000 134.3000 142.3000 14.0000	
246.00300 240.0030 376.0030 	44.0000 312.0000 172.0000 172.0000 312.0000 312.0000 376.0000 104.0000	44.0000 312.30053 172.00002 312.00002 44.0001 376.00003 104.0000	44.0000 ;44. 76.0000376. 04.0000104. 40.0000240. 40.0000240. 40.0000240. <u>04.0000240.</u> 76.0000376.		0 1104.00001 0 376.00003 0 44.0000 0 312.00003 0 312.00003 0 312.00003 0 312.00002 0 312.000024 0 312.000024	$\begin{array}{c} 22.0001122.0000\\ 72.000172.000\\ 12.00030312.000\\ 44.0000\\ 75.00001044.0000\\ 76.0000104.000\\ 94.0000104.000\\ 94.0000104.000\\ 90.00000\\ 90.000$	240.300 240.000 134.0000 376.0000 312.1000 172.0000 172.0000	
0.0000 	.0 J50 .5 J2 <u>C</u> .7 J60 .8 110 .86 3C .9 116 .9 459 <u>.9 684</u> .3 813 .9 897	.0 (90 .5060 .7146 .8350 .9136 .9466 .9466 .9823 .9917		J 410 .171 5 100	10	.7240 .7340 .8510 .8520 .9070 .9083 .9416 .9436 .3606 .9646		
21.0600 31.0000 41.0000 51.0000 61.0000 71.0000 81.0000	22.0300 32.0000 42.0300 52.0000 62.0300 72.0300 72.0300 52.0300	13.0000 2 33.0000 2 43.0000 4 53.0000 4 53.0000 5 63.0000 7 83.0000 7	4.0000 25. 4.0000 25. 4.0000 45. 4.0000 45. 4.0000 55. 4.0000 75. 4.0000 85.	1001 16.11 1000 26.000 0000 36.000 0000 46.000 1000 56.00 1000 76.000 1000 76.00	$\begin{array}{c} 17.3337 \\ 27.3503 \\ 27.3503 \\ 37.3503 \\ 30 \\ 47.0000 \\ 47.0000 \\ 6 \\ 57.0000 \\ 57.0000 \\ 6 \\ 77.0000 \\ 7.000 \\ 7.0000 \\ 7.000 \\ 7.0$	4.00.0 4.000 8.000 29.000 8.000 39.000 8.000 49.000 8.000 69.000 8.000 69.000 8.000 73.000 8.000 99.000	+0.3000 50.3000 50.3000 50.3000 50.3000 50.3000 50.3000 50.3000	

C-15 Input Data for Layout (7)

17.0000 17.0000 20.0000 22.0000 23.0000 23.0000 25.0000	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	000 21.0000 21.0000 21.0000 000 21.0000 21.0000 21.0000 000 24.0000 24.0000 26.0000	6.3000 6.3000 7.0000 9.0000 9.0000 9.0000 12.000 14.0000 14.0000 15.0000 20.0000 20.0000 21.0000 25.0000
$\begin{array}{c} -3.0000 & -1.0000 \\ 1.0000 & -1.0000 \\ 1.0000 & -3.0000 \\ \hline 3.0000 & -3.0000 \\ \hline -3.0000 & 1.0000 \\ \hline -1.0000 & 1.0000 \\ -1.0000 & 3.0000 \\ 3.0000 & 3.0000 \\ \hline -3.0000 & -3.0000 \\ \hline -2.0000 & -1.0000 \\ \hline \end{array}$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccc} -1.0006 & -3.0000 \\ \hline 3.0000 & 3.0000 \\ \hline 3.0000 & -1.0000 \\ 1.0000 & -1.0000 \\ 1.0000 & -3.0000 \\ -3.0000 & -3.0000 \\ 2.0000 & -2.0000 \\ \hline \end{array}$
$\begin{array}{c} 126.0000126.0000\\ 154.0000154.0000\\ 192.0000210.0000\\ 238.0000238.00002\\ 266.0000266.00002\\ 244.0000294.00002\\ 322.0000350.00003\\ 378.0000378.00003\\ 406.0000\end{array}$	126.0000128.0000128.00 126.0000182.0000182.00 210.0000210.0000210.00 238.0000238.0000238.00 266.0000266.0000266.00 294.0000322.0000322.00 150.0000350.0000350.00 178.0000378.0000378.00	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	126.000 000 154.000 154.000 154.000 154.000 154.000 154.000 154.000 122.000 154.000 122.000 154.000 122.000 154.000 122.000 150.000 122.000 150.000 122.000 150.000 122.000 150.000 122.000
$\begin{array}{c} 172.0000108.00001\\ 172.0000236.00002\\ 44.000044.0000\\ 236.0000172.00001\\ 108.0000172.00001\\ 108.000044.0000\\ 236.0000236.00002\\ 44.0000\\ 236.0000236.00002\\ 45.0000236.00002\\ 45.00000\\ 108.00001\\ 108.00001\\ 108.0000\\ 108.000\\ 108.0000\\ 108.000\\ 108.000\\ 108.0000\\ 108.$	04.0000172.0000172.00 36.0000236.0000236.00 44.0000108.0000108.00 72.0000108.0000108.00 72.000236.0000108.00 44.0000236.0000172.00 56.0000172.0000172.00 08.0000172.0000172.00	$\begin{array}{c} 0 1 0 8.0001 0 8.6000 44.0000\\ 0 0 2 3 6.0000 2 3 6.0000 2 3 6.0000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 $	36.0000172.0000 08.0000172.0000 36.0000172.0000 36.0000236.0000 44.0006108.0000 72.0000108.0000 72.0000236.0000
0.000 0.0180 .5050 .5450 .7580 .7820 .8650 .8690 .9070 .9090 .9360 .9400 .9360 .9400 .9760 .9770 .9759 .9855 .9935 .9943 1.0000	.0360 .1660 .28 .5700 .6350 .67 .8060 .5120 .81 .8730 .8750 .87 .3110 .9160 .92 .9440 .9470 .95 .9640 .9650 .96 .3780 .9777 .97 .3573 .9583 .94 .9951 .3959 .99	50 .6950 .6930 .6930 70 .8210 .8250 .8350 70 .840 .8910 .4970 00 .9240 .3280 .9300 00 .9520 .9540 .9550 50 .9670 .9680 .9700 94 .9814 .9813 .9413	.4898 .4978 .7050 .7340 .8457 .8557 .9036 .9050 .9326 .9580 .9560 .9580 .9720 .9740 .9244 .9852 .9925 .9937 .9949 .3995
51.0000 52.0000	23.0000 24.0008 25.00 33.0000 34.0008 35.00 44.0008 45.00 53.0000 54.0008 55.00 53.0000 54.0008 55.00 63.0000 54.0008 55.00 73.0000 74.0008 75.00	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	29.0000 30.0000 39.0000 40.0000 19.0000 50.0000 19.0000 60.0000 19.0000 70.0000 19.0000 70.0000 19.0000 70.0000 19.0000 70.0000

**GASP FILE STORAGE	AREA DUMP	AT TIME	0.	**
----------------------------	-----------	---------	----	----

MAXIMUM NUMBER OF ENTRIES IN FILE STORAGE AREA = 2 PRINTOUT OF FILE NUMBER 1 THOW = 0. QQTIM= 0. and a second FILE CONTENTS ENTRY 1 = 0. i000€+01 0. θ. +1000E+01 ٥. ENTRY 2 = Ο. -1000E+01 0. 0. .2000E+01 ٥. revenues as an an and a second second second -----PRINTCUT OF FILE NUMBER 2 TNOW = 0. QOTIM= 0. THE FILE IS EPPTY PRINTCUT OF FILE NUMBER 3 TNOW = 0. QQTIM= 0. and the second state of th THE FILE IS EMPTY PRINTCUT OF FILE NUMBER 4 TNOW = 0. THE FILE IS EMPTY

C-17 Typical File Storage Area at Time Zero

PRINTCUT OF FILE NUMBER 5 QQTIM= 0. THE FILE IS EMPTY PRINTOUT OF FILE NUMBER 6 TNOW = 0. QQTIM= 0. THE FILE IS EMPTY PRINTOUT OF FILE NUMBER 7 TNON = 0. DOT IN= 0. THE FILE IS EMPTY en and a second a second s PRINTOUT OF FILE NUMBER 4 TNOW = 0. OOTIN= 0. THE FILE IS EMPTY PRINTOUT OF FILE NUMBER --- 9-----TNOW = 0. QOTIM= 0. THE FILE IS EMPTY

PRINTCUT OF FILE NUMBER 10 TNOW = 0. Ogtim= 0.

THE FILE IS EMPTY

PRINTOUT OF FILE NUMBER 11 TNOW = 0. AQTIM= 0.

-----THE-FILE-IS-ENPTY-----

PRINTCUT OF FILE NUMBER 12 TNOW = 0. QQTIM= 0.

THE FILE IS EMPTY

THE FILE IS EMPTY

PRINTOUT OF FILE NUMBER 14 TNOW - 01 QQTIM= 0.

THE FILE IS EMPTY

C-17 (Continued)

- -----

TNOW = 0. QQTIM= 0. THE FILE IS EMPTY ------PRINTOUT OF FILE NUMBER 16 TNOW = 0. QQTIM= 0. THE FILE IS EMPTY (a) A set of the se PRINTCUT OF FILE NUMBER 17 TNOW = 0. DOTIM= 0. THE FILE IS EMPTY TNON = 0. QQTIM= 0.

THE FILE IS EMPTY

------ PRINTOUT- OF- FILE-NUNBER--- 15-----

PRINTCUT OF FILE NUMBER 19 TNOW = 0. QOTIM= 0.

THE FILE IS EMPTY

.

PRINTOUT OF FILE NUMBER 20 TNOW = 0. QQTIM= 0.

THE FILE IS-ENPTY-----

. `

PRINTOUT OF FILE NUMBER 21 TNOW = 0. QQTIM= 0.

THE FILE IS EMPTY

PRINTCUT OF FILE NUMBER 22 TNOW = 0. Qqtim=___0.

THE FILE IS EMPTY

PRINTCUT OF FILE NUMBER 23 TNOW = 0. QQTIM= 0.

THE FILE IS EMPTY

THE FILE IS EMPTY

C-17 (Continued)

PRINTOUT OF FILE NUMBER 25 PRINTOUT OF FILE NUMBER 30 TNOW = 0. TNON = 0. JOTIME 0. QQTIM= 0. THE FILE IS EMPTY THE FILE IS EMPTY PRINTOUT OF FILE NUMBER 26 PRINTGUT OF FILE NUMBER 31 TNOW = 0. TNOW = 0. QQTIM= 0. -901 IM--01-----THE FILE IS EMPTY THE FILE IS EMPTY PRINTOUT OF FILE NUMBER 27-----PRINTOUT OF FILE NUMBER 32 TNOW = 0. QQTIN= 0. QQTIM= 0. THE FILE IS EMPTY THE FILE IS ENPTY PRINTOUT OF FILE NUMBER 28 TNOW = Q. TNOW = 0. QQTIM= 0. QQTIM= 0. THE FILE IS EMPTY THE FILE IS EMPTY The second comparison of the second comparison of the second comparison of the second s PRINTOUT OF FILE NUMBER 29 TNOW = 0.QQTIM= 0. THE FILE IS EMPTY -----

C-17 (Continued)

	** - *****	nene tota o con e o nene	• · - • • • • • • • • • •	AXIMUM NUMBER OF	ENTRIES IN FILE	STORAGE" AREA- *	32	
				Ť	OUT OF FILE NUMB NOM = .3000E+0 QTIM= .3000E+0	4		
				TIME PERIOD Average Num Standard de Maximum Num	VIATION	.3000E+04 2.0775 .3737 4		
ENTRY	1	=	•3000E+04	•1000E+01	-FILE-CONTENTS •6800E+02	•5000E+01	•2000E+01	.1000E+02
ENTRY	2	Ŧ	• 3 00 2E + 0 4	•1000E+01	• 540 0E + 0 2	•9800E+81	.1000E+01	•8000E+01

GASP FILE STORAGE AREA DUMP AT TIME .3000E+04

C-18 Typical File Storage Area at Time 3,000

PRINTOUT OF FILE NUMBER 2 TNCW = •3000E+04 QQTIM= •3000E+04

TIME PERIOD FOR STATISTICS	•3000E+04	
A VERAGE NUMBER-IN FILE		
STANDARD DEVIATION	3.5276	
HAXIHUH NUHBER IN FILE	18	

ENTRY	1	7	•2987E+04	•1000E+01	FILE CONTENTS •5500E+02	•4000E+01	•1000E+81	• 8000E+01
ENTRY	2	=	•2987E+04	+1000E+01	• 560 0E +0 2	.5 COE+01	+1000E+01	• 9000E+01
ENTRY	3	3	•2987E+04	.1000E+01	• 5700E +02	•6 COQE +01	•1000E+01	•900QE+01
ENTRY	4	=	•2987E+04	+1000E+01	+ 58002+02	•9000E+01	•1000E+01	•9000E+01
ENTRY	5	Ŧ	•2987E+04	.1000E+01	+6700E+02	•4000E+01	+1000E+01	+1000E+02
ENTRY	6	z	+2987E+04	•1000E+01	• 8 10 0E + 0 2	.6 COOE+01	•1000E+01	•1300E+02
ENTRY	7	x	•2987E+04	•1000E+01	+ 890 8E +02	• 8 CODE + 81	• 1 00 0E + 01	•1400E+02
ENTRY	8	Ŧ	+2987E+04	•1000E+01	• 9500E +02	•8000E+01	•1000E+01	+1500E+02

		····		+	CUT OF FILE NUME NGW • +3000E+0 IQTIM= +2939E+0	4		
				AVERAGE NUM Standard de		.3000E+04 2.\$192 3.6241		
ENTRY	1	Ŧ	•2987E+04	•1000E+01	FILE CONTENTS •6900E+02	•4000E+01	.2000E+01	•1100E+02
ENTRY	2	2	•2987E+04	.1000E+01	•7600E+02	.3000E+01	• 2000E +01	•1200E+02

C-18 (Continued)

THE FILE IS EMPTY

PRINTOUT OF FILE NUMBER - 5-TNCH = .3000E+04 QQTIM* .8909E+04

TIME PERIOD FOR STATISTICS +300DE+04 AVERAGE NUMBER IN FILE +0357 STANDARD DEVIATION MAXIMUM NUMBER IN FILE 1

THE FILE IS EMPTY

THE FILE IS ENPTY

THE FILE IS EMPTY

TIME PERIOD FOR STATISTICS \$3000E+04 AVERAGE NUMBER IN FILE \$0007 STANDARD DEVIATION \$2724 MAXIMUM NUMBER IN FILE 1

THE FILE IS EMPTY

PRINTCUT OF FILE NUMBER 9 TNOW = .3000E+04 QQTIM= .2994E+04 TIME PERIOD FOR STATISTICS .3000E+04 AVERAGE NUMBER IN FILE .0957 STANDARD OEVIATION .2941 MAXIMUM NUMBER IN FILE 1

THE FILE IS ENPTY

C-18 (Continued)

	T	CUT OF FILE NUMBE NOW = .3000E+04 NOTIM= .2997E+04	-		
	TINE PERIOD Average Num Standard de	FCR STATISTICS	• 3000E +04 • 1445 • 3516		
	••••••••••••••••••••••••••••••••••••	HE FILE IS EMPTY			
	T	OUT OF FILE NUMBE NOM = .3090E+04 QTIM= .3000E+04			
	AVERAGE NUM Standard de	FOR STATISTICS BEF IN FILE VIATION BER IN FILE	•1795 •3838		
ENTRY 1 = .2987E+04	•1000E+01	•FILE GONTENTS •5400E+02	•9000E+01	•1000E+01	• 8000E+01
		CUT OF FILE NUMBER Now-=	12		
	AVERAGE NUM Standard de	FOR STATISTICS . BER IN FILE VIATION BEF IN FILE	•1382 •3452		
		HE FILE IS EMPTY			

C-18 (Continued)

PRINT CUT OF FILE NUMBER 13
TNOW = .3000E+04 QQTIM= .2999E+04
TIME PERIOD FOR STATISTICS .3000E+04
AVERAGE NUMBER IN FILE .1081
AVERAGE NUMBER IN FILE .1081 STANDARD DEVIATION .3105
MAXIMUH NUMBER IN FILE 1
THE FILE IS EMPTY
PRINTCUT OF FILE NUMBER 14
TNOH = .3000E+04 Qotim= .2999E+04
TIME PERIOD FCR STATISTICS +3000E+04
AVERAGE NUMBER IN FILE .0739
STANDARD DE VIATION .2616
MAXINUM NUMBER IN FILE 1
FILE CONTENTS ENTRY 1 +2000E+01 +6000E+02 +5000E+01 +2000E+01 +1000E+02
PRINTOUT OF FILE NUMBER 15 TNOW = .3000E+04
TNOW = .3000E+04 QQTIM= .2974E+04
TIME PERIOD FOR STATISTICS +3000E+04
AVERAGE NUMBER IN FILE .0407
STANDARD DE VIATION .2153
MAXIMUM NUMBER IN FILE 1
THE FILE IS EMPTY

C-18 (Continued)

PRINTOUT OF FILE NUMBER 16 TNOM # •3000E+04 	PRINTOUT OF FILE NUMBER 19 TNOW = .3000E+04
TIME PERIOD FOR STATISTICS +3000E+04 AVERAGE NUMBER IN FILE .0335 STANDARD DEVIATION .1799	QOTIN= .2358E+04 TIME PERIOD FOR STATISTICS .3000E+04 AVERAGE NUMBER IN FILE
MAXIMUM NUMBER IN FILE 1	STANDARD DEVIATION .0290 MAXIMUM NUMBER IN FILE 1
THE FILE IS EMPTY	THE FILE IS EMPTY
PRINTOUT OF FILE NUMBER 17 TNOW = .3000E+04 	PRINTOUT OF FILE NUMBER 20 TNOW = .3000E+04 QQTIM= .2519E+04
TIME PERIOD FOR STATISTICS .3000E+04 AVERAGE NUMBER IN FILE .0324 STANDARD DEVIATION .1770 MAXIMUM NUMBER IN FILE 1	TIME PERIOD FOR STATISTICS .3000E+04 ————————————————————————————————————
THE FILE IS EMPTY	THE FILE IS EMPTY
PRINTCUT OF FILE NUMBER 18 TNOM = .3000E+04 	PRINTCUT OF FILE NUMBER 21 TNOM = +3000E+04 QQTIM= +1013E+04
TIME PERIOD FOR STATISTICS .3000E+04 AVERAGE NUMBER IN FILE .0255 STANDARD DEVIATION .1576 MAXIMUM NUMBER IN FILE 1	TIME PERIOD FOR STATISTICS •3000E+04 Average Number in file •0003 Standard Deviation •0177 Maximum Number in file 1

THE FILE IS EMPTY

THE FILE IS EMPTY

C-18

.

(Continued)

PRINTOUT OF FILE NUMBER 22 TNOM = •3000E+04 QQTIM= •2671E+04

THE FILE IS EMPTY

- PRINTCUT OF FILE NUMBER 23 TNOW = .3000E+04 QQTIM= .2523E+04

THE FILE IS EMPTY

PRINTOUT OF FILE NUMBER 24 TNOM = .3000E+04 OOTIM= .2893E+04 TIME PERIOD FOR STATISTICS .3000E+04

AVERAGE NUMBER IN FILE .0048 STANDARD DEVIATION .0688 MAXIMUM NUMBER IN FILE 1

a communication of the second s

THE FILE IS EMPTY

1. A second sec second sec PRINTOUT OF FILE NUMBER 25 TNOW = .3000E+04 QQTIM= .2676E+04

TIME PERIOD FOR STATISTICS	.3000E+04
AVERAGE NUMBER IN FILE	.0072
STANDARD DEVIATION	.0846
MAXIMUM NUMBER IN FILE	1

THE FILE IS EMPTY

TIME PERIOD FOR STATISTICS	-3000E+04
AVERAGE NUMBER IN FILE	.0124
STANDARD DEVIATION	.1107
MAXINUH NUHBER IN FILE	1

THE FILE IS EMPTY

THE FILE IS EMPTY

C-18 (Cont

(Continued)

TIME PERIOD FOR STATISTICS.3000E+04AVERAGE NUMBER IN FILE.0023STANDARD DEVIATION.0483MAXIMUM NUMBER IN FILE1

THE FILE IS EMPTY

a construction of the second second

TIME PERIOD FOR STATISTICS.3000E+04AVERAGE NUMPEF IN FILE.0003STANDARD DE VIATION.0158MAXIMUM NUMBEF IN FILE1

THE FILE IS EMPTY

PRINTOUT OF FILE NUMBER 30 TNOW = .3000E+04 QQTIM= .1047E+04

THE FILE IS EMPTY

> PRINTCUT OF FILE NUMBER 32 TNOW - .3000E+04 QQTIM= 0.

THE FILE IS EMPTY

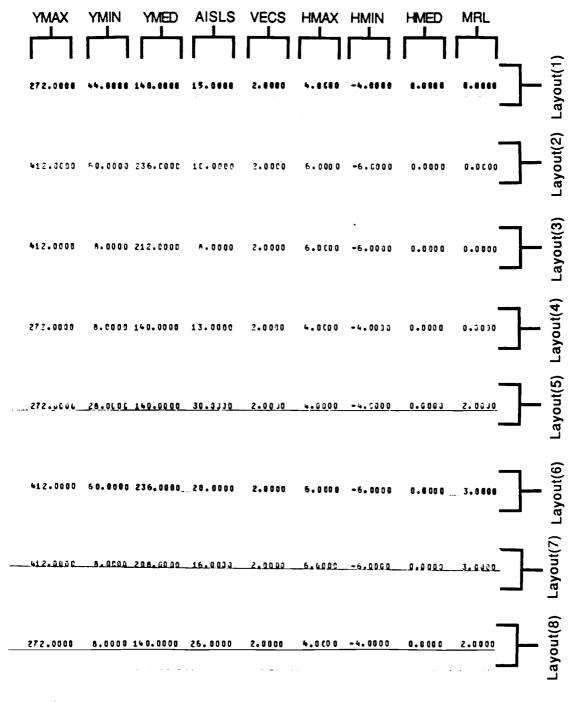
PRINTOUT OF FILE NUMBER 33 TNOM = .3000E+04 QQTIM= .6477E+03

TIME PERIOD FOR STATISTICS .3000E+04 AVERAGE NUMBER IN FILE STANDARD DEVIATION .0283 MAXIMUM NUMBER IN FILE 1

THE FILE IS EPPTY

C-18

(Continued)



C-19 Last Part of Input Data for all Layouts

APPENDIX D

Output Summary Report

SASP SUNHARY REPORT

SIMULATION PROJECT NUMBER 1 BY V. BENNAMMUD

DATE \$7 207 1932 RUN NUMBER 1 OF 1

CURRENT TIME = .3000E+04

the second se

PARAMETER SET	1 =	. 9 00 DE + 0 1	-1000E+01	-2000E+02	۰.	
PARAHETER SET	ζ Ξ	.400 DE+01	.1000E#01	-1000E+02	- 1	

		* *STATIST	ICS FOR VARIABLE	S BASED ON OBSE	RVATION **		
	MEAN	STO DEV	SD OF HEAN	C V	MINIWUM	MAXINUM	085
Q(1)	•9360E+01						
Q(2) TUN(1)	• 9857E +01 • 4720E + 02	+2853E+81 +1501E+02	-2615E+80 -1348E+81	.2894E+88 .3179E+88	.5 00 0E+ 01	-1888E+82	119
TUN(2) TVT(1)	•4965E+02 •4885E+01	-1693E+02	-1552E+01	-3489E+80	•7009E+01 •1900E+02	8600E+92 .1088E+83	124
TVT (2)	.4986E+01	•1536E+01 •1533E+01	•1434E+D0 •1406E+ 00	•3268E+88 •3075E+08	-7879E+00 -2061E+01	-9152E+01 -9061E+01	124 119
TPT(1) === TPT(2)	-1861E+02 -1952E+02	.6051E+01 .6919E+01	-5413E+88		-2800E+01-	.5328E+82-	124
THT(1) THT(2)	• 2 91 2E +00 • 3 21 3E +00	-8277E+00 -8808E+00	+7433E-01 -8074E-01	+2842E+81		.4855E+01	119 124
SVWT(1) SVWT(2)	•5176E+01 •5307E+01	.1788E+01	-1686E+80	•2741E+01 •3455E+00	0. .7879E+00	.4218E+81 .1051E+02	119 126
PCT(1)	-2378E+02	-1708E+01 -7227E+01	+1565E+00 +6490E+00	-3217E+00 -3038E+00	-2 06 1E+81 -3588E+81	-1894E+82	119
PCT(Z)	•2482E+02	-7970E+01	-7386E+88	•3211E+00	-1006E+02	.4771E+82	119

D-1 Results Summary Report for Layout (1)

** GASP SUNNARY REPORT **

SIMULATION PROJECT NUMBER 2 BY Y. BENMAHMUD

		DATE 4	/ 20/ 1982	RUN NUMBER 1	OF 1		
		CURRENT	TINE = .3000E+	04			
PARAMETER	<u>SEI 1 =</u>	9000E+01	.1008E+01!	2 000E+02	0.		
PARAMETER	SET 2 =	. 4008E+01	-1000E+01	-1 000E+02	0.		
		**STATIS	TICS FOR VARIABLE	S BASED ON OBSER	VATION .		
	MEAN	STD DEV	SD OF HEAN	CV	HINIMUN	HUNIXAN	085
Q(1)	. 9588E+81	.2489E+81	+2643E+88	.3016E+00	- 30 88E +81	.1600E+02	119
8(2)	• 9672E+01	.2017E+01	.2582E+00	,2912E+00	.2000E+01	.1800E+02	119
TUN(1)	•4836E+02	.1662E+02	-1538E+01	.3437E+00	.1700E+02	• 9708E+82	
[UN(2)	,4821 <u>E</u> +82	.1₽\$1E+\$2	-1382E+01	. 3 11 3E + 00	+7 800E+01	. 8700E+02	116
TVT(1)	.5186E+01	.1874E+01	-1725E+00	. 3 61 3E + 00	-1818E+01	.9667E+01	118
<u>[VI (2) </u>	,5285E+01	<u>+1795E+01</u>	-1652E+##	, 3 396E+00	-1303E+01		118
FPF(1)	.1881E+02	. 6837E+81	. 62 94 E+ 80	.3634E+00	.6800E+01	-1036E+02	110
[5] [5]	+1875E+02	.6145E+81	.5657E+08	• 3277E+00	.2800E+01	.3880E+02	114
FHF(1)	.6856E+88	.1551E+01	.1428E+88	.2262E+01	-	.3480E+02	118
TWT(2)	.5562E+80	.1353E+01	,1245E+08	+2432E+01	••	.6048E+01	118
SVHT(1)	.5872E+01	.2294E+01	-2112E+00		9.	.7164E+01	118
SVHT(2)	,5842E+01	.2187E+01	.1940E+00	•3906E+00	•1818E+01	.1268E+82	118
PCT(1)	.2468E+02	.7944E+81	.7313E+00	.3608E+00	.1303E+01	+1140E+02	118
PCT (2)	.2459E+82	.7265E+81		. 3 21 8E + 00	• 8618E+01	•4559E+02	118
	·····	4. CAAC.AT	+6688E+00	• 2 954E+ 80	.6255E+01	.4323E+02	118

D-2 Results Summary Report for Layout (2)

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**GASP SUNMARY REPORT **

SINULATION PROJECT NUMBER 3 BY Y. BENNAMMUD

DATE 4/ 20/ 1952 RUN NUMBER 1 DF 1

CURRENT TIME = .3000E+04

PARAMETER SET	1 =	•9000E+01	1080E+01	.2000E+02	٥.
PARAMETER SET	2 =	•4000E+01	•1000E+81	+1000E+02	q.

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	_	-			·····		
	MEAN	STD DEV	SD OF HEAN	CV	MINIMUM	HAXIMUM	0P S
Q(1)	•9755E+01	-2596E+01	•2521E+00	•2661E+08	• 3 00 0E + 01	• 16 QQE • # 2	106
Q(2)	• 939 1E +01	-3C47E+01	-2986£+60	-3265E+00	2000E+01	+1680E+82	110
TUN (1)	.4987E+02	.1451E+02	.1438E+01	.2970E+00	.2000E+02	.9780E+82	106
TUN(2)	•4627E+02	• 1688E +02	-1616E+01	.3647E+00	.7000E+01	+9180E+02	109
TVT(1)	•7476E+01	1919E+01	•1864E+08	.2567E+80	.3015E+01	1335E+02	106
TVT (2)	.7494E+01	•2111E+01	.2022E+90	-2816E+00	.297 BE+01	.1318E+82	109
TPT (1)	•1958E+02	•6128E+01	.5952E+BO	.3130E+90	- 4 00 QE + 01	.3780E+82	106
TPT (2)	.1800E+02	.6943E+01	.6659E+00	.3857E+88	-280 0E+ 11	.354#E+#2	109
TWT (1)	• 8 03 5E + 00	• 169 JE + 0 1	.16%1E*88	.2182E+81	0.	.7897E+01	105
TWT(2)	.1190E+D1	.2330E+01	• 2230E+00	.2009E+01	0.	•1093E+02	109
SVHT(1)	.8280E+01	.2345E+01	.227 8E+00	.2832E+00	.3485E+01	-1348E+12	106
SVHT (2)	.8635E+01	.2894E+01	.2772E+08	.3332E+00	.2970E+01	.1736E+02	109
PCT(1)	.2786E+02	.7075E+01	.6872E+80	+254 8E+00	.1491E+02	.4971E+02	
PCT(2)	.2669E+02	+8450E+01	.8103E+90	.3170E+00			106
				* 211 NC 4 M N	•7233E+01	•4655E+02	109

D-3 Results Summary Report for Layout (3)

GASP SUMMARY REPORT

SIMULATION PROJECT NUMBER 4 BY Y. BENNAHMUD

DATE	47	29/	1982	RUN NUMBER	1	OF	1	
DATE	47	28/	1982	RUN NUMBER	1	OF	1	

CURRENT TIME = .3008E+04

· · ·

PARAMETER SET	1 =	.9000E+01	.1000E+01	.2000E+02	8.
PARAMETER SET	2 =	.4080E+01	.1808E+01	.1000E+82	l.

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN	STD DEV	SD OF HEAN	CV	NINIMUN	HAXIHUH	085
Q(1)	•9250E+01	.2822E+01	.2628E+00	.3 051E+00	.3000E+01	.1600E+02	116
Q (2)	, <u>9955E+01</u>	<u>+2894E+81</u>	+\$65QE+ 88	.2817E+00	+2000E+01	.1600E+02	112
TUN(1))	.4673E+82	.1505E+02	.1490E+81	.3434E+00	-1300E+02	.9700E+02	116
TUN (2)	,4982E+02	,1593E+02	.1505E+01	.3197E+00	.7000E+01	.9100E+02	112
TVT(1)	.6110E+01	.1676E+01	.1555E+84	.2743E+80	.1530E+01	•9227E+01	116
TVT(2)	.6163E+01	<u>-1448E+01</u>	.1360E+00	.2336E+00	.1636E+01	•9182E+01	
TPT(1)	-1825E+82	.6569E+01	.6899E+88	. 3 5 9 9 E + 8 8	.5280E+81	.3788E+82	
[5]19]	.1958E+02	.6490E+ 01	.6132E+88	.3314E+00	.2800E+81	.36402+02	116
THT(1)	.9737E+00	.1851E+01	+1718E+60	.1901E+01	1.	. 0385E+01	112
THT(2)	.6667E+88	.1477E+01	.1395E+80	.2215E+01	4.		116
SVHT(1)	.7084E+91	.2303E+01	.2138E+88	.3251E+00	•1603E+01	.6758E+01	112
SVHT(2)	.6830E+01	.2000E+01	.1897E+88			-1496E+02	116
PCT(1)	.2533E+82	.7636E+01	.7890E+80	.29405+00	•1636E+#1	•1448E+02	112
PCT(2)	.2641E+02	.7438E+01		.3014E+00	. 8883E+01	.4683E+02	116
	et uvet vet	********	•7028E+00	• 2 816E+00	.4436E+01	.4361E+02	112

D-4 Results Summary Report for Layout (4)

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GASP SUMMARY REPORT

SIMULATION PROJECT NUMBER 5 BY Y. BENMAHHUD

DATE 4/ 20/ 1992 RUN NUMBER 1 DF 1

CURRENT TIME = .3600E+04

PARAMETER SET	1 =	.900CE+31	•100CE+31	.2 LGLE+02	э.	
PERAMETER SET	2 =	.4000E+01	.1C0GE+01	.1066E+02	0.	•

٢.

STATISTICS FCK VARIABLES BASED ON OBSERVATION

	MEAN	STD DEV	SD CF MEAN	CV	MINIMUM	MAXIMUM	OES
9(1)	.9941E+01	2817E+01	.2583E+05	.2834E+06	.4 UCOE +01	• 1600E + 12	119
Q(2)	.9299E+C1	.2793 <u>i</u> +01	.2475E+00	.30032+00	.2CG0E+31	.1800E+02	127
TUN(1)	•5[17E+02	.1656E+02	.1515E+01	.3301E+00	1906E+02	.9700E+02	119
TUN(2)	•4672E+J2	.1515E+J2	.1344E+D1	.3241E+00	.706.E+01	·10002+63	127
T V T (10	•4892E+01	.1433E+01	.1311E+00	. 2 923 + 00	.2061E +01	. 8 d1 3£ + 61	119
TVT (2)	.4642£+01	.1455E+C1	.1292E+0L	.3137E+40	.78796+35	.85152+J1	127
T PT (1))	.1981E+C2	.5703E+01	.6144E+00	. 3 26 3E + 0.0	.760LE+01	·3 880£ +02	119
TPT(2)	1 53 95 + 0 2	.610JE+01	.5+:3L+00	.3318E+30	.2800E+01	.4JCJE+U2	:27
T WT (:)	.2318E+00	.7525[+36	+699E-J1	.32+6E+01	0.	• 4 542E+C1	119
THT(2)	.3021E+ú0	. 8849E+80	.7652E-0:	.2929E+01	0.	• 4 91 5E + J1	127
SVHT(1)	.51245+01	• 15 99E +01	+1466E+00	.3122E+00	•206_E+01	•11452+32	119
SVHT(2)	. 49445+31	+1739E+01	.1543E+0C	.3517E+60	.7879E+00	+1108E+02	
PCT(1)	.24945+32	.7697E+0:	.7:57E+6C	+30872+30	.100 fr +52	.47106+62	1 27
PCT (2)	.23331+12	•7149 ^F +31	•634+E+DC	.31542+00	.3588£+01	. 47102+02 . 47062+02	127

D-5 Results Summary Report for Layout (5)

**GASP SUNMARY REPORT **

STMULATION PROJECT NUMBER 6 BY V. BENNAHMUC

DATE 4/ 20/ 1982 RUN HUMBER 1 DF 1

CURRENT TIME = .3000E+04

PARAMETER SET	1 =	.900E+01	.1000E+01	.2080E+02	١.
PARAMETER SET	2 =	-4800E+01	-1888E+01	-1000E+02	

STATISTICS FOR VARIABLES BASED DN OBSERVATION

	MEAN	STD DEV	SD OF NEAN	cv	MININUM	HAXIHUH	085
Q(1)	• 966 1E + D1	-2771E+01	.2519E+00	-2868E+90	.2000E+01	.1608E+82	121
9(2)	•9579E+01	.2898E+D1	-2034E+00	.3025E+00	.3080E+81	-1888E+82	121
TUN(1)	•4839E+82	•1572E+#2	-1429E+01	3248E+00	.7000E+01	.8900E+02	121
TUN(2)	.4854E+02	-1633E+02	-1454E+01	-3364E+80	-170 BE+ B2	.1040E+03	121
TVT(1)	-2009E+01	-1592E+01	-14+8E+00	.3179E+88	-1303E+01	.9333E+#1	121
TVT(2)	•4914E+01	-1538E+01	-1338E+00	.3129E+00	.1819E+01	.4304E+01	121
TPT(1)	-1903E+02	-6301E+01	.5728E+80	.3311E+#0	-2600E+01	.3480E+02	121
TPT(2)	.1901E+02	-6620E+01	.6018E+00	-3482E+80	-630 DE+01	.3880E+02	121
TWT(1)	.361oE+00	-9837E+80	.8943E-01	-2720E+01	0.	•5339E+01	121
TWT (2)	-4581E+00	-1129E+01	- 1027E+00	-2465E+01	1.	•4903E+01	
SVWT(1)	- 5371E+01	.1828E+01	-1652E+80	.3483E+90	.1303E+01	.1093E+02	121 121
SVMT(2)	•2372E+01	.1874E+01	.1784E+80	.3488E+88	.191 SE+ 01	-1138E+02	121
PCT(1)	+24+0E+02	.74205+01	-67+5E+00	.3041E+88	•6073E+01	-4389E+02	
PCT(2)	-2438E+02	.7658E+01	-6952E+00	.3141E+00	. 061 SE + 01	•4809E+02 •4612E+02	121 121

D-6 Results Summary Report for Layout (6)

GASP SUNNARY REPORT

SINULATION PROJECT NUMBER 7 BY Y. BENNAHMUD

D	ATE 4	/ 28	/ 1982	RUN NUMBER	1	-	 • •
C	URRENT	TIM	Ε =	. 300 DE + 04			

<u>PARAMETER SET</u>	<u>1 = </u>	. <u></u>	_1008E+01!	.2000E+02	۹.	
PARAMETER SET	2 =	.4000E+01	+1000E+01	-1 000E+02	0.	

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	HEAN	STD DEV	SD OF MEAN	CV	HINIHUH	HUHIXAN	085
Q(1)	.9576E+81	. 3008E+01	.2769E+00	. 3 14 1E + 00	. 300 QE + 0 1	.1800E+02	118
Q(2)	.9675E+01	+ 2692E+01	.2457E+00	.2782E+00	.2000E+01	.1600E+02	120
TUN(1)	• 4 84 8E + 0 2	.1638E+02	.1514E+01	.33796+88	.1700E+82	.9700E+02	117
EUNE23	.4809E+02	,1528E+82	.1401E+01	.3177E+00	.7080E+01	.8900E+02	119
TVT(1)	.5451E+01	.1525E+01	.1410E+00	. 2798E+00	+1955E+81	•9076E+01	117
111(2)	.5321E+01	.1500E+01	,1375E+00	.2819E+00	.180 JE + 01	.8742E+01	119
TPT(1)	.1895E+82	.6501E+01	.6103E+00	.3483E+00	.6200E+01	.3880E+02	117
[5]14]	.1883E+02	.6268E+01	.5746E+88	. 3329E+08	.2800E+81	.3560E+02	119
T WT (1)	.5687E+00	.1330E+01	.1230E+00	.2339E+01	0.	.6642E+01	117
THT(2)	.4592E+00	.1186E+01	.1088E+80	.2584E+01	1.	.6309E+81	119
SVHT(1)	.6019E+01	.1903E+01	.1759E+00	. 3 162E + 00	.2379E+01	.1267E+02	117
SVHT(2)	.5780E+01	.1835E+01	.1682E+00	• 3 175E + 00	.1803E+01	.1059E+02	
PCT(1)	.2497E+02	.7692E+#1	.7111E+08	.3080E+00	.9179E+01	.4688E+02	119
PCT(2)	+2461E+02	,7308E+01	.6699E+00	+ 2970E+00	.4603E+01	.4319E+02	117 119

D-7 Results Summary Report for Layout (7)

GASP SUNMARY REPORT

SIMULATION PROJECT NUMBER 8 BY Y. BENNAHMUD

DATE 4/ 20/ 1932 RUN NUMBER 1 DF 1

JURRENT TIME = .3000E+04

PARAMETER SET	1 =	• 9 00 0E + 0 1	.1000E+01	.2000E+02	۱.
PARAMETER SET	2 =	-4080E+01	.1000E+01	.1008E+02	8.

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	HEAN	STD DEV	SD OF HEAN	CV	HINIHUH	HAXIHUN	OBS
9(1)	• 9403E+01	.2436E+01	.2188E+00	-2591E+00	.2000E+01	.1610E+12	124
Q(2)	-9847E+01	. 31565+01	.2932E+88	.3235E+00	.3000E+01	.1800E+02	118
TUN (1)	• 4 72 0E + 0 2	•1419E+02	-1274E+01	-3805E+80	.7000E+01	.9780E+82	124
TUN (2)	•4977E+02	• 1773E+02	.1639E+81	.3563E+00	-1300E+62	.1080E+03	117
TVT(1) TVT(2)	•4906E+01 •4984E+01	•14192+01 •13552+01	.1274E+00 .1253E+00	.2893E+00 .2719E+00	•1079E+01 •2303E+01	•8636E+81 •8636E+81	124
TPT(1)	1858E+02	.57195+01	.5136E+80	.3076E+00	.260 #E+81	. 38 1 0E + 8 Z	124
TPT(2) TWT(1)	.1955E+02 .3595E+00	-71295+81 -9936E+00	•6591€+00 •8923€+01	-3647E+00 -2764E+01	.5288E+01	-3920E+02 -7115E+01	117
THT (2)	.5545E+00	1116E+01	.1032E+00	.2012E+01	•.	.4394E+01	117
SVWT (1)	.5265E+01	1697E+01	.1524E+ 8 ₿	-3223E+00	-1879E+01	.1040E+82	124
SVHT(2)	.5538E+01	1686E+01	•1559E+0●	.3045E+00	-2303E+01	.1038E+02	117
PCT(1)	+2384E+02	.6786E+01	.6022E+90	-2812E+09	-5012E+01	.4663E+82	124
PCT (2)	• 2 50 9E +0 2	-8129E+01	•7515E+00	- 324 1E+88	.7776E+01	.4618E+82	117

D-8 Results Summary Report for Layout (8)

PLOT NUMBER 1 PUN NUMBER 1

V=TRAVL-TM P=PICK-TM B=WAIT-IM S=TRVL+WT C=CYCLE-TM	1. 1. 1. 1.	_							. 2 . 2 . 2	250E 250E 250E 250E 250E	+82 +82 +82				OF PL .4588 .4588 .4588 .4588 .4588	E+82 E+82 E+82 E+82				•	6750(6750(6750(6750(6750(+82 +82 +82				. 9000E +02 . 9000L +02 . 9000E +02 . 9000E +02 . 9000E +02
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.50005+02	•				_				•					•						٠					•	
.60005+02 .70005+02	:	۷			5	P			+C											•					•	
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+10002+03 .11002+03			۷.						•		· • · · · ·			•						• •	-	· · · · -			•	VS
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D-9 Typical Plot of Traveling, Waiting, and Picking Cycle Time against Time

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.55012+13	• • • • •	
.6888E+83	• • • •	
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.64882+83	• • • • •	
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