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MATERIAL REQUIREMENTS PLANNING (MRP),
MANUFACTURING RESOURCE PLANNING (MRP II) AND
THE IMPLEMENTATION OF A DYNAMIC PRODUCTION AND
INVENTORY CONTROL SYSTEM IN A MANUFACTURING COMPANY
(MASTER THESIS)

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ABSTRACT

The success of Japanese firms in world markets has been regarded as a result, to a significant degree, of their superior manufacturing systems. Recent developments in the manufacturing environment and Japan's success have changed people's perceptions of the role and importance of manufacturing function in industrial firms. As a result, today manufacturing is appraised as a competitive weapon which is a vital element in order to survive, especially in today's highly automated and integrated continuous process industries. Therefore, firms have to achieve perfection in the management of manufacturing operations. One of the key strategies to be used to attain this goal is Computer Integrated Manufacturing (CIM).

Although a number of definitions of CIM have been put forward, none of them has been able to cover its scope. Harhen and Browne in 1984 described CIM as the integrated application of computer based automation and decision support systems to manage the total operation of the manufacturing system, from product design through the manufacturing process itself, and finally on to distribution; and including production and inventory management, as well as financial resource management. On the other hand, Bessant in 1991 described CIM as the integration of computer based monitoring and control of all

aspects of the manufacturing process, drawing on a common database and communication via some form of computer network.

If CIM is examined from the point of view of Production Management Systems (PMS) which gives life to the CIM by its decisions on what and when to buy and make, we see that several strategies play an important role. The present study will focus on Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRP II) which are the two strategies of Production Management Systems.

Since the early 1970s the most widely implemented Production Management System has been Material Requirements Planning, developed to manage inventories of manufacturing companies effectively. MRP can be defined as a technique which calculates the requirements for materials.

MRP generates the demand for component parts by exploding the requirements for the top level product through the Bill of Materials (BOM), level by level, and, item by item until all components are planned. Then, the gross requirements are compared with the available inventory and scheduled receipts during the planning horizon for each item in the BOM.

As described above, MRP is based on priority planning, also known as scheduling, which keeps due dates valid and synchronized with the changes. However, in its calculations, it does not take into account the constraints that exist in the planning problem, especially in capacity planning which is just as important as priority planning. In other words, MRP tells us what has to be done in order to meet the master production schedule, rather than what can be done. Therefore, as time passed, MRP quickly evolved by a gradual series of extensions into something more than merely an ordering tool.

These extensions, including capacity planning with the potential for feedback from the execution functions (Production Activity Control-PAC and purchasing) to the planning functions (Master Production Scheduling-MPS, MRP and Capacity Requirements Planning-CRP), introduced a new version of MRP called Closed Loop MRP. Then, the new additional elements, including finance, simulation (also known as what-if capability) and Rough Cut Capacity Planning (RCCP), with the extension of Master Production Scheduling to support Master Planning, introduced a new system labelled as Manufacturing Resource Planning.

MRP II can be defined as a proven method for managing manufacturing business effectively and professionally. With the introduction of the concept of MRP II into business life, companies have gained enormous benefits including better customer service, an

increase in productivity, a decrease in purchase costs and reduced inventory levels. Thus, it has to be the focus of attention.

In the light of the concepts described above, the present study has three aims:

i- Determining the necessity of an inventory control system in a manufacturing company where the solution of the problems requires the use of MRP or MRP II.

ii- Developing a computer program which includes the main characteristics of MRP and MRP II.

iii- Implementing the developed program in the company.

In order to reach the first aim, it was determined that the use of an inventory control system was necessary to solve the problems which Kamed, a branch of Kavala Holding with an interest area of medical instruments, faced with when it intended to manufacture a new product.

This company is thinking about manufacturing a recently developed surgical operation table called ADMI 140 H 11. This surgical operation table has the following high technological characteristics:

i- It is flexible in that its multiple divided table top suits any position, from general surgery to special disciplines.

ii- It is totally X-ray translucent. Image Amplification Devices are usable under almost the whole table top and X-ray cassettes slide underneath the upholstery at any point.

iii- It is easy to control. Each segment of the top is operated by a central crank, which can either be mounted on both sides of the table or at the head end. All functions are selected simply by pressing one of the control levers.

iv- It is comfortable even for the height adjustment. A foot controlled extendable pump pedal makes it easy to operate the system.

v- It is safe and solid. Self locking spindle drives operate the table top to ensure proper function for years. The triangular design of the table's segments provides extra stability.

vi- It is easy to move. All castors are equipped with ball-bearings and thread protection. A foot operated brake locks the entire system safely in position.

Even though the ADMI 140 H 11 has important characteristics as described above and a ready market, the company hesitates whether to get into this business or not. The underlying reason for this hesitation is that the company has no system to manage inventories and the manufacturing process effectively. Without the use of such a system, it is nearly impossible to achieve an effective management of the manufacturing operations of the ADMI 140 H 11, since it is composed of 82 component products.

It is obvious that the more components a product contains, the greater the complexity in the control process of that product's production. In the case of a complex assembly, if carried out manually, calculations of the requirements for component parts, whose demands are dependent on the demand for the assemblies of which they are a part, not only take time but also tend to be inaccurate since the complexity of calculations increases the possibility of making mistakes. On the other hand, by the use of the developed computer program, called Man-Res-Plan, the calculations are carried out in seconds and their accuracy is also maintained.

Then, in order to reach the second aim, the question that had to be answered was the programming language to be used. Among various programming languages, Pascal was chosen by comparing the goal of the program, its application areas and the programmer's knowledge. Some of

the characteristics of Pascal which influenced this choice can be classified as follows:

i- Its similarity to English facilitates both its instruction and its use.

ii- It requires less memory capacity than some other languages such as Cobol, APL and PL/1.

iii- While some other languages have no or limited capability of defining data types which makes things easier for the compiler and the programmer, Pascal programming language has a rich data type definition capability.

iv- With its modular structure, it makes it possible to use procedures and functions. As a result, it not only shortens the program but also increases its readability.

v- It is possible to use Pascal in various types of computers.

vi- It has more predisposition to mathematical operations than some other languages such as Cobol and RPG.

Since it is easy to develop and modify Pascal language, there are various versions on the market. The program presented in this thesis is written by Turbo Pascal which has important superiorities in comparison to the other versions.

After determining the programming language by which the program called Man-Res-Plan was written, the characteristics of MRP and MRP II to be used were chosen. These include basically priority planning and rough cut capacity planning.

In this thesis, Material Requirements Planning analysis is carried out by the computer program for the planning horizon of 12 weeks (approximately 3 months) for the ADMI 140 H 11 and for each of its component parts. Furthermore, Rough Cut Capacity Planning analysis for the parent product, ADMI 140 H 11, is carried out for the two key resources; machine hours and labour hours. In this way, the aims of this present study are achieved.

ÖZET

Son yıllarda, Japon firmaları dünya pazarlarında büyük başarı göstermişlerdir. Özellikle 1970'lerin başından beri, birçok imalat endüstrisinde pazara girmiş ve bu pazarlarda hakimiyet kurmuşlardır. Bu başarının nedeni, kısmende olsa, üstün imalat sistemlerine bağlanmıştır. İmalat sanayindeki son teknolojik gelişmeler ve Japonların bu başarısı, imalat fonksiyonunun rolü ve önemi hakkındaki görüşlerin değişmesine yol açmıştır. Bu değişim sonucunda, bugün imalat bir rekabet silahı olarak değerlendirilmektedir ve dolayısıyla firmalar imalat işlemlerinin yönetiminde mükemmelliğe ulaşmak zorundadırlar. Bilgisayar Tümlşik Üretim (CIM) bu hedefe ulaşmada kullanılabilecek stratejilerden bir tanesidir.

CIM, bilgisayarlarla sağlanan otomasyonun entegrasyonu üzerine kurulmuştur ve imalat sistemi işlemlerini yöneten karar destek sistemlerine sahiptir. CIM'i, firmaya entegrasyon fikri ile uyarlanmış sistemleri birbirleriyle veri alışverişi yapacak şekilde bağlayan ve entegre tek bir sistem haline getiren teknoloji olarak tanımlayabiliriz.

Üretim Yönetim Sistemleri (PMS) , satın alma ve üretim kararları ile CIM'e hayat verir. Eğer CIM, PMS açısından incelenirse birkaç stratejinin önemli rol

oynadıđı gör÷l÷r. Bu tez, bu stratejilerden sadece ikisini, Malzeme Gereksinim Planlaması (MRP) ve İmalat Kaynak Planlamasını (MRP II) inceleyecektir.

1970'lerin başından beri en yaygın kullanılan Üretim Yönetim Sistemi, MRP olmuştur. Özellikle bu yıllarda APICS (American Production and Inventory Control Society) tarafından desteklenen bu planlama tekniđi, malzeme yönetiminde yeni bir dönemi başlatmıştır. MRP, imalat şirketlerinin envanterlerinin etkili bir şekilde yönetilmesi amacıyla geliştirilmiştir ve malzeme ihtiyaçlarını hesaplayan bir teknik olarak tanımlanabilir.

MRP, belirli bir zaman dilimine ait satış tahminlerinin yapılması ile başlar. Sonra bu satış tahminleri, bir üretim planına dönüştür÷l÷r. Bu üretim - planı, sözkonusu üründen ne kadar üretileceđini ve bu üretimin deđişik üretim kaynakları üzerindeki etkilerini belirler. Bu işlem sonucunda, belirli bir döneme ait üretim planını gösteren bir rapor hazırlanır. Bu rapora Ana Üretim Planı (MPS) denir. Bu MPS'den hareket edilerek parça ihtiyaçları hesaplanır. Bu ihtiyaçlar, eldeki mevcut miktar ve ismarlanmış miktarlarla karşılaştırılarak her parçadan ne kadar gerektiđi belirlenir. Sonra, önsüreler gözönüne alınarak, her parçadan belirlenen miktarlarda ne zaman satın alınması veya üretilmesi gerektiđi hesaplanır.

Yukarıda da açıklandığı gibi, MRP öncelik planlaması tekniği üzerine kurulmuştur. Ancak hesaplamalarında, planlama probleminde ve özellikle öncelik planlaması kadar önemli olan kapasite planlamasında yer alan kısıtları gözönüne almaz. Bir başka deyişle, kullanıcıya MPS'i gerçekleştirebilmek için ne yapılabileceği yerine ne yapılması gerektiğini söyler. Bundan dolayı, zamanla MRP yalnızca bir sipariş aracı olmaktan çıkmış, ve kademeli olarak yapılan bir seri eklerle çok hızlı bir şekilde geliştirilmiştir.

Kapalı Devre Malzeme Gereksinim Planlaması, MRP'ye kapasite planlamasının eklenmesi ve uygulama fonksiyonlarıyla planlama fonksiyonları arasında bir geri besleme potansiyelinin kazandırılmasıyla ortaya çıkmıştır. Daha sonra, finansman, benzetim ve kaba bir kapasite planlamasını içeren yeni eklemelerle, ve ana üretim planının ana planlamayı destekleyecek şekilde geliştirilmesi ile MRP II ortaya çıkmıştır.

MRP II, üretimi verimli ve profesyonel bir şekilde yönetebilmek için kullanılan denenmiş bir teknik olarak tanımlanabilir. MRP II olgusunun iş hayatına girmesiyle birlikte, şirketler önemli kazançlar elde etmişlerdir. Bunların başlıcaları, daha iyi müşteri servisi, verimlilik artışı, satın alma fiyatlarında düşüş ve daha düşük envanter seviyeleri olarak sayılabilir. Bu nedenlerden dolayı, ilginin esas odak noktası olması gerektiği ileri sürülmektedir.

Yukarıda açıklanan konuların ışığı altında, bu çalışmada üç hedef belirlenmiştir:

i- Bir şirkette envanter kontrol sistemi kullanımının gerektiğinin saptanması.

ii- MRP ve MRP II'nin bazı temel özelliklerini içeren bir bilgisayar programının geliştirilmesi.

iii- Geliştirilen programın belirlenen şirkette uygulanması.

Bu hedefler çerçevesinde, ilgi alanı tıbbi cihazlar olan Kamed şirketinin bir ürününe ilişkin envanter sorunları olduğu ve bunların MRP veya MRP II kullanımı ile çözülebileceği saptanmıştır.

Bu şirket, ismi ADMI 140 H 11 olan yeni geliştirilmiş bir ameliyat masasını üretmeyi planlamaktadır. Bu ameliyat masası yüksek teknolojik özelliklere sahiptir ve daha da önemlisi, hazır bir pazarı bulunmaktadır. Ancak, tüm bu özelliklere rağmen, Kamed şirketi üretime geçip geçmemekte kararsızdır. Bu kararsızlık, şirketin envanterlerini ve ameliyat masasının üretimini etkili bir şekilde yönetecek bir sisteme sahip olamamasından kaynaklanmaktadır. Bu tip bir sistemin kullanımı olmaksızın, sekseniki parçadan

oluşan ameliyat masasının üretimini etkili bir şekilde yönetebilmek neredeyse imkansızdır. Bundan dolayı, MRP ve MRP II'nin bazı temel özelliklerini içeren bir bilgisayar programı geliştirilmiştir.

İsmi Man-Res-Plan olan bu bilgisayar programının yazılımından önce karar verilmesi gereken husus kullanılacak programlama dili olmuştur. Değişik programlama dilleri arasından Pascal dili, programın amacı, kullanım sahaları ve programcının bilgisi karşılaştırılarak seçilmiştir. Bu seçimde, Pascal'ın aşağıdaki bazı özellikleri etkili olmuştur:

i- Konuşma diline uygunluğu.

ii- Cobol, APL ve PL/1 gibi dillere nazaran daha az bellek kapasitesine ihtiyaç duyması.

iii- Zengin veri tanımlama kabiliyeti.

iv- Programı kısaltan ve okunabilirliğini artıran prosedür ve fonksiyonların kullanımına olanak tanınması.

v- Değişik bilgisayarlarda kullanılabilirliği.

vi- Matematiksel işlemlere yatkınlığı.

Pascal dilini geliştirmek ve değiştirmek kolay olduğundan piyasada değişik çeşitleri bulunmaktadır. Bu tezde sunulan program, diğer çeşitlere göre önemli üstünlükleri olan Turbo Pascal ile yazılmıştır.

Programın yazılacağı dile karar verildikten sonra, MRP ve MRP II'nin programda kullanılacak özellikleri seçilmiştir. Bunlar, öncelik planlaması ve kaba bir kapasite planlamasından oluşur.

Bu programın kullanımı ile, oniki haftalık (yaklaşık üç ay) bir döneme ait temel MRP analizleri, ameliyat masası ve her parçası için uygulanmıştır. Ayrıca, ameliyat masası için kaba bir kapasite planlaması analizi de yapılmıştır. Böylelikle, bu tezin belirlenen üç hedefi gerçekleştirilmiş olur.

LIST OF NOTATIONS

Notation

APICS	American Production and Inventory Control Society
BOM	Bill Of Materials
CIM	Computer Integrated Manufacturing
CRP	Capacity Requirements Planning
EBQ	Economic Batch Quantity
EOQ	Economic Order Quantity
JIT	Just In Time
MPS	Master Production Schedule
MRP	Material Requirements Planning
MRP II	Manufacturing Resource Planning
OPT	Optimized Production Technology
PAC	Production Activity Control
PMS	Production Management Systems
RCCP	Rough Cut Capacity Planning
TQC	Total Quality Control

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I. INTRODUCTION

The present study is on Material Requirements Planning, Manufacturing Resource Planning and the implementation of a dynamic production and inventory control system in a manufacturing company.

Since the early 1970s, MRP has been the most widely implemented production management system. It is a computer based technique for the planning of materials acquisition and production.

As time passed, various functions were added to extend the range of tasks that an MRP system performs. These extensions introduced first Closed Loop MRP and then MRP II.

MRP II is defined as a proven method for managing manufacturing business effectively and professionally. With the use of MRP II systems, companies have gained enormous benefits, such as better customer service, increases in productivity, decreases in purchase costs, and reduced inventory levels.

The major aims of this present study are:

i- Determining the necessity of an inventory control system in a manufacturing company where the solution of the problems requires the use of MRP or MRP II.

ii- Developing a computer program which includes the main characteristics of MRP and MRP II.

iii- Implementing the developed program in the company.

In order to do so, this study consists of seven parts. The aim in the second part is to describe what MRP is. The emergence and the elements of MRP are discussed and its operation is illustrated by a very simple example.

In the third part, a representative selection of lot sizing procedures is reviewed.

In the fourth part, MRP II is described. The evolution from MRP to MRP II is discussed and some of the major modules of MRP II are also outlined.

In the fifth part, the structure and the operation of the developed program are defined.

In the sixth part, the definition of the problem in the company is given with the list of the necessary information of the product and the solution of the problem by the use of the computer program is illustrated.

In the seventh part, findings are discussed.



II. MATERIAL REQUIREMENTS PLANNING

A. THE EMERGENCE OF MRP

In recent years, Japanese firms have gained enormous success in world's markets. A huge proportion of this success belongs to their superior manufacturing systems. The success of Japan has urged people to focus their attention on recent developments in the manufacturing environment and consequently, their perceptions have changed. Today, most people appraise manufacturing function as a competitive weapon. This change in perceptions, regarding manufacturing as a competitive weapon has led industrial firms to operate in a completely new environment where manufacturing is seen as a vital element in the competition between industrial firms. Thus, the manufacturing operations of these industrial firms have to be excellent in order to be successful in competitive markets. There are several strategies that can be used to accomplish manufacturing function excellently, one of them being Computer Integrated Manufacturing.^{[1] [2]}

Before giving the definition of CIM, it is important to imagine what the factory of the future will look like. The following are some of the main characteristics of the factory of the future:^[2]

i- Continuous equipment operation : The equipment used in the factory of the future will have to work more or less continuously in order to pay back the high capital cost tied up in it.

ii- Greatly reduced lot sizes : Since small lot sizes offer more flexibility, especially where there is frequent change in the design of products and in the requirements of the customer, products and components to be manufactured and assembled will necessarily be in small lot sizes.

iii- Shortened lead times : In today's environment, lead times are measured in months and weeks, and, rarely, in days. However, in the factory of the future the unit of measurement of lead time will be days and hours.

iv- Involvement of little or no human labour in production : With the introduction of the concept of automation, there has been an ongoing effort in reducing human involvement in manufacturing. However, this brings forth an important, complicated and inevitable result; a change in cost patterns. Traditionally, manufacturing costs are classified under three groups : material, labour, and overhead. One of the most important relations directly affected by the decrease in human labour is between overhead and labour cost groups. Today, many industries use labour hours in their calculations to recover overhead.

Bonsack (1986) indicates that 'current overhead accounting most often uses the full absorption method which assigns all factory overhead to units of production based on the labour costs incurred.'^[9] However, when taking into account the prediction that direct labour cost will be either a very small fraction of the total cost or eliminated in the factory of the future, it is very obvious that it can no longer be the basis of a standard costing system. Therefore, renewed costing systems will certainly have to be developed so that overhead costs can be allocated against meaningful measures of output.

Thus, CIM is the technology which will satisfy the needs of the factory of the future. Bessant described CIM as

'the integration of computer based monitoring and control of all aspects of the manufacturing process, drawing on a common database and communicating via some form of computer network.'^[11]

Production Management Systems has an important role in the CIM environment. If CIM were a human body, then PMS would be the heart which not only gives life to the CIM but also affects either the success or the failure of CIM by the rhythm of its pulses and through the decisions on what and when to buy and make. There are several strategies in

PMS. These include Material Requirements Planning, Manufacturing Resource Planning, Just In Time / Total Quality Control (JIT/TQC), Optimized Production Technology (OPT).^[2]

MRP started life in the early 1960s in the USA as a computerized technique developed to manage inventories of manufacturing companies effectively. However, the changes in the economy and manufacturing environment have obliged to extend the existing MRP system. These extensions first introduced Closed Loop MRP and then MRP II.

B. THE ELEMENTS OF MRP

Before giving the explanation of how MRP works, the following concepts are described by a very simple example. This example represents the simplified form of the product structure and the related data used in the sixth part. The real data are only used in the implementation phase of the computer program listed in the sixth part of this study.

1. BILL OF MATERIALS

The starting point of an MRP process is the preparation of a bill of materials which shows the parent/child relationship between a product and its

component parts. A typical BOM is illustrated in Figure 1 and in Table 1 in tabular form for a surgical operation table. Here, Table 1 and Figure 1 are prepared by eliminating most of the levels with the aim of simplifying the example by considering that some of the upper level items are purchased from an outside vendor rather than made by the company.

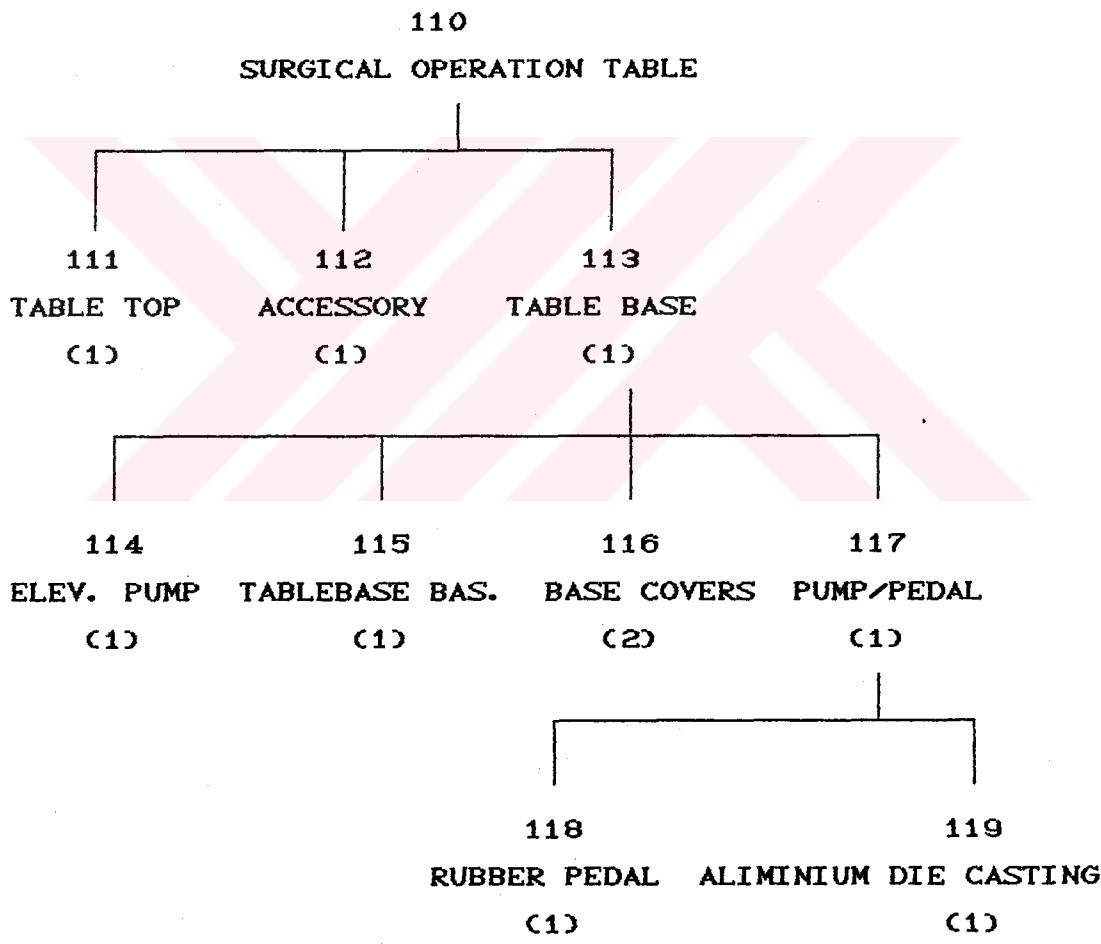


Figure 1. Product Structure for Surgical Operation Table.

SURGICAL OPERATION TABLE			
Part Num.	Description	Quantity Per	Make/Buy Code
111	Table Top	1	B
112	Accessory	1	B
113	Table Base	1	M
TABLE BASE			
Part Num.	Description	Quantity Per	Make/Buy Code
114	Elevation Pump	1	B
115	Tablebase Basic	1	B
116	Base Covers	2	B
117	Pump/Pedal	1	M
PUMP/PEDAL			
Part Num.	Description	Quantity Per	Make/Buy Code
118	Rubber Pedal	1	B
119	Alimin. Die Cast.	1	B

Table 1. Bill of Materials for Surgical Operation Table,
Table Base and Pump/Pedal.

As can be seen from the figure and the table, a bill of material includes information on the product in question and its component parts or raw materials, and possesses a hierarchical levelling structure starting from generally 0 rather than 1 and increasing one by each level, and is consisted of branches at the bottom of which there are the purchased items.

The information for each component generally includes the following :⁽²⁾

i- Part Number : This numbering system may vary with different companies. However, the underlying reason for using the system is to differentiate all products, whether parent or child, in the product structure.

ii- Description : It is a brief description of the product.

iii- Quantity per : It is the product quantity required to produce one unit of its preceeding product.

iv- Make or Buy Code : It is the code indicating whether the product is going to be made by the company or to be bought from an outside vendor.

Even though the concept behind the bill of materials file is quite simple as described above, the complexity in its preparation might grow extensively if the components and assemblies required to make the product in question are numerous, because when such a product is broken down into its components we might reach a level which includes thousands of items. Consequently, a computer-based information processing rather than a manual work should be used during the preparation phase of BOM files in order to achieve the accuracy, usefulness in updating, and the ability of time saving.^{[2] [4]}

2. MASTER PRODUCTION SCHEDULE

Master Production Schedule is a statement including the data of the independent demand for top level items in the BOM file during the planning horizon. This data is usually obtained by the evaluation of forecasts, orders from customers and requirements from different distribution centers.^[1]

MPS is prepared according to the chosen planning horizon, which is divided into units of time called time bucket. At this point, it has to be emphasised that the planning horizon should not be chosen arbitrarily; instead it has to be carefully determined so as to cover the longest cumulative lead time for the product in question.^[2] The master production schedule for the surgical operation table is illustrated in

Table 2 with the planning horizon of 12 weeks (approximately 3 months) and the time bucket of one week.

Week												
Number	1	2	3	4	5	6	7	8	9	10	11	12
Surg.												
Op. Tab.							10		40	20		40

Table 2. Master Production Schedule for Surgical Operation Table.

3. INVENTORY MASTER PARTS FILE

Inventory master parts file consists of two types of data files, namely inventory data and master parts data. The inventory data file generally records the current inventory and the allocated amount for each product or component. Current inventory of an item represents the amount of that item physically available in stock while allocated amount of an item represents the amount of that item in current inventory which has already committed for released orders but has not been yet issued.^[2] Inventory data for the items in Figure 1 is shown in Table 3.

Part Number	Current Inventory	Allocated Amount
110	50	35
111	0	0
112	56	6
113	0	0
114	18	8
115	0	0
116	0	0
117	12	7
118	3	3
119	0	0

Table 3. Inventory Data for Surgical Operation Table, Table Top, Accessory, Table Base, Elevation Pump, Tablebase Basic, Base Covers, Pump/Pedal, Rubber Pedal and Aliminium Die Casting.

Master parts data is composed of the following information for each product in the BOM: ^[2]

i- Level.

ii- Part Number.

iii- Lot Size Policy: There are a number of procedures available in the determination of appropriate lot sizes. These techniques will be discussed in the next part. In order to simplify the example, the lot for lot method is chosen as a lot size policy for all the items in the BOM. It is the simplest method among others and translates directly each net requirement into planned order quantities by offsetting the net requirement by the appropriate lead time.

iv- Lead Time.

v- Description.

vi- Make or Buy Code.

This information is recorded in master parts data either in part number order or in level order. The solution used in this example to standardise the method is to select part numbers in a way that will give the same order with levels. The master parts data for the items in Figure 1 is shown in Table 4.

Level	Part Number	Description	Lead Time	Lot Size	Make/Buy Code
0	110	Surg. Op. Table	2	L	M
1	111	Table Top	1	L	B
1	112	Accessory	3	L	B
1	113	Table Base	2	L	M
2	114	Elev. Pump	3	L	B
2	115	Tablebase Bas.	4	L	B
2	116	Base Covers	4	L	B
2	117	Pump/Pedal	2	L	M
3	118	Rubber Pedal	1	L	B
3	119	Alim. Die. Cast.	3	L	B

Table 4. Master Parts Data for Surgical Operation Table, Table Top, Accessory, Table Base, Elevation Pump, Tablebase Basic, Base Covers, Pump/Pedal, Rubber Pedal and Aliminium Die Casting.

4. OPEN ORDERS DATA

Open orders data includes the amount and the date of an order that will be received, named scheduled receipt and due date respectively. The open orders data for the items in Figure 1 is illustrated in Table 5.

Part Number	Scheduled Receipt	Due Date (Week)
110	25	6
111	5	3
113	5	2
114	25	4
115	5	2
116	5	3
118	10	2

Table 5. Open Orders Data for Surgical Operation Table, Table Top, Table Base, Elevation Pump, Tablebase Basic, Base Covers and Rubber Pedal.

C. THE OPERATION STRUCTURE OF MRP

The basic structure and the information flow of an MRP system is illustrated in Figure 2.

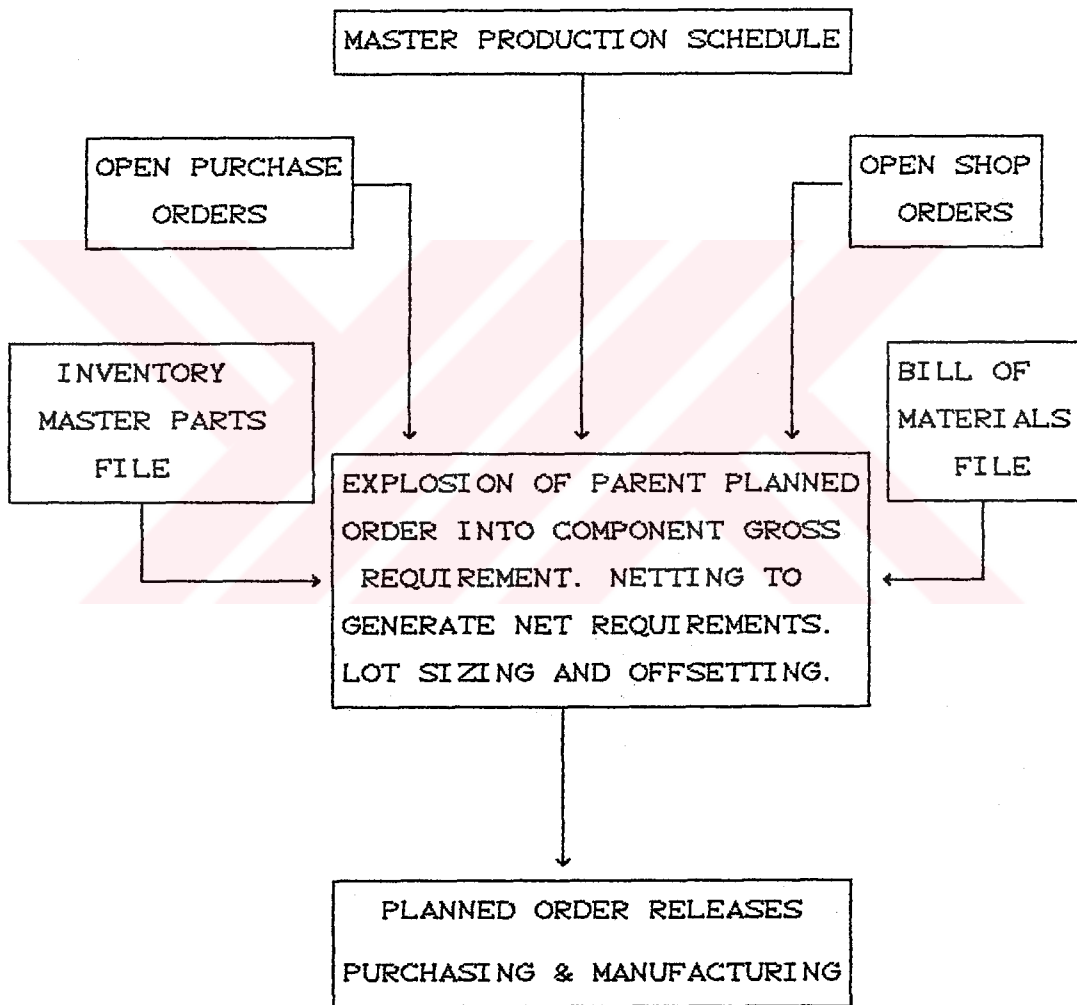


Figure 2. Basic Structure and Information Flow of an MRP system. ⁽²¹⁾

The following procedure gives the details of how MRP works: ⁽²⁾ ⁽⁴⁾

a- Work through master production schedule, item by item, until all independent demand items are planned. Apply the following procedure:

i- Get the gross requirement for parent products (independent demand items) from the MPS.

ii- Calculate the net requirements for those products. The calculation of net requirements is carried out by the following equation:

$$\text{Net requirement} = \text{Gross requirement} - \text{Scheduled receipts} \\ - \text{Current inventory} + \text{Allocations}$$

iii- Translate the net requirements into planned order quantities by taking into account the lot sizing procedure used. For example, the lot by lot method requires offsetting the net requirement quantity by the appropriate lead time to generate the planned order quantity.

b- Work through the BOM, level by level, and item by item, until all components are planned. Apply the following procedure:

i- Ascertain the dependent product's gross requirement by multiplying the quantity required to produce one unit of its preceeding product by the planned order quantity

of that preeceding product.

ii- Carry out the net requirement calculation stated in step a-ii.

iii- Carry out the planned order calculation stated in step a-iii.

Now, let's see how this procedure is applied for the same example used in explaining the elements of MRP:

Item : Surgical Operation Table								Part Number : 110				
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.							10		40	20		40
Scheduled Receipt					25							
Projected Inventory	15					40	30	-10	-30			-70
Net Requirem.									10	20		40
Planned Order							10	20		40		

Table 6. MRP Analysis of Surgical Operation Table.

Item : Table Top								Part Number : 111				
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.							10	20		40		
Scheduled Receipt			5									
Projected Inventory	0		5				-5	-25		-65		
Net Requirem.							5	20		40		
Planned Order						5	20		40			

Table 7. MRP Analysis of Table Top.

Item : Accessory							Part Number : 112					
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.							10	20		40		
Scheduled Receipt												
Projected Inventory	50						40	20		-20		
Net Requirem.										20		
Planned Order							20					

Table 8. MRP Analysis of Accessory.

Item : Table Base							Part Number : 113					
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.							10	20		40		
Scheduled Receipt		5										
Projected Inventory	0	5					-5	-25		-65		
Net Requirem.							5	20		40		
Planned Order					5	20		40				

Table 9. MRP Analysis of Table Base.

Item : Elevation Pump								Part Number : 114				
Week Numb.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.					5	20		40				
Scheduled Receipt				25								
Projected Inventory	10			35	30	10		-30				
Net Requirem.								30				
Planned Order					30							

Table 10. MRP Analysis of Elevation Pump.

Item : Tablebase Basic						Part Number : 115						
Week Numb.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.					5	20		40				
Scheduled Receipt		5										
Projected Inventory	0	5			0	-20		-60				
Net Requirem.						20		40				
Planned Order		20		40								

Table 11. MRP Analysis of Tablebase Basic.

Item : Base Covers								Part Number : 116				
Week Numb.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.					10	40		80				
Scheduled Receipt			5									
Projected Inventory	0		5		-5	-45		-125				
Net Requirem.					5	40		80				
Planned Order	5	40		80								

Table 12. MRP Analysis of Base Covers.

Item : Pump/Pedal								Part Number : 117				
Week Numb.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.					5	20		40				
Scheduled Receipt												
Projected Inventory	5				0	-20		-60				
Net Requirem.						20		40				
Planned Order				20		40						

Table 13. MRP Analysis of Pump/Pedal.

Item : Rubber Pedal								Part Number : 118				
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.				20		40						
Scheduled Receipt		10										
Projected Inventory	0	10		-10		-50						
Net Requirem.				10		40						
Planned Order			10		40							

Table 14. MRP Analysis of Rubber Pedal.

Item : Aliminium Die Casting							Part Number : 119					
Week Numb.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.				20		40						
Scheduled Receipt												
Projected Inventory	0			-20		-60						
Net Requirem.				20		40						
Planned Order	20		40									

Table 15. MRP Analysis of Aliminium Die Casting.

III. LOT SIZING

A. LOT SIZING TECHNIQUES

Lot by lot method has been used in calculating planned orders in the examples presented in the previous part. However, the selection of an appropriate lot sizing procedure varies with different situations. For example, while a situation may require the use of a one specific technique, a different situation may require the use of another one. Therefore, several lot sizing methods have been developed and naturally MRP systems provide the use of these developed techniques. Some of them are listed below:

- i- The lot for lot method.
- ii- The fixed order quantity method.
- iii- The economic order quantity method.
- iv- The fixed order period method.
- v- The part period balancing method.

Now, let us see what kind of procedures these methods apply.

1. THE LOT FOR LOT METHOD

As mentioned before, it is the simplest method among other techniques. In this method, the planned order quantity is equal to the net requirement quantity and the order release date is calculated by offsetting the net requirement due date by the appropriate lead time.^[2]

2. THE FIXED ORDER QUANTITY METHOD

It is the most frequently used method in practice. If the fixed order quantity method is used by the MRP system, then another line is added to the MRP analysis sheet. This added line is called the planned order receipt indicating the amount and the date of an order that should be received.^[2]

In this method, there must be a predetermined fixed lot size. Then, a comparison between the total of net requirements during the planning horizon and the fixed lot size is carried out. If the total is less than or equal to the fixed lot size, then the amount equal to the fixed lot size is ordered. Otherwise, the amount equal to the total of net requirements is ordered. The release date of this order is calculated by offsetting the planned order receipt due date by the appropriate lead time.^[2]

Now, let us assume that the assigned fixed lot size quantity for the surgical operation table is 100. As it can be seen from Table 16, the amount specified in the fixed lot size is ordered since the total of net requirements (=70) is less than the fixed lot size (=100).

Item : Surgical Operation Table										Part Number : 110		
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.							10		40	20		40
Scheduled Receipt						25						
Projected Inventory	15					40	30		-10	-30		-70
Net Requirem.									10	20		40
Plan. Or. Receipt								100				
Planned Order								100				

Table 16. MRP Analysis 1 of Surgical Operation Table using Fixed Order Quantity Method.

However, if the assigned fixed lot size quantity for the same product is 50, then the total net requirement quantity (=70) has to be ordered since it is greater than the fixed lot size (=50) (see Table 17).

Item : Surgical Operation Table								Part Number : 110				
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.							10		40	20		40
Scheduled Receipt						25						
Projected Inventory	15					40	30		-10	-30		-70
Net Requirem.									10	20		40
Plan. Or. Receipt									70			
Planned Order							70					

Table 17. MRP Analysis of Surgical Operation Table using Fixed Order Quantity Method.

3. THE ECONOMIC ORDER QUANTITY METHOD

This method accomodates the calculation of an economic order quantity. The underlying reason for this calculation is the trade-off between the set-up cost for the manufactured items or the ordering cost for purchased items, and the inventory cost. It is clear that large batches cause high inventory levels and is therefore expensive in terms of the high capital costs tied up in it. On the other hand, small batches cause low inventory levels and therefore high set-up costs by the replacement of an order or high start-up costs of a batch on a machine. In the case of high set-up or ordering costs, larger batches might be used in order to reduce the per unit cost of set-up or order. However, this will result in high inventory levels and thereby, high capital costs. This trade-off is expressed by the Economic Order Quantity (EOQ), also known as Economic Batch Quantity (EBQ), method. The EOQ is the optimum ordering quantity reflecting the most effective trade-off between the costs of set-up and inventory. ^{[2] [5]}

The calculation of the EOQ is illustrated in Table 18.

Let

EOQ : The Economic Order Quantity
S : The Set-up Cost Per Batch
D : The Demand For The Item Per Unit Time
C : The Inventory Carrying Cost Per Item Per
Unit Time

Then

$$EOQ = \sqrt{\frac{2 S D}{C}}$$

Table 18. Economic Order Quantity Calculation.⁽²⁾

As it can be seen from the table, in order to calculate the EOQ, the demand for the product in question, and set-up costs, and inventory carrying costs should be known, and the demand should be constant. These assumptions cause some difficulties in the implementation of the EOQ model in MRP systems. It is obvious that most of the items in a bill of materials file are dependent demand items. Therefore, their demand can not be isolated from others. However, the demand in the EOQ calculation is assumed to be independent. Furthermore, the assumption of constant demand is not valid in most of the MRP installations. On the other hand, the calculation of the set-up and inventory carrying costs accurately is another difficulty in using the EOQ model in MRP.⁽²⁾

Now, let us assume that the demand for the surgical operation table is 96 over a twelve week period. This represents a weekly demand of 8 ($=96/12$), and an annual demand of 416 ($=8*52$). Let us also assume that the inventory carrying cost per year and the set-up cost are \$6 and \$100, respectively. If this data is used in the EOQ equation, the optimum ordering quantity will be approximately 117. The new MRP analysis of surgical operation table using EOQ is illustrated in Table 19.

Item : Surgical Operation Table								Part Number : 110				
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.							10		40	20		40
Scheduled Receipt						25						
Projected Inventory	15					40	30	-10	-30			-70
Net Requirem.									10	20		40
Plan. Or. Receipt								117				
Planned Order							117					

Table 19. MRP Analysis of Surgical Operation Table using Economic Order Quantity Method.

4. THE FIXED ORDER PERIOD METHOD

This method is a variation of the fixed order quantity method. They differ in that the fixed order period method sets a fixed time between orders, while the fixed order quantity method sets a fixed lot size to order. In this method, the total of net requirements in this assigned fixed time period is ordered by taking into consideration the fact that the weeks with no net requirement are not included in the ordering interval.^[2]

Let us assume that the assigned fixed time is 4 weeks for the surgical operation table. This new situation is illustrated in Table 20.

5. PART PERIOD BALANCING METHOD

Part period balancing method is established on the logic of the economic order quantity method. In other words, it seeks the quantity where the set-up or ordering cost is more or less equal to the inventory cost.^[2]

Item : Surgical Operation Table										Part Number : 110		
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.							10		40	20		40
Scheduled Receipt						25						
Projected Inventory	15					40	30		-10	-30		-70
Net Requirem.									10	20		40
Plan. Or. Receipt									70			
Planned Order							70					

Table 20. MRP Analysis of Surgical Operation Table using Fixed Order Period Method.

The calculation of this quantity is best explained by an example. Now, let us assume that the net requirements of the surgical operation table are as shown in Table 21.

The calculation of this quantity is best explained by an example. Now, let us assume that the net requirements of the surgical operation table are as shown in Table 21.

Item : Surgical Operation Table	
Week Number	Net Requirements
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	20
9	40
10	20
11	30
12	80

Table 21. Net Requirements of Surgical Operation Table.

If the inventory cost per unit per week and the set-up cost for the surgical operation table are \$1 and \$140 respectively, then different ordering policies are calculated in Table 22 and the related MRP analysis is illustrated in Table 23.

SET-UP COST : \$140	
Ordering Policy 1 : Order for week 8 only	
Order Quantity	: 20 units
Inventory Cost	: $20 \times \frac{1}{2} \times 1 = \$10$
Ordering Policy 2 : Order for weeks 8 and 9 only	
Order Quantity	: 60 units
Inventory Cost	: $20 \times \frac{1}{2} \times 1 + 40 \times \frac{3}{2} = \$70$
Ordering Policy 3 : Order for weeks 8,9 and 10 only	
Order Quantity	: 80 units
Inventory Cost	: $20 \times \frac{1}{2} \times 1 + 40 \times \frac{3}{2} + 20 \times \frac{5}{2}$ = \$120
Ordering Policy 4 : Order for weeks 8,9,10 and 11 only	
Order Quantity	: 110 units
Inventory Cost	: $20 \times \frac{1}{2} \times 1 + 40 \times \frac{3}{2} + 20 \times \frac{5}{2}$ + $30 \times \frac{7}{2} = \$225$
Ordering policy 3 is selected since its inventory cost (=120) is more or less equal to the set-up cost (=140).	
Ordering Policy 5 : Order for week 11 only	
Order Quantity	: 30 units
Inventory Cost	: $30 \times \frac{1}{2} \times 1 = \$15$
Ordering Policy 6 : Order for weeks 11 and 12 only	
Order Quantity	: 110 units
Inventory Cost	: $30 \times \frac{1}{2} \times 1 + 80 \times \frac{3}{2} = \$135$
Ordering policy 6 is selected since its inventory cost (=135) is more or less equal to the set-up cost (=140).	

Table 22. The Calculation and the Determination of the Ordering Policy.

Item : Surgical Operation Table								Part Number : 110				
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirem.								20	40	20	30	80
Scheduled Receipt												
Projected Inventory	0							-20	-60	-80	-110	-190
Net Requirem.								20	40	20	30	80
Plan. Or. Receipt								80			110	
Planned Order						80			110			

Table 23. MRP Analysis of Surgical Operation Table using Part Period Balancing Method.

IV. MANUFACTURING RESOURCE PLANNING

A. THE EVOLUTION FROM MRP TO MRP II

The gradual series of changes in the economic climate made it difficult for the existing MRP systems to meet the needs of the new manufacturing environment in which conditions change constantly. Change in the manufacturing environment is not simply a possibility but a constant certainty, and a reality. In this new economic climate and manufacturing environment, firms had to use their capacity more effectively, produce smaller batches more economically, and provide more flexibility. However, MRP systems worked best for those firms that have little product diversity and relatively constant order and supply patterns. That is why MRP systems did not have the potential to satisfy those new requirements. On the other hand, if extended properly to become something more than merely an ordering tool and to cover special processes to support several functions of the firm such as purchasing, inventory control and finance, the system could easily be used in this new environment. These special processes should use the whole production resources and construct a link between planning and execution functions as well as between those and the whole system. (2) (4) (5)

This was the underlying reason for the development of Closed Loop MRP and MRP II. Closed Loop MRP, which is a stage in MRP development, provides the opportunity to

link Master Production Scheduling , Material Requirements Planning and Capacity Requirements Planning with purchasing and production activity control (see Figure 3). Once the planning phase is complete and the resulting plans have been accepted as realistic and attainable, the execution functions such as controlling input-output, dispatching on the shop floor, and following up purchasing, are carried out.^[2]

Closed loop MRP has a number of important characteristics :^[6]

- i- It is a series of functions, not merely material requirements planning.
- ii- It contains tools to address both priority and capacity, and to support both planning and execution.
- iii- It has provisions for feedback from the execution functions to the planning functions. Plans can then be altered when necessary, thereby keeping priorities valid as conditions change.

However due to the continuous changes in the manufacturing environment and technology, it has become necessary to extend the existing MRP system. These extensions to the Closed Loop MRP produced a new system

called MRP II which can be described as a totally integrated approach to the management of all manufacturing resources.^[2]

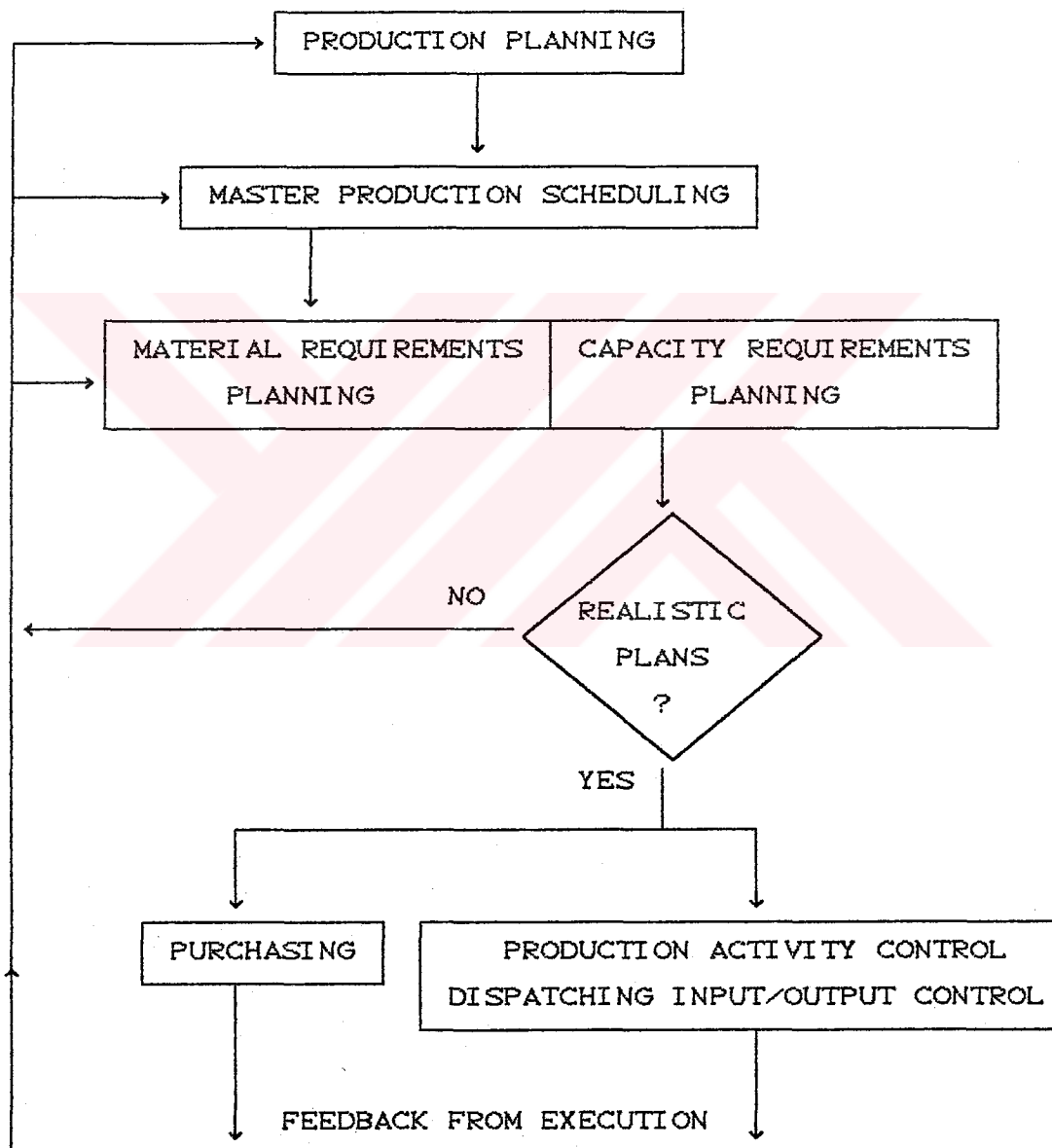


Figure 3. Closed Loop MRP.^[2]

As a concept, MRP II was well established by the 1980s, when it became possible to use PCs or, in other words, low-cost terminals. But why? There are three main reasons:⁽¹⁾

i- They increased and diffused the availability of access since they can be used as both intelligent terminals (connected to a larger network with a minicomputer at the core) or local stand-alone processors. (See Figure 4).

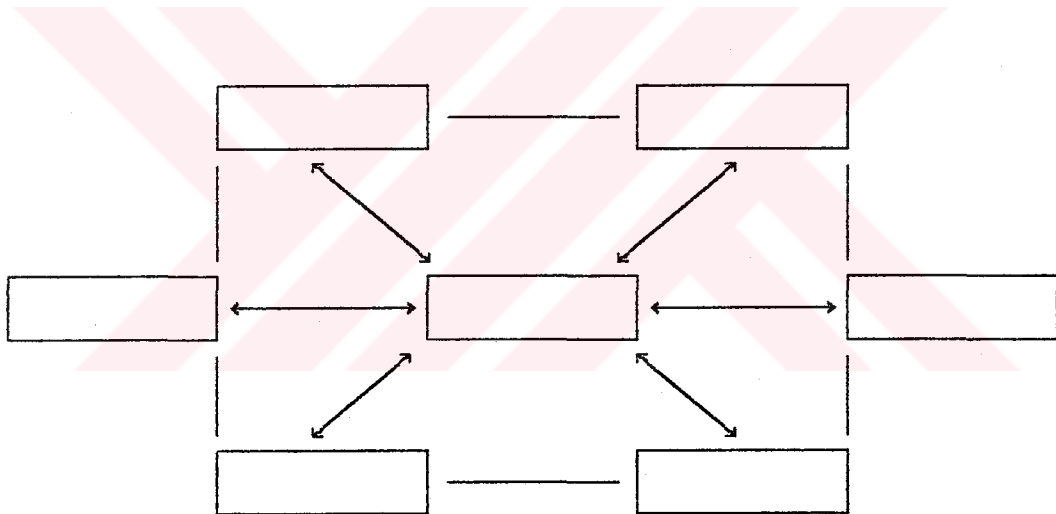


Figure 4. Mini and PC Based Terminals Distributed to Different Areas and Networked.⁽¹⁾

ii- They provided higher levels of integration.

iii- They gave the possibility of faster processing so that MRP can be used on a weekly basis much faster.

Briefly, MRP II involves two additional elements : finance and simulation (see figure 5). Through the addition of certain financial features, it is possible to translate the operating plan into financial terms while simulation gives the ability to ask what-if questions and gets detailed answers. ⁽²⁾ (6)

B. THE ELEMENTS OF MRP II

Some of the modules that a typical MRP II system includes are explained below :

1. MASTER PRODUCTION SCHEDULING

Master Production Scheduling is a statement of what products the company plans to manufacture. It includes answers to the questions: how many and when. Thus, it comprises the scheduled quantities and dates for individual items rather than families. MPS also takes into account existing customer orders, sales forecasts, current inventory, availability of capacity, company goals etc., in order to determine the best manufacturing strategy for the planned horizon. ⁽²⁾

MPS can easily affect the success or failure of MRP process. Any errors in MPS such as poor or unrealistic sales forecast will definitely result in a failure of the MRP analysis since it is the key input to the MRP system. One important method of overcoming this difficulty and maintaining the accuracy of MPS is the use of short-term planning horizons, since change in the short-term rarely occurs and planning data for the near-term tends to be more accurate because it is dominated by actual orders and requirements. Furthermore, especially in today's industries, where product life cycles are greatly reduced and tend to be relatively short, it is very important to take where each product sits in the company's product portfolio in terms of the product life cycle into account during the preparation of forecasts.^[2]

An MPS sheet typically looks like Table 24. As can be seen, the company plans to manufacture three types of surgical operation tables, A, B, and C. Generally, an MPS software uses the actual customer orders and the forecasts generated by the system and entered manually. Then, it applies a very simple procedure to estimate the demand.

The analysis of the MPS is carried out for the products, B and C, in Tables 25 and 26, respectively. In these examples, the procedure to estimate the total demand is as follows:

i- For the first three weeks, get the actual customer orders.

ii- Beyond the first three weeks, get manual forecasts if available, otherwise system generated forecasts.

The last three lines in the MPS analysis sheet are named as starting inventory, projected inventory and cumulative available to promise. Starting inventory is the amount in inventory available to be used. Projected inventory is the amount equal to initial inventory plus the firm planned orders less total demand, while cumulative available to promise is the amount equal to initial inventory plus the firm planned orders less actual orders.

Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Sur. Op. Tab. A	50	50	50	50	60	60	60	60	60	60	60	60
Sur. Op. Tab. B	60	60	60	60	60	60	60	40	40	40	40	40
Sur. Op. Tab. C	30	30	30	40	40	40	40	40	40	40	40	40

Table 24. The MPS for Surgical Operation Tables A, B, C for 12 weeks.

Item : Surgical Operation Table B												
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Syst. Gen. Forecast	40	40	40	40	40	40	40	40	40	40	40	40
Manual Forecast	50	50	40	60	70	60	80	30	50	60		
Act. Cust. Orders	55	60	55	20		30	40		20			
Total Demand	55	60	55	60	70	60	80	30	50	60	40	40
Firm Pl. Orders	60	60	60	60	60	60	60	40	40	40	40	40
Starting Invent.	30											
Projected Invent.	35	35	40	40	30	30	10	20	10	-10	-10	-10
Cum. Avail. To Prom.	35	35	40	80	140	170	190	230	250	290	330	370

Table 25. MPS Analysis of Surgical Operation Table B.

Item : Surgical Operation Table C												
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Syst. Gen. Forecast	30	30	30	30	30	30	30	30	30	30	30	30
Manual Forecast	30	30	60	60	40	40	20	10	10			
Act. Cust. Orders	20	20	30	40	20	20	30	30			20	
Total Demand	20	20	30	60	40	40	20	10	10	30	30	30
Firm Pl. Orders	30	30	30	40	40	40	40	40	40	40	40	40
Starting Invent.	20											
Projected Invent.	30	40	40	20	20	20	40	70	100	110	120	130
Cum. Avail. To Prom.	30	40	40	40	60	80	90	100	140	180	200	240

Table 26. MPS Analysis of Surgical Operation Table C.

After the preparation of the MPS and before the implementation, its feasibility should be checked. This feasibility check is usually accomplished by the help of the Rough Cut Capacity Planning.

2. ROUGH CUT CAPACITY PLANNING

As we mentioned above, RCCP is generally used to check whether the prepared MPS is feasible from the capacity of key resources point of view. Thus, this planning technique simply determines the impact of the MPS on key resources such as labour hours and machine hours. In order to accomplish this checking procedure, a bill of resources is prepared for each item in the MPS. The bill of resources includes the required quantities for each source to produce one unit of each item in the MPS. Then, the required resource quantity for each item in the MPS is calculated by multiplying the resource quantity required to produce one unit of that item (obtained from bill of resources) by the total demand of the same item during the planning horizon (obtained from MPS). Once the required resource quantity for each item in the MPS is calculated, they are added together to generate the total of required resource quantities. Then, rough cut capacity analysis is carried out for each source by subtracting the total required resource quantity from the available resource quantity in order to find whether there is a negative or positive deviation. This feasibility check indicates that the proposed MPS is infeasible if there is a negative deviation. In the

event of such a case it becomes necessary either to revise the MPS or to increase the quantity of insufficient resource.^{(2) (6)}

In Table 27 and 28, the required resource quantities, labour hours and machine hours, respectively, are listed for the items in the MPS (see Table 24).

Resource : Labour Hours	
Item	Resource Quantity
Surgical Operation Table A	5
Surgical Operation Table B	6
Surgical Operation Table C	6

Table 27. Bill of Labour Hours for Surgical Operation Tables A, B, C.

Resource : Machine Hours	
Item	Resource Quantity
Surgical Operation Table A	4
Surgical Operation Table B	4
Surgical Operation Table C	4

Table 28. Bill of Machine Hours for Surgical Operation Tables A, B, C.

By multiplying the firm planned orders in each week for each product by the required resource quantity to produce one unit of that product, Table 29 and 30 showing the required resource quantity in each week for each product are obtained.

Resource : Labour Hours												
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Sur. Op. Tabl. A	250	250	250	250	300	300	300	300	300	300	300	300
Sur. Op. Tabl. B	360	360	360	360	360	360	360	240	240	240	240	240
Sur. Op. Tabl. C	180	180	180	240	240	240	240	240	240	240	240	240

Table 29. Required Labour Hours for Surgical Operation
Tables A, B, C.

Resource : Machine Hours												
Week Num.	1	2	3	4	5	6	7	8	9	10	11	12
Surg. Op. Tabl. A	200	200	200	200	240	240	240	240	240	240	240	240
Surg. Op. Tabl. B	240	240	240	240	240	240	240	160	160	160	160	160
Surg. Op. Tabl. C	120	120	120	160	160	160	160	160	160	160	160	160

Table 30. Required Machine Hours for Surgical Operation
Tables A, B, C.

By adding the weekly required resource quantities listed in Tables 29 and 30 for each resource, a comparison is made between the available and the total of required resource quantities. This comparison and its results are illustrated in Table 31 and 32 for labour hours and machine hours, respectively.

Resource : Labour Hours												
Week N.	1	2	3	4	5	6	7	8	9	10	11	12
Requir. Hours	790	790	790	850	900	900	900	780	780	780	780	780
Avail. Hours	800	800	800	800	800	800	800	800	800	800	800	800
Negat. Dev.				-50	-100	-100	-100					
Posit. Dev.	10	10	10					20	20	20	20	20

Table 31. Rough Cut Capacity Analysis for Labour Hours.

Resource : Machine Hours												
Week N.	1	2	3	4	5	6	7	8	9	10	11	12
Requir. Hours	560	560	560	600	640	640	640	560	560	560	560	560
Avail. Hours	600	600	600	600	600	600	600	600	600	600	600	600
Negat. Dev.					-40	-40	-40					
Posit. Dev.	40	40	40					40	40	40	40	40

Table 32. Rough Cut Capacity Analysis for Machine Hours.

3. CAPACITY REQUIREMENTS PLANNING

Capacity Requirements Planning is a more detailed version of Rough Cut Capacity Planning. But, inspite of this characteristic of CRP, its importance is less than RCCP in practice. The underlying reason is that while RCCP and the MPS are developed interactively, CRP is not used in parallel with the MPS. ^[2]

As mentioned above, CRP and RCCP are based on the same logic; that is checking the capacity. However, they differ in that while RCCP compares the available capacity of the key resources with the capacity required to meet

the MPS, capacity requirements planning compares the available capacity in each work centre with the capacity required to implement the MPS. Thus, it identifies the possible situations that might be overload, underload or balance in each work centre.^[2]

CRRP uses either one of the following two scheduling techniques:^[2]

i- Backward Scheduling : In this technique, the latest start date of an operation is found by offsetting the due date by the appropriate lead time. If the earliest start date of an operation is prior to the latest start date, then there is a slack time. If the latest start date is prior to the earliest start date, then there is a negative slack indicating a delay. This situation is illustrated in Figure 6.

ii- Forward Scheduling : In this technique, the completion date of an operation is obtained by offsetting the earliest start date by the appropriate lead time. If the completion date is prior to the due date, then there is a slack time. If the due date is prior to the completion date, then there is a negative slack indicating a delay. This situation is illustrated in Figure 7.

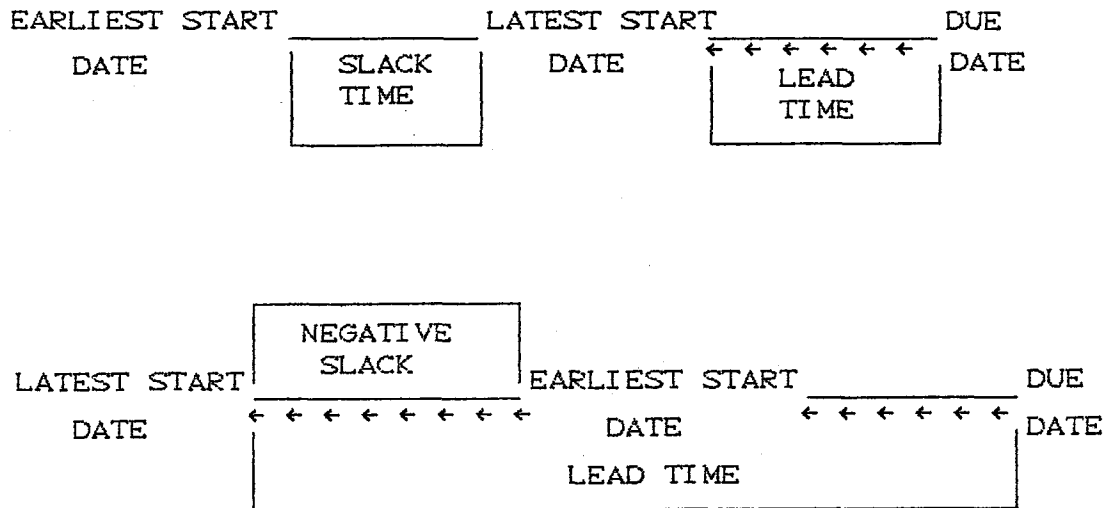


Figure 6. Backward Scheduling Technique. ^[2]

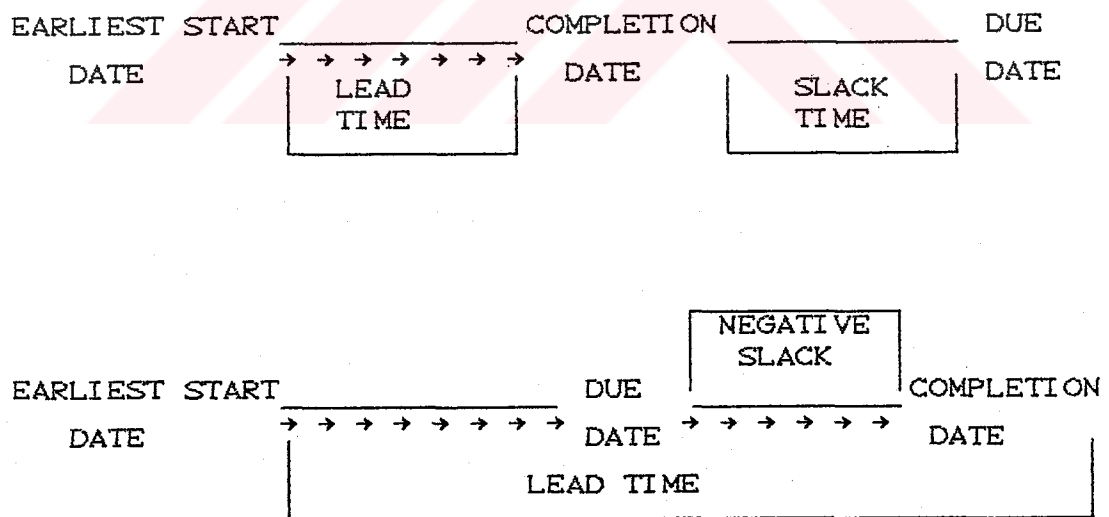


Figure 7. Forward Scheduling Technique. ^[2]

The lead time used in these two scheduling techniques is called an operation lead time and is different from the lead time used in the basic MRP analysis. The manufacturing process of a component may require several operations such as assembly and inspection in different work centres, for example the assembly room or the inspection laboratory. To complete each operation in its associated work centre takes time, and this is the operation lead time. Then, the lead time used by the MRP system is calculated by adding together the operation lead times of each operation in each work centre for the component in question.^[2]

Now, let us use the surgical operation table in our example for CRP. As can be seen from Figure 1 and Table 1, table top and accessory should be assembled to the table base in order to manufacture the surgical operation table. This assembly procedure is carried out in assembly room 1. Then, let us consider that the surgical operation table is examined in inspection laboratory A.

In Table 33, the routing information for the surgical operation table is illustrated. Its route as described above starts in assembly room 1 and ends in the inspection laboratory A.

In the calculation of operation lead times, some information about work centres such as the queue time and the available capacity should be known. The work centre

information for surgical operation table is shown in Table 34.

WORK CENTRE	ASSEMBLY ROOM 1
OPERATION DESCRIPTION	ASSEMBLE TABLE TOP AND ACCESSORY TO TABLE BASE
SET-UP TIME	1 HOURS
PROCESSING TIME	1.8 HOURS
TRANSPORT TIME	6 HOURS
NEXT WORK CENTRE	INSPECTION LABORATORY
WORK CENTRE	INSPECTION LABORATORY A
OPERATION DESCRIPTION	INSPECT THE SURGICAL OPERATION TABLE
SET-UP TIME	0.5 HOURS
PROCESSING TIME	1 HOURS
TRANSPORT TIME	5 HOURS
NEXT WORK CENTRE	STOCK ROOM

Table 33. Routing Information for Surgical Operation Table.

WORK CENTRE	ASSEMBLY ROOM 1
QUEUE TIME	35 HOURS
AVAILABLE CAPACITY	45 HOURS
WORK CENTRE	INSPECTION LABORATORY A
QUEUE TIME	14.5 HOURS
AVAILABLE CAPACITY	45 HOURS

Table 34. Work Centre Information for Surgical Operation Table.

The procedure of the calculation of operation lead times for each operation is as follows :

- i- Get the value of queue time from work centre information table.
- ii- Get the values of set-up time, processing time and transport time from routing information table.
- iii- Multiply the processing time by the determined batch size.
- iv- Add together the values of queue time, set-up time, processing time multiplied by the batch size, and

transport time to obtain the value of the operation time for each operation.

In our example for the surgical operation table, we consider that the determined batch size is 10. Then, the calculation of operation lead times is carried out and illustrated in Table 35.

As can be seen from Table 6, planned orders for the surgical operation table are 10, 20, and 40 in weeks 7, 8, and 10, respectively. And the due dates are weeks 9, 10, and 12.

In tables 36, 37, and 38, the load on the departments of assembly and inspection for the planned orders 10, 20, and 40, respectively is calculated based on the planned orders information obtained from Table 6.

OPERATION : ASSEMBLY	HOURS
SET-UP TIME	1
PROCESSING TIME * BATCH SIZE (1.8 * 10)	18
TRANSPORT TIME	6
QUEUE TIME	35
TOTAL OPERATION TIME	60
SET-UP TIME	0.5
PROCESSING TIME * BATCH SIZE (1 * 10)	10
TRANSPORT TIME	5
QUEUE TIME	14.5
TOTAL OPERATION TIME	30

Table 35. Calculation of Operation Lead Times for Surgical Operation Table.

ITEM : SURGICAL OPERATION TABLE	HOURS
DEPARTMENT : ASSEMBLY	
BATCH SIZE * PROCESSING TIME (10 * 1.8)	18
SET-UP TIME	1
LOAD	19
DEPARTMENT : INSPECTION	
BATCH SIZE * PROCESSING TIME (10 * 1)	10
SET-UP TIME	0.5
LOAD	10.5

Table 36. Calculation of Department Loads for Surgical Operation Table for the Planned Order Quantity 10.

ITEM : SURGICAL OPERATION TABLE	HOURS
DEPARTMENT : ASSEMBLY	
BATCH SIZE * PROCESSING TIME (20 * 1.8)	36
SET-UP TIME	1
LOAD	37
DEPARTMENT : INSPECTION	
BATCH SIZE * PROCESSING TIME (20 * 1)	20
SET-UP TIME	0.5
LOAD	20.5

Table 37. Calculation of Department Loads for Surgical Operation Table for the Planned Order Quantity 20.

ITEM : SURGICAL OPERATION TABLE	HOURS
DEPARTMENT : ASSEMBLY	
BATCH SIZE * PROCESSING TIME (40 * 1.8)	72
SET-UP TIME	1
LOAD	73
DEPARTMENT : INSPECTION	
BATCH SIZE * PROCESSING TIME (40 * 1)	40
SET-UP TIME	0.5
LOAD	40.5

Table 38. Calculation of Department Loads for Surgical Operation Table for the Planned Order Quantity 40.

V. THE DEVELOPMENT OF THE COMPUTER PROGRAM

My primary aim in writing the computer program listed in Appendix A is to use my background knowledge on computer science in MRP. There are two main important factors which heavily influenced my decision. One of them covers the financial restrictions, that is, both MRP and MRP II softwares are expensive to buy. Some companies with limited production capacity in terms of the range of products they produce or the ones with small profits and with the desire of improving the productivity neither invest nor want to invest in this kind of a system. Therefore, they have to spend time and human effort on a job which can be carried out by the MRP software in a maximum of one or two minutes. Another factor is that current MRP softwares cover so many details. Many functions of such software are neither used nor needed to be used. Thus, this program is developed by taking into account these factors and the requirements of the company where it is implemented.

A. THE STRUCTURE OF THE PROGRAM

This program consists of primarily four sections. Now let us examine each one.

a- Record Entry : In this section of the program, it is possible to record the necessary related information of desired number of products. Each record includes the following information that is entered by the user:

i- Part Number

ii- Part Description

iii- Unit of Measurement

iv- Make or Buy Code

v- Supplier Code

vi- Lead Time

vii- Level Code

viii- Quantity Required : This is the amount of an item required to produce one unit of its preceeding product. The program automatically assigns 1 to this variable if it sees that the level code is zero meaning that the item is a parent product.

ix- Preceeding Product's Part Number : The program automatically assigns zero to this variable in the case of a parent product since it is the top level item in the product structure tree.

x- Current Inventory

xi- Allocations

xii- Required Labour Hour : It is possible to enter the value of this variable only when the item is a parent product.

xiii- Required Machine Hour : The same restriction in xii is also valid for this variable.

xiv- Scheduled Receipt Quantities

xv- Gross Requirement Quantities: The user is allowed to enter these quantities only for parent products. The gross requirements of child products are calculated by the program since they are dependent on the requirements of the parent product.

xvi- Lot Sizing Method : The program makes the following three types of method available to be used as the lot sizing procedure for each product:

- * The lot for lot method

- * The fixed order quantity method

- * The economic order quantity method

If the fixed order quantity method is chosen, then the assigned fixed lot size for the product is asked by the program. If the economic order quantity method is chosen, then either the user enters the economic order quantity directly or the program calculates it by

obtaining from the user the values of three variables :
set-up cost per batch, inventory carrying cost per item
per unit time, and the demand for the item per unit time.

b- Record Reading : This section is consisted of three
subsections : reading records, reading analysis, rough
cut capacity analysis.

i- Reading Records : In this subsection the following
group of information of a record is displayed on the
screen.

* Record Number

* Part Number

* Part Description

* Unit of Measurement

* Make or Buy Code

* Supplier Code

* Lead Time

* Level Code

* Quantity Required

* Preceeding Product's Part Number

* Current Inventory

* Allocations

* Scheduled Receipts

* Gross Requirements

* Lot Sizing Policy : If the lot size policy is the fixed order quantity method, then the fixed order quantity amount is displayed, if it is economic order quantity method, then economic order quantity amount is also displayed with the name of the chosen lot size policy technique.

This subsection includes the following five alternatives:

* All Records : All the records are displayed in the sequence they exist in the file.

* Record Number : The record whose record number is specified by the user is displayed.

* Parent Product : All the parent products are displayed in the order they exist in the file.

* Part Number : The record whose part number is specified by the user is displayed.

* Part Description : The record whose part description is specified by the user is displayed.

ii- Reading Analysis : This subsection offers two alternatives : all analysis and specific product analysis. The former one, if chosen, lists the analysis of all the products in the order they exist in the file, while the later one lists the analysis of the product whose part number is specified by the user.

The analysis in this subsection covers the basic material requirements planning analysis: that is, the calculation of gross requirements of child products, projected inventories, net requirements, planned orders, and planned order receipt quantities only in the case of either fixed or economic order quantity methods.

iii- Rough Cut Capacity Analysis : This analysis is carried out by the program for only two types of resources : labour hours and machine hours. The program asks the available hours in each week for the resource choosen. Then, it compares the required hours that are calculated by the program itself with the available hours in each week for each parent product. Through the comparison, it lists the deviations whether negative or positive for the parent product in question.

c- Record Rewriting : This section allows the user either to change the information of a product or to delete a record. By the use of this section, it is not only possible to obtain the analysis of the products in another planning horizon (12 weeks) but also to see the opportunities and the treats when the data is changed.

In order to protect the program, this section is not included in the print-out listed in Appendix A. If desired, please phone 265 53 04.

d- Program Exit : This section allows the user to quit the program.

B. THE OPERATION OF THE PROGRAM

The decision that has to be given before the writing of the computer program presented in Appendix A was the programming language to be used. Among various languages, Pascal is selected as the most suitable one by comparing the goal of the program, its application areas and the programmer's knowledge.

Pascal programming language is involved in the category of third generation programming languages (also known as modern or structured languages). The languages in this class are characterized by strong procedural and

data structuring capabilities.

Pascal is developed in the 1970s in Zurich Eidgenossische Technische Hochschule by the group under the administration of Niklaus Wirth. The main goals of this group in developing Pascal language can be summarized as follows: ^{[7] [8]}

- i- A programming language with a modular structure which can be instructed systematically.
- ii- A programming language similar to English.
- iii- A reliable programming language.
- iv- An effective programming language.

Pascal programming language with the characteristics described above, when possessed the structured program writing technique defined in ALGOL 60, gained a big success in comparison to Fortran and Cobol languages which were widely implemented in those years. Furthermore, this success caused to define Pascal language as being the Fortran of the 1980s.

When compared with other programming languages, we see the following main characteristics of Pascal to be in the most important place : ^{[7] [8]}

i- The similarity of Pascal to English facilitates both its instruction and its use. This characteristic makes Pascal superior to some other languages such as Fortran, RPG, Basic and APL.

ii- It requires less memory capacity than some other languages such as Cobol, APL, PL/1 and ALGOL 68.

iii- While some other languages have no or limited capacity of defining data types which make things easier for both the compiler and the programmer, Pascal has a rich data type definition capability. This characteristic not only increases the speed of the execution time but also, by necessitating the definition of data types, it disciplines the programmer and therefore, it prevents the occurrence of logical mistakes.

iv- Pascal programming language makes it possible to use procedures and functions which verify different problems. Thus, the group of commands which has to be executed more than one time in the whole program, can be gathered under the name of a procedure and therefore, it can be called by the desired number of times and from the desired number of places in the program.

v- It is possible to use Pascal language in various types of computers. On the other hand, this availability is not valid for such languages as PL/1 and APL.

vi- It has more predisposition to mathematical operations than some other languages such as Cobol and RPG.

Since it is easy to develop and modify Pascal language, there is a wide range of versions on the market. The computer program listed in Appendix A is written by Turbo Pascal which has important superiorities in comparison to the other versions.

After giving the details of the structure and the language by which the program is written, its operation can be followed by the list and the flowchart of it listed in Appendix A and B, respectively.



VI. THE IMPLEMENTATION OF THE SYSTEM IN A MANUFACTURING COMPANY

A. DEFINITION OF THE PROBLEM

The company, whose problems are solved by the use of the computer program, Man-Res-Plan, is Kamed which is a branch of Kavala Holding. The interest area of this company is limited with medical instruments. The company either imports or manufactures them.

This company faced with a problem when it intended for manufacturing a recently developed surgical operation table called ADMI 140 H 11. This operation table has important characteristics and a ready market. However, the company hesitates whether to get into this business or not, since it has no sophisticated system to manage inventories and the manufacturing process effectively. The underlying reason for this hesitation is that the ADMI 140 H 11 contains 82 component parts which result in a complexity in controlling of the table's production without the use of a computer based system. Furthermore, if carried out manually, it is time consuming to calculate the requirements for 82 component parts whose demands are dependent on the demand for the assemblies of which they are a part. It should also be pointed out that the calculations tend to be inaccurate since making mistakes is for humans.

In the light of the concepts mentioned above, now we can define the problem as being formed by the following questions:

i- How to manage inventories effectively ?

ii- How to calculate the component and assembly requirements to manufacture and assemble the final product ?

iii- How to determine the correct requirement dates ?

iv- How to carry out the calculations in a short time ?

v- How to obtain accurate results ?

B. DEFINITION OF THE PRODUCT

1. CHARACTERISTICS

The ADMI 140 H 11 has the following high technological characteristics:

i- It is flexible in that its multiple divided table top suits any position, from general surgery to special disciplines.

ii- It is totally X-ray translucent. Image Amplification Devices are usable under almost the whole table top and X-ray cassettes slide underneath the upholstery at any point.

iii- It is easy to control. Each segment of the top is operated by a central crank, which can either be mounted on both sides of the table or at the head end. All functions are selected simply by pressing one of the control levers.

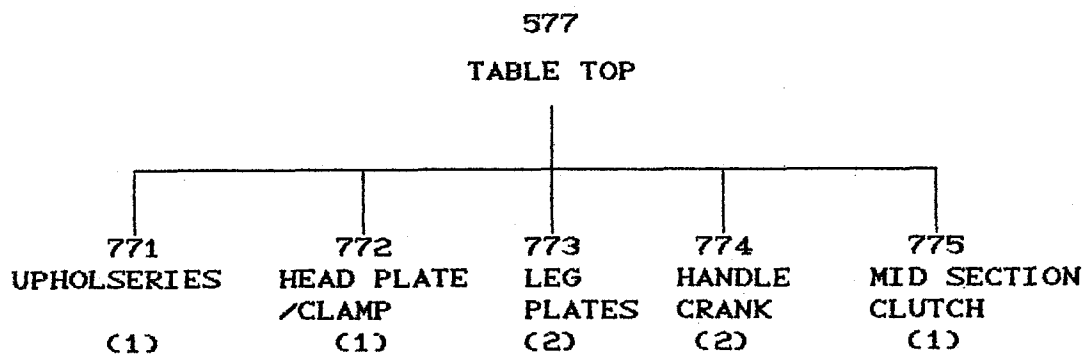
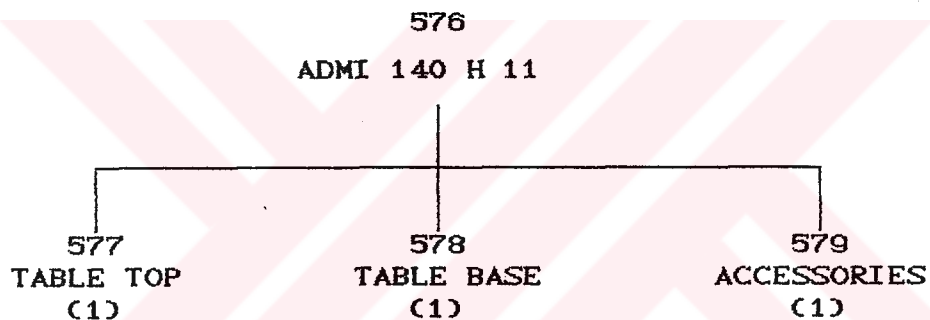
iv- It is comfortable even for the height adjustment. A foot controlled extendable pump pedal makes it easy to operate the system.

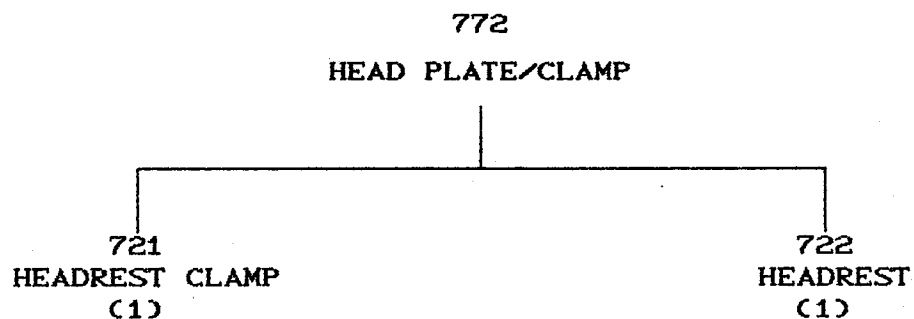
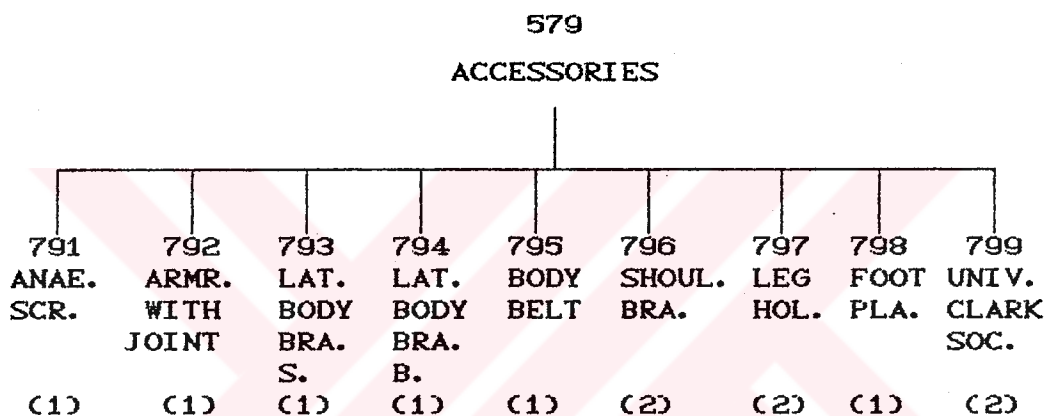
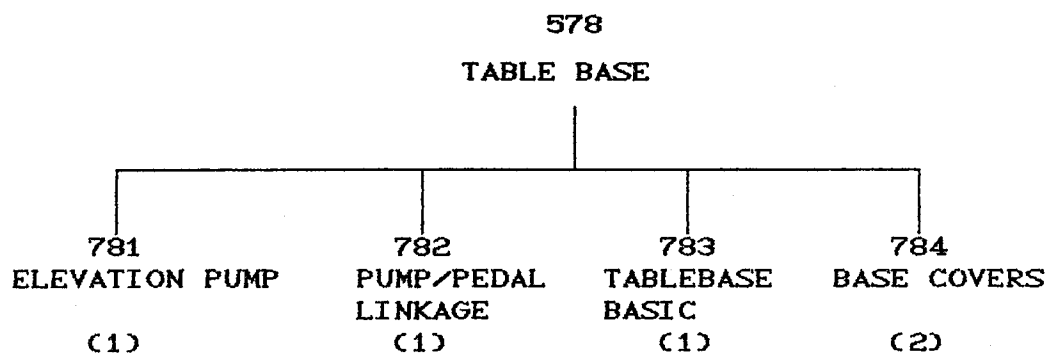
v- It is safe and solid. Self locking spindle drives operate the table top to ensure proper function for years. The triangular design of the table's segments provides extra stability.

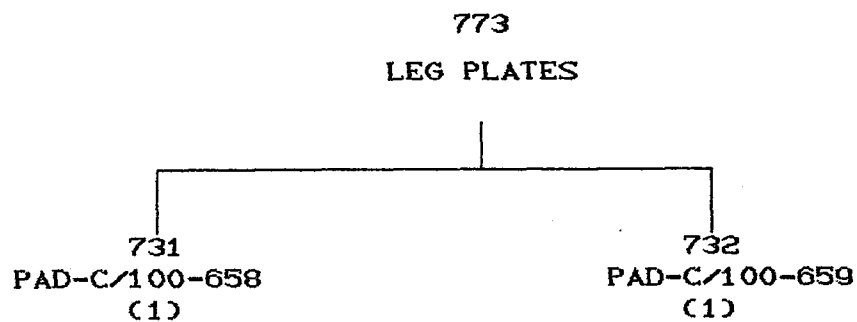
vi- It is easy to move. All castors are equipped with ball-bearings and thread protection. A foot operated brake locks the entire system safely in position.

2. PRODUCT STRUCTURE

The product structure of ADMI 140 H 11 is illustrated in the following pages in Figure 8 by dividing it into units since it is not possible to draw it on one page.



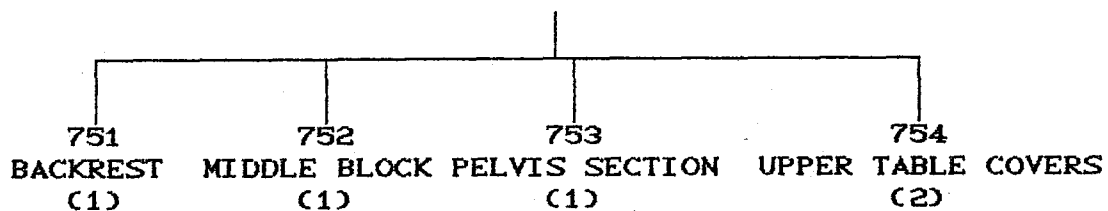




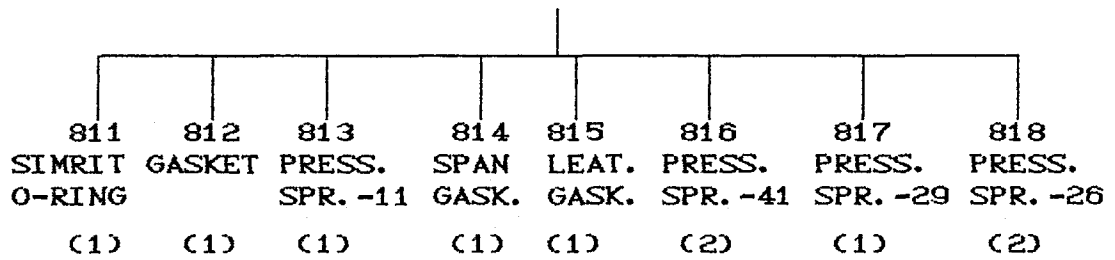
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HANDLE CRANK



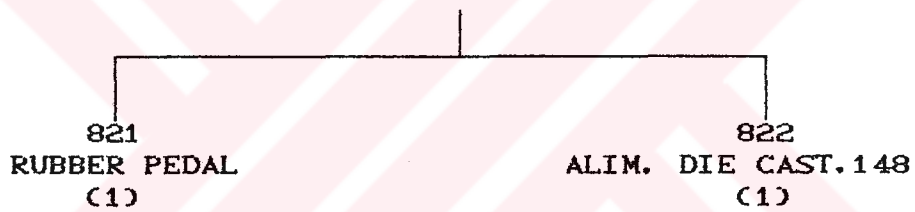
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MID SECTION CLUTCH



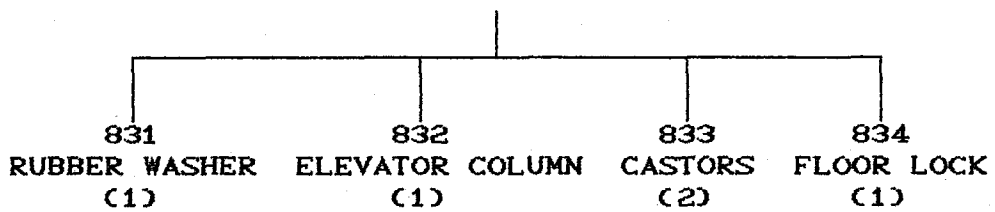
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ELEVATION PUMP

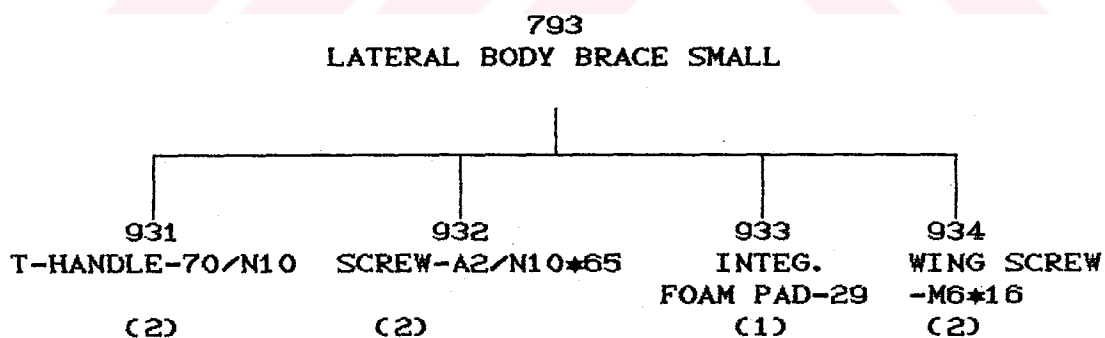
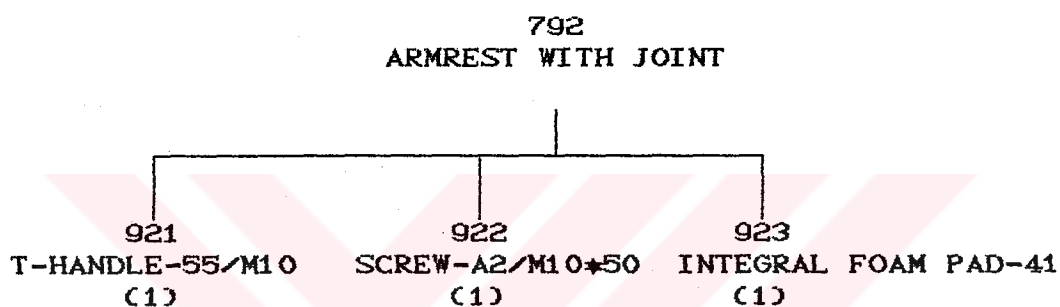
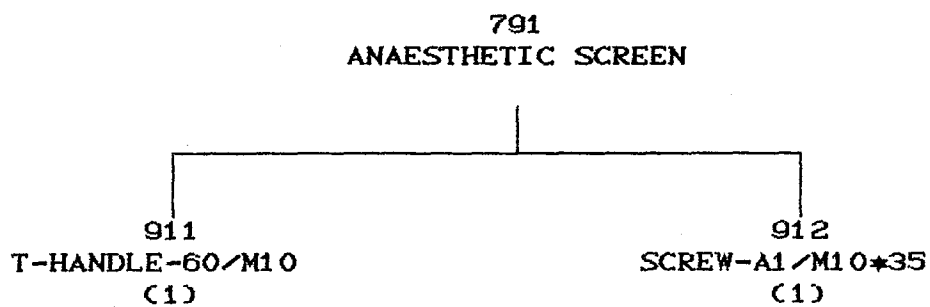


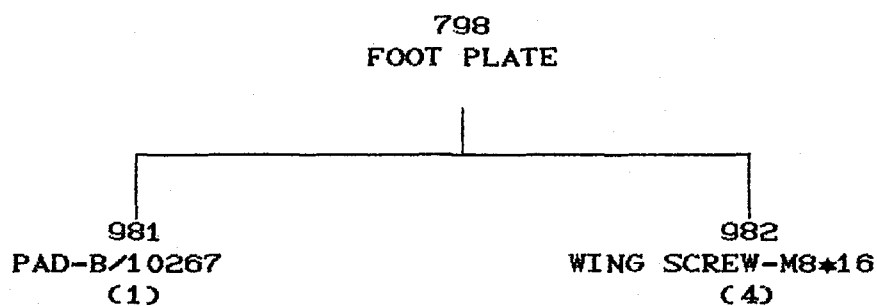
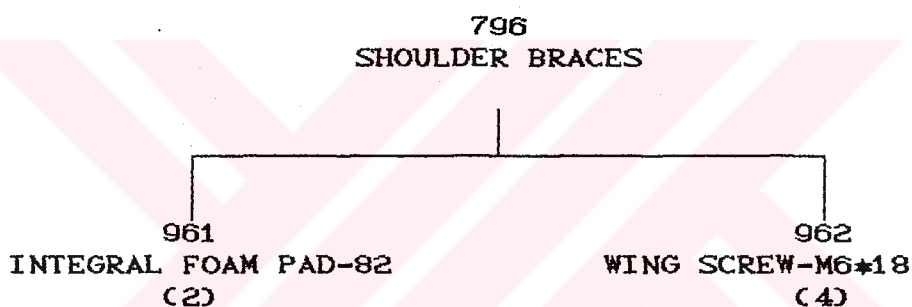
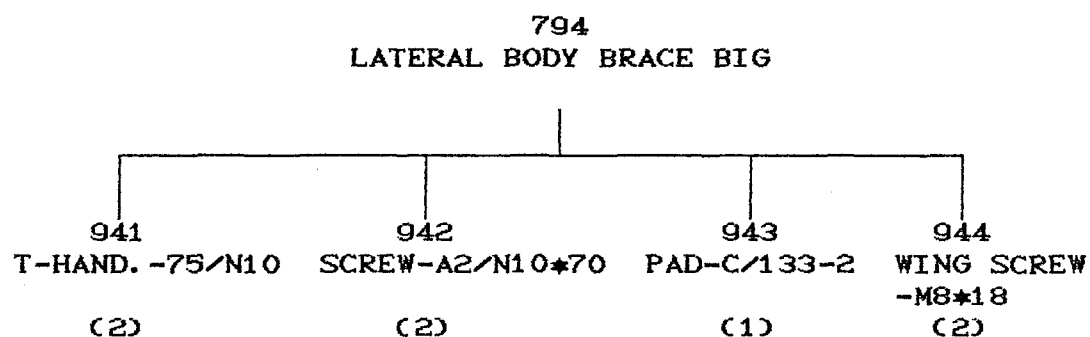
782
PUMP/PEDAL LINKAGE

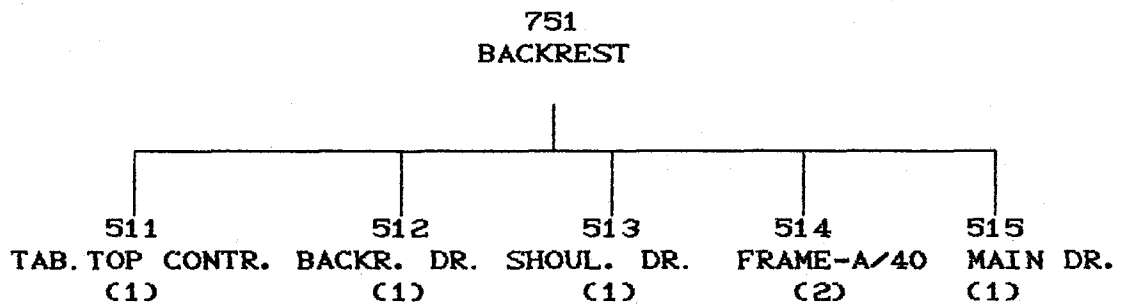
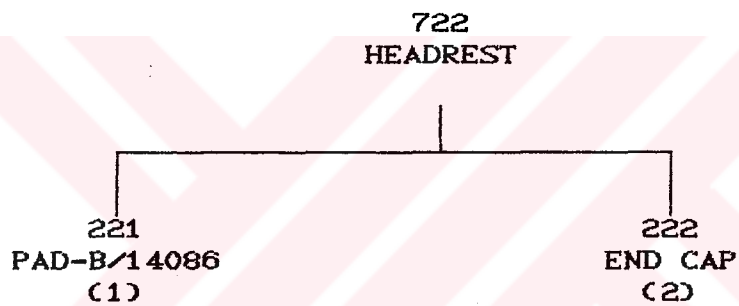
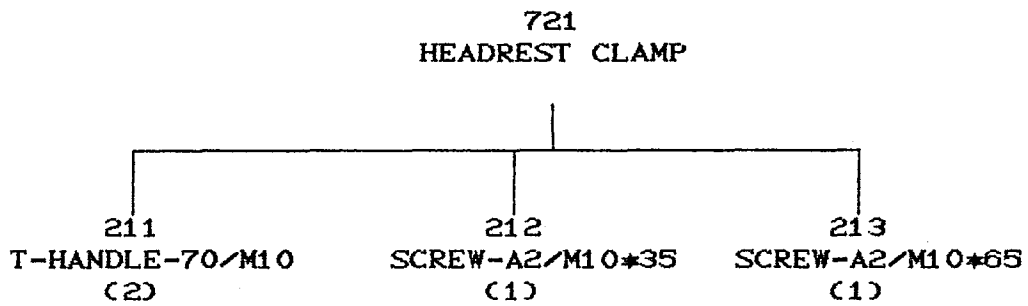


783
TABLEBASE BASIC









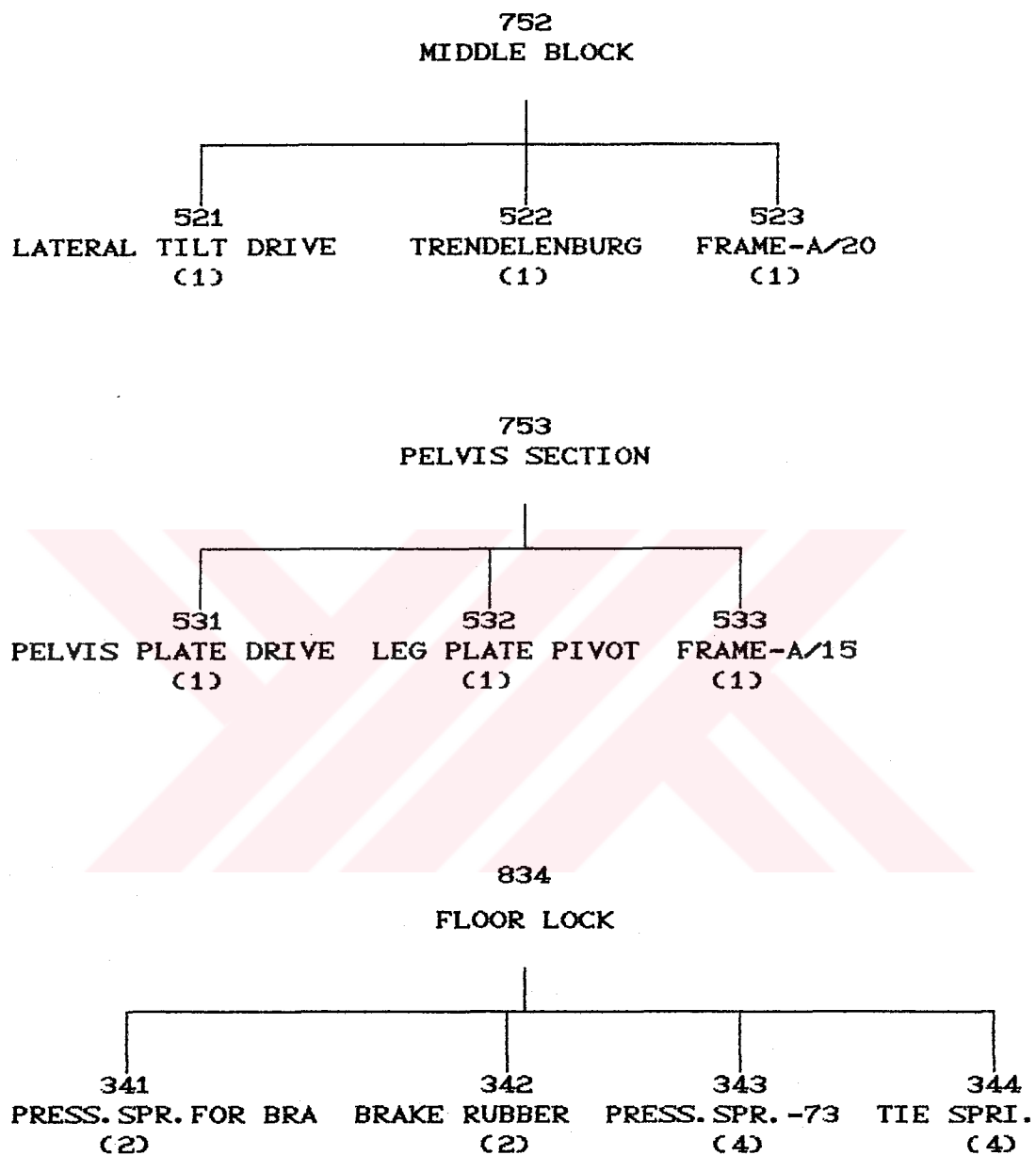


Figure 8. Product Structure for ADMI 140 H 11.

3. BILL OF MATERIALS

ADMI 140 H 11

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
577	TABLE TOP	1	M
578	TABLE BASE	1	M
579	ACCESSORIES	1	M

TABLE TOP

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
771	UPHOLSERIES	1	B
772	HEAD PLATE/CLAMP	1	M
773	LEG PLATES	2	M
774	HANDLE CRANK	2	M
775	MID SECTION CLUTCH	1	M

TABLE BASE

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
781	ELEVATION PUMP	1	M
782	PUMP/PEDAL LINKAGE	1	M
783	TABLEBASE BASIC	1	M
784	BASE COVERS	2	B

ACCESSORIES

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
791	ANAESTHETIC SCREEN	1	M
792	ARMREST WITH JOINT	1	M
793	LATERAL BODY BRACE SMALL	1	M
794	LATERAL BODY BRACE BIG	1	M
795	BODY BELT	1	B
796	SHOULDER BRACES	2	M
797	LEG HOLDER	2	B
798	FOOT PLATE	1	M
799	UNIVERSAL CLARK SOCKET	2	B

HEAD PLATE/CLAMP			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
721	HEADREST CLAMP	1	M
722	HEADREST	1	M

LEG PLATES			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
731	PAD-C/100-658	1	B
732	PAD-C/100-659	1	B

HANDLE CRANK			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
741	KONE GRIP	2	B
742	HEAD NUT	2	B

MID SECTION CLUTCH			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
751	BACKREST	1	M
752	MIDDLE BLOCK	1	M
753	PELVIS SECTION	1	M
754	UPPER TABLE COVERS	2	B

ELEVATION PUMP			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
811	SIMRIT O-RING	1	B
812	GASKET	1	B
813	PRESSURE SPRING-11	1	B
814	SPAN GASKET	1	B
815	LEATHER GASKET	1	B
816	PRESSURE SPRING-41	2	B
817	PRESSURE SPRING-29	1	B
818	PRESSURE SPRING-26	2	B

PUMP/PEDAL LINKAGE			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE. BUY
821	RUBBER PEDAL	1	B
822	ALIMINIUM DIE CASTING.148	1	B

TABLEBASE BASIC

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
831	RUBBER WASHER	1	B
832	ELEVATOR COLUMN	1	B
833	CASTORS	2	B
834	FLOOR LOCK	1	M

ANAESTHETIC SCREEN

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
911	T-HANDLE-60/M10	1	B
912	SCREW-A1/M10*35	1	B

ARMREST WITH JOINT

PART NUM.	DESCRIPTION	QUANT. PER	MAKE. BUY
921	T-HANDLE-55/M10	1	B
922	SCREW-A2/M10*50	1	B
923	INTEGRAL FOAM PAD-41	1	B

LATERAL BODY BRACE SMALL

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
931	T-HANDLE-70/N10	2	B
932	SCREW-A2/N10*65	2	B
933	INTEGRAL FOAM PAD-29	1	B
934	WING SCREW-M6*16	2	B

LATERAL BODY BRACE BIG

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
941	T-HANDLE-75/N10	2	B
942	SCREW-A2/N10*70	2	B
943	PAD-C/133-2	1	B
944	WING SCREW-M8*18	2	B

SHOULDER BRACES

PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
961	INTEGRAL FOAM PAD-82	2	B
962	WING SCREW-M6*18	4	B

FOOT PLATE			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
981	PAD-B/10267	1	B
982	WING SCREW-M8*16	4	B
HEADREST CLAMP			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
211	T-HANDLE-70/M10	2	B
212	SCREW-A2/M10*35	1	B
213	SCREW-A2/M10*65	1	B
HEADREST			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
221	PAD-B/14086	1	B
222	END CAP	2	B
BACKREST			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
511	TABLE TOP CONTROLS	1	B
512	BACKREST DRIVE	1	B
513	SHOULDER DRIVE	1	B
514	FRAME-A/40	2	B
515	MAIN DRIVE	1	B
MIDDLE BLOCK			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
521	LATERAL TILT DRIVE	1	B
522	TRENDELENBURG	1	B
523	FRAME-A/20	1	B
PELVIS SECTION			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
531	PELVIS PLATE DRIVE	1	B
532	LEG PLATE PIVOT	1	B
533	FRAME-A/15	1	B

FLOOR LOCK			
PART NUM.	DESCRIPTION	QUANT. PER	MAKE/BUY
341	PRESSURE SPRING FOR BRA	2	B
342	BRAKE RUBBER	2	B
343	PRESSURE SPRING-73	4	B
344	TIE SPRING	4	B

Table 39. Bill of Materials for ADMI 140 H 11 and its
Component Parts.

4. MASTER PARTS DATA

LEVEL	PART NUM.	DESCRIPTION	LEAD TIME	LOT SIZE	MAKE/BUY CODE
0	576	ADMI 140 H 11	2	L	M
1	577	TABLE TOP	1	L	M
1	578	TABLE BASE	1	L	M
1	579	ACCESSORIES	1	L	M
2	771	UPHOLSERIES	2	L	B
2	772	HEAD PLATE/CLAMP	1	L	M
2	773	LEG PLATES	2	L	M
2	774	HANDLE CRANK	1	L	M
2	775	MID SECTION CLUTCH	1	L	M
2	781	ELEVATION PUMP	1	L	M
2	782	PUMP/PEDAL LINKAGE	1	L	M
2	783	TABLEBASE BASIC	1	L	M
2	784	BASE COVERS	1	L	B
2	791	ANAESTHETIC SCREEN	1	L	M
2	792	ARMREST WITH JOINT	1	L	M
2	793	LATERAL BODY BR. S.	1	L	M
2	794	LATERAL BODY BR. B.	1	L	M
2	795	BODY BELT	1	L	B
2	796	SHOULDER BRACES	1	L	M
2	797	LEG HOLDER	2	L	B
2	798	FOOT PLATE	1	L	M
2	799	UNIVERSAL CLARK SOC.	1	L	B

LEVEL	PART	DESCRIPTION	LEAD	LOT	MAKE/BUY
	NUM.		TIME	SIZE	CODE
3	721	HEADREST CLAMP	1	L	M
3	722	HEADREST	1	L	M
3	731	PAD-C/100-658	1	L	B
3	732	PAD-C/100-659	1	L	B
3	741	KONE GRIP	1	L	B
3	742	HEAD NUT	1	L	B
3	751	BACKREST	1	L	M
3	752	MIDDLE BLOCK	1	L	M
3	753	PELVIS SECTION	1	L	M
3	754	UPPER TABLE COVERS	2	L	B
3	811	SIMRIT O-RING	1	L	B
3	812	GASKET	1	L	B
3	813	PRESSURE SPRING-11	1	L	B
3	814	SPAN GASKET	2	L	B
3	815	LEATHER GASKET	2	L	B
3	816	PRESSURE SPRING-41	1	L	B
3	817	PRESSURE SPRING-29	1	L	B
3	818	PRESSURE SPRING-26	1	L	B
3	821	RUBBER PEDAL	1	L	B
3	822	ALIM. DIE CAST.148	1	L	B
3	831	RUBBER WASHER	1	L	B
3	832	ELEVATOR COLUMN	1	L	B
3	833	CASTORS	1	L	B
3	834	FLOOR LOCK	1	L	M
3	911	T-HANDLE-60/M10	1	L	B
3	912	SCREW-A1/M10*35	1	L	B
3	921	T-HANDLE-55/M10	1	L	B
3	922	SCREW-A2/M10*50	1	L	B
3	923	INT. FOAM PAD-41	1	L	B
3	931	T-HANDLE-70/N10	1	L	B
3	932	SCREW-A2/N10*65	1	L	B
3	933	INT. FOAM PAD-29	1	L	B
3	934	WING SCREW-M6*16	1	L	B
3	941	T-HANDLE-75/N10	1	L	B
3	942	SCREW-A2/N10*70	1	L	B
3	943	PAD-C/133-2	1	L	B
3	944	WING SCREW-M8*18	1	L	B
3	961	INT. FOAM PAD-82	1	L	B
3	962	WING SCREW-M6*18	1	L	B
3	981	PAD-B/10267	1	L	B
3	982	WING SCREW-M8*16	1	L	B

LEVEL	PART NUM.	DESCRIPTION	LEAD TIME	LOT SIZE	MAKE/BUY CODE
4	211	T-HANDLE-70/M10	1	L	B
4	212	SCREW-A2/M10*35	1	L	B
4	213	SCREW-A2/M10*65	1	L	B
4	221	PAD-B/14086	1	L	B
4	222	END CAP	1	L	B
4	341	PRESS. SPR. FOR BRA	1	L	B
4	342	BRAKE RUBBER	1	L	B
4	343	PRESSURE SPRING-73	1	L	B
4	344	TIE SPRING	1	L	B
4	511	TABLE TOP CONTROLS	1	L	B
4	512	BACKREST DRIVE	1	L	B
4	513	SHOULDER DRIVE	1	L	B
4	514	FRAME-A/40	1	L	B
4	515	MAIN DRIVE	1	L	B
4	521	LATERAL TILT DRIVE	1	L	B
4	522	TRENDELENBURG	1	L	B
4	523	FRAME-A/20	1	L	B
4	531	PELVIS PLATE DRIVE	1	L	B
4	532	LEG PLATE PIVOT	1	L	B
4	533	FRAME-A/15	1	L	B

Table 40. Master Parts Data for ADMI 140 H 11 and its
Component Parts.

5. INVENTORY DATA

PART NUMBER	CURRENT INVENTORY	ALLOCATED AMOUNT
211	12	2
212	40	0
213	20	5
221	10	5
222	50	20
341	40	5
342	0	0
343	50	30
344	0	0
511	15	0
512	20	0
513	0	0
514	30	10
515	0	0
521	45	10
522	5	0
523	22	2
531	5	0
532	60	25
533	0	0
576	10	5
577	20	10
578	0	0
579	0	0
721	0	0
722	40	10
731	50	30
732	25	15
741	45	15
742	35	10
751	0	0
752	40	20
753	20	0
754	43	3
771	5	0
772	20	5
773	0	0
774	10	5
775	0	0

PART NUMBER	CURRENT INVENTORY	ALLOCATED AMOUNT
781	15	0
782	20	15
783	0	0
784	60	0
791	5	0
792	5	0
793	0	0
794	0	0
795	15	5
796	0	0
797	15	0
798	10	0
799	60	15
811	0	0
812	20	0
813	45	15
814	20	10
815	0	0
816	15	5
817	0	0
818	0	0
821	30	0
822	50	25
831	0	0
832	0	0
833	40	35
834	10	5
911	55	25
912	40	25
921	0	0
922	20	5
923	10	5
931	0	0
932	15	0
933	20	0
934	35	10
941	0	0
942	40	25

PART NUMBER	CURRENT INVENTORY	ALLOCATED AMOUNT
943	40	30
944	0	0
961	15	0
962	0	0
981	0	0
982	0	0

Table 41. Inventory Data for ADMI 140 H 11 and its
Component Parts.

6. OPEN ORDERS DATA

PART NUMBER	SCHEDULED RECEIPT	DUE DATE (WEEK)
211	100	2
212	50	1
	15	2
213	45	1
511	5	1
512	15	1
521	30	1
522	5	1
523	8	1
	15	2
531	15	1
731	90	1
	20	2
732	85	1
741	20	2
742	10	2
754	15	1
	5	2
771	40	1
	10	2
784	20	1
	15	2
	20	3
795	20	1
	20	3
797	15	2
812	10	2
813	10	1
	10	2
816	15	2
817	25	3
821	30	2
822	15	2
832	20	1
	20	2

Table 42. Open Orders Data for the Component Parts of
ADMI 140 H 11.

7. MASTER PRODUCTION SCHEDULE

WEEK NUM.	1	2	3	4	5	6	7	8	9	10	11	12
ADMI 140 H 11							40		25	50	35	30

Table 43. Master Production Schedule for ADMI 140 H 11.

C. SOLUTION OF THE PROBLEM

The solution of the problem is illustrated on the following pages by the use of the computer program. The first pages include the entry of the data. Then, the basic MRP analysis and the RCCP analysis for labour and machine hours are listed. However, since it is a waste of pages, the entry and the analysis are only shown for the ADMI 140 H 11 and nine of its component parts.

```
*****
*           MAIN MENU           *
*****
*                               *
*   1- RECORD ENTRY            *
*                               *
*   2- RECORD READING          *
*                               *
*   3- RECORD REWRITING        *
*                               *
*   4- PROGRAM EXIT            *
*                               *
*****
```

MAKE YOUR CHOICE <1-4> : 1

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT:

```
*****
*
* PART NUMBER           : 576
*
* PART DESCRIPTION      : ADMI 140 H 11
*
* UNIT OF MEASUREMENT   : ITEM
*
* MAKE OR BUY CODE (M/B) : M
*
* SUPPLIER CODE         : X05
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT:

```
*****
*
* LEAD TIME           : 2
*
* LEVEL CODE          : 0
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT:

```
*****
*
* CURRENT INVENTORY      : 10      *
*
* ALLOCATIONS            : 5        *
*
* REQUIRED LABOR HOUR     : 6        *
*
* REQUIRED MACHINE HOUR   : 4        *
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0      *
*
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT:

```
*****
*
* HOW MANY GROSS REQUIREMENTS OCCUR DURING THE PERIOD : 5      *
*
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT'S
1 ST GROSS REQUIREMENT:

```
*****
*
* NUMBER OF THE WEEK      : 7      *
*
* AMOUNT OF REQUIREMENT  : 40     *
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT'S
2 ND GROSS REQUIREMENT:

```
*****
*
* NUMBER OF THE WEEK      : 9      *
*
* AMOUNT OF REQUIREMENT  : 25     *
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT'S
3 RD GROSS REQUIREMENT:

```
*****
*
* NUMBER OF THE WEEK      : 10      *
*
* AMOUNT OF REQUIREMENT   : 50      *
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT'S
4 TH GROSS REQUIREMENT:

```
*****
*
* NUMBER OF THE WEEK      : 11      *
*
* AMOUNT OF REQUIREMENT   : 35      *
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 1 ST PRODUCT'S
5 TH GROSS REQUIREMENT:

```
*****
*
* NUMBER OF THE WEEK      : 12      *
*
* AMOUNT OF REQUIREMENT  : 30      *
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD      *
*
* 2- THE FIXED ORDER QUANTITY METHOD *
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD *
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 1 ST PRODUCT: 1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y *
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 2 ND PRODUCT:

```
*****
*
* PART NUMBER           : 577
*
* PART DESCRIPTION      : TABLE TOP
*
* UNIT OF MEASUREMENT   : ITEM
*
* MAKE OR BUY CODE (M/B) : M
*
* SUPPLIER CODE         : X11
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 2 ND PRODUCT:

```
*****
*
* LEAD TIME            : 1
*
* LEVEL CODE           : 1
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 2 NO PRODUCT:

```
*****
*
* QUANTITIY REQUIRED                : 1
*
* PRECEEDING PRODUCT'S PART NUMBER : 576
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 2 NO PRODUCT:

```
*****
*
* CURRENT INVENTORY                : 20
*
* ALLOCATIONS                      : 10
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 2 ND PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0
*
*****
```

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 2 ND PRODUCT: 1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y *
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 3 RD PRODUCT:

```
*****
*
* PART NUMBER           : 578
*
* PART DESCRIPTION      : TABLE BASE
*
* UNIT OF MEASUREMENT   : ITEM
*
* MAKE OR BUY CODE (M/B) : M
*
* SUPPLIER CODE         : X11
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 3 RD PRODUCT:

```
*****
*
* LEAD TIME           : 1
*
* LEVEL CODE          : 1
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 3 RD PRODUCT:

```
*****
*
* QUANTITIY REQUIRED           : 1
*
* PRECEEDING PRODUCT'S PART NUMBER : 576
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 3 RD PRODUCT:

```
*****
*
* CURRENT INVENTORY         : 0
*
* ALLOCATIONS               : 0
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 3 RD PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0
*
*****
```

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 3 RD PRODUCT: 1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y *
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 4 TH PRODUCT:

```
*****
*
* PART NUMBER           : 579
*
* PART DESCRIPTION      : ACCESSORIES
*
* UNIT OF MEASUREMENT   : ITEM
*
* MAKE OR BUY CODE (M/B) : M
*
* SUPPLIER CODE         : X05
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 4 TH PRODUCT:

```
*****
*
* LEAD TIME      :      1
*
* LEVEL CODE     :      1
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 4 TH PRODUCT:

```
*****
*
* QUANTITIY REQUIRED           : 1
*
* PRECEEDING PRODUCT'S PART NUMBER : 576
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 4 TH PRODUCT:

```
*****
*
* CURRENT INVENTORY         : 0
*
* ALLOCATIONS               : 0
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 4 TH PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0
*
*****
```

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 4 TH PRODUCT: 1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y
*
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 17 TH PRODUCT:

```
*****
*
* PART NUMBER           : 774
*
* PART DESCRIPTION      : HANDLE CRANK
*
* UNIT OF MEASUREMENT   : ITEM
*
* MAKE OR BUY CODE (M/B) : M
*
* SUPPLIER CODE         : C21
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 17 TH PRODUCT:

```
*****
*
* LEAD TIME           : 1
*
* LEVEL CODE          : 2
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 17 TH PRODUCT:

```
*****
*
* QUANTITIY REQUIRED           : 2
*
* PRECEEDING PRODUCT'S PART NUMBER : 577
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 17 TH PRODUCT:

```
*****
*
* CURRENT INVENTORY          : 10
*
* ALLOCATIONS                 : 5
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 17 TH PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0
*
*****
```

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 17 TH PRODUCT:1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y *
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 20 TH PRODUCT:

```
*****
*
* PART NUMBER           : 742
*
* PART DESCRIPTION      : HEAD NUT
*
* UNIT OF MEASUREMENT   : ITEM
*
* MAKE OR BUY CODE (M/B) : B
*
* SUPPLIER CODE         : X11
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 20 TH PRODUCT:

```
*****
*
* LEAD TIME           : 1
*
* LEVEL CODE          : 3
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 20 TH PRODUCT:

```
*****
*
* QUANTITIY REQUIRED           : 2
*
* PRECEEDING PRODUCT'S PART NUMBER : 774
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 20 TH PRODUCT:

```
*****
*
* CURRENT INVENTORY          : 35
*
* ALLOCATIONS                 : 10
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 20 TH PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 1
*
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 20 TH PRODUCT'S
1 ST SCHEDULED RECEIPT:

```
*****
*
* NUMBER OF THE WEEK : 2
*
* AMOUNT OF RECEIPT : 10
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```

*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*****

```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 20 TH PRODUCT:1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```

*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y *
*****

```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 38 TH PRODUCT:

```

*****
*
* PART NUMBER : 783
*
* PART DESCRIPTION : TABLEBASE BASIC
*
* UNIT OF MEASUREMENT : ITEM
*
* MAKE OR BUY CODE (M/B) : M
*
* SUPPLIER CODE : C05
*
*****

```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 38 TH PRODUCT:

```
*****
*
* LEAD TIME      :      1      *
*
* LEVEL CODE     :      2      *
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 38 TH PRODUCT:

```
*****
*
* QUANTITIY REQUIRED      : 1      *
*
* PRECEEDING PRODUCT'S PART NUMBER : 578 *
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 38 TH PRODUCT:

```
*****
*
* CURRENT INVENTORY      : 0
*
* ALLOCATIONS            : 0
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 38 TH PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0
*
*****
```

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 38 TH PRODUCT: 1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

* ENTRY OF ANOTHER RECORD? <Y-N> : Y *

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 43 RD PRODUCT:

*
* PART NUMBER : 815 *
*
* PART DESCRIPTION : LEATHER GASKET *
*
* UNIT OF MEASUREMENT : ITEM *
*
* MAKE OR BUY CODE (M/B) : B *
*
* SUPPLIER CODE : C21 *
*

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 43 RD PRODUCT:

*
* LEAD TIME : 2 *
*
* LEVEL CODE : 3 *
*

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 43 RD PRODUCT:

```
*****
*
* QUANTITIY REQUIRED           : 1
*
* PRECEEDING PRODUCT'S PART NUMBER : 781
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 43 RD PRODUCT:

```
*****
*
* CURRENT INVENTORY         : 0
*
* ALLOCATIONS               : 0
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 43 RD PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0
*
*****
```

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 43 RD PRODUCT: 1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y *
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 51 ST PRODUCT:

```
*****
*
* PART NUMBER           : 833
*
* PART DESCRIPTION      : CASTORS
*
* UNIT OF MEASUREMENT   : ITEM
*
* MAKE OR BUY CODE (M/B) : B
*
* SUPPLIER CODE         : C02
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 51 ST PRODUCT:

```
*****
*
* LEAD TIME           : 1
*
* LEVEL CODE          : 3
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 51 ST PRODUCT:

```
*****
*
* QUANTITIY REQUIRED                : 2
*
* PRECEEDING PRODUCT'S PART NUMBER : 783
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 51 ST PRODUCT:

```
*****
*
* CURRENT INVENTORY              : 40
*
* ALLOCATIONS                    : 35
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 51 ST PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0
*
*****
```

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 51 ST PRODUCT:1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y *
*****
```

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 60 TH PRODUCT:

```
*****
*
* PART NUMBER           : 793
*
* PART DESCRIPTION      : LATER. BODY BR. S.
*
* UNIT OF MEASUREMENT   : ITEM
*
* MAKE OR BUY CODE (M/B) : M
*
* SUPPLIER CODE         : LBB
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 60 TH PRODUCT:

```
*****
*
* LEAD TIME           : 1
*
* LEVEL CODE          : 2
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 60 TH PRODUCT:

```
*****
*
* QUANTITIY REQUIRED                : 1
*
* PRECEEDING PRODUCT'S PART NUMBER : 579
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 60 TH PRODUCT:

```
*****
*
* CURRENT INVENTORY                : 0
*
* ALLOCATIONS                      : 0
*
*****
```

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

PLEASE ENTER THE FOLLOWING RELATED INFORMATION
ON THE 60 TH PRODUCT:

```
*****
*
* HOW MANY SCHEDULED RECEIPTS OCCUR DURING THE PERIOD : 0
*
*****
```

```
*****
* LOT SIZING PROCEDURES *
*****
*
* 1- THE LOT FOR LOT METHOD
*
* 2- THE FIXED ORDER QUANTITY METHOD
*
* 3- THE ECONOMIC ORDER QUANTITY METHOD
*
*****
```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE 60 TH PRODUCT:1

IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : Y

```
*****
* ENTRY OF ANOTHER RECORD? <Y-N> : Y *
*****
```

```

#####
#           MAIN MENU           #
#####
#                               #
# 1- RECORD ENTRY              #
#                               #
# 2- RECORD READING            #
#                               #
# 3- RECORD REWRITING          #
#                               #
# 4- PROGRAM EXIT              #
#                               #
#####

```

MAKE YOUR CHOICE <1-4> : 2

```

#####
#           READING MENU       #
#####
#                               #
# A- READING RECORDS          #
#                               #
# B- READING ANALYSIS          #
#                               #
# C- ROUGH CUT CAPACITY ANALYSIS #
#                               #
#####

```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE <A-B-C> : B

```

#####
#   READING ANALYSIS MENU   #
#####
# 1- ALL ANALYSIS           #
# 2- SPECIFIC PRODUCT ANALYSIS #
#####

```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE <1-2> : 1

PART DESCRIPTION:ADMI 140 H 11

RECORD NUMBER :1

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.						40		25	50	35	30	
SCH.REC.												
PR. INV. 5						-35		-60	-110	-145	-175	
NET REQ.						35		25	50	35	30	
PL. ORD.				35		25	50	35	30			

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:ADMI 140 H 11

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:TABLE TOP

RECORD NUMBER :2

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.					35		25	50	35	30		
SCH.REC.												
PR. INV. 10					-25		-50	-100	-135	-165		
NET REQ.					25		25	50	35	30		
PL. ORD.				25		25	50	35	30			

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:TABLE TOP

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:TABLE BASE

RECORD NUMBER :3

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.					35		25	50	35	30		
SCH.REC.												
PR. INV. 0					-35		-60	-110	-145	-175		
NET REQ.					35		25	50	35	30		
PL. ORD.				35		25	50	35	30			

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:TABLE BASE

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:ACCESSORIES

RECORD NUMBER :4

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.					35		25	50	35	30		
SCH. REQ.												
PR. INV. 0					-35		-60	-110	-145	-175		
NET REQ.					35		25	50	35	30		
PL. ORD.				35		25	50	35	30			

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:ACCESSORIES

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:HANDLE CRANK

RECORD NUMBER :17

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.				50		50	100	70	60			
SCH.REC.												
PR. INV. 5				-45		-95	-195	-265	-325			
NET REQ.				45		50	100	70	60			
PL. ORD.			45		50	100	70	60				

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:HANDLE CRANK

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:HEAD NUT

RECORD NUMBER :20

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.			90		100	200	140	120				
SCH.REC.		10										
PR. INV. 25	35	-55			-155	-355	-495	-615				
NET REQ.			55		100	200	140	120				
PL. ORD.		55		100	200	140	120					

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:HEAD NUT

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:TABLEBASE BASIC

RECORD NUMBER :38

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.				35		25	50	35	30			
SCH.REC.												
PR. INV. 0				-35		-60	-110	-145	-175			
NET REQ.				35		25	50	35	30			
PL. ORD.				35		25	50	35	30			

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:TABLEBASE BASIC

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:LEATHER GASKET

RECORD NUMBER :43

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.		20			25	50	35	30				
SCH.REC.												
PR. INV. 0		-20			-45	-95	-130	-160				
NET REQ.		20			25	50	35	30				
PL. ORD. 20		25	50	35	30							

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:LEATHER GASKET

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:CASTORS

RECORD NUMBER :51

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.		70			50	100	70	60				
SCH.REC.												
PR. INV. S		-65			-115	-215	-285	-345				
NET REQ.		65			50	100	70	60				
PL. ORD.		65		50	100	70	60					

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:CASTORS

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

PART DESCRIPTION:LATER. BODY BR. S. RECORD NUMBER :60

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
GR. REQ.				35		25	50	35	30			
SCH.REC.												
PR. INV. 0				-35		-60	-110	-145	-175			
NET REQ.				35		25	50	35	30			
PL. ORD.			35		25	50	35	30				

PRESS A BUTTON TO DISPLAY THE REPORT OF THE CURRENT ANALYSIS : Y

PART DESCRIPTION:LATER. BODY BR. S.

ALL THE NET REQUIREMENTS FOR THE PRODUCT IN QUESTION
CAN BE MET DURING THE PERIOD.

PRESS A BUTTON TO DISPLAY THE ANALYSIS OF ANOTHER RECORD : Y

```

#####
#                               #
#           MAIN MENU           #
#                               #
#                               #
#       1- RECORD ENTRY        #
#                               #
#       2- RECORD READING      #
#                               #
#       3- RECORD REWRITING    #
#                               #
#       4- PROGRAM EXIT        #
#                               #
#####

```

MAKE YOUR CHOICE <1-4> : 2

```

#####
#                               #
#           READING MENU       #
#                               #
#                               #
#       A- READING RECORDS     #
#                               #
#       B- READING ANALYSIS    #
#                               #
#       C- ROUGH CUT CAPACITY  #
#           ANALYSIS           #
#                               #
#####

```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE <A-B-C> : C

```

#####
#                               #
#       ROUGH CUT ANALYSIS     #
#                               #
#                               #
#       1- LABOR HOURS         #
#                               #
#       2- MACHINE HOURS       #
#                               #
#####

```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE : 1

NUMBER OF THE WEEK AVAILABLE HOURS

1	150
2	150
3	150
4	150
5	200
6	200
7	200
8	200
9	150
10	150
11	300
12	300

PLEASE ENTER THE RELATED INFORMATION!

RESOURCE : TOTAL LABOR HOURS

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
----------	---	---	---	---	---	---	---	---	---	----	----	----

REQUIRED

HOURS	0	0	0	0	0	0	240	0	150	300	210	180
-------	---	---	---	---	---	---	-----	---	-----	-----	-----	-----

AVAILABLE

HOURS	150	150	150	150	200	200	200	200	150	150	300	300
-------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

NEG.DEV.

							-40			-150		
--	--	--	--	--	--	--	-----	--	--	------	--	--

POS.DEV.	150	150	150	150	200	200		200			90	120
----------	-----	-----	-----	-----	-----	-----	--	-----	--	--	----	-----

PRESS A BUTTON TO CONTINUE : Y

```

#####
#          MAIN MENU          #
#####
#                             #
# 1- RECORD ENTRY            #
#                             #
# 2- RECORD READING          #
#                             #
# 3- RECORD REWRITING        #
#                             #
# 4- PROGRAM EXIT            #
#                             #
#####

```

MAKE YOUR CHOICE <1-4> : 2

```

#####
#          READING MENU      #
#####
#                             #
# A- READING RECORDS         #
#                             #
# B- READING ANALYSIS        #
#                             #
# C- ROUGH CUT CAPACITY ANALYSIS #
#                             #
#####

```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE <A-B-C> : C

```

#####
# ROUGH CUT ANALYSIS        #
#####
# 1- LABOR HOURS            #
# 2- MACHINE HOURS          #
#####

```

CHOOSE ONE AMONG THE ALTERNATIVES ABOVE : 2

NUMBER OF THE WEEK AVAILABLE HOURS

1	200
2	200
3	200
4	200
5	200
6	200
7	150
8	150
9	100
10	200
11	300
12	300

PLEASE ENTER THE RELATED INFORMATION!

RESOURCE : TOTAL MACHINE HOURS

WEEK NO.	1	2	3	4	5	6	7	8	9	10	11	12
----------	---	---	---	---	---	---	---	---	---	----	----	----

REQUIRED

HOURS	0	0	0	0	0	0	160	0	100	200	140	120
-------	---	---	---	---	---	---	-----	---	-----	-----	-----	-----

AVAILABLE

HOURS	200	200	200	200	200	200	150	150	100	200	300	300
-------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

NEG. DEV.

-10

POS. DEV.	200	200	200	200	200	200		150			160	180
-----------	-----	-----	-----	-----	-----	-----	--	-----	--	--	-----	-----

PRESS A BUTTON TO CONTINUE : Y

```

*****
*               *
*   MAIN MENU   *
*               *
*               *
*   1- RECORD ENTRY   *
*               *
*   2- RECORD READING *
*               *
*   3- RECORD REWRITING *
*               *
*   4- PROGRAM EXIT   *
*               *
*****

```

MAKE YOUR CHOICE <1-4> : 4

* SEE YOU SOON! *

IV. CONCLUSIONS

As can be seen from this study, a computer program which satisfies the specific needs of a company can be developed. It can be recommended that the computer program in this study may cover the following subjects:

- i- Capacity Requirements Planning
- ii- Production Activity Control

When added to the computer program, it can easily be used by the companies as a tool to manage manufacturing business.

I also recommend others who will study MRP/MRP II to remember that the people are the ones who make these systems possible. While the computer is necessary for manipulating data, people really make MRP/MRP II happen. Today, there are numerous companies using MRP/MRP II in their business. But, not all of them are happy with their results. Their reactions to these systems are quite different. Some who failed put the blame on the computer. But, the truth is that computer or MRP did not fail. People failed to implement it. Therefore, in order to operate MRP/MRP II effectively, people in the company has to know how to implement and operate it effectively. Thus, the implementation phase of this subject should be highlighted. For the people who are interested in the implementation phase of MRP/MP II, I could recommend the book written by Thomas F. Wallace. "MRP II : Making It Happen, The Implementers' Guide To Success With Manufacturing Resource Planning", published by the Oliver Wight Company in 1990.

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APPENDIX A
THE COMPUTER PROGRAM NAMED MAN-RES-PLAN

PROGRAM MAN_RES_PLAN;

USES CRT;

TYPE KPRINV=RECORD

PRINQ: ARRAY [1..12] OF LONGINT;
END;

KINVENT=RECORD

CURIN: LONGINT;
ALLOC: LONGINT;
PRINV: KPRINV;
END;

KSCHREC=RECORD

SCHRQ: ARRAY[1..12] OF LONGINT;
END;

KGRREQ=RECORD

GRRQ: ARRAY[1..12] OF LONGINT;
END;

KNTREQ=RECORD

NTRQ: ARRAY[1..12] OF LONGINT;
END;

KPLORD=RECORD

PLORQ: ARRAY[1..12] OF LONGINT;
END;

KPLOREC=RECORD

PLORRQ: ARRAY [1..12] OF LONGINT;
END;

KSI TUATI ON=RECORD

STTN: ARRAY[1..12] OF CHAR;
END;

RCRD_TYP=RECORD

NUM: LONGINT;
UNOFM: STRING[10];
PRTNM: WORD;
PRTDES: STRING[20];
MBCD: CHAR;
SUPPCD: STRING[5];
LDTM: BYTE;
LVCD: BYTE;
LTSZ: BYTE;
IMUP: WORD;
QUANR: INTEGER;
LBHR: INTEGER;
MNHR: INTEGER;
INVENT: KINVENT;
SCHREC: KSCHREC;
GRREQ: KGRREQ;
NTREQ: KNTREQ;
PLORD: KPLORD;
PLOREC: KPLOREC;
SITUATION: KSI TUATION;
EOQ: LONGINT;
FOQ: LONGINT;
END;

```

VAR      RCRD: RCRD_TYP;
          MRP: FILE OF RCRD_TYP;
          A: STRING[2];
          B: STRING[2];
          J: LONGINT;
          K: LONGINT;
          L: LONGINT;
          I: LONGINT;
          P: LONGINT;
          Z: LONGINT;
          KN: BYTE;
          KK: BYTE;
ANSWER: CHAR;
          M: BYTE;
          N: BYTE;
CHOICE: CHAR;
          SUMNR: LONGINT;
          S: LONGINT;
          C: LONGINT;
          D: LONGINT;
          SIT: BYTE;
          EOQN: REAL;
PREFERENCE: BYTE;
          REPLY: BYTE;
          CONTROL: BOOLEAN;
          CCONTROL: BOOLEAN;
          CCCONTROL: BOOLEAN;
          CC: STRING[34];
          NUMBER: LONGINT;
          TNUMBER: LONGINT;
          NMBR: WORD;
          DESC: STRING[20];
          CODE: LONGINT;
          XNUMBER: LONGINT;

```

```

YPRTNM: WORD;
ZNUMBER: LONGINT;
      T: ARRAY [1..12] OF LONGINT;
AVAILHR: ARRAY [1..12] OF INTEGER;
      TOTREQ: ARRAY [1..12] OF LONGINT;

```

```

PROCEDURE FRAME1;

```

```

BEGIN

```

```

  CLRSCR;

```

```

  GOTOXY (40,1);

```

```

  WRITELN ('RECORD NUMBER : ',RCRD.NUM);

```

```

  GOTOXY (1,3);

```

```

  WRITELN ('-----');

```

```

  GOTOXY (41,3);

```

```

  WRITELN ('-----');

```

```

  GOTOXY (1,4);

```

```

  WRITELN ('WEEK NO.      1      2      3      4      5      6');

```

```

  GOTOXY (43,4);

```

```

  WRITELN ('      7      8      9     10     11     12');

```

```

  GOTOXY (1,5);

```

```

  WRITELN ('-----');

```

```

  GOTOXY (41,5);

```

```

  WRITELN ('-----');

```

```

  GOTOXY (1,6);

```

```

  WRITELN ('-----');

```

```

  GOTOXY (41,6);

```

```

  WRITELN ('-----');

```

```

  GOTOXY (1,7);

```

```

  WRITELN ('GR. REQ. ');

```

```

  GOTOXY (1,8);

```

```

  WRITELN ('-----');

```

```

  GOTOXY (41,8);

```

```

  WRITELN ('-----');

```

```

GOTOXY (1,9);
WRITELN ('SCH. REC. ');
GOTOXY (1,10);
WRITELN ('-----');
GOTOXY (41,10);
WRITELN ('-----');
GOTOXY (1,11);
WRITELN ('PR. INV. ');
GOTOXY (1,12);
WRITELN ('-----');
GOTOXY (41,12);
WRITELN ('-----');
GOTOXY (1,13);
WRITELN ('NET REQ. ');
GOTOXY (1,14);
WRITELN ('-----');
GOTOXY (41,14);
WRITELN ('-----');
END;

```

```

PROCEDURE FRAME2;
BEGIN
  GOTOXY (1,15);
  WRITELN ('PL. ORD. ');
  GOTOXY (1,16);
  WRITELN ('-----');
  GOTOXY (41,16);
  WRITELN ('-----');
END;

```

```

PROCEDURE FRAME3;
BEGIN
  GOTOXY (1,15);
  WRITELN ( 'P.O.REC.' );
  GOTOXY (1,16);
  WRITELN ( '-----' );
  GOTOXY (41,16);
  WRITELN ( '-----' );
  GOTOXY (1,17);
  WRITELN ( 'PL. ORD.' );
  GOTOXY (1,18);
  WRITELN ( '-----' );
  GOTOXY (41,18);
  WRITELN ( '-----' );
END;

```

```

PROCEDURE ZERO_ASSIGNMENT;
BEGIN
  FOR J:=1 TO 12 DO
  BEGIN
    RCRD.INVENT.PRINV.PRINQ [J]:=0;
    RCRD.SCHREC.SCHRQ [J]:=0;
    RCRD.GRREQ.GRRQ [J]:=0;
    RCRD.NTREQ.NTRQ [J]:=0;
    RCRD.PLORD.PLORQ [J]:=0;
    RCRD.PLOREC.PLORRQ [J]:=0;
  END;
END;

```

```

PROCEDURE ASSIGNMENT_1;
BEGIN
  FOR J:=1 TO 12 DO RCRD.SITUATION.STTN [J]:= 'Y';
END;

```

```

PROCEDURE ASSIGNMENT_2;
BEGIN
  CASE RCRD.NUM OF
    11: A:='TH';
    12: A:='TH';
    13: A:='TH';
  ELSE
    KN:=RCRD.NUM MOD 10;
    CASE KN OF
      1: A:='ST';
      2: A:='ND';
      3: A:='RD';
    ELSE
      A:='TH';
    END;
  END;
END;

```

```

PROCEDURE ASSIGNMENT_3;
BEGIN
  CASE K OF
    11: B:='TH';
    12: B:='TH';
    13: B:='TH';
  ELSE
    KK:=K MOD 10;

```

```

        CASE KK OF
            1: B: ='ST';
            2: B: ='ND';
            3: B: ='RD';
        ELSE
            B: ='TH';
        END;
    END;
END;
END;

```

```

PROCEDURE ENTRY_1;
BEGIN
    ANSWER: ='N';
    WHILE ANSWER='N' DO
    BEGIN
        CLRSCR;
        GOTOXY (17,2);
        Writeln ('PLEASE ENTER THE FOLLOWING RELATED INFORMATION');
        GOTOXY (31,3);
        Writeln ('ON THE ',RCRD.NUM,' ',A,' PRODUCT: ');
        GOTOXY (16,5);
        Writeln ('*****');
        GOTOXY (16,6);
        Writeln ('*                                     *');
        GOTOXY (16,7);
        Writeln ('* PART NUMBER                        : *');
        GOTOXY (16,8);
        Writeln ('*                                     *');
        GOTOXY (16,9);
        Writeln ('* PART DESCRIPTION                   : *');
        GOTOXY (16,10);
        Writeln ('*                                     *');
    END;

```

```

GOTOXY (16,11);
WRITELN ('* UNIT OF MEASUREMENT      :                *');
GOTOXY (16,12);
WRITELN ('*                                *');
GOTOXY (16,13);
WRITELN ('* MAKE OR BUY CODE (M/B)    :                *');
GOTOXY (16,14);
WRITELN ('*                                *');
GOTOXY (16,15);
WRITELN ('* SUPPLIER CODE                :                *');
GOTOXY (16,16);
WRITELN ('*                                *');
GOTOXY (16,17);
WRITELN ('*****');
GOTOXY (44,7); READLN (RCRD.PRTNMD);
GOTOXY (44,9); READLN (RCRD.PRTDES);
GOTOXY (44,11); READLN (RCRD.UNOFMD);
GOTOXY (44,13); READLN (RCRD.MBCD);
WHILE (RCRD.MBCD<>'M') AND (RCRD.MBCD<>'B') DO
BEGIN
  GOTOXY (44,13); READLN (RCRD.MBCD);
END;
GOTOXY (44,15); READLN (RCRD.SUPPCD);
GOTOXY (16,21);
WRITELN ('IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> :');
GOTOXY (16,22);
WRITELN ('-----');
GOTOXY (64,21); READLN (ANSWER);
END;
END;

```

```

PROCEDURE ENTRY_2;
BEGIN
  ANSWER:='N';
  WHILE ANSWER='N' DO
  BEGIN
    CLRSCR;
    GOTOXY (17,2);
    WRITELN ('PLEASE ENTER THE FOLLOWING RELATED INFORMATION');
    GOTOXY (31,3);
    WRITELN ('ON THE ',RCRD.NUM,' ',A,' PRODUCT:');
    GOTOXY (24,5);
    WRITELN ('*****');
    GOTOXY (24,6);
    WRITELN ('*                                     *');
    GOTOXY (24,7);
    WRITELN ('* LEAD TIME      :                                     *');
    GOTOXY (24,8);
    WRITELN ('*                                     *');
    GOTOXY (24,9);
    WRITELN ('* LEVEL CODE      :                                     *');
    GOTOXY (24,10);
    WRITELN ('*                                     *');
    GOTOXY (24,11);
    WRITELN ('*****');
    GOTOXY (43,7); READLN (RCRD.LDTMD);
    GOTOXY (43,9); READLN (RCRD.LVCD);
    GOTOXY (16,21);
    WRITELN ('IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> :');
    GOTOXY (16,22);
    WRITELN ('-----');
    GOTOXY (64,21); READLN (ANSWER);
  END;
END;

```

```

PROCEDURE ENTRY_3;
BEGIN
  IF RCRD.LVCD=0 THEN
    BEGIN
      RCRD.IMUP:=0;
      RCRD.QUANR:=1;
    END;
  IF RCRD.LVCD>0 THEN
    BEGIN
      ANSWER:='N';
      WHILE ANSWER='N' DO
        BEGIN
          CLRSCR;
          GOTOXY (17,2);
          WRITELN ('PLEASE ENTER THE FOLLOWING RELATED INFORMATION');
          GOTOXY (31,3);
          WRITELN ('ON THE ',RCRD.NUM,' ',A,' PRODUCT:');
          GOTOXY (9,5);
          WRITELN ('*****');
          GOTOXY (38,5);
          WRITELN ('*****');
          GOTOXY (9,6);
          WRITELN ('*                               ');
          GOTOXY (38,6);
          WRITELN ('*                               ');
          GOTOXY (9,7);
          WRITELN ('* QUANTITY REQUIRED                ');
          GOTOXY (38,7);
          WRITELN ('*                               ');
          GOTOXY (9,8);
          WRITELN ('*                               ');
          GOTOXY (38,8);
          WRITELN ('*                               ');
          GOTOXY (9,9);
          WRITELN ('* PRECEDING PRODUCT'S PART N');
        END;
      END;
    END;
  END;

```

```

GOTOXY (38,9);
WRITELN ('NUMBER          :                *');
GOTOXY (9,10);
WRITELN ('*                ');
GOTOXY (38,10);
WRITELN ('                *');
GOTOXY (9,11);
WRITELN ('*****');
GOTOXY (38,11);
WRITELN ('*****');
GOTOXY (49,7);
READLN (RCRD.QUANR);
GOTOXY (49,9);
READLN (RCRD.IMUP);
GOTOXY (16,21);
WRITELN ('IS THE INFORMATION ENTRY ABOVE');
GOTOXY (46,21);
WRITELN (' CORRECT? <Y-N> :');
GOTOXY (16,22);
WRITELN ('-----');
GOTOXY (40,22);
WRITELN ('-----');
GOTOXY (64,21);
READLN (ANSWER);
END;
END;
END;

```

PROCEDURE ENTRY_4A;

BEGIN

GOTOXY (22,11);

WRITELN ('* REQUIRED LABOR HOUR : *');

```

GOTOXY (22,12);
WRITELN ( '*                                     *');
GOTOXY (22,13);
WRITELN ( '* REQUIRED MACHINE HOUR           :           *');
GOTOXY (22,14);
WRITELN ( '*                                     *');
END;

```

PROCEDURE ENTRY_4;

BEGIN

CONTROL :=FALSE;

ANSWER: ='N';

WHILE ANSWER='N' DO

BEGIN

CLRSCR;

GOTOXY (17,2);

WRITELN ('PLEASE ENTER THE FOLLOWING RELATED INFORMATION');

GOTOXY (31,3);

WRITELN ('ON THE ',RCRD.NUM,' ',A,' PRODUCT: ');

GOTOXY (22,5);

WRITELN ('*****');

GOTOXY (22,6);

WRITELN ('* *');

GOTOXY (22,7);

WRITELN ('* CURRENT INVENTORY : *');

GOTOXY (22,8);

WRITELN ('* *');

GOTOXY (22,9);

WRITELN ('* ALLOCATIONS : *');

GOTOXY (22,10);

WRITELN ('* *');

IF RCRD.LVCD=0 THEN

BEGIN

ENTRY_4A;

```

CONTROL:=TRUE;
END;
IF CONTROL THEN
BEGIN
GOTOXY (22,15);
WRITELN ('*****');
END
ELSE
BEGIN
GOTOXY (22,11);
WRITELN ('*****');
END;
GOTOXY (49,7); READLN (RCRD.INVENT.CURIN);
GOTOXY (49,9); READLN (RCRD.INVENT.ALLOC);
IF CONTROL THEN
BEGIN
GOTOXY (49,11); READLN (RCRD.LBHR);
GOTOXY (49,13); READLN (RCRD.MNHR);
END;
GOTOXY (16,21);
WRITELN ('IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> :');
GOTOXY (16,22);
WRITELN ('-----');
GOTOXY (64,21); READLN (ANSWER);
END;
END;

```

```

PROCEDURE ENTRY_5;
BEGIN
L:=13;
WHILE L>12 DO
BEGIN
CLRSCR;
GOTOXY (17,2);

```

```

WRITELN ('PLEASE ENTER THE FOLLOWING RELATED INFORMATION');
GOTOXY (31,3);
WRITELN ('ON THE ',RCRD.NUM,' ',A,' PRODUCT: ');
GOTOXY (9,5);
WRITELN ('*****');
GOTOXY (40,5);
WRITELN ('*****');
GOTOXY (9,6);
WRITELN ('*');
GOTOXY (40,6);
WRITELN ('*');
GOTOXY (9,7);
WRITELN ('* HOW MANY SCHEDULED RECEIPTS 0');
GOTOXY (40,7);
WRITELN ('CCUR DURING THE PERIOD : *');
GOTOXY (9,8);
WRITELN ('*');
GOTOXY (40,8);
WRITELN ('*');
GOTOXY (9,9);
WRITELN ('*****');
GOTOXY (40,9);
WRITELN ('*****');
GOTOXY (65,7); READLN (L);
IF L>12 THEN
BEGIN
  GOTOXY (23,12);
  WRITELN ('THIS PROGRAM USES 12 WEEKS PERIOD. ');
  GOTOXY (20,14);
  WRITELN ('THUS, THE AMOUNT OF SCHEDULED RECEIPTS');
  GOTOXY (27,16);
  WRITELN ('CAN NOT BE MORE THAN 12 !!!');
  GOTOXY (31,18);
  WRITELN ('PLEASE TRY AGAIN!!!');
  GOTOXY (30,19);

```

```

WRITELN ('-----');
DELAY (9000);
END;
END;
IF L>0 THEN
BEGIN
FOR K:=1 TO L DO
BEGIN
ASSIGNMENT_3;
ANSWER:='N';
WHILE ANSWER='N' DO
BEGIN
CLRSCR;
GOTOXY (17,2);
WRITELN ('PLEASE ENTER THE FOLLOWING RELATED INFORMATION');
GOTOXY (29,3);
WRITELN ('ON THE ',RCRD.NUM,' ',A,' PRODUCT'S');
GOTOXY (28,4);
WRITELN (K,' ',B,' SCHEDULED RECEIPT: ');
GOTOXY (23,6);
WRITELN ('*****');
GOTOXY (23,7);
WRITELN ('*');
GOTOXY (23,8);
WRITELN ('* NUMBER OF THE WEEK :');
GOTOXY (23,9);
WRITELN ('*');
GOTOXY (23,10);
WRITELN ('* AMOUNT OF RECEIPT :');
GOTOXY (23,11);
WRITELN ('*');
GOTOXY (23,12);
WRITELN ('*****');
GOTOXY (47,8); READLN (J);
WHILE (J>12) OR (J=0) DO

```

```

BEGIN
    GOTOXY (47,8); READLN (J);
END;
GOTOXY (47,10); READLN (RCRD.SCHREC.SCHRQ [J]);
GOTOXY (16,21);
WRITELN ('IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> :');
GOTOXY (16,22);
WRITELN ('-----');
GOTOXY (64,21); READLN (ANSWER);
END;
END;
END;
END;

```

```

PROCEDURE ENTRY_6;
BEGIN
    IF RCRD.LVCD=0 THEN
    BEGIN
        L:=13;
        WHILE L>12 DO
        BEGIN
            CLRSCR;
            GOTOXY (17,2);
            WRITELN ('PLEASE ENTER THE FOLLOWING RELATED INFORMATION');
            GOTOXY (31,3);
            WRITELN ('ON THE ',RCRD.NUM,' ',A,' PRODUCT:');
            GOTOXY (9,5);
            WRITELN ('*****');
            GOTOXY (39,5);
            WRITELN ('*****');
            GOTOXY (9,7);
            WRITELN ('* HOW MANY GROSS REQUIREMENTS ');

```

```

GOTOXY (39,7);
WRITELN ('OCCUR DURING THE PERIOD :      *');
GOTOXY (9,9);
WRITELN ('*****');
GOTOXY (39,9);
WRITELN ('*****');
GOTOXY (65,7); READLN (L);
IF L>12 THEN
BEGIN
  GOTOXY (23,12);
  WRITELN ('THIS PROGRAM USES 12 WEEKS PERIOD. ');
  GOTOXY (20,14);
  WRITELN ('THUS, THE AMOUNT OF GROSS REQUIREMENTS');
  GOTOXY (27,16);
  WRITELN ('CAN NOT BE MORE THAN 12 !!!');
  GOTOXY (31,18);
  WRITELN ('PLEASE TRY AGAIN!!!');
  GOTOXY (30,19);
  WRITELN ('-----');
  DELAY (9000);
END;
END;
IF L>0 THEN
BEGIN
  FOR K:=1 TO L DO
  BEGIN
    ASSIGNMENT_3;
    ANSWER:='N';
    WHILE ANSWER='N' DO
    BEGIN
      CLRSCR;
      GOTOXY (17,2);
      WRITELN ('PLEASE ENTER THE FOLLOWING RELATED INFORMATION');
      GOTOXY (29,3);
      WRITELN ('ON THE ',RCRD.NUM,' ',A,' PRODUCT'S');

```

```

GOTOXY (28,4);
WRITELN (K,' ',B,' GROSS REQUIREMENT: ');
GOTOXY (22,6);
WRITELN ('*****');
GOTOXY (22,7);
WRITELN ('*                               *');
GOTOXY (22,8);
WRITELN ('* NUMBER OF THE WEEK           : *');
GOTOXY (22,9);
WRITELN ('*                               *');
GOTOXY (22,10);
WRITELN ('* AMOUNT OF REQUIREMENT        : *');
GOTOXY (22,11);
WRITELN ('*                               *');
GOTOXY (22,12);
WRITELN ('*****');
GOTOXY (49,8); READLN (J);
WHILE (J>12) OR (J=0) DO
BEGIN
  GOTOXY (49,8); READLN (J);
END;
GOTOXY (49,10); READLN (RCRD.GRREQ.GRRQ [J]);
GOTOXY (16,21);
WRITELN ('IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> : ');
GOTOXY (16,22);
WRITELN ('-----');
GOTOXY (64,21); READLN (ANSWER);
END;
END;
END;
END;
END;

```

```

PROCEDURE ENTRY_7;
BEGIN
  ANSWER:='N';
  WHILE ANSWER='N' DO
  BEGIN
    CLRSCR;
    GOTOXY (27,4);
    WRITELN ('*****');
    GOTOXY (27,5);
    WRITELN ('* LOT SIZING PROCEDURES *');
    GOTOXY (19,6);
    WRITELN ('*****');
    GOTOXY (19,7);
    WRITELN ('*                                     *');
    GOTOXY (19,8);
    WRITELN ('* 1- THE LOT FOR LOT METHOD                                     *');
    GOTOXY (19,9);
    WRITELN ('*                                     *');
    GOTOXY (19,10);
    WRITELN ('* 2- THE FIXED ORDER QUANTITY METHOD                               *');
    GOTOXY (19,11);
    WRITELN ('*                                     *');
    GOTOXY (19,12);
    WRITELN ('* 3- THE ECONOMIC ORDER QUANTITY METHOD *');
    GOTOXY (19,13);
    WRITELN ('*****');
    GOTOXY (5,17);
    WRITELN ('CHOOSE ONE AMONG THE ALTERNATIVES ABOVE FOR THE ',
    RCRD.NUM,' ',A,' PRODUCT:');
    GOTOXY (67,17);
    READLN (RCRD.LTSZ);
    IF (RCRD.LTSZ<1) OR (RCRD.LTSZ>3)
    THEN
    BEGIN
      GOTOXY (22,21);

```

```

WRITELN ( '*****');
GOTOXY (22,22);
WRITELN ( '* FALSE ENTRY!!!PLEASE TRY AGAIN. *');
GOTOXY (22,23);
WRITELN ( '*****');
DELAY (9000);
END;
IF (RCRD.LTSZ>0) AND (RCRD.LTSZ<4)
THEN
BEGIN
    GOTOXY (16,21);
    WRITELN ( 'IS THE INFORMATION ENTRY');
    GOTOXY (40,21);
    WRITELN ( ' ABOVE CORRECT? <Y-N> :');
    GOTOXY (16,22);
    WRITELN ( '-----');
    GOTOXY (65,21);
    READLN (ANSWER);
END;
END;
END;

```

```

PROCEDURE ASK_2;
BEGIN
    ANSWER:='N';
    WHILE ANSWER='N' DO
    BEGIN
        CLRSCR;
        GOTOXY (18,4);
        WRITELN ( '*****');
        GOTOXY (18,6);
        WRITELN ( '* ENTER THE ASSIGNED FIXED LOT SIZE:      *');
    END;

```

```

GOTOXY (18,8);
WRITELN ( '*****');
GOTOXY (55,6);
READLN (RCRD.FOO);
GOTOXY (16,11);
WRITELN ( 'IS THE INFORMATION ENTRY');
GOTOXY (40,11);
WRITELN ( ' ABOVE CORRECT? <Y-N> :');
GOTOXY (64,11);
READLN (ANSWER);
END;
END;

```

```

PROCEDURE ASK_3A;
BEGIN
  ANSWER:='N';
  WHILE ANSWER='N' DO
  BEGIN
    CLRSCR;
    GOTOXY (15,2);
    WRITELN ( '*****');
    GOTOXY (15,3);
    WRITELN ( '* ENTER THE FOLLOWING RELATED INFORMATION *');
    GOTOXY (11,4);
    WRITELN ( '*****');
    GOTOXY (40,4);
    WRITELN ( '*****');
    GOTOXY (11,6);
    WRITELN ( '* SET-UP COST PER BATCH : ');
    GOTOXY (40,6);
    WRITELN ( ' ');
    GOTOXY (11,8);
    WRITELN ( '* INVENTORY CARRYING COST PER');

```

```

GOTOXY (40,8);
WRITELN (' ITEM PER UNIT TIME :          *');
GOTOXY (11,10);
WRITELN ('* THE DEMAND FOR THE ITEM PER');
GOTOXY (40,10);
WRITELN (' UNIT TIME :                      *');
GOTOXY (11,12);
WRITELN ('*****');
GOTOXY (40,12);
WRITELN ('*****');
GOTOXY (37,6); READLN (S);
GOTOXY (62,8); READLN (C);
GOTOXY (53,10); READLN (D);
GOTOXY (16,15);
WRITELN ('IS THE INFORMATION ENTRY ABOVE CORRECT? <Y-N> :');
GOTOXY (64,15); READLN (ANSWER);
END;
EOQN: =2*S*D/C;
EOQN: =SQRT(EOQN);
RCRD.EOQ: =ROUND (EOQN);
END;

```

```

PROCEDURE ASK_3B;
BEGIN
  ANSWER: ='N';
  WHILE ANSWER='N' DO
  BEGIN
    CLRSCR;
    GOTOXY (17,4);
    WRITELN ('*****');
    GOTOXY (17,6);
    WRITELN ('* ENTER THE ECONOMIC ORDER');
  
```

```

GOTOXY (43,6);
WRITELN ( ' QUANTITY :          *');
GOTOXY (17,8);
WRITELN ( '*****');
GOTOXY (40,8);
WRITELN ( '*****');
GOTOXY (55,6); READLN (EOQN);
RCRD.EQ:=ROUND (EOQN);
GOTOXY (16,11);
WRITELN ( 'IS THE INFORMATION ENTRY');
GOTOXY (40,11);
WRITELN ( ' ABOVE CORRECT? <Y-N> :');
GOTOXY (64,11);
READLN (ANSWER);
END;
END;

```

```

PROCEDURE ASK_3;
BEGIN
CHOICE:='C';
WHILE (CHOICE<>'A') OR (CHOICE<>'B') DO
BEGIN
CLRSCR;
GOTOXY (15,3);
WRITELN ( '*****');
GOTOXY (42,3);
WRITELN ( '*****');
GOTOXY (15,5);
WRITELN ( '* A- CALCULATION OF THE ECO');
GOTOXY (42,5);
WRITELN ( 'NOMIC ORDER QUANTITY          *');
GOTOXY (15,7);

```

```

WRITELN ('* B- DIRECT ENTRY OF THE EC');
GOTOXY (42,7);
WRITELN ('ONOMIC ORDER QUANTITY      *');
GOTOXY (15,9);
WRITELN ('*****');
GOTOXY (42,9);
WRITELN ('*****');
GOTOXY (24,12);
WRITELN ('CHOOSE ONE AMONG THE ALTERNATIVES :');
GOTOXY (56,12);
READLN (CHOICE);
END;
IF CHOICE='A' THEN ASK_3A;
IF CHOICE='B' THEN ASK_3B;
END;

```

```

PROCEDURE SEND;
BEGIN
  IF RCRD.LTSZ=2 THEN ASK_2; IF RCRD.LTSZ=3 THEN ASK_3;
END;

```

```

PROCEDURE CALCULATION_1;
BEGIN
  RCRD.INVENT.PRINV.PRINQ [1] :=RCRD.INVENT.CURIN-RCRD.INVENT.ALLOC
+RCRD.SCHREC.SCHRQ [1]-RCRD.GRREQ.GRRQ [1];
  FOR J:=2 TO 12 DO
    BEGIN
      RCRD.INVENT.PRINV.PRINQ [J] :=RCRD.INVENT.PRINV.PRINQ [J-1]
      -RCRD.GRREQ.GRRQ [J]+RCRD.SCHREC.SCHRQ [J];
    END;
  END;
END;

```

PROCEDURE CALCULATION_2;

BEGIN

IF (RCRD.GRREQ.GRRQ [1]>0) AND (RCRD.INVENT.PRINV.PRINQ [1]<0)

THEN RCRD.NTREQ.NTRQ [1]:=-RCRD.INVENT.PRINV.PRINQ [1];

FOR J:=2 TO 12 DO

BEGIN

IF (RCRD.GRREQ.GRRQ[J]>0) AND (RCRD.INVENT.PRINV.PRINQ [J]<0)

THEN

BEGIN

IF RCRD.INVENT.PRINV.PRINQ [J-1]<0 THEN

RCRD.NTREQ.NTRQ [J]:=RCRD.INVENT.PRINV.PRINQ [J-1]

-RCRD.INVENT.PRINV.PRINQ [J]

ELSE RCRD.NTREQ.NTRQ [J]:=-RCRD.INVENT.PRINV.PRINQ [J];

END;

END;

END;

PROCEDURE CALCULATION_3;

BEGIN

FOR J:=1 TO 12 DO

BEGIN

IF RCRD.NTREQ.NTRQ [J]>0 THEN

BEGIN

K:=J-RCRD.LDTM;

IF K>0 THEN RCRD.PLORD.PLORQ [K]:=RCRD.NTREQ.NTRQ [J]

ELSE RCRD.SITUATION.STTN [J]:='N';

END;

END;

END;

```

PROCEDURE CALCULATION_4;
BEGIN
  FOR J:=1 TO 12 DO
  BEGIN
    IF (RCRD.NTREQ.NTRQ [J]>0) THEN
    BEGIN
      L:=J-RCRD.LDTM;
      IF (L<0) OR (L=0) THEN RCRD.SITUATION.STTN [J]:='N';
    END;
  END;
  SIT:=0;
  J:=1;
  WHILE SIT=0 DO
  BEGIN
    IF (RCRD.NTREQ.NTRQ [J]>0) AND (RCRD.SITUATION.STTN [J]='Y')
    THEN
    BEGIN
      K:=J;
      SIT:=1;
    END;
    J:=J+1;
  END;
  SUMNR:=0;
  FOR J:=1 TO 12 DO
  BEGIN
    IF RCRD.SITUATION.STTN [J]='Y' THEN
      SUMNR:=SUMNR+RCRD.NTREQ.NTRQ [J];
  END;
  IF (SUMNR<RCRD.FOQ) OR (SUMNR=RCRD.FOQ)
  THEN RCRD.PLOREC.PLORRQ [K]:=RCRD.FOQ
  ELSE RCRD.PLOREC.PLORRQ [K]:=SUMNR;
  L:=K-RCRD.LDTM;
  RCRD.PLORD.PLORQ [L]:=RCRD.PLOREC.PLORRQ [K];
END;

```

```

PROCEDURE CALCULATION_5;
BEGIN
  FOR J:=1 TO 12 DO
  BEGIN
    IF (RCRD.NTREQ.NTRQ [J]>0) THEN
    BEGIN
      L:=J-RCRD.LDTM;
      IF (L<0) OR (L=0) THEN RCRD.SITUATION.STTN [J] :='N';
    END;
  END;
  SIT:=0;
  J:=1;
  WHILE SIT=0 DO
  BEGIN
    IF (RCRD.NTREQ.NTRQ [J]<0) AND (RCRD.SITUATION.STTN [J]='Y')
    THEN
    BEGIN
      K:=J;
      SIT:=1;
    END;
    J:=J+1;
  END;
  RCRD.PLOREC.PLORRQ [K]:=RCRD.EOQ;
  L:=K-RCRD.LDTM;
  RCRD.PLORD.PLORQ [L]:=RCRD.PLOREC.PLORRQ [K];
END;

```

```

PROCEDURE CALCULATION;
BEGIN
  CALCULATION_1;
  CALCULATION_2;
  CASE RCRD.LTSZ OF

```

```

1: CALCULATION_3;
2: CALCULATION_4;
3: CALCULATION_5;

END;
END;

```

```

PROCEDURE GR_CALCULATION;
BEGIN
  CODE: =-1;
  P: =0;
  WHILE (P<FILESIZE (MRP)) DO
  BEGIN
    CODE: =CODE+1;
    NUMBER: =0;
    SEEK (MRP,0);
    WHILE NOT EOF (MRP) DO
    BEGIN
      READ (MRP,RCRD);
      IF RCRD.LVCD=CODE THEN
      BEGIN
        P: =P+1;
        CALCULATION;
        SEEK (MRP,NUMBER);
        WRITE (MRP,RCRD);
        SEEK (MRP,NUMBER);
        READ (MRP,RCRD);
        FOR J: =1 TO 12 DO TI[J]: =RCRD.PLORD.PLORQ [J];
        YPRTNM: =RCRD.PRNM;
        SEEK (MRP,0);
        ZNUMBER: =0;
        WHILE NOT EOF (MRP) DO
        BEGIN
          READ (MRP,RCRD);

```

```

    IF RCRD.IMUP=YPRTNM THEN
    BEGIN
        FOR J:=1 TO 12 DO RCRD.GRREQ.GRRQ [J]:=T[J]*RCRD.QUANR;
        SEEK (MRP,ZNUMBER);
        WRITE (MRP,RCRD);
        END;
        ZNUMBER:=ZNUMBER+1;
        SEEK (MRP,ZNUMBER);
        END;
        NUMBER:=NUMBER+1;
        SEEK (MRP,NUMBER);
        END;
    END;
END;

```

```

PROCEDURE SIT_REPORT;
BEGIN
    M:=3;
    N:=0;
    FOR K:=1 TO 12 DO
    BEGIN
        IF RCRD.SITUATION.STTN [K]='N' THEN
        BEGIN
            N:=1;
            M:=M+1;
            ASSIGNMENT_3;
            GOTOXY (23,M);
            WRITELN ('NET REQUIREMENT IN THE ',K,' ',B,' WEEK');
            END;
        END;
    IF N=1 THEN

```

```

BEGIN
  M:=M+2;
  GOTOXY (32,MD;
  WRITELN ('CAN NOT BE MET. ');
END
ELSE
BEGIN
  GOTOXY (30,2);
  WRITELN ('PART DESCRIPTION:',RCRD.PRTPDES);
  GOTOXY (14,4);
  WRITELN ('ALL THE NET REQUIREMENTS');
  GOTOXY (38,4);
  WRITELN (' FOR THE PRODUCT IN QUESTION');
  GOTOXY (25,5);
  WRITELN ('CAN BE MET DURING THE PERIOD. ');
  END;
END;

PROCEDURE RRENTRY;
BEGIN
  RCRD.NUM:=FILESIZE (MRP)+1;
  ZERO_ASSIGNMENT;
  ASSIGNMENT_1;
  ASSIGNMENT_2;
  ENTRY_1;
  ENTRY_2;
  ENTRY_3;
  ENTRY_4;
  ENTRY_5;
  ENTRY_6;
  ENTRY_7;
  SEND;
END;

```

```

PROCEDURE RENTRY;
BEGIN
  ANSWER:='Y';
  WHILE ANSWER='Y' DO
  BEGIN
    RENTRY;
    SEEK (MRP,RCRD.NUM-1);
    WRITE (MRP,RCRD);
    CLRSCR;
    GOTOXY (21,10);
    WRITELN ( '*****');
    GOTOXY (21,11);
    WRITELN ( '* ENTRY OF ANOTHER RECORD? <Y-N> :   *');
    GOTOXY (21,12);
    WRITELN ( '*****');
    GOTOXY (56,11); READLN (ANSWER);
  END;
END;

```

```

PROCEDURE WWRITE_1;
BEGIN
  CLRSCR;
  GOTOXY (26,1);
  WRITELN ( '*****');
  GOTOXY (26,2);
  WRITELN ( '* RECORD NUMBER :           *');
  GOTOXY (26,3);
  WRITELN ( '*****');
  GOTOXY (44,2);
  WRITELN (RCRD.NUM);
  GOTOXY (2,5);
  WRITELN ( 'PART NUMBER           : ',RCRD.PRTNMD;

```

```

GOTOXY (2,6);
WRITELN ('PART DESCRIPTION' : ',RCRD.PRTDES);
GOTOXY (2,7);
WRITELN ('UNIT OF MEASUREMENT' : ',RCRD.UNOFMD);
GOTOXY (2,8);
WRITELN ('MAKE OR BUY CODE' : ',RCRD.MBCD);
GOTOXY (2,9);
WRITELN ('SUPPLIER CODE' : ',RCRD.SUPPCD);
GOTOXY (2,10);
WRITELN ('LEAD TIME' : ',RCRD.LDTMD);
GOTOXY (2,11);
WRITELN ('LEVEL CODE' : ',RCRD.LVCD);
GOTOXY (2,12);
WRITELN ('QUANTITY REQUIRED' : ',RCRD.QUANR);
GOTOXY (2,13);
WRITELN ('PRECEEDING PRODUCT'S PART NUMBER : ',RCRD.IMUP);
GOTOXY (2,14);
WRITELN ('CURRENT INVENTORY' : ',RCRD.INVENT.CURIND);
GOTOXY (2,15);
WRITELN ('ALLOCATIONS' : ',RCRD.INVENT.ALLOC);
GOTOXY (26,19);
WRITELN ('PRESS A BUTTON TO CONTINUE : ');
GOTOXY (55,19); READLN (CHOICE);
END;

```

```

PROCEDURE WWRITE_2;
BEGIN
  CLRSCR;
  GOTOXY (1,1);
  WRITELN ('RECORD NUMBER : ',RCRD.NUMD);
  GOTOXY (29,2);
  WRITELN ('*****');

```

```

GOTOXY (29,3);
WRITELN ('*      SCHEDULED RECEIPTS      *');
GOTOXY (29,4);
WRITELN ('*****');
CONTROL:=FALSE;
FOR J:=1 TO 12 DO
BEGIN
  IF RCRD.SCHREC.SCHRQ [J]>0 THEN CONTROL:=TRUE;
END;
IF NOT CONTROL THEN
BEGIN
  GOTOXY (17,6);
  WRITELN ('NO SCHEDULED RECEIPT OCCURS DURING THE PERIOD. ');
END
ELSE
BEGIN
  GOTOXY (17,6);
  WRITELN ('NUMBER OF THE WEEK');
  GOTOXY (45,6);
  WRITELN ('AMOUNT OF RECEIPT');
  GOTOXY (1,7);
  WRITELN ('*****');
  GOTOXY (42,7);
  WRITELN ('*****');
  M:=7;
  FOR J:=1 TO 12 DO
  BEGIN
    IF (RCRD.SCHREC.SCHRQ [J]>0) THEN
    BEGIN
      M:=M+1;GOTOXY (25,M); WRITELN (J);
      GOTOXY (50,M); WRITELN (RCRD.SCHREC.SCHRQ [J]);
    END;
  END;
END;
GOTOXY (26,21);

```

```

WRITELN ('PRESS A BUTTON TO CONTINUE : ');
GOTOXY (55,21); READLN (CHOICE);
END;

```

```

PROCEDURE WWRITE_3;
BEGIN
  IF RCRD.LVCD=0 THEN
  BEGIN
    CLRSCR;
    GOTOXY (1,1);
    WRITELN ('RECORD NUMBER : ',RCRD.NUMD;
    GOTOXY (20,2);
    WRITELN ('*****');
    GOTOXY (20,3);
    WRITELN ('*                GROSS REQUIREMENTS                *');
    GOTOXY (20,4);
    WRITELN ('*****');
    GOTOXY (15,6);
    WRITELN ('NUMBER OF THE WEEK');
    GOTOXY (43,6);
    WRITELN ('AMOUNT OF REQUIREMENT');
    GOTOXY (15,7);
    WRITELN ('*****');
    GOTOXY (45,7);
    WRITELN ('*****');
    M:=7;
    FOR J:=1 TO 12 DO
    BEGIN
      IF RCRD.GRREQ.GRRQ [J]>0 THEN
      BEGIN
        M:=M+1;
        GOTOXY (23,M); WRITELN (J);

```

```

    GOTOXY (48,MD; WRITELN (RCRD.GRREQ.GRRQ [J]);
END;
END;
GOTOXY (26,21);
WRITELN ('PRESS A BUTTON TO CONTINUE :');
GOTOXY (55,21);
READLN (CHOICE);
END;
END;

```

```

PROCEDURE WWRITE_4;
BEGIN
    CLRSCR;
    GOTOXY (1,1);
    WRITELN ('RECORD NUMBER : ',RCRD.NUM;
    GOTOXY (25,4);
    WRITELN ('LOT SIZE POLICY : ');
    GOTOXY (25,5);
    WRITELN ('*****');
    GOTOXY (43,4);
    CASE RCRD.LTSZ OF
        1: CC:='THE LOT FOR LOT METHOD';
        2: CC:='THE FIXED ORDER QUANTITY METHOD';
        3: CC:='THE ECONOMIC ORDER QUANTITY METHOD';
    END;
    WRITELN (CC);
    IF RCRD.LTSZ=2 THEN
    BEGIN
        GOTOXY (20,8);
        WRITELN ('FIXED ORDER QUANTITY : ',RCRD.FOQ);
    END;
    IF RCRD.LTSZ=3 THEN

```

```

BEGIN
    GOTOXY (20,8);
    WRITELN ('ECONOMIC ORDER QUANTITY : ',RCRD.EOQ);
    END;
END;

```

```

PROCEDURE READING_1;
BEGIN
    NUMBER:=0;
    SEEK (MRP,0);
    WHILE NOT EOF (MRP) DO
    BEGIN
        READ (MRP,RCRD);
        WWRITE_1;
        WWRITE_2;
        WWRITE_3;
        WWRITE_4;
        GOTOXY (9,16);
        WRITELN ('PRESS A BUTTON TO DISPLAY THE');
        GOTOXY (38,16);
        WRITELN (' INFORMATION OF ANOTHER RECORD : ');
        GOTOXY (72,16); READLN (CHOICE);
        NUMBER:=NUMBER+1;
        SEEK (MRP,NUMBER);
    END;
    CLRSCR;
    GOTOXY (32,9);
    WRITELN ('*****');
    GOTOXY (32,10);
    WRITELN ('* END OF FILE *');
    GOTOXY (32,11);
    WRITELN ('*****');

```

```
    DELAY (9000);  
END;
```

```
PROCEDURE READING_2;  
BEGIN  
    CLRSCR;  
    GOTOXY (8,10);  
    WRITELN ('ENTER THE RECORD NUMBER OF THE');  
    GOTOXY (38,10);  
    WRITELN (' PRODUCT YOU WOULD LIKE TO READ :');  
    GOTOXY (8,11);  
    WRITELN ('-----');  
    GOTOXY (39,11);  
    WRITELN ('-----');  
    GOTOXY (73,10); READLN (NUMBER);  
    IF NUMBER > FILESIZE (MRP) THEN  
        BEGIN  
            CLRSCR;  
            GOTOXY (16,12);  
            WRITELN ('THERE IS NO RECORD WITH THIS NUMBER IN THE FILE. ');  
            GOTOXY (16,13);  
            WRITELN ('-----');  
            DELAY (9000);  
        END;  
    IF (NUMBER < FILESIZE (MRP)) OR (NUMBER = FILESIZE (MRP)) THEN  
        BEGIN  
            SEEK (MRP,NUMBER-1);  
            READ (MRP,RCRD);  
            WWRITE_1;  
            WWRITE_2;  
            WWRITE_3;  
            WWRITE_4;
```

```

GOTOXY (26,10);
WRITELN ('PRESS A BUTTON TO CONTINUE : ');
GOTOXY (54,10); READLN (CHOICE);
END;
END;

```

```

PROCEDURE READING_3;
BEGIN
  NUMBER:=-1;
  SEEK (MRP,0);
  CCCONTROL:=FALSE;
  REPEAT
  BEGIN
    NUMBER:=NUMBER+1;
    SEEK (MRP,NUMBER);
    READ (MRP,RCRD);
    IF RCRD.LVCD=0 THEN
    BEGIN
      CCCONTROL:=TRUE;
      WWRITE_1;
      WWRITE_2;
      WWRITE_3;
      WWRITE_4;
      GOTOXY (12,10);
      WRITELN ('PRESS A BUTTON TO CONTINUE');
      GOTOXY (38,10);
      WRITELN (' WITH ANOTHER PARENT PRODUCT : ');
      GOTOXY (69,10);
      READLN (CHOICE);
    END;
  END
  UNTIL (EOF (MRP));
  IF NOT CCCONTROL THEN

```

```

BEGIN
  CLRSCR;
  GOTOXY (18,9);
  WRITELN ('*****');
  GOTOXY (18,10);
  WRITELN ('* NO PARENT PRODUCT HAS BEEN RECORDED YET. *');
  GOTOXY (18,11);
  WRITELN ('*****');
END
ELSE
BEGIN
  CLRSCR;
  GOTOXY (18,9);
  WRITELN ('*****');
  GOTOXY (18,10);
  WRITELN ('* ALL PARENT PRODUCTS HAVE BEEN DISPLAYED. *');
  GOTOXY (18,11);
  WRITELN ('*****');
END;
GOTOXY (26,16);
WRITELN ('PRESS A BUTTON TO CONTINUE :');
GOTOXY (54,16);
READLN (CHOICE);
END;

```

```

PROCEDURE READING_4;
BEGIN
  CLRSCR;
  GOTOXY (9,10);
  WRITELN ('ENTER THE PART NUMBER OF THE');
  GOTOXY (37,10);
  WRITELN ('PRODUCT YOU WOULD LIKE TO READ :');
  GOTOXY (9,11);

```

```

WRITELN ('-----');
GOTOXY (39,11);
WRITELN ('-----');
GOTOXY (72,10); READLN (NMBR);
NUMBER:=-1;
SEEK (MRP,0);
CCCONTROL:=FALSE;
WHILE (NOT CCCONTROL) AND (NOT EOF (MRP)) DO
BEGIN
  READ (MRP,RCRD);
  IF RCRD.PRTNM=NMBR THEN
  BEGIN
    CCCONTROL:=TRUE;
    CLRSCR;
    GOTOXY (14,9);
    WRITELN ('*****');
    GOTOXY (14,10);
    WRITELN ('* THE RECORD YOU WOULD LIKE TO READ IS FOUND. *');
    GOTOXY (14,11);
    WRITELN ('* PRESS A BUTTON TO DISPLAY THE INFORMATION: *');
    GOTOXY (14,12);
    WRITELN ('*****');
    GOTOXY (58,11); READLN (CHOICE);
    WWRITE_1;
    WWRITE_2;
    WWRITE_3;
    WWRITE_4;
    GOTOXY (26,10);
    WRITELN ('PRESS A BUTTON TO CONTINUE :');
    GOTOXY (54,10); READLN (CHOICE);
  END;
  NUMBER:=NUMBER+1;
  SEEK (MRP,NUMBER);
END;
IF NOT CCCONTROL THEN

```

```

BEGIN
  CLRSCR;
  GOTOXY (21,9);
  WRITELN ('*****');
  GOTOXY (21,10);
  WRITELN ('* THE RECORD YOU WOULD LIKE TO READ *');
  GOTOXY (21,11);
  WRITELN ('*          CAN NOT BE FOUND.          *');
  GOTOXY (21,12);
  WRITELN ('*****');
  GOTOXY (26,16);
  WRITELN ('PRESS A BUTTON TO CONTINUE :');
  GOTOXY (54,16); READLN (CHOICE);
END;
END;

```

```

PROCEDURE READING_5;
BEGIN
  CLRSCR;
  GOTOXY (7,10);
  WRITELN ('ENTER THE DESCRIPTION OF THE');
  GOTOXY (35,10);
  WRITELN (' PRODUCT YOU WOULD LIKE TO READ :');
  GOTOXY (7,11);
  WRITELN ('-----');
  GOTOXY (37,11);
  WRITELN ('-----');
  GOTOXY (74,10); READLN (DESC);
  NUMBER:=-1;
  SEEK (MRP,0);
  CONTROL:=FALSE;
  WHILE (NOT CONTROL) AND (NOT EOF (MRP)) DO

```

```

BEGIN
  READ (MRP,RCRD);
  IF RCRD.PRIDES=DESC THEN
  BEGIN
    CONTROL:=TRUE;
    CLRSCR;
    GOTOXY (14,9);
    WRITELN ('*****'),
    GOTOXY (14,10);
    WRITELN ('* THE RECORD YOU WOULD LIKE TO READ IS FOUND. *'),
    GOTOXY (14,11);
    WRITELN ('* PRESS A BUTTON TO DISPLAY THE INFORMATION: *'),
    GOTOXY (14,12);
    WRITELN ('*****'),
    GOTOXY (58,11); READLN (CHOICE);
    WWRITE_1;
    WWRITE_2;
    WWRITE_3;
    WWRITE_4;
    GOTOXY (26,10);
    WRITELN ('PRESS A BUTTON TO CONTINUE :');
    GOTOXY (54,10); READLN (CHOICE);
  END;
  NUMBER:=NUMBER+1;
  SEEK (MRP,NUMBER);
END;
IF NOT CONTROL THEN
BEGIN
  CLRSCR;
  GOTOXY (21,9);
  WRITELN ('*****');
  GOTOXY (21,10);
  WRITELN ('* THE RECORD YOU WOULD LIKE TO READ *');
  GOTOXY (21,11);
  WRITELN ('*          CAN NOT BE FOUND.          *');

```

```

GOTOXY (21,12);
WRITELN ('*****');
GOTOXY (26,16);
WRITELN ('PRESS A BUTTON TO CONTINUE :');
GOTOXY (54,16);
READLN (CHOICE);
END;
END;

```

```

PROCEDURE FILL_GROSS;
BEGIN
  FOR J:=1 TO 12
  DO
    BEGIN
      IF RCRD.GRREQ.GRRQ [J] > 0
      THEN
        BEGIN
          K:=10+(J-1)*6;
          GOTOXY (K,7);
          WRITE (RCRD.GRREQ.GRRQ [J]);
        END;
    END;
  END;
END;

```

```

PROCEDURE FILL_SCHEDULED;
BEGIN
  FOR J:=1 TO 12
  DO
    BEGIN

```

```

IF RCRD.SCHREC.SCHRQ [J] > 0
THEN
BEGIN
  K: =10+(J-1)*6;
  GOTOXY (K,9);
  WRITE (RCRD.SCHREC.SCHRQ [J]);
END;
END;
END;

```

```

PROCEDURE FILL_PROJECTED;
BEGIN
  GOTOXY (10,11);
  WRITE (RCRD.INVENT.PRINV.PRINQ [1]);
  FOR J: =2 TO 12
  DO
  BEGIN
    IF RCRD.INVENT.PRINV.PRINQ [J] <> RCRD.INVENT.PRINV.PRINQ
    THEN
    BEGIN
      K: =10+(J-1)*6;
      GOTOXY (K,11);
      WRITE (RCRD.INVENT.PRINV.PRINQ [J]);
    END;
  END;
END;

```

```

PROCEDURE FILL_NET;
BEGIN
  FOR J: =1 TO 12

```

```

DO
BEGIN
  IF (RCRD.NTREQ.NTRQ [J] > 0) AND (RCRD.GRREQ.GRRQ [J] > 0)
  THEN
    BEGIN
      K: =10+(J-1)*6;
      GOTOXY (K,13);
      WRITE (RCRD.NTREQ.NTRQ [J]);
    END;
  END;
END;

```

```

PROCEDURE FILL_RECEIPT;
BEGIN
  FOR J: =1 TO 12
  DO
    BEGIN
      IF RCRD.PLOREC.PLORRQ [J] > 0
      THEN
        BEGIN
          K: =10+(J-1)*6;
          GOTOXY (K,15);
          WRITE (RCRD.PLOREC.PLORRQ [J]);
        END;
      END;
    END;
  END;

```

```

PROCEDURE FILL_ORDER1;
BEGIN
  FOR J: =1 TO 12 DO

```

```

BEGIN
  IF RCRD.PLORD.PLORQ [J] > 0 THEN
    BEGIN
      K: =10+(J-1)*6;
      GOTOXY (K,15);
      WRITE (RCRD.PLORD.PLORQ [J]);
    END;
  END;
END;

```

```

PROCEDURE FILL_ORDER2;
BEGIN
  FOR J: =1 TO 12 DO
    BEGIN
      IF RCRD.PLORD.PLORQ [J] > 0 THEN
        BEGIN
          K: =10+(J-1)*6;
          GOTOXY (K,17);
          WRITE (RCRD.PLORD.PLORQ [J]);
        END;
      END;
    END;
  END;

```

```

PROCEDURE DRAW_FRAME;
BEGIN
  FRAME1;
  IF RCRD.LTSZ=1 THEN FRAME2 ELSE FRAME3;
END;

```

```

PROCEDURE FILL_FRAME;
BEGIN
    GOTOXY (1,1);
    WRITELN ('PART DESCRIPTION: ',RCRD.PRTDES);
    FILL_GROSS;
    FILL_SCHEDULED;
    FILL_PROJECTED;
    FILL_NET;
    IF RCRD.LTSZ=1 THEN FILL_ORDER1
    ELSE
    BEGIN
        FILL_RECEIPT;
        FILL_ORDER2;
    END;
END;

```

```

PROCEDURE ANALYSIS_1;
BEGIN
    NUMBER:=-1;
    SEEK (MRP,0);
    WHILE NOT EOF (MRP) DO
    BEGIN
        NUMBER:=NUMBER+1;
        SEEK (MRP,NUMBER);
        READ (MRP,RCRD);
        DRAW_FRAME;
        FILL_FRAME;
        GOTOXY (9,18);
        WRITELN ('PRESS A BUTTON TO DISPLAY THE');
        GOTOXY (38,18);
        WRITELN ('REPORT OF THE CURRENT ANALYSIS :');
        GOTOXY (72,18); READLN (CHOICE);
    END;

```

```

CLRSCR;
SIT_REPORT;
GOTOXY (11,18);
WRITELN ('PRESS A BUTTON TO DISPLAY');
GOTOXY (36,18);
WRITELN (' THE ANALYSIS OF ANOTHER RECORD :');
GOTOXY (70,18); READLN (CHOICE);
END;
CLRSCR;
GOTOXY (32,9);
WRITELN ('*****');
GOTOXY (32,10);
WRITELN ('* END OF FILE *');
GOTOXY (32,11);
WRITELN ('*****');
DELAY (9000);
END;

```

```

PROCEDURE ANALYSIS_2;
BEGIN
  CLRSCR;
  GOTOXY (9,10);
  WRITELN ('ENTER THE PART NUMBER OF THE');
  GOTOXY (37,10);
  WRITELN (' PRODUCT YOU WOULD LIKE TO READ :');
  GOTOXY (9,11);
  WRITELN ('*****');
  GOTOXY (39,11);
  WRITELN ('*****');
  GOTOXY (71,10); READLN (NMBR);
  NUMBER:=-1;
  SEEK (MRP,0);

```

```

CONTROL: =FALSE;
WHILE (NOT CONTROL) AND (NOT EOF (MRP)) DO
BEGIN
    NUMBER: =NUMBER+1;
    SEEK (MRP,NUMBER);
    READ (MRP,RCRD);
    IF RCRD.PRTNM=NMBR
    THEN
    BEGIN
        CONTROL: =TRUE;
        CLRSCR;
        GOTOXY (14,9);
        WRITELN ('*****'),
        GOTOXY (14,10);
        WRITELN ('* THE RECORD YOU WOULD LIKE TO READ IS FOUND. *'),
        GOTOXY (14,11);
        WRITELN ('* PRESS A BUTTON TO DISPLAY THE ANALYSIS : *'),
        GOTOXY (14,12);
        WRITELN ('*****'),
        GOTOXY (58,11);
        READLN (CHOICE);
        DRAW_FRAME;
        FILL_FRAME;
        GOTOXY (9,18);
        WRITELN ('PRESS A BUTTON TO DISPLAY');
        GOTOXY (34,18);
        WRITELN (' THE REPORT OF THE CURRENT ANALYSIS :');
        GOTOXY (72,18);
        READLN (CHOICE);
        CLRSCR;
        SIT_REPORT;
        GOTOXY (26,18);
        WRITELN ('PRESS A BUTTON TO CONTINUE :');
        GOTOXY (54,18);
        READLN (CHOICE);
    
```

```

    END;
END;
IF NOT CONTROL
THEN
BEGIN
    CLRSCR;
    GOTOXY (21,9);
    WRITELN ('*****');
    GOTOXY (21,10);
    WRITELN ('* THE RECORD YOU WOULD LIKE TO READ *');
    GOTOXY (21,11);
    WRITELN ('*          CAN NOT BE FOUND.          *');
    GOTOXY (21,12);
    WRITELN ('*****');
    GOTOXY (26,16);
    WRITELN ('PRESS A BUTTON TO CONTINUE :');
    GOTOXY (54,16);
    READLN (CHOICE);
END;
END;

```

```

PROCEDURE SUBMENU_1;
BEGIN
    REPLY:=0;
    WHILE (REPLY<1) OR (REPLY>5) DO
    BEGIN
        CLRSCR;
        GOTOXY (28,6);
        WRITELN ('*****');
        GOTOXY (28,7);
        WRITELN ('* RECORD READING MENU *');
        GOTOXY (28,8);
        WRITELN ('*****');
    
```

```

GOTOXY (28,9);
WRITELN ('* 1- ALL RECORDS      *');
GOTOXY (28,10);
WRITELN ('* 2- RECORD NUMBER    *');
GOTOXY (28,11);
WRITELN ('* 3- PARENT PRODUCT    *');
GOTOXY (28,12);
WRITELN ('* 4- PART NUMBER       *');
GOTOXY (28,13);
WRITELN ('* 5- PART DESCRIPTION *');
GOTOXY (28,14);
WRITELN ('*****');
GOTOXY (16,18);
WRITELN ('CHOOSE ONE AMONG THE ALTERNATIVES ABOVE <1-5> :');
GOTOXY (64,18); READLN (REPLY);
END;
IF REPLY=1 THEN READING_1;
IF REPLY=2 THEN READING_2;
IF REPLY=3 THEN READING_3;
IF REPLY=4 THEN READING_4;
IF REPLY=5 THEN READING_5;
END;

```

```

PROCEDURE SUBMENU_2;
BEGIN
  REPLY:=0;
  WHILE (REPLY<1) OR (REPLY>2) DO
  BEGIN
    CLRSCR;
    GOTOXY (24,8);
    WRITELN ('*****');
    GOTOXY (24,9);
  
```

```

WRITELN ('*      READING ANALYSIS MENU      *');
GOTOXY (24,10);
WRITELN ('*****');
GOTOXY (24,11);
WRITELN ('* 1- ALL ANALYSIS                      *');
GOTOXY (24,12);
WRITELN ('* 2- SPECIFIC PRODUCT ANALYSIS *');
GOTOXY (24,13);
WRITELN ('*****');
GOTOXY (16,18);
WRITELN ('CHOOSE ONE AMONG THE ALTERNATIVES ABOVE <1-2> :');
GOTOXY (64,18); READLN (REPLY);
END;
GR_CALCULATION;
IF REPLY=1 THEN ANALYSIS_1;
IF REPLY=2 THEN ANALYSIS_2;
END;

```

```

PROCEDURE FRAME_4;
BEGIN
  CLRSCR;
  GOTOXY (1,3);
  WRITELN ('-----');
  GOTOXY (41,3);
  WRITELN ('-----');
  GOTOXY (1,4);
  WRITELN ('RESOURCE :');
  GOTOXY (1,5);
  WRITELN ('-----');
  GOTOXY (41,5);
  WRITELN ('-----');
  GOTOXY (1,6);

```

```

WRITELN ('WEEK NO.   1       2       3       4       5       6       7');
GOTOXY (49,6);
WRITELN ('           8       9      10      11      12');
GOTOXY (1,7);
WRITELN ('-----');
GOTOXY (41,7);
WRITELN ('-----');
GOTOXY (1,9);
WRITELN ('REQUIRED');
GOTOXY (1,10);
WRITELN ('HOURS');
GOTOXY (1,11);
WRITELN ('-----');
GOTOXY (41,11);
WRITELN ('-----');
GOTOXY (1,12);
WRITELN ('AVAILABLE');
GOTOXY (1,13);
WRITELN ('HOURS');
GOTOXY (1,14);
WRITELN ('-----');
GOTOXY (41,14);
WRITELN ('-----');
GOTOXY (1,15);
WRITELN ('NEG. DEV. ');
GOTOXY (1,17);
WRITELN ('POS. DEV. ');
GOTOXY (1,18);
WRITELN ('-----');
GOTOXY (41,18);
WRITELN ('-----');
END;

```

```

PROCEDURE FILL_FRAME4;
BEGIN
  FOR J:=1 TO 12 DO
  BEGIN
    K:=10+(J-1)*6;
    GOTOXY (K,10);
    WRITELN (TOTREQ [J]);
    GOTOXY (K,13);
    WRITELN (AVAILHR [J]);
    IF (TOTREQ [J] < AVAILHR [J]) THEN
    BEGIN
      GOTOXY (K,17);
      WRITELN (AVAILHR [J]-TOTREQ [J]);
    END;
    IF (TOTREQ [J] > AVAILHR [J]) THEN
    BEGIN
      GOTOXY (K,15);
      WRITELN (AVAILHR [J]-TOTREQ [J]);
    END;
  END;
END;
END;

```

```

PROCEDURE ASK_4;
BEGIN
  CLRSCR;
  GOTOXY (20,21);
  WRITELN ('PLEASE ENTER THE RELATED INFORMATION!');
  GOTOXY (20,22);
  WRITELN ('-----');
  GOTOXY (1,1);
  WRITELN ('RESOURCE :');
  GOTOXY (20,4);

```

```

WRITELN ('NUMBER OF THE WEEK');
GOTOXY (20,5);
WRITELN ('-----');
GOTOXY (40,4);
WRITELN ('AVAILABLE HOURS');
GOTOXY (40,5);
WRITELN ('-----');
I:=5;
FOR J:=1 TO 12 DO
BEGIN
  I:=I+1;
  GOTOXY (28,I);
  WRITELN (J);
  GOTOXY (48,I);
  READLN (AVAILHR [J]);
END;
END;

```

```

PROCEDURE RCA1;
BEGIN
  GOTOXY (12,1);
  WRITELN ('LABOR HOURS');
  ASK_4;
  FOR J:=1 TO 12 DO TOTREQ [J] :=0;
  NUMBER:=0;
  SEEK (MRP,0);
  WHILE NOT EOF (MRP) DO
  BEGIN
    READ (MRP,RCRD);
    IF RCRD.LVCD=0 THEN
    BEGIN
      FOR J:=1 TO 12 DO

```

```

    TOTREQ [J]:=TOTREQ [J]+RCRD.GRREQ.GRRQ [J]*RCRD.LBHR;
END;
NUMBER:=NUMBER+1;
SEEK (MRP,NUMBER);
END;
FRAME_4;
GOTOXY (12,4);
WRITELN ('TOTAL LABOR HOURS');
FILL_FRAME4;
GOTOXY (26,22);
WRITELN ('PRESS A BUTTON TO CONTINUE :');
GOTOXY (55,22); READLN (CHOICE);
END;

```

```

PROCEDURE RCA2;
BEGIN
    GOTOXY (12,1);
    WRITELN ('MACHINE HOURS');
    ASK_4;
    FOR J:=1 TO 12 DO TOTREQ [J] :=0;
    NUMBER:=0;
    SEEK (MRP,0);
    WHILE NOT EOF (MRP)
    DO
        BEGIN
            READ (MRP,RCRD);
            IF RCRD.LVCD=0
            THEN
                BEGIN
                    FOR J:=1 TO 12 DO
                        TOTREQ [J]:=TOTREQ [J]+RCRD.GRREQ.GRRQ [J]*RCRD.MNHR;
                    END;

```

```

    NUMBER: =NUMBER+1;
    SEEK (MRP,NUMBER);
END;
FRAME_4;
GOTOXY (12,4);
WRITELN ('TOTAL MACHINE HOURS');
FILL_FRAME4;
GOTOXY (26,22);
WRITELN ('PRESS A BUTTON TO CONTINUE : ');
GOTOXY (55,22);
READLN (CHOICE);
END;

```

```

PROCEDURE ROUGH_CUT;
BEGIN
    REPLY: =0;
    WHILE (REPLY<1) OR (REPLY>2)
    DO
    BEGIN
        CLRSCR;
        GOTOXY (29,10);
        WRITELN ('*****');
        GOTOXY (29,11);
        WRITELN ('* ROUGH CUT ANALYSIS *');
        GOTOXY (29,12);
        WRITELN ('*****');
        GOTOXY (29,13);
        WRITELN ('* 1- LABOR HOURS      *');
        GOTOXY (29,14);
        WRITELN ('* 2- MACHINE HOURS     *');
        GOTOXY (29,15);
        WRITELN ('*****');
    END;

```

```

GOTOXY (19,17);
WRITELN ('CHOOSE ONE AMONG THE ALTERNATIVES ABOVE : ');
GOTOXY (61,17);
READLN (REPLY);
END;
IF REPLY=1 THEN RCA1;
IF REPLY=2 THEN RCA2;
END;

```

```

PROCEDURE READING_MENU;
BEGIN
  ANSWER:='D';
  WHILE (ANSWER<>'A') AND (ANSWER<>'B') AND (ANSWER<>'C')
  DO
    BEGIN
      CLRSCR;
      GOTOXY (28,5);
      WRITELN ('*****');
      GOTOXY (28,6);
      WRITELN ('*          READING MENU          *');
      GOTOXY (28,7);
      WRITELN ('*****');
      GOTOXY (28,8);
      WRITELN ('*                                     *');
      GOTOXY (28,9);
      WRITELN ('* A- READING RECORDS                *');
      GOTOXY (28,10);
      WRITELN ('*                                     *');
      GOTOXY (28,11);
      WRITELN ('* B- READING ANALYSIS                *');
      GOTOXY (28,12);
      WRITELN ('*                                     *');
      GOTOXY (28,13);
    END;
  END;

```

```

WRITELN ('* C- ROUGH CUT CAPACITY ANALYSIS *');
GOTOXY (28,14);
WRITELN ('*                                     *');
GOTOXY (28,15);
WRITELN ('*****');
GOTOXY (16,18);
WRITELN ('CHOOSE ONE AMONG THE');
GOTOXY (36,18);
WRITELN ('ALTERNATIVES ABOVE <A-B-C> :');
GOTOXY (66,18);
READLN (ANSWER);
END;
IF ANSWER='A' THEN SUBMENU_1;
IF ANSWER='B' THEN SUBMENU_2;
IF ANSWER='C' THEN ROUGH_CUT;
END;

```

```

PROCEDURE RREAD;
BEGIN
  READING_MENU;
END;

```

```

PROCEDURE PREXIT;
BEGIN
  CLRSCR;
  GOTOXY (25,10);
  WRITELN ('*****');
  GOTOXY (25,11);
  WRITELN ('* SEE YOU SOON! *');

```

```

GOTOXY (25,12);
WRITELN ('*****');
DELAY (9000);
END;

```

```

PROCEDURE MAIN_MENU;

```

```

BEGIN

```

```

  CCONTROL:=FALSE;

```

```

  PREFERENCE:=1;

```

```

  WHILE (PREFERENCE>0) AND (PREFERENCE<5) AND (CCONTROL=FALSE)
  DO

```

```

    BEGIN

```

```

      CLRSCR;

```

```

      GOTOXY (22,3);

```

```

      WRITELN ('*****');

```

```

      GOTOXY (22,4);

```

```

      WRITELN ('*          MAIN MENU          *');

```

```

      GOTOXY (22,5);

```

```

      WRITELN ('*****');

```

```

      GOTOXY (22,6);

```

```

      WRITELN ('*                                *');

```

```

      GOTOXY (22,7);

```

```

      WRITELN ('*      1- RECORD ENTRY      *');

```

```

      GOTOXY (22,8);

```

```

      WRITELN ('*                                *');

```

```

      GOTOXY (22,9);

```

```

      WRITELN ('*      2- RECORD READING    *');

```

```

      GOTOXY (22,10);

```

```

      WRITELN ('*                                *');

```

```

      GOTOXY (22,11);

```

```

      WRITELN ('*      3- RECORD REWRITING  *');

```

```

      GOTOXY (22,12);

```

```

      WRITELN ('*                                *');

```

```

GOTOXY (22,13);
WRITELN ('*      4- PROGRAM EXIT      *');
GOTOXY (22,14);
WRITELN ('*                                *');
GOTOXY (22,15);
WRITELN ('*****');
GOTOXY (22,20);
WRITELN ('MAKE YOUR CHOICE <1-4> : ');
GOTOXY (22,21);
WRITELN ('-----');
GOTOXY (48,20);
READLN (PREFERENCE);
IF PREFERENCE=1 THEN RENTRY;
IF PREFERENCE=2 THEN RREAD;
IF PREFERENCE=4 THEN
BEGIN
  CCONTROL:=TRUE;
  PREXIT;
END;
END;
END;
END;

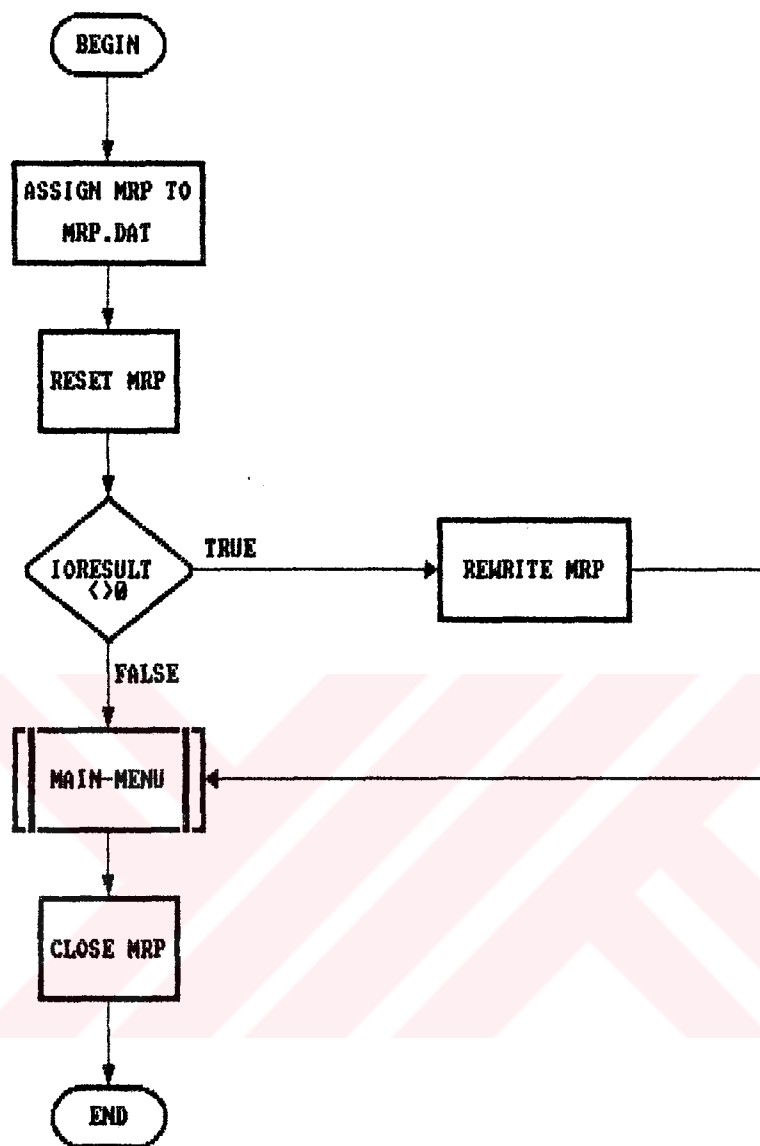
```

```

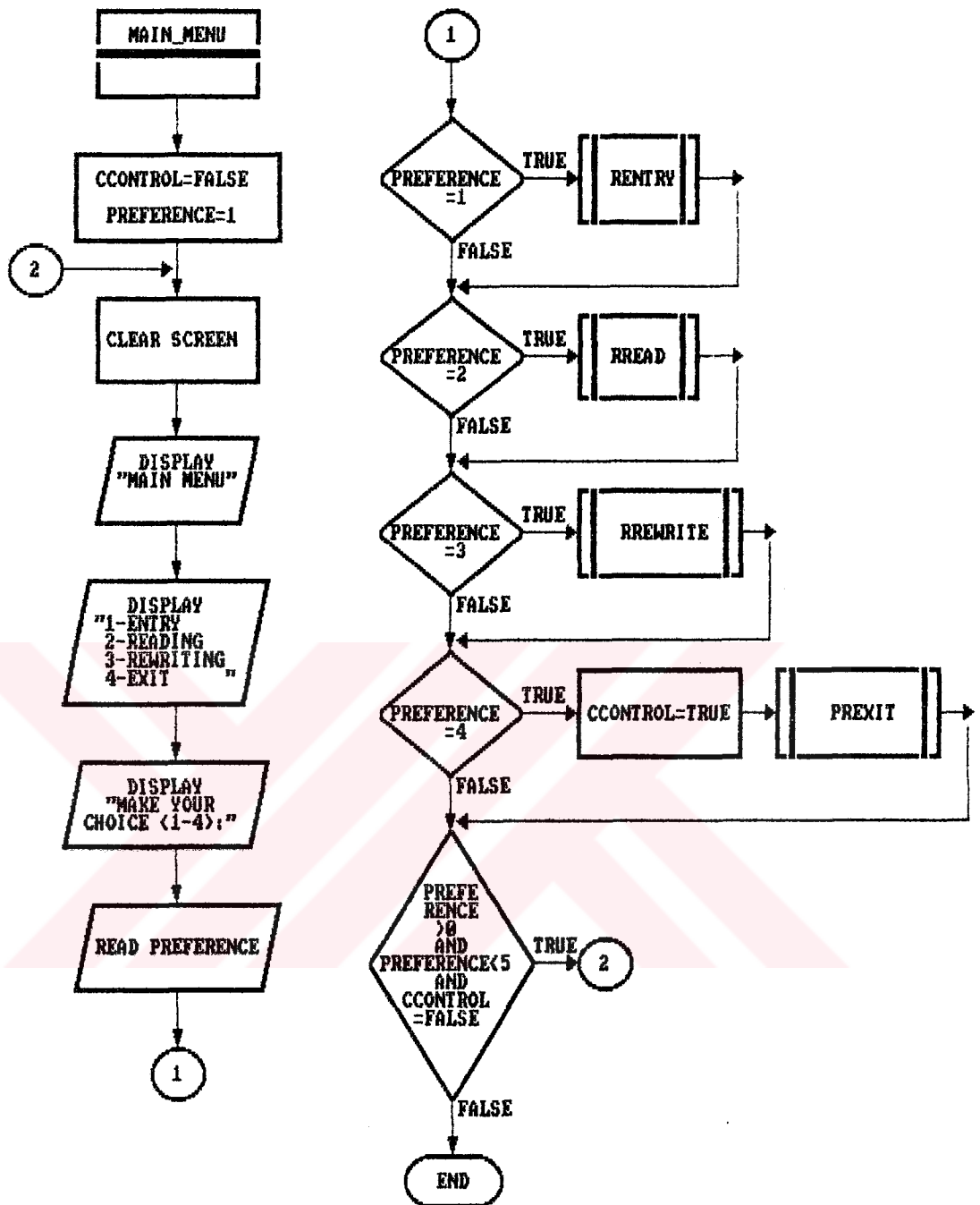
BEGIN
  ASSIGN (MRP, 'MRP.DAT');
  <$I->
  RESET (MRP);
  <$I+>
  IF IORESULT<>0 THEN REWRITE (MRP);
  MAIN_MENU;
  CLOSE (MRP);
END.

```

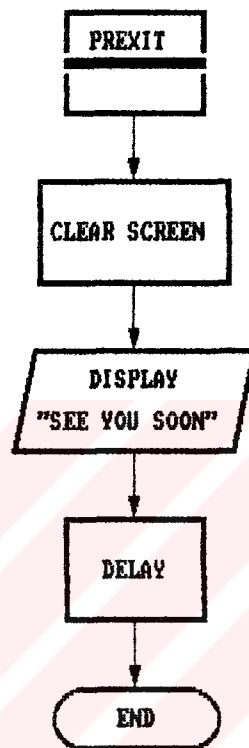

APPENDIX B
THE FLOWCHART OF THE PROGRAM MAN-RES-PLAN



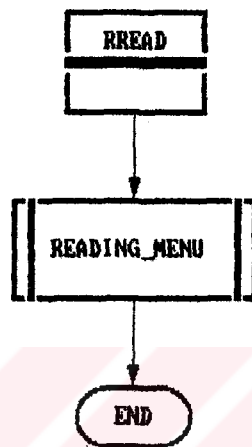
FLOWCHART OF THE MAIN PROGRAM



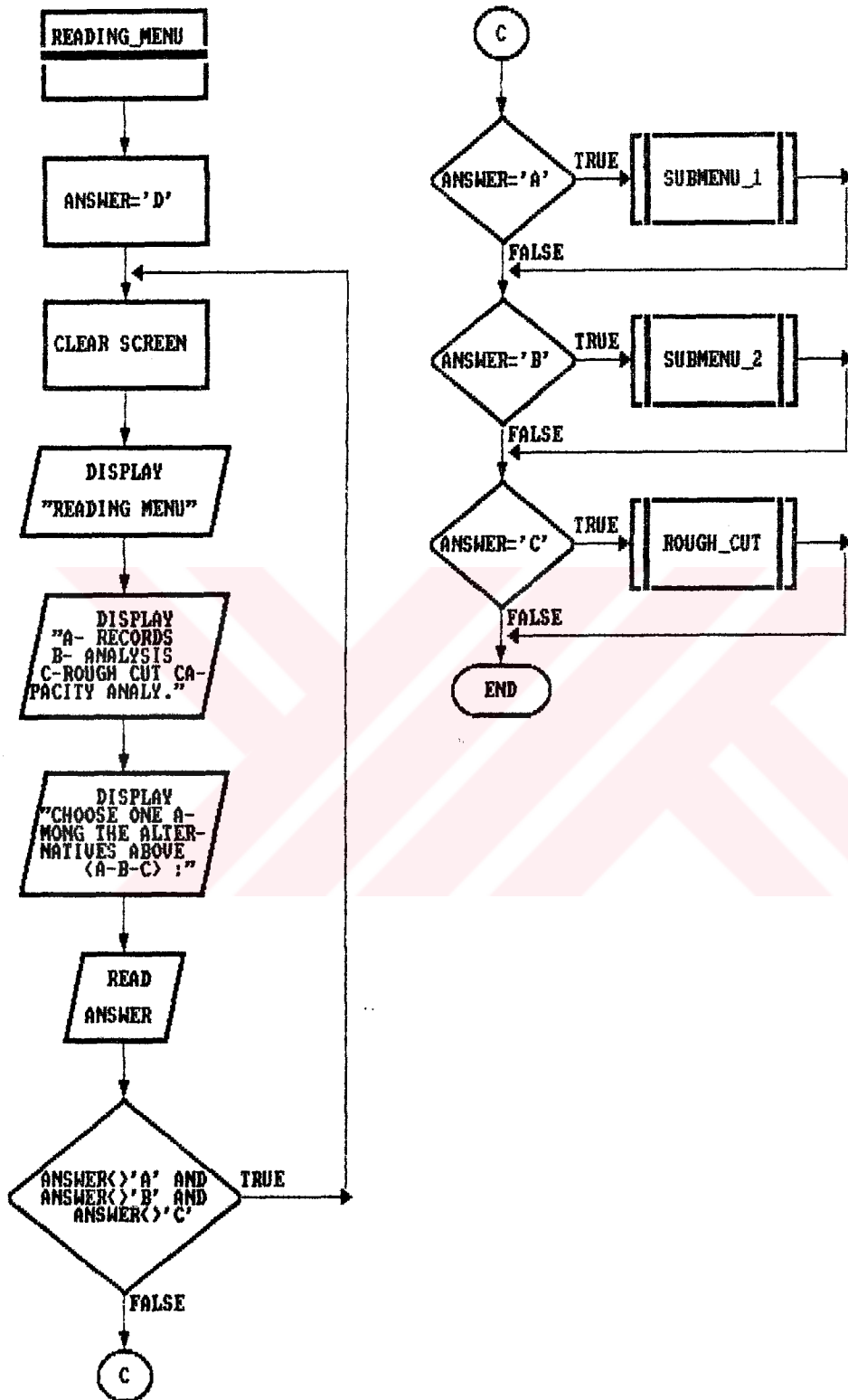
FLOWCHART OF THE PROCEDURE MAIN_MENU



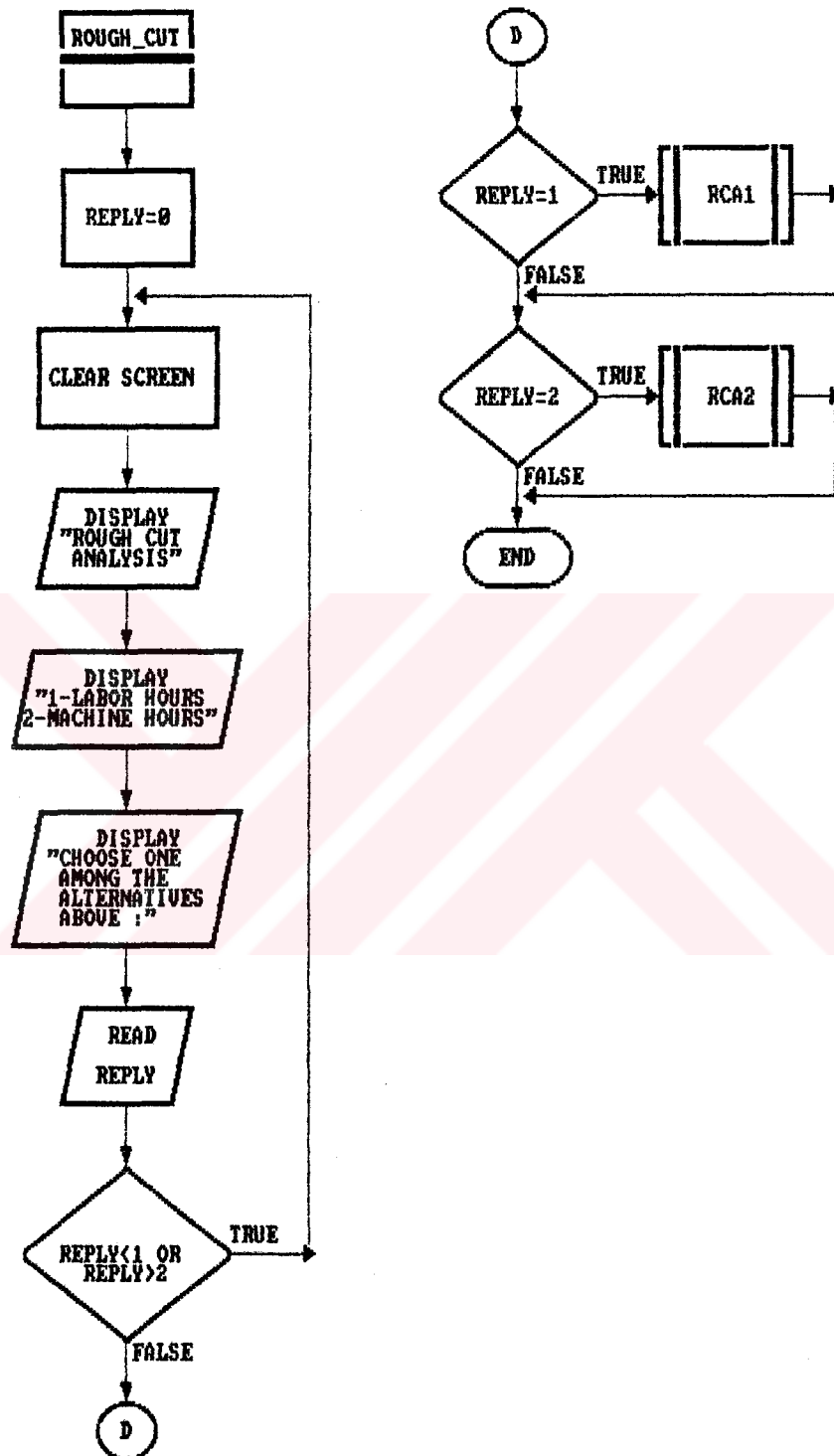
FLOWCHART OF THE PROCEDURE PREXIT



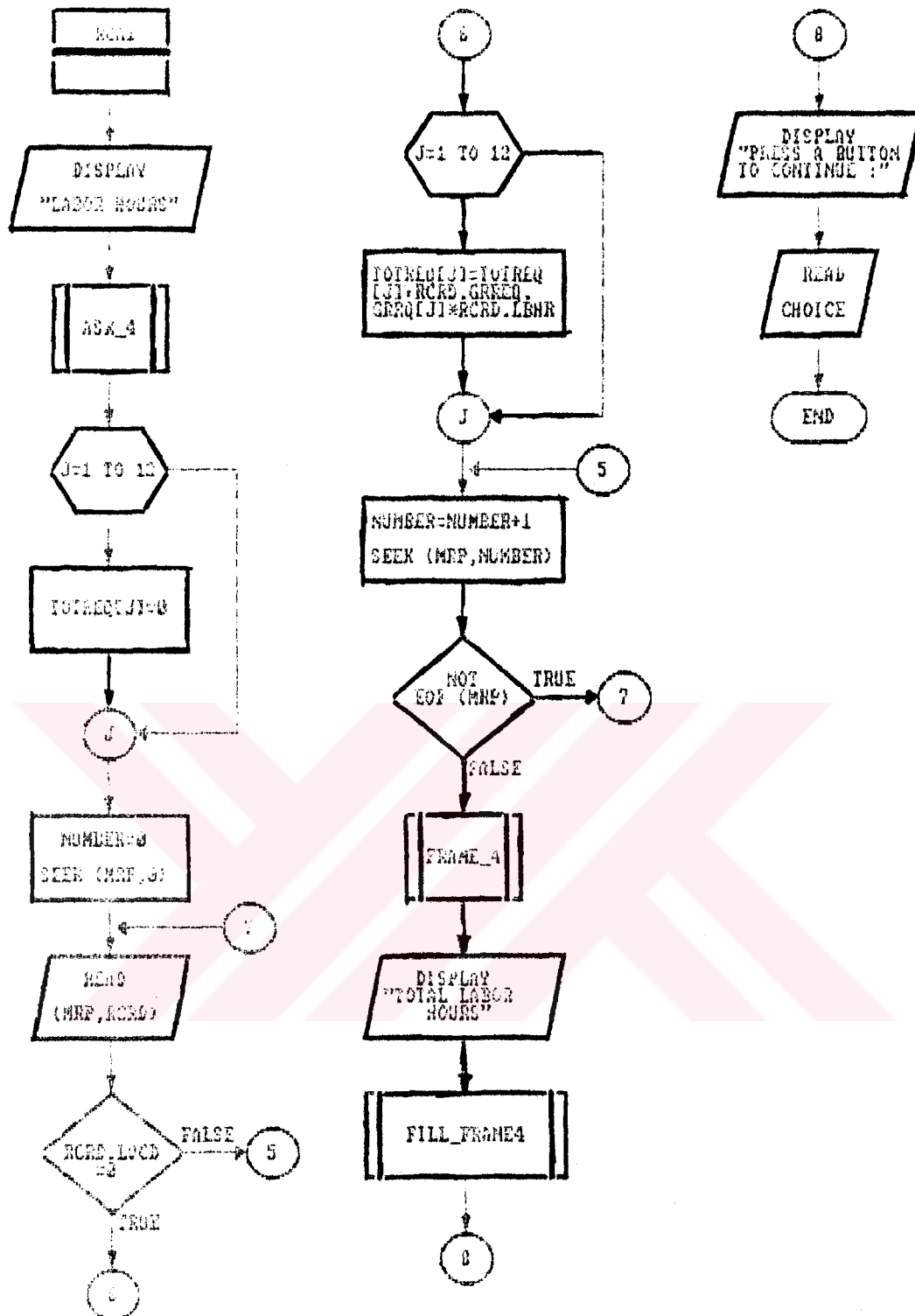
FLOWCHART OF THE PROCEDURE RREAD



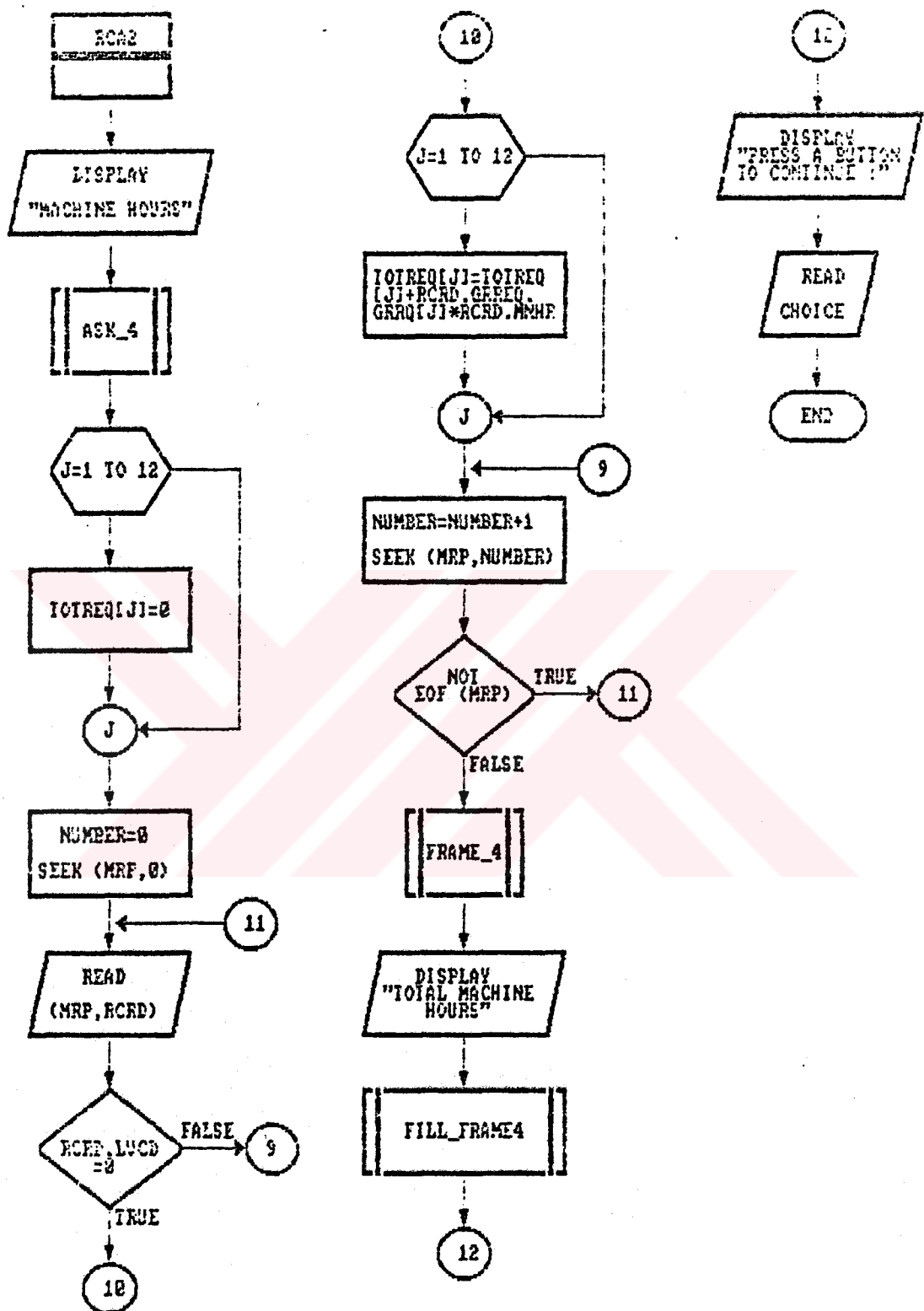
FLOWCHART OF THE PROCEDURE READING_MENU



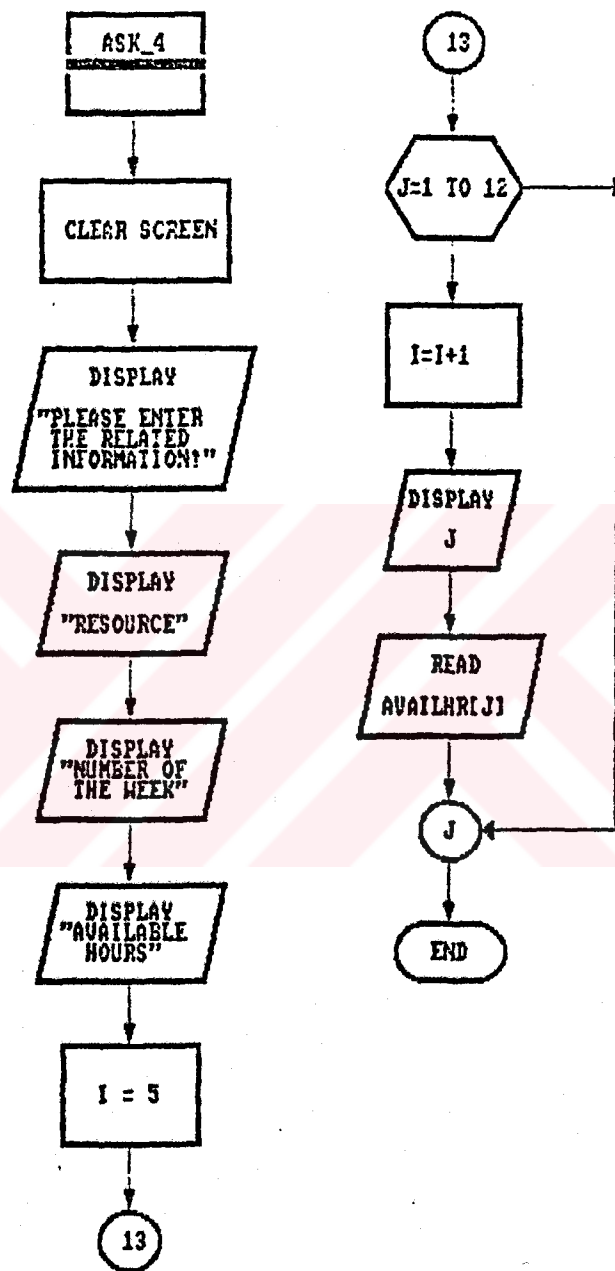
FLOWCHART OF THE PROCEDURE ROUGH_CUT



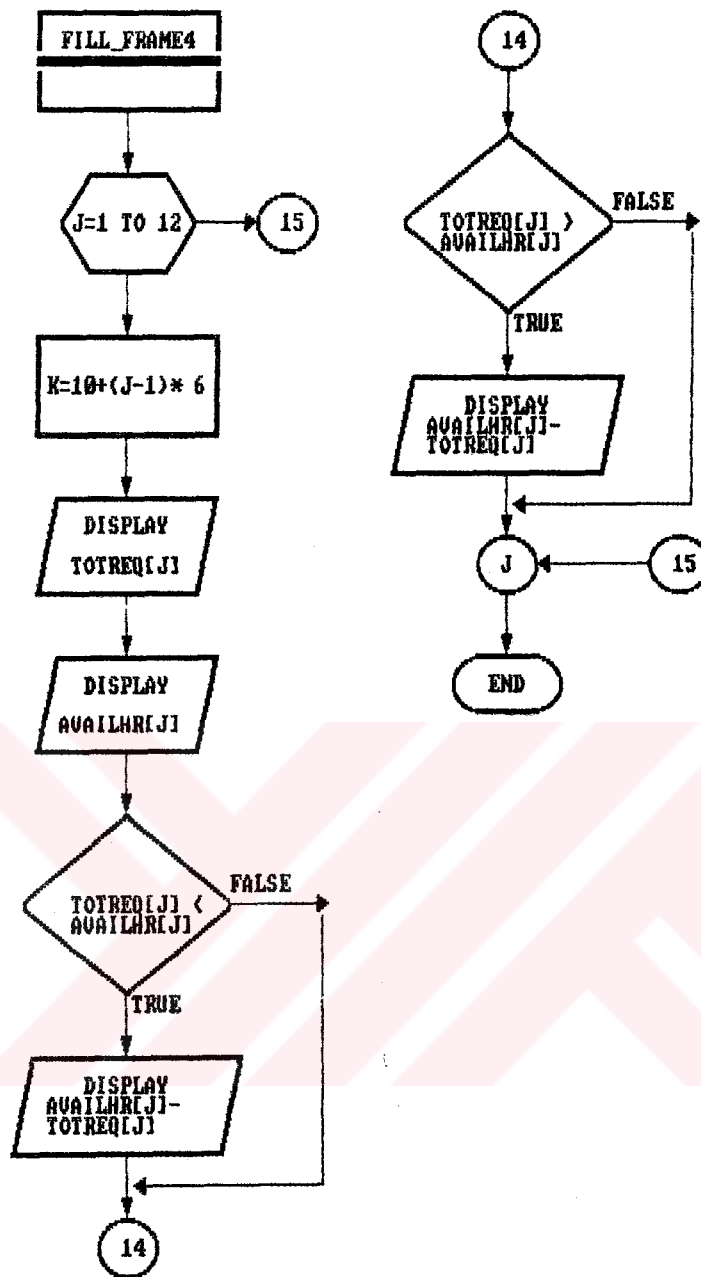
FLOWCHART OF THE PROCEDURE RC41



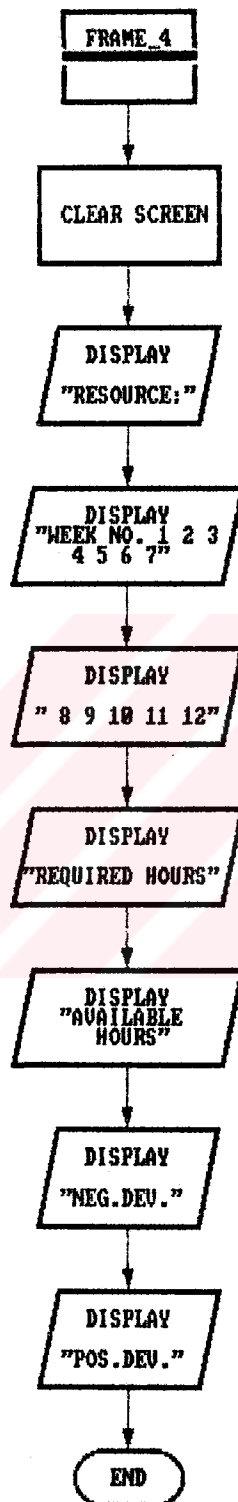
FLOWCHART OF THE PROCEDURE RCR2



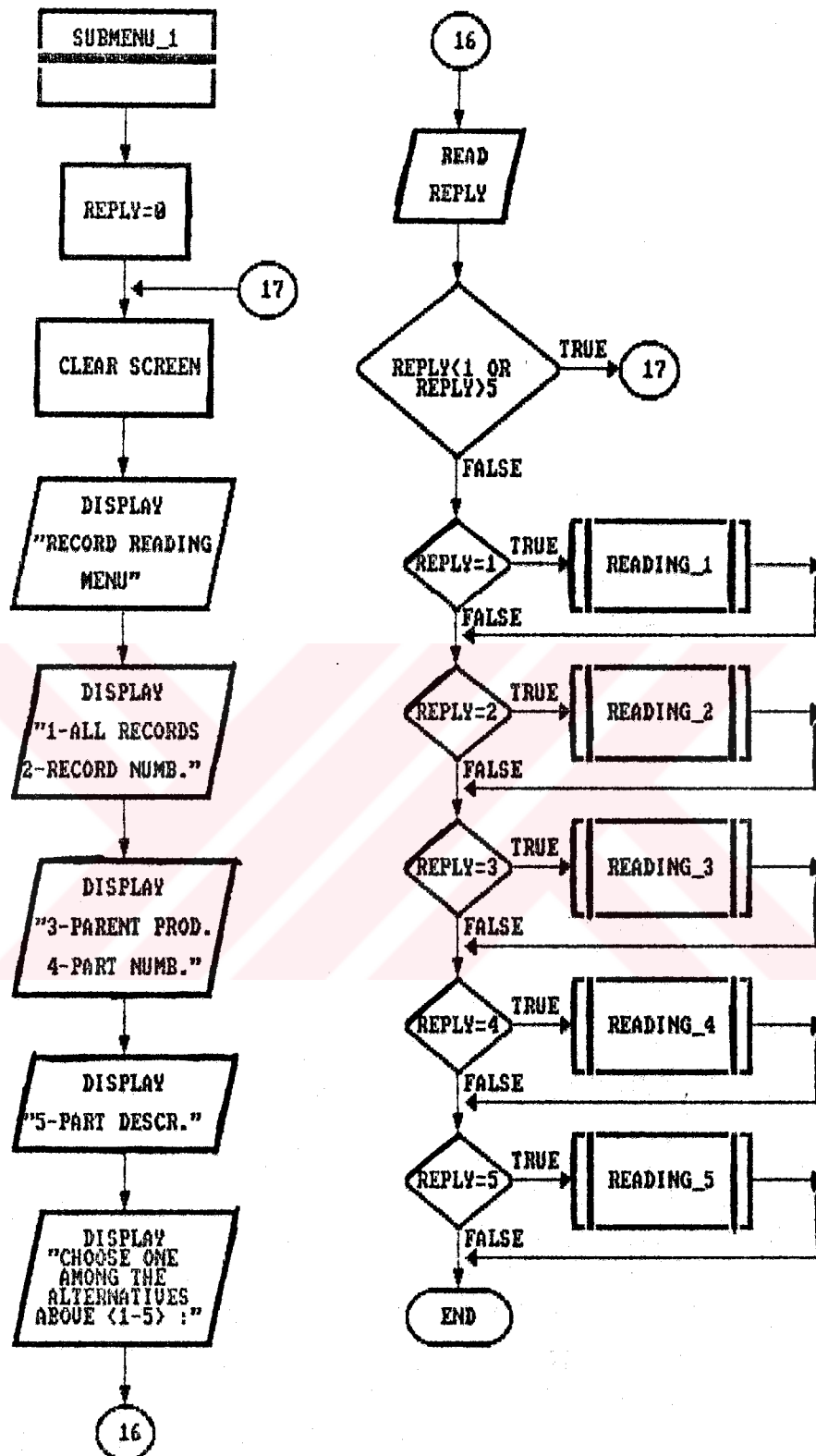
FLOWCHART OF THE PROCEDURE ASK_4



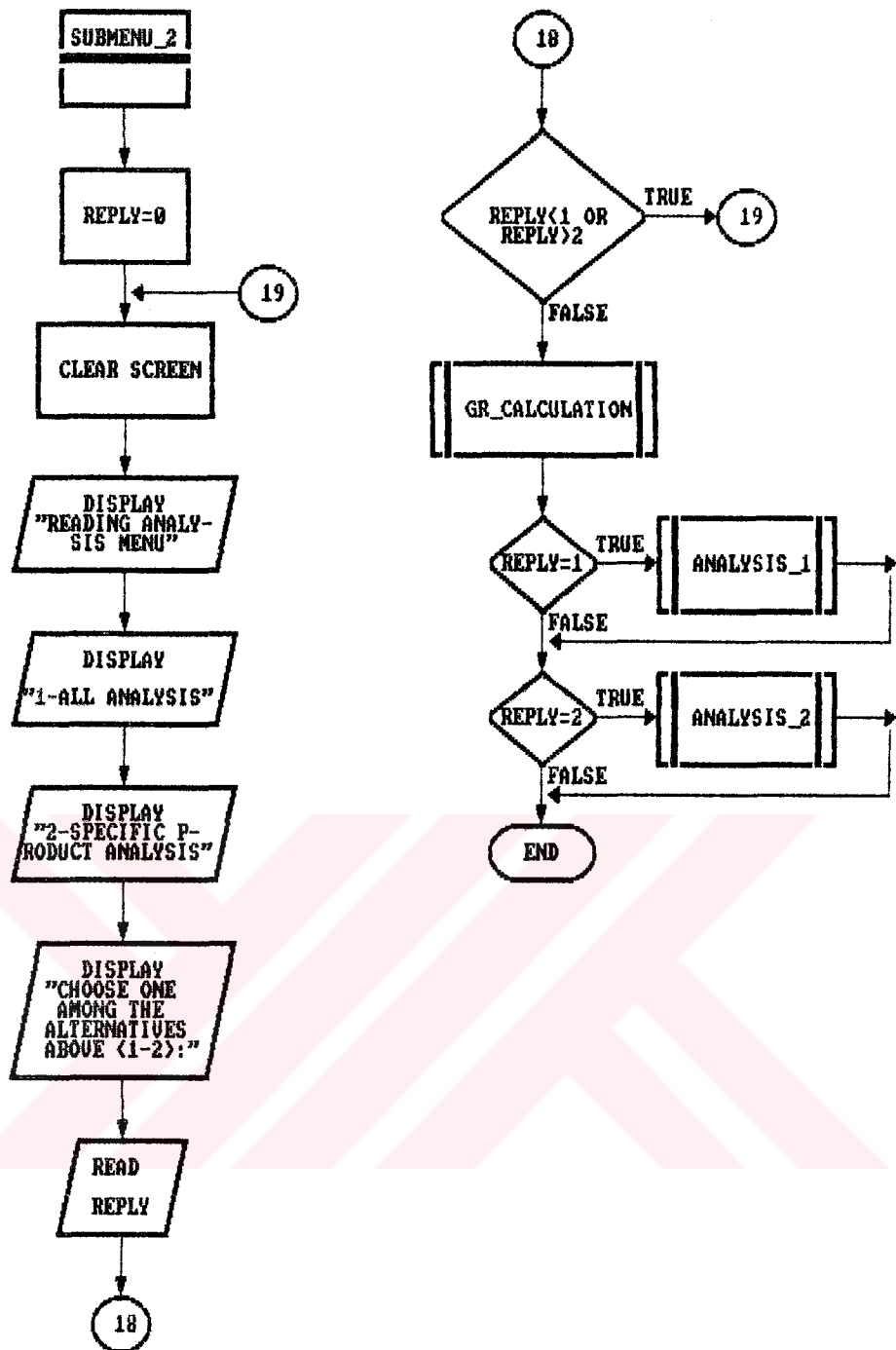
FLOWCHART OF THE PROCEDURE FILL_FRAME4



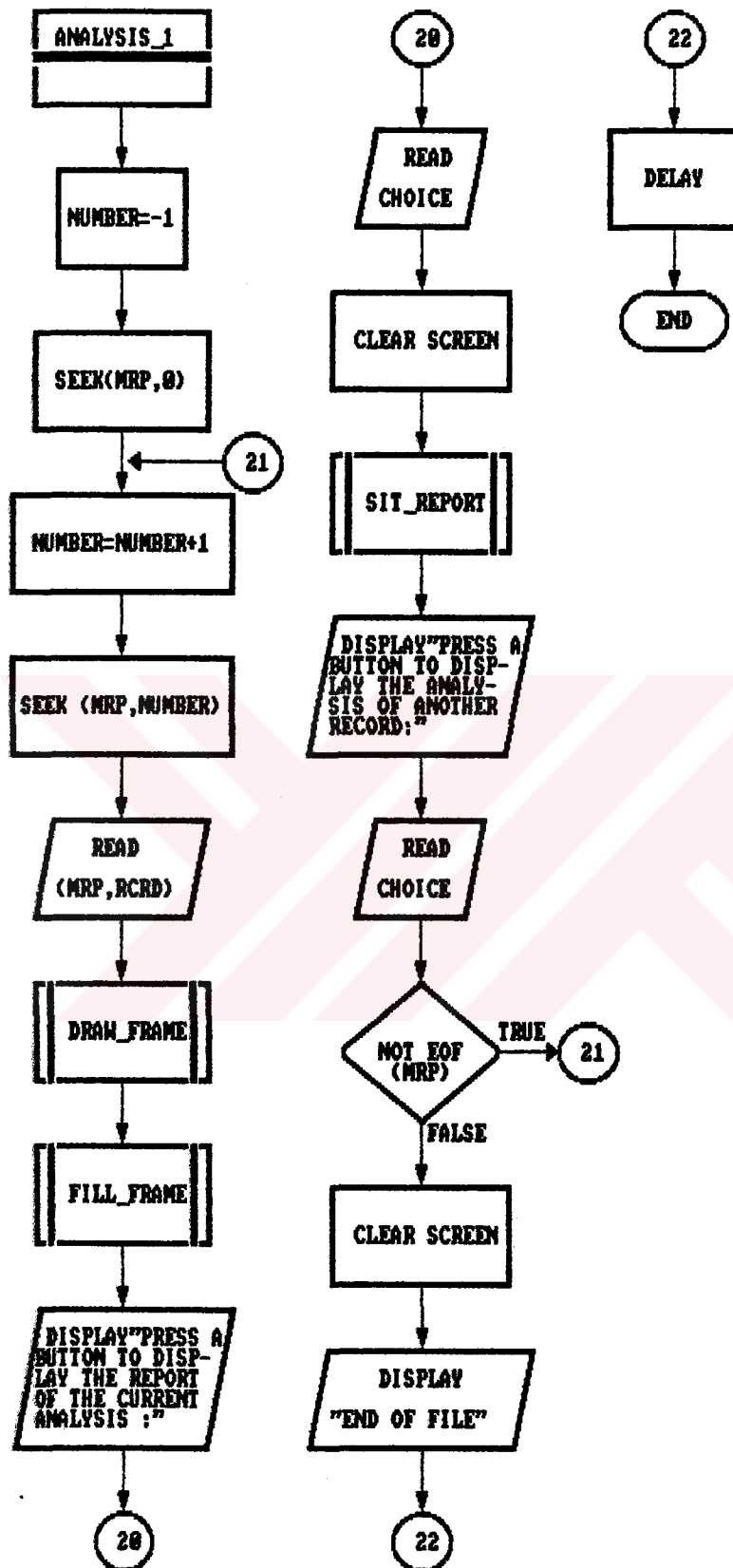
FLOWCHART OF THE PROCEDURE FRAME_4



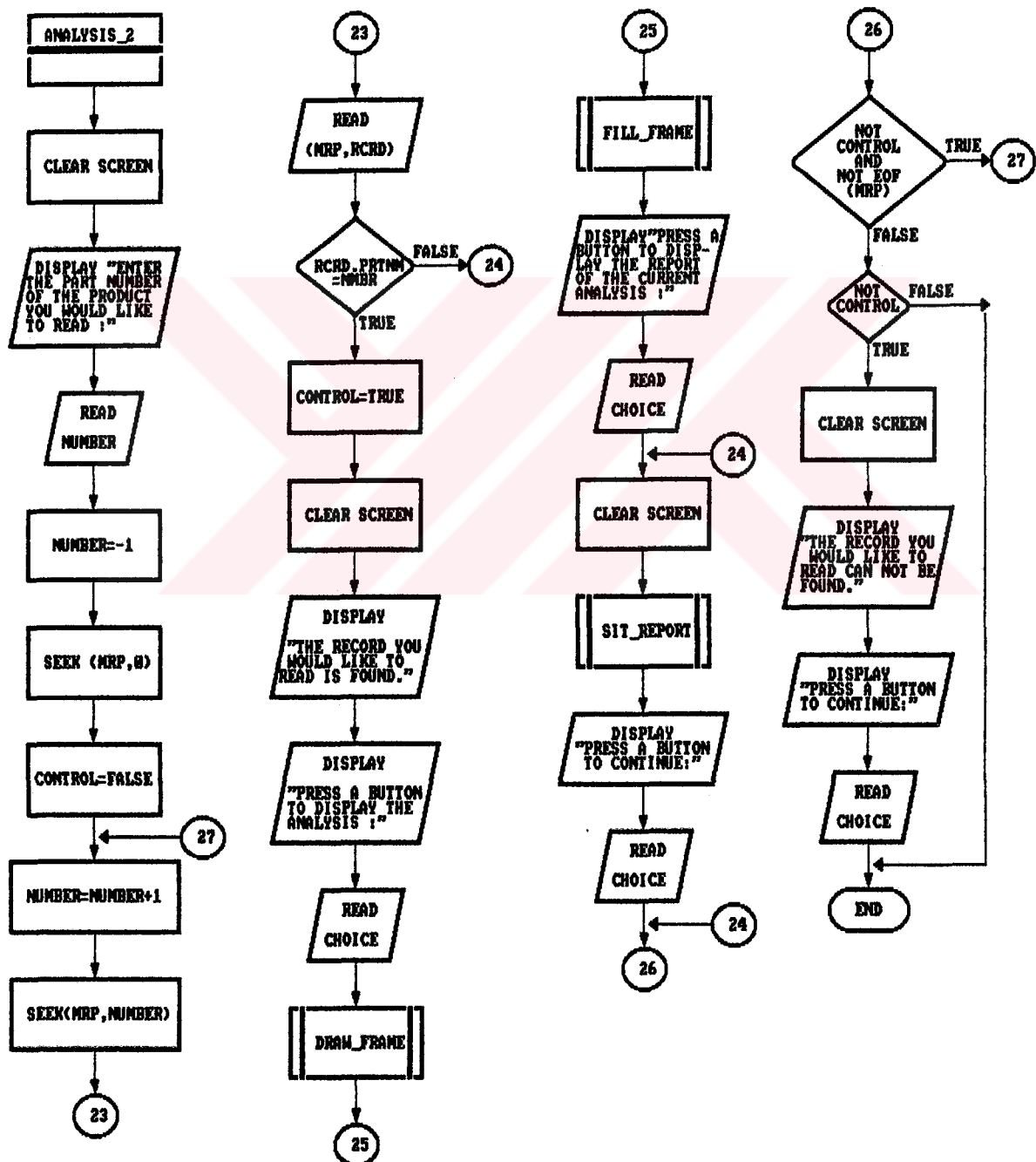
FLOWCHART OF THE PROCEDURE SUBMENU_1



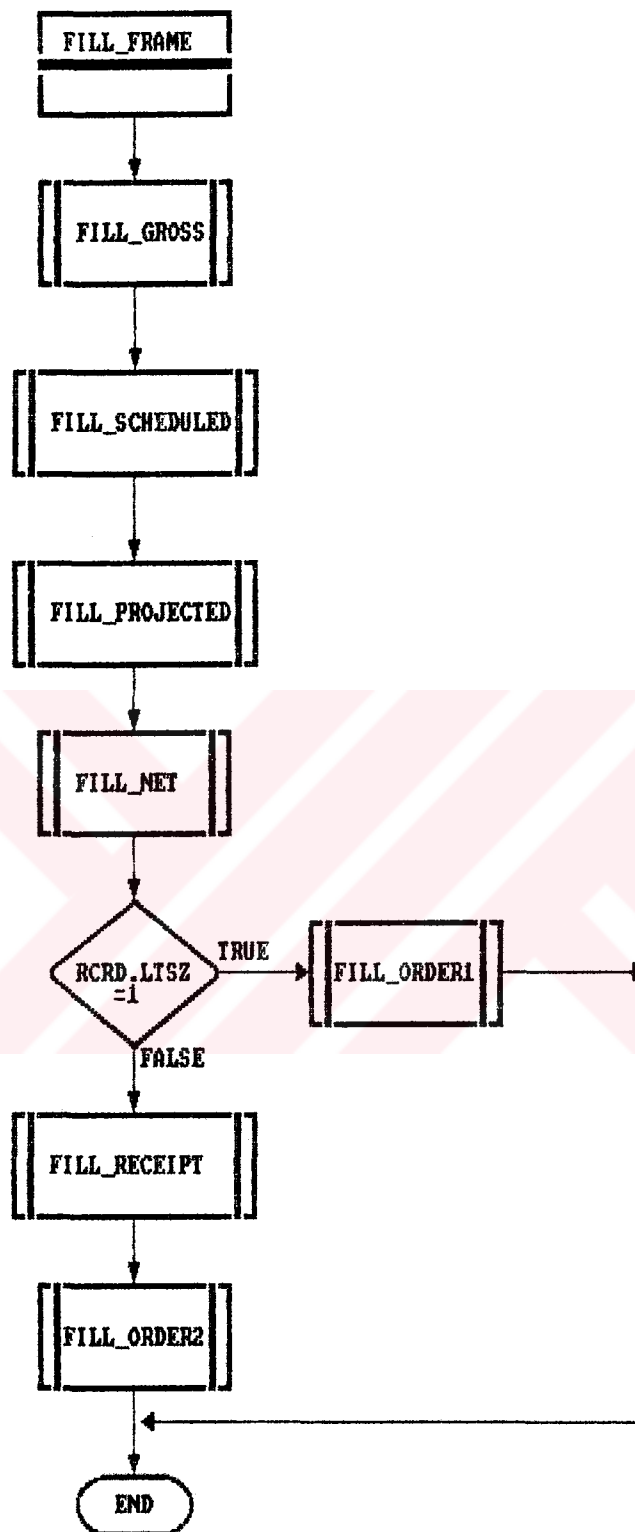
FLOWCHART OF THE PROCEDURE SUBMENU_2



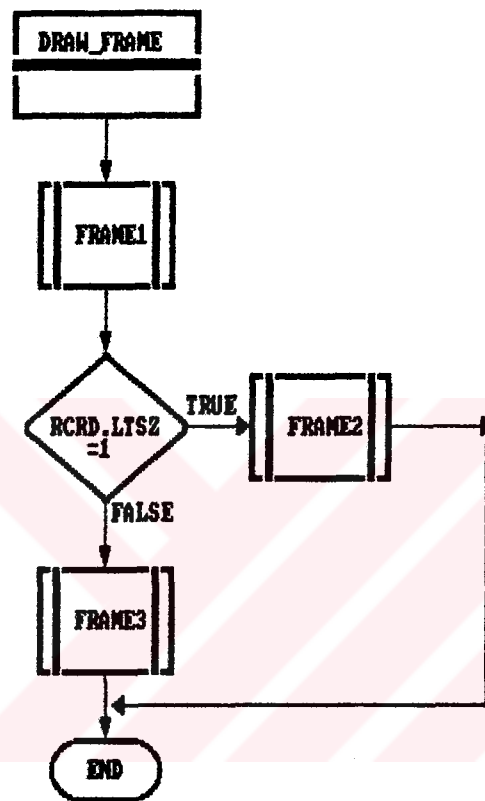
FLOWCHART OF THE PROCEDURE ANALYSIS_1



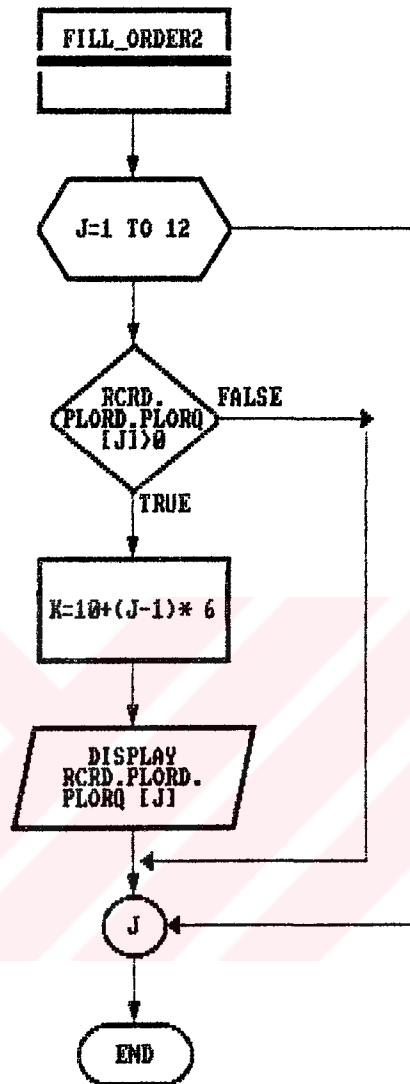
FLOWCHART OF THE PROCEDURE ANALYSIS_2



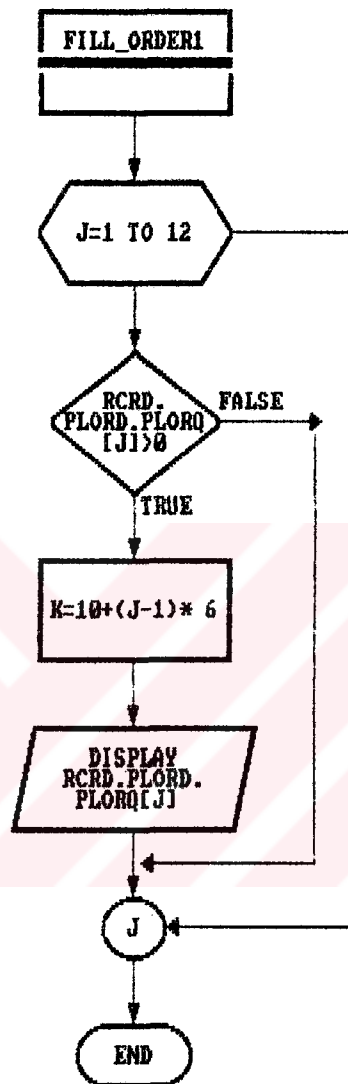
FLOWCHART OF THE PROCEDURE FILL_FRAME



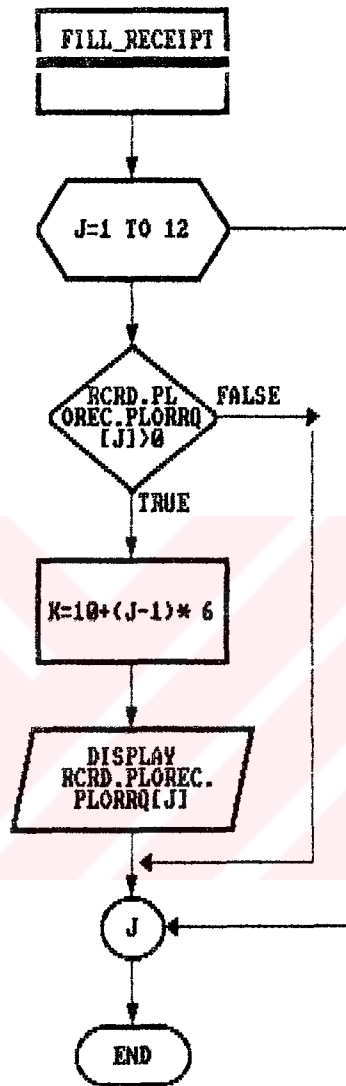
FLOWCHART OF THE PROCEDURE `DRAW_FRAME`



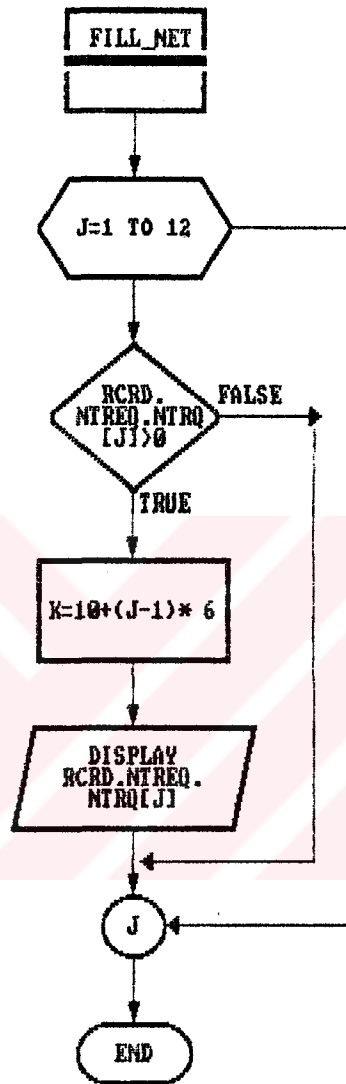
FLOWCHART OF THE PROCEDURE FILL_ORDER2



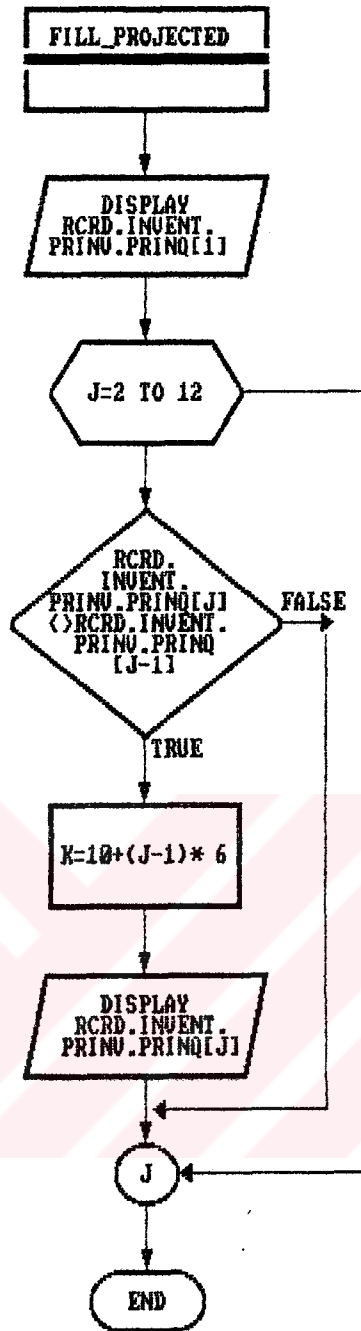
FLOWCHART OF THE PROCEDURE FILL_ORDER1



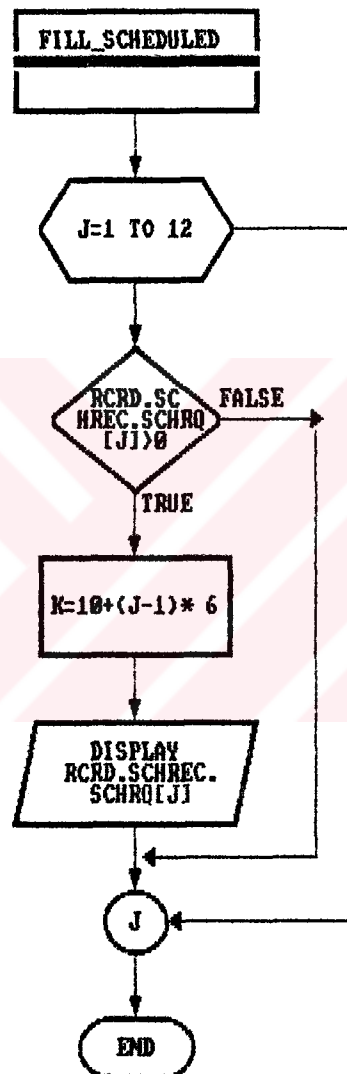
FLOWCHART OF THE PROCEDURE FILL_RECEIPT



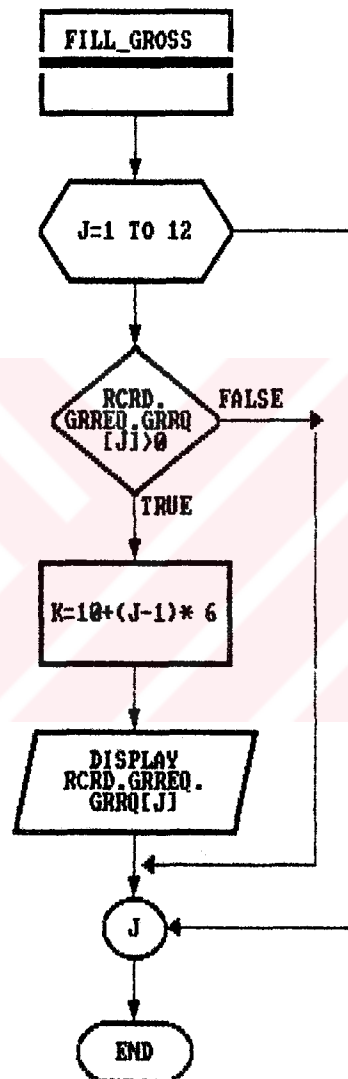
FLOWCHART OF THE PROCEDURE FILL_NET



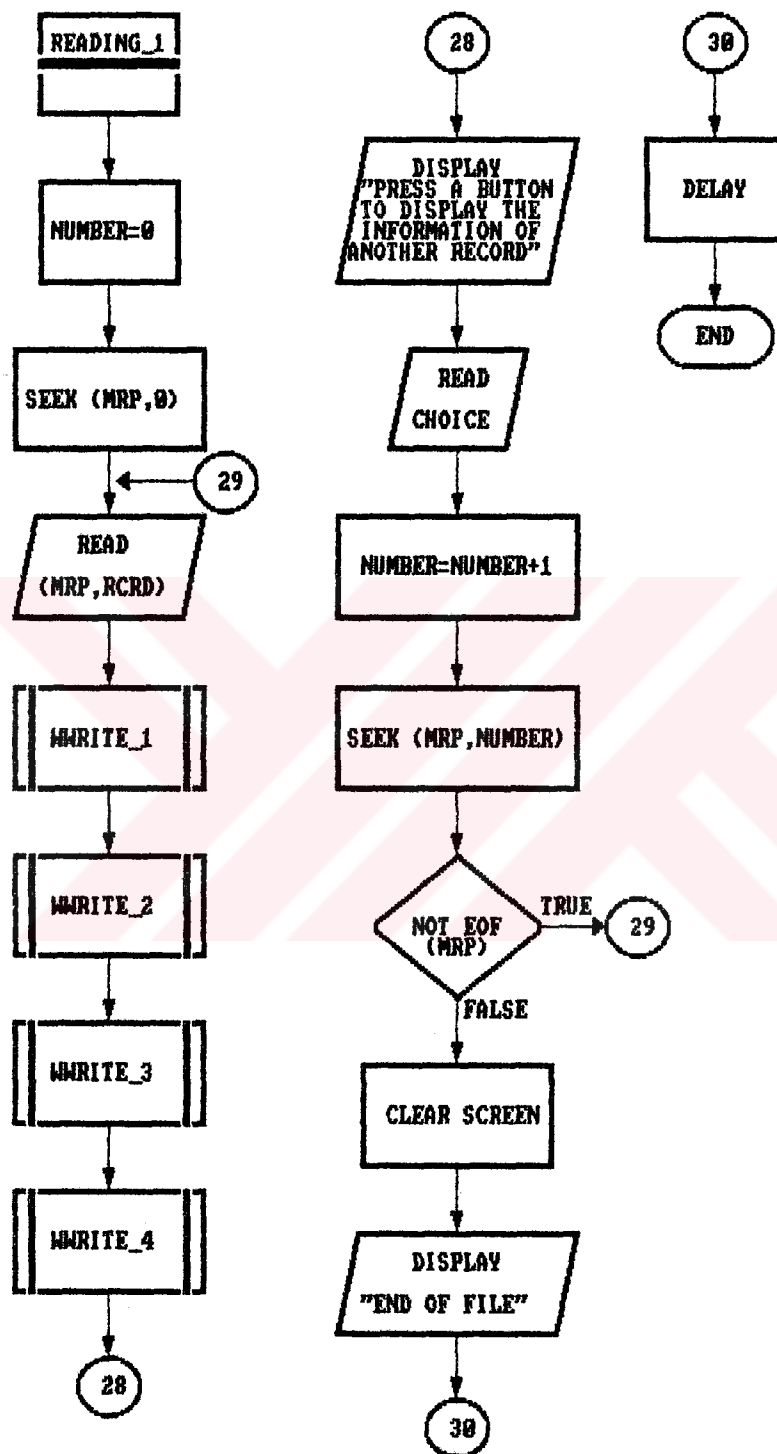
FLOWCHART OF THE PROCEDURE FILL_PROJECTED



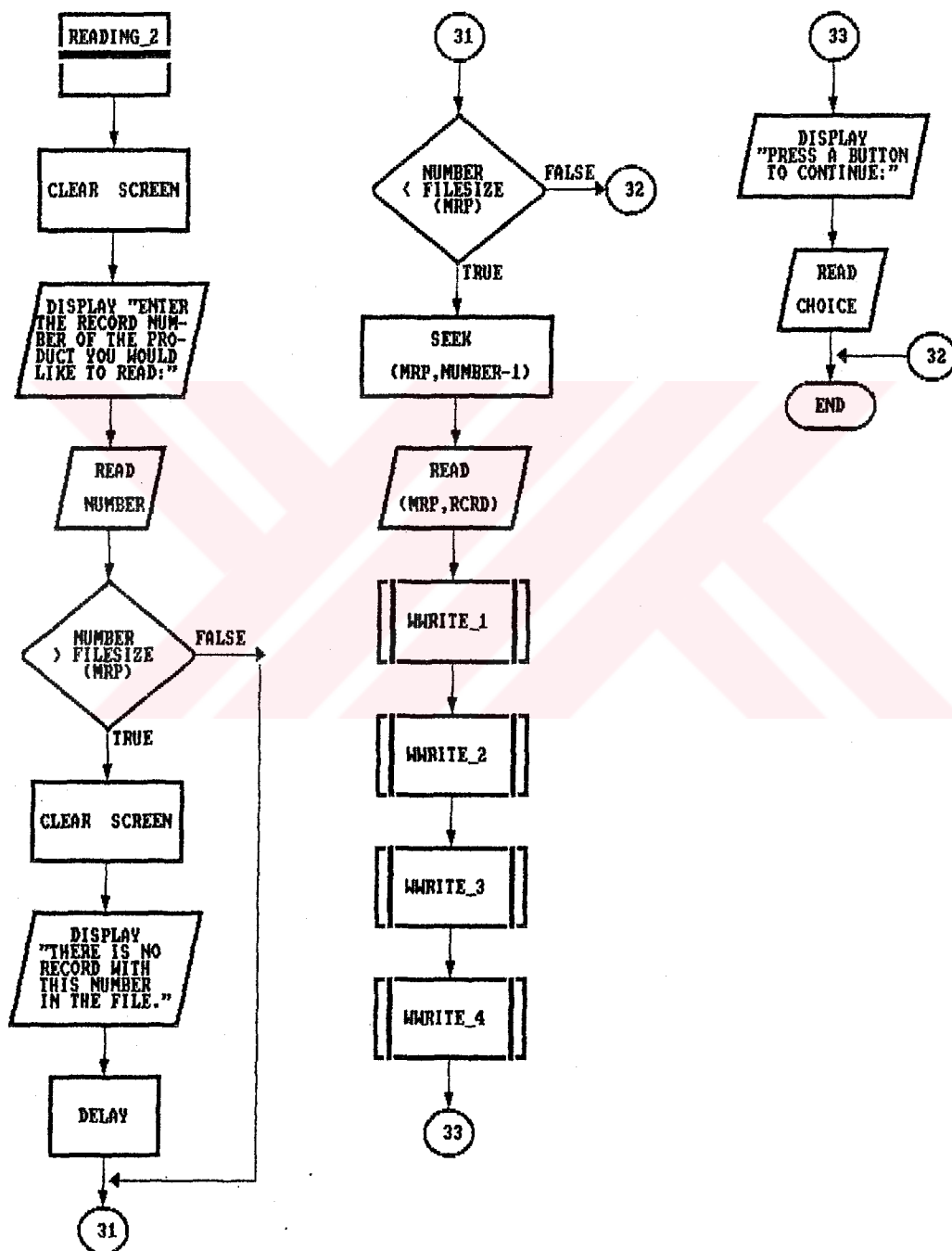
FLOWCHART OF THE PROCEDURE FILL_SCHEDULED



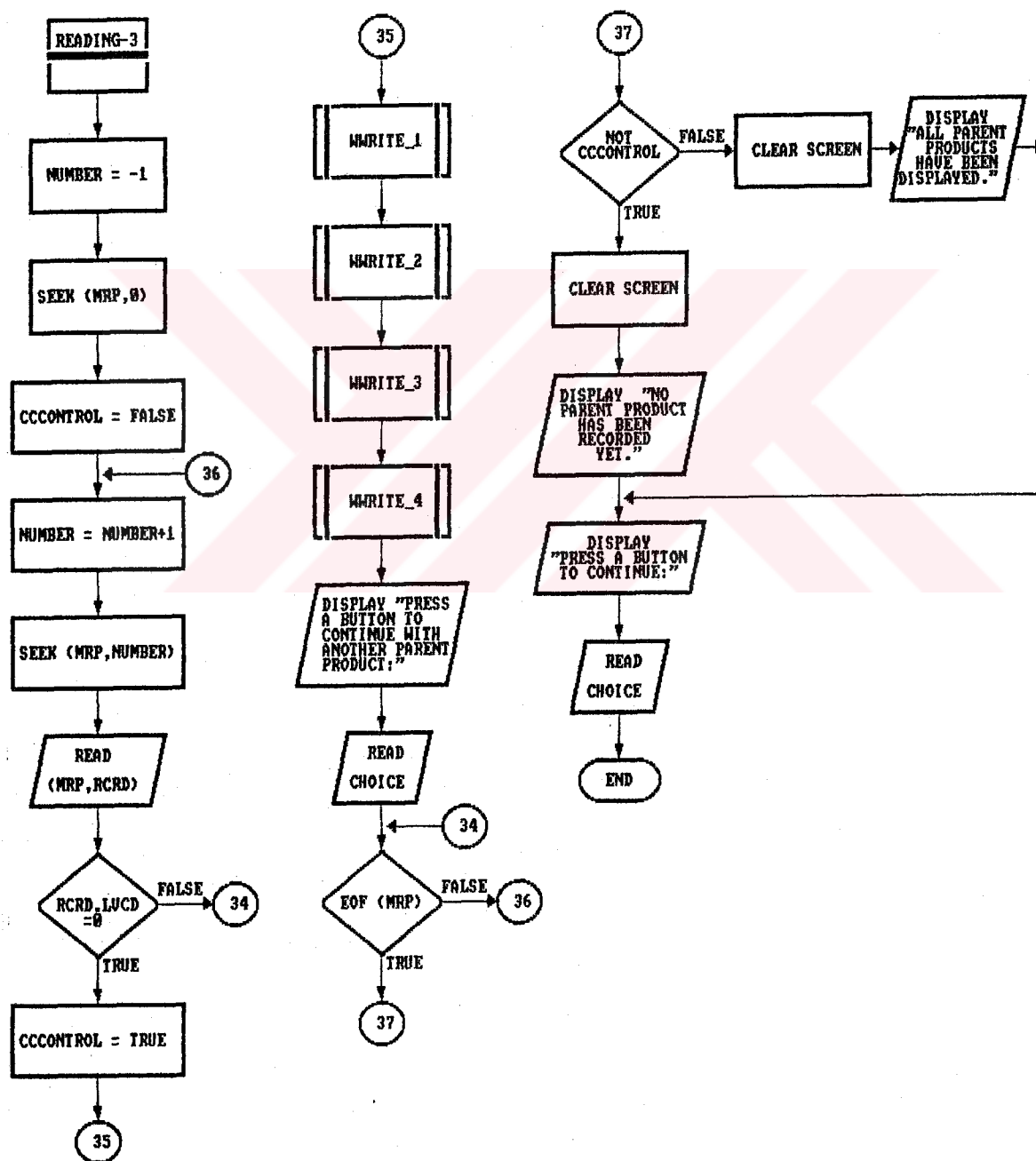
FLOWCHART OF THE PROCEDURE FILL_GROSS



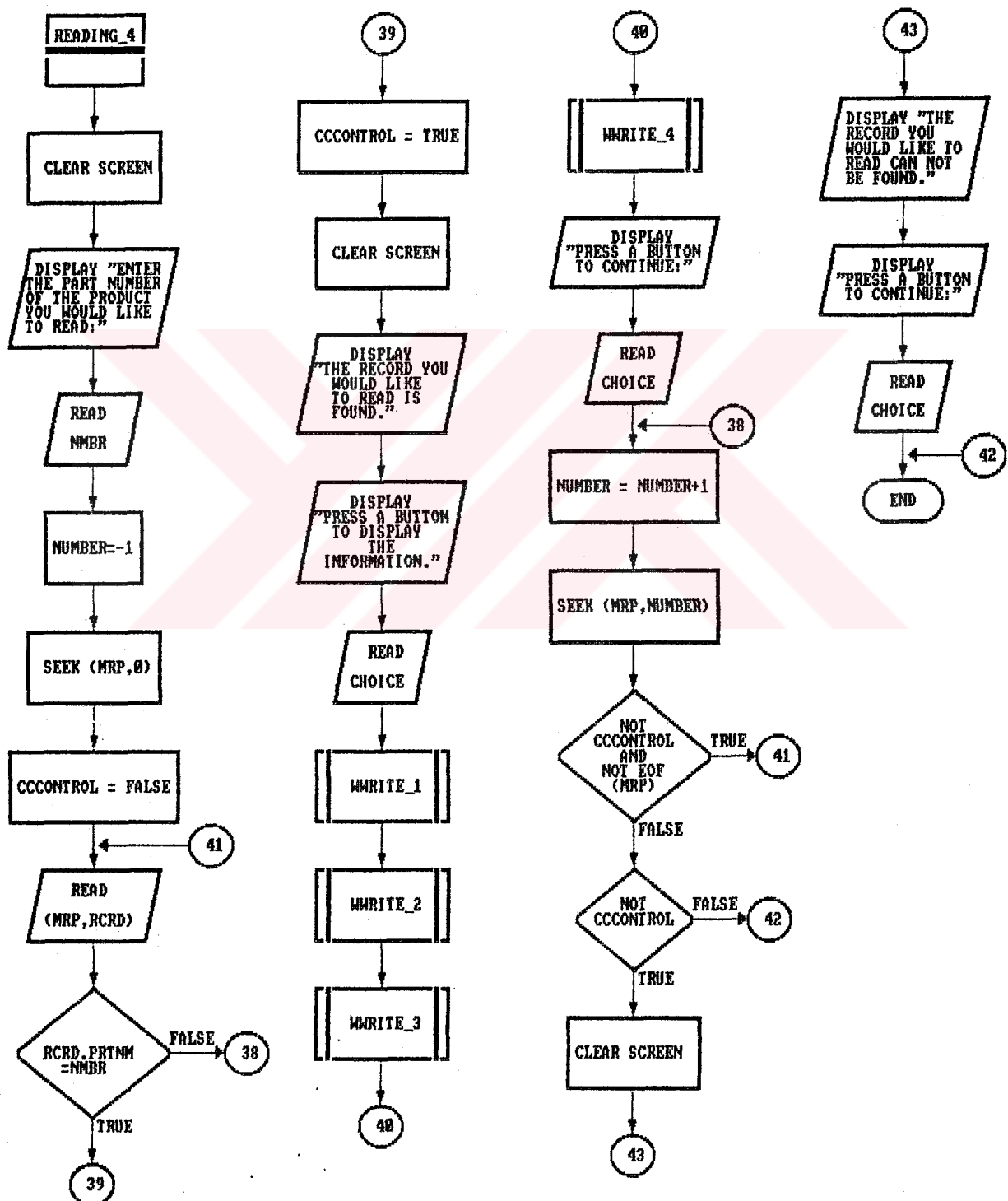
FLOWCHART OF THE PROCEDURE READING_1



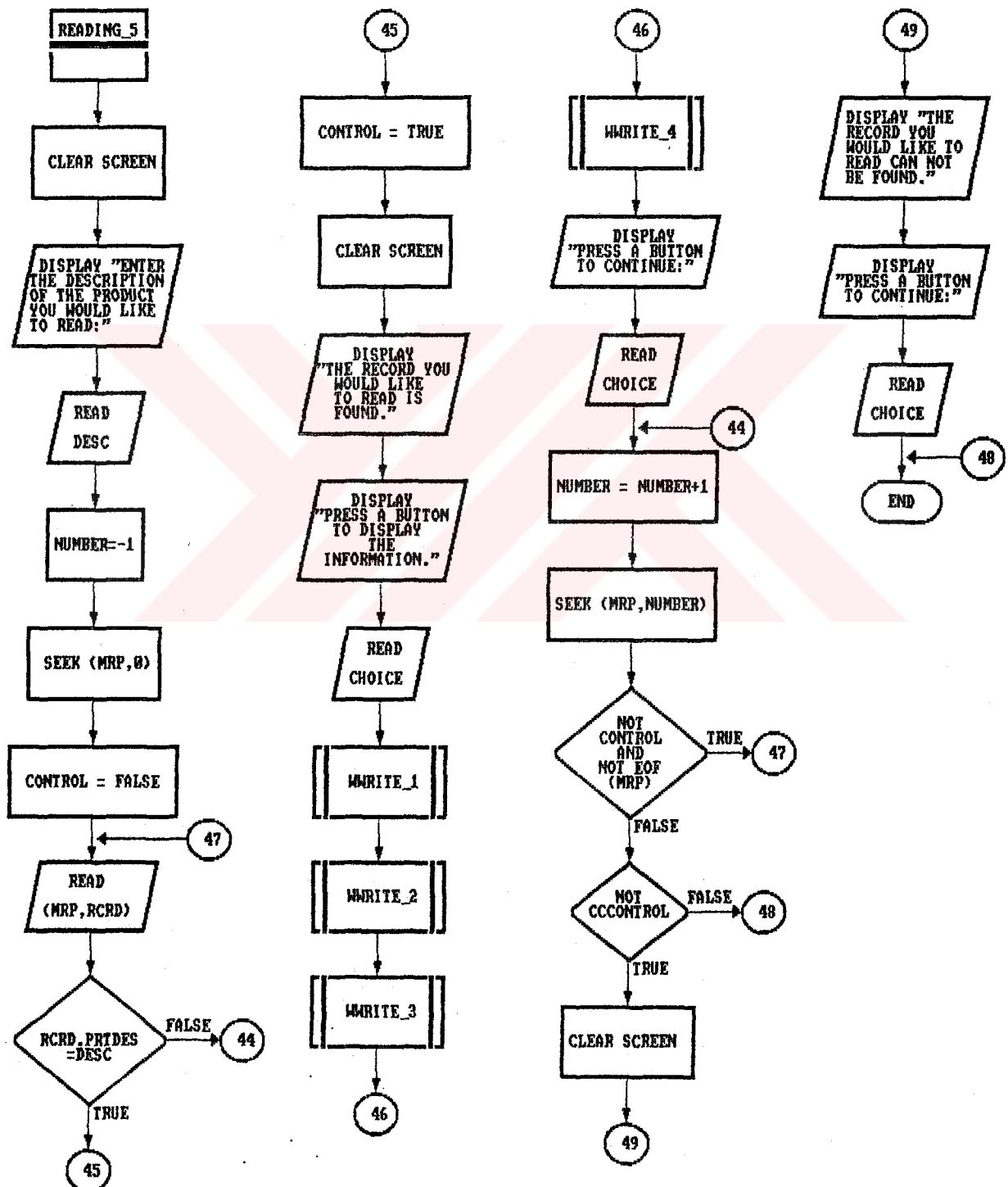
FLOWCHART OF THE PROCEDURE READING_2



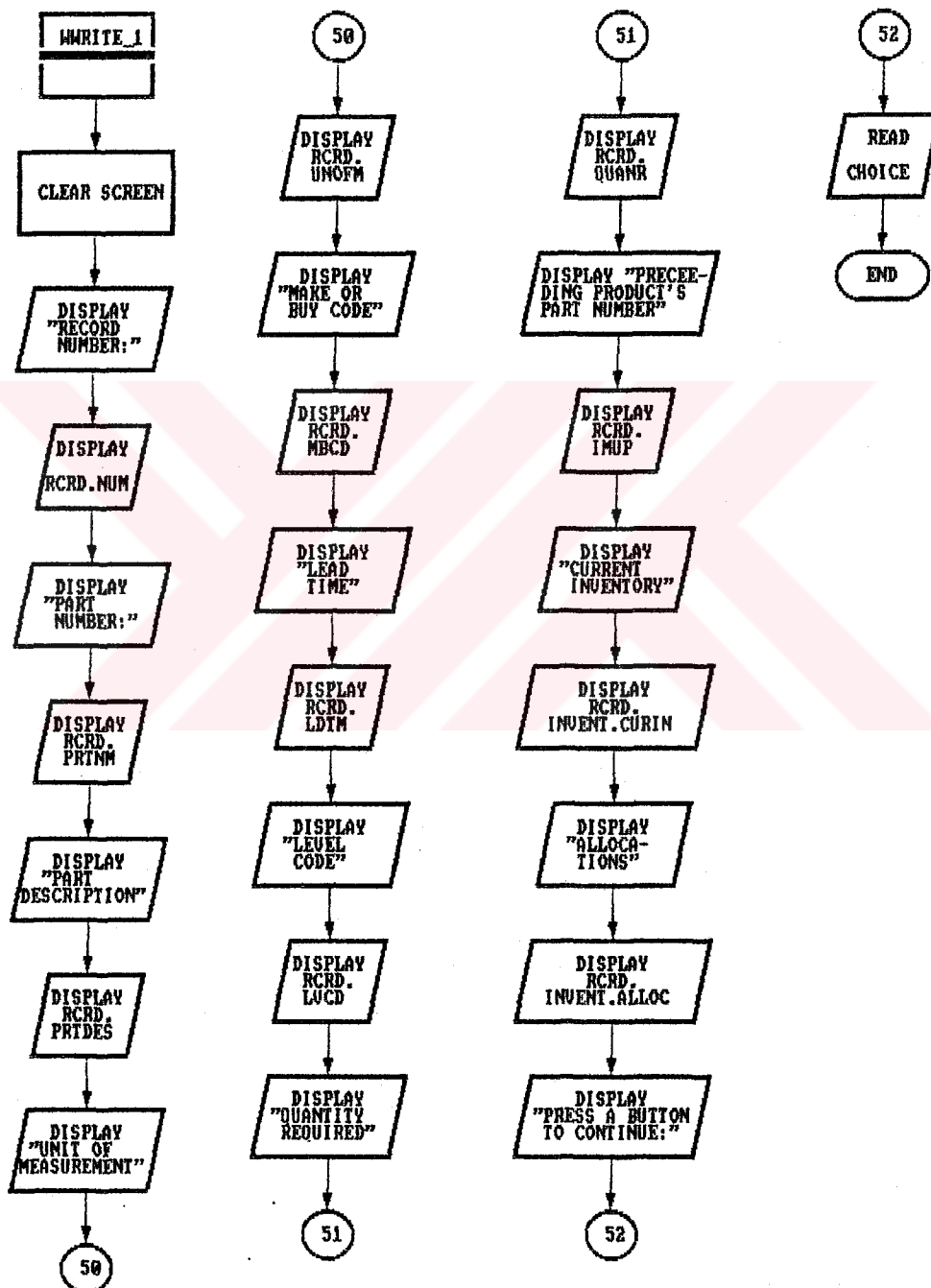
FLOWCHART OF THE PROCEDURE READING_3



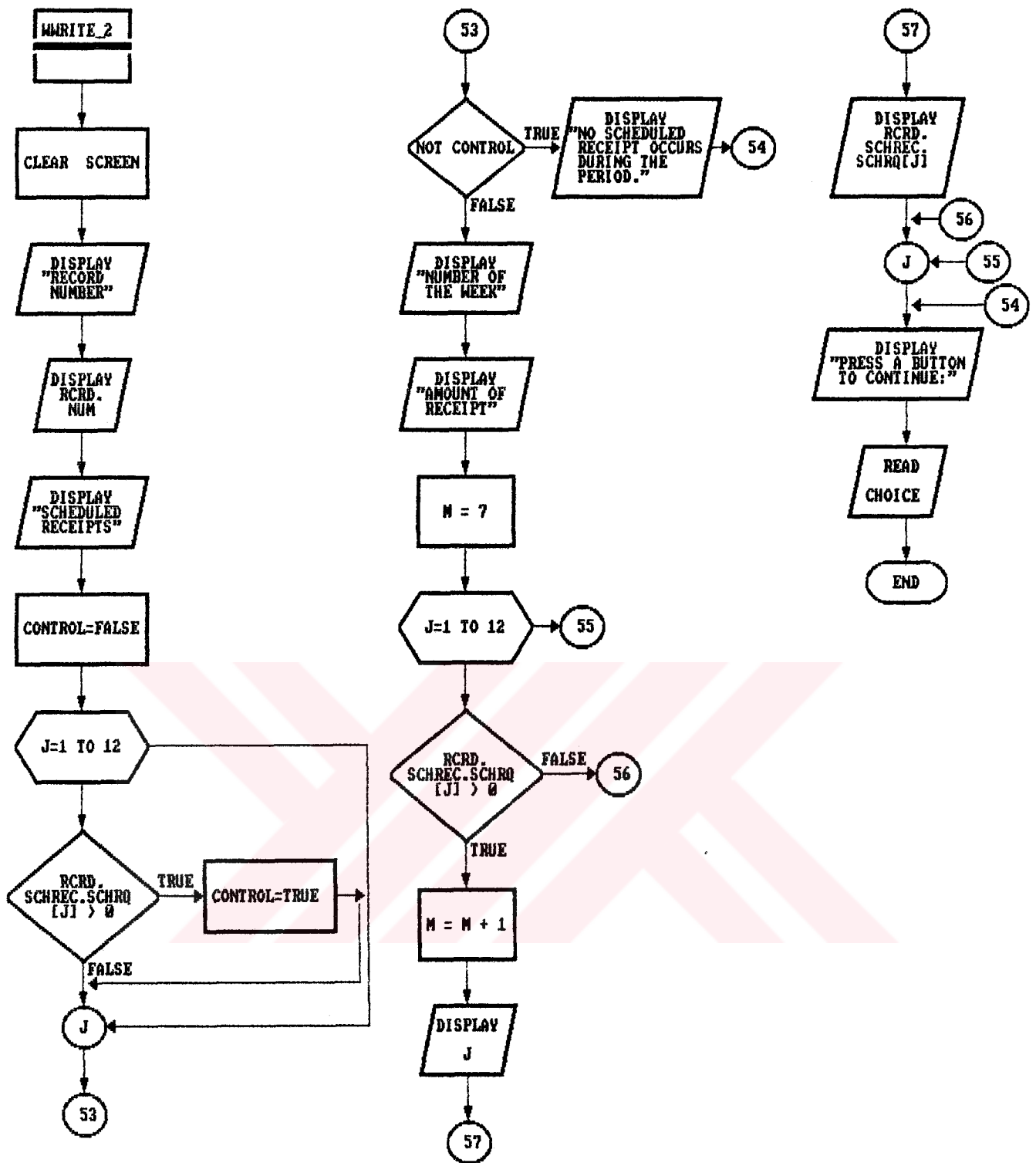
FLOWCHART OF THE PROCEDURE READING_4



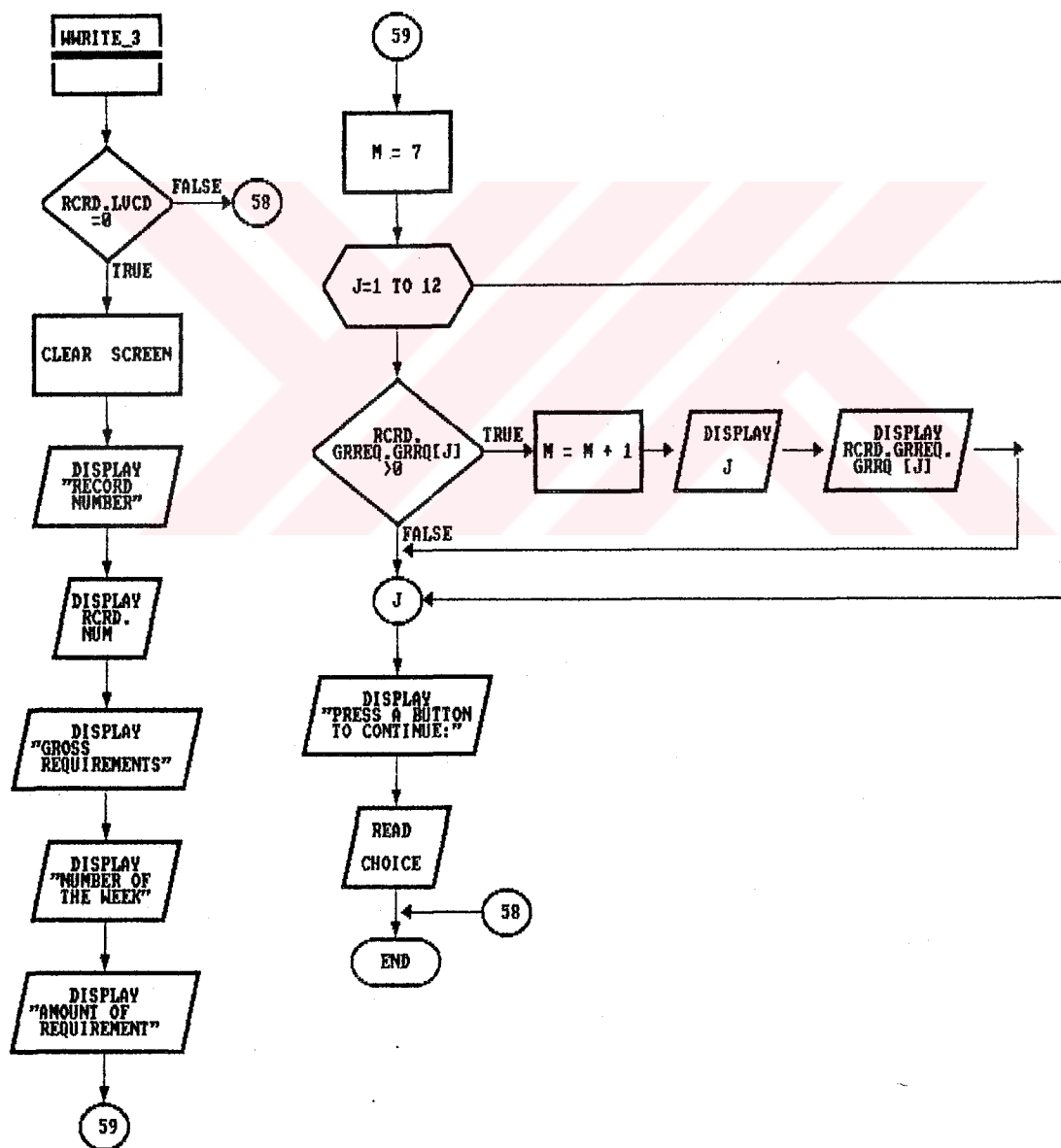
FLOWCHART OF THE PROCEDURE READING_5



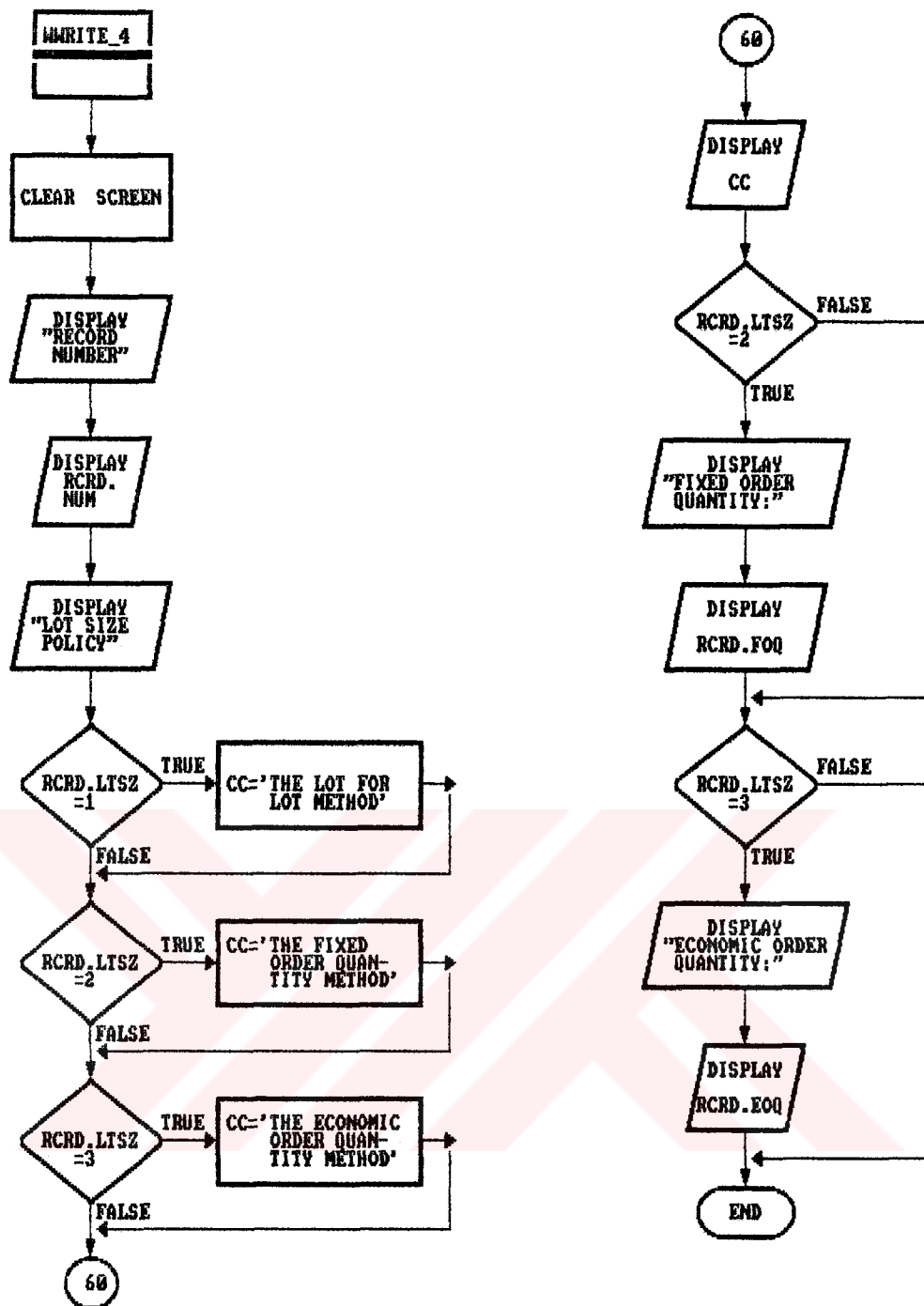
FLOWCHART OF THE PROCEDURE WWRITE_1



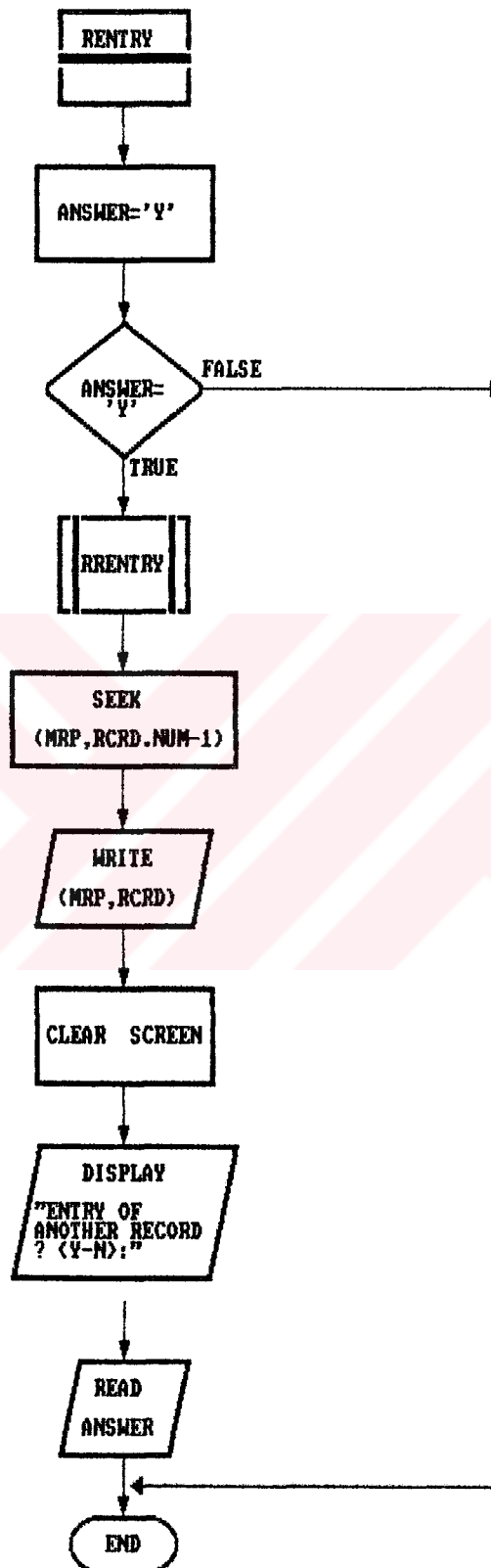
FLOWCHART OF THE PROCEDURE WWRITE_2



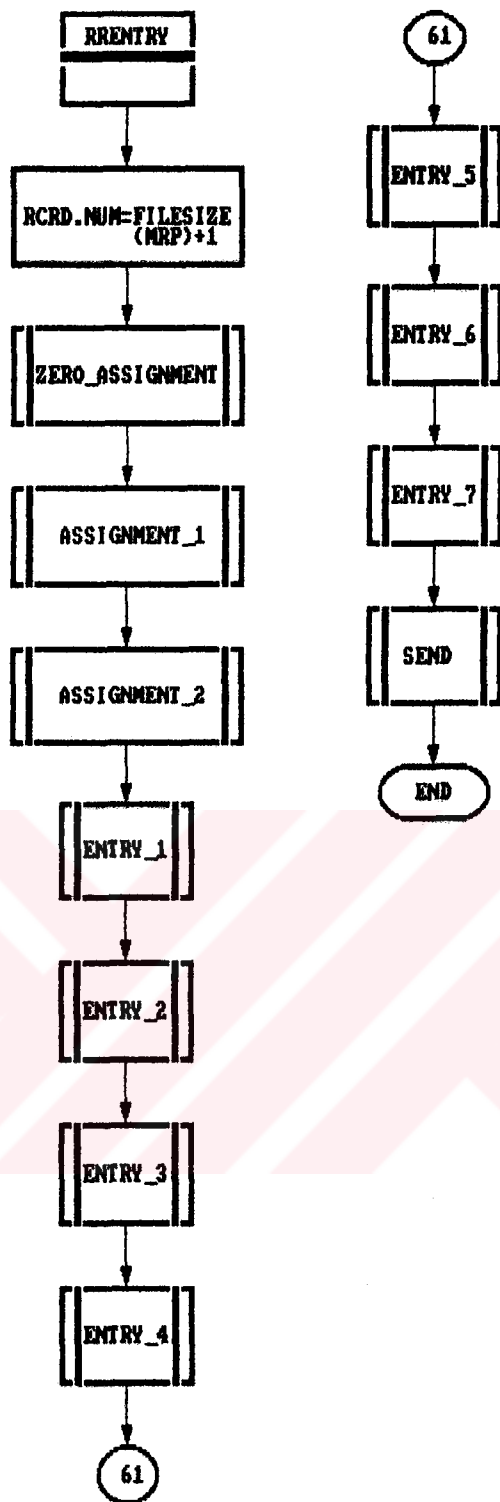
FLOWCHART OF THE PROCEDURE WWRITE_3



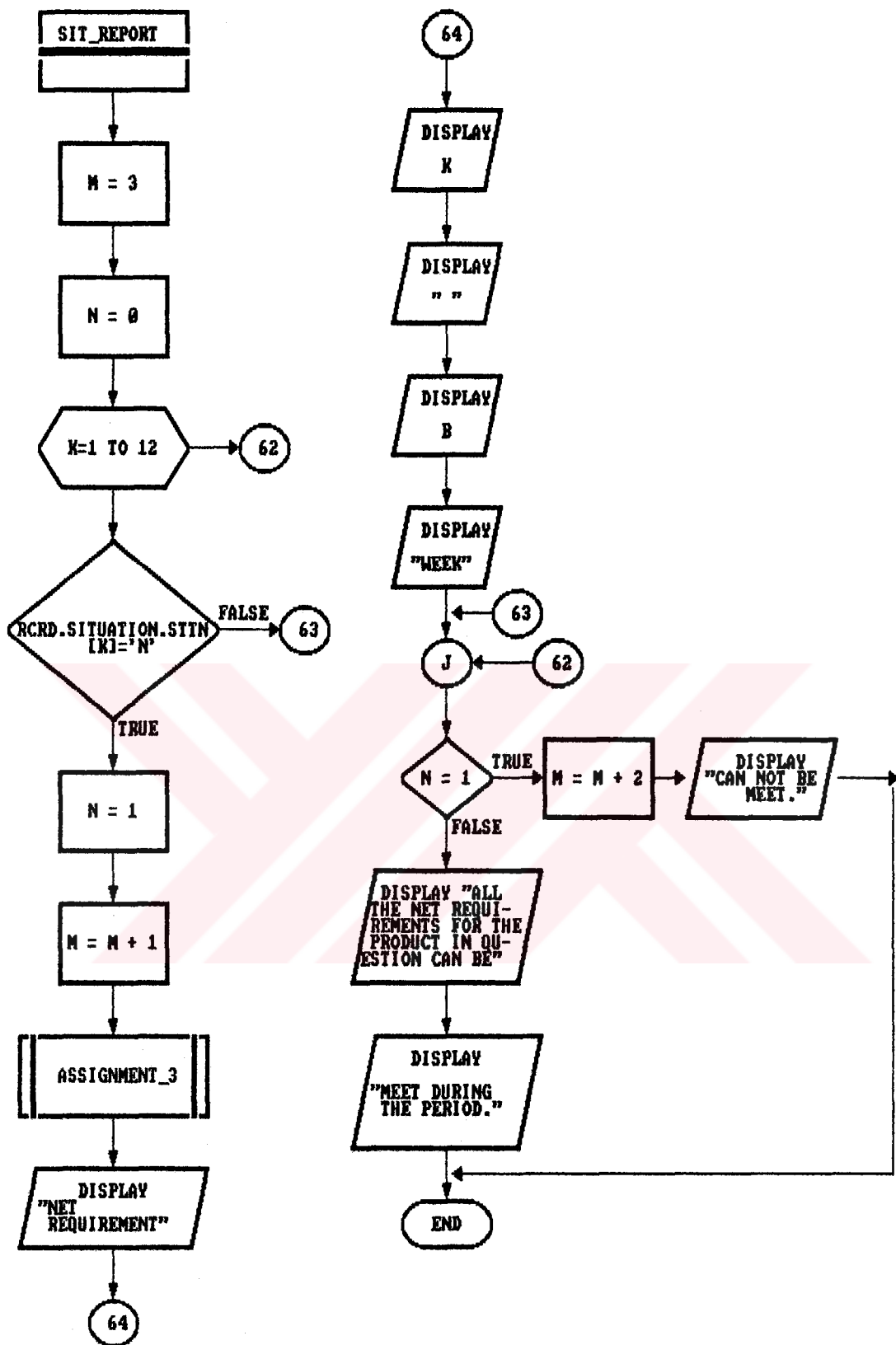
FLOWCHART OF THE PROCEDURE WWRITE_4



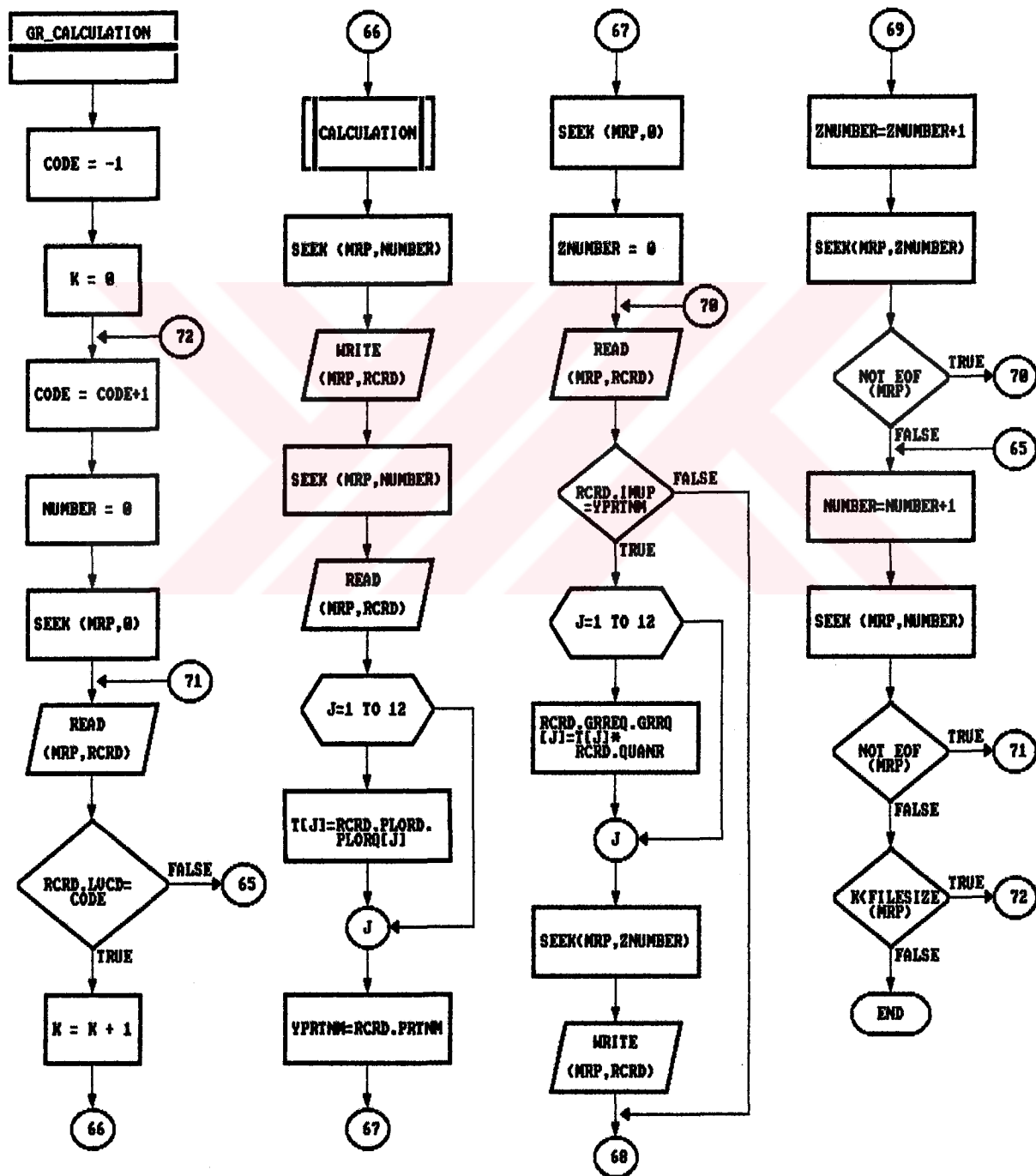
FLOWCHART OF THE PROCEDURE RENTRY



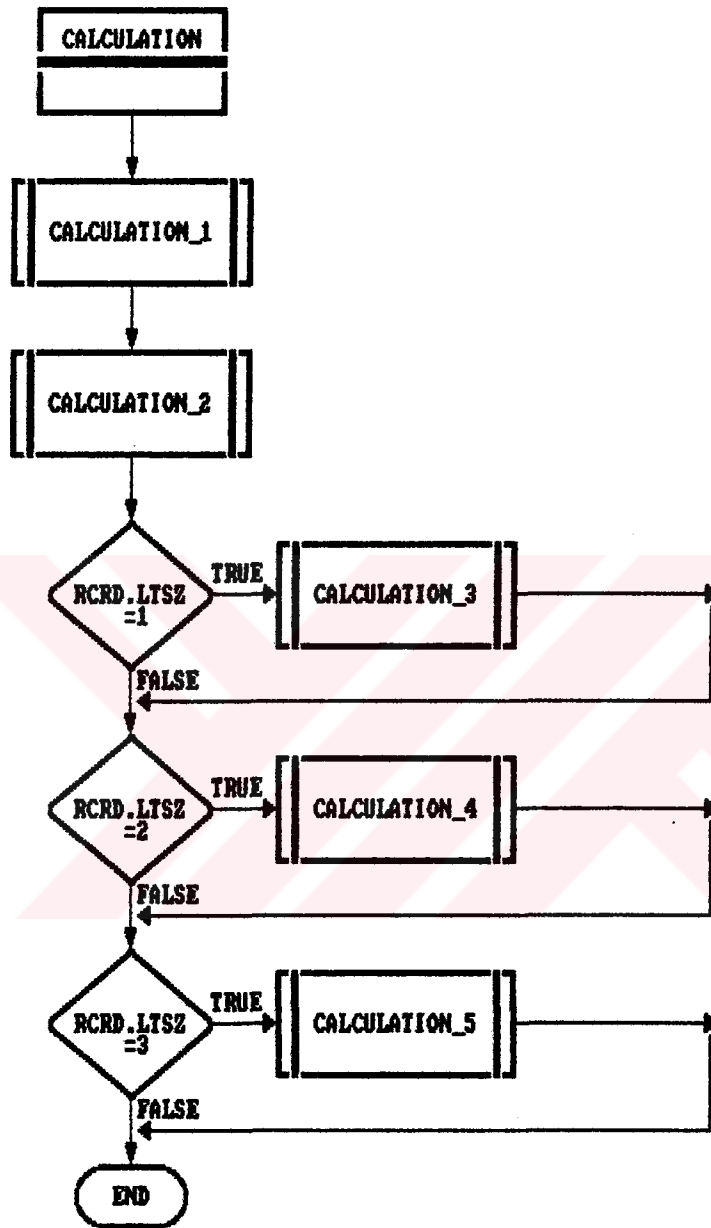
FLOWCHART OF THE PROCEDURE RRENTY



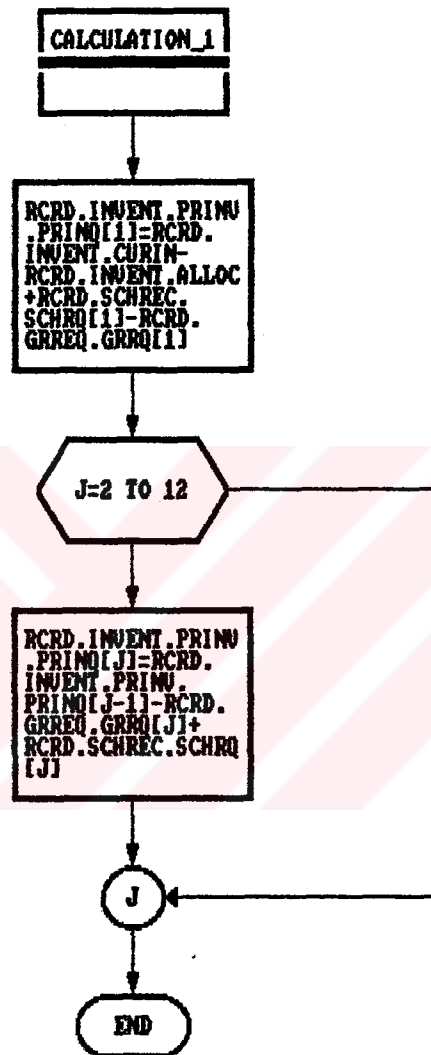
FLOWCHART OF THE PROCEDURE SIT_REPORT



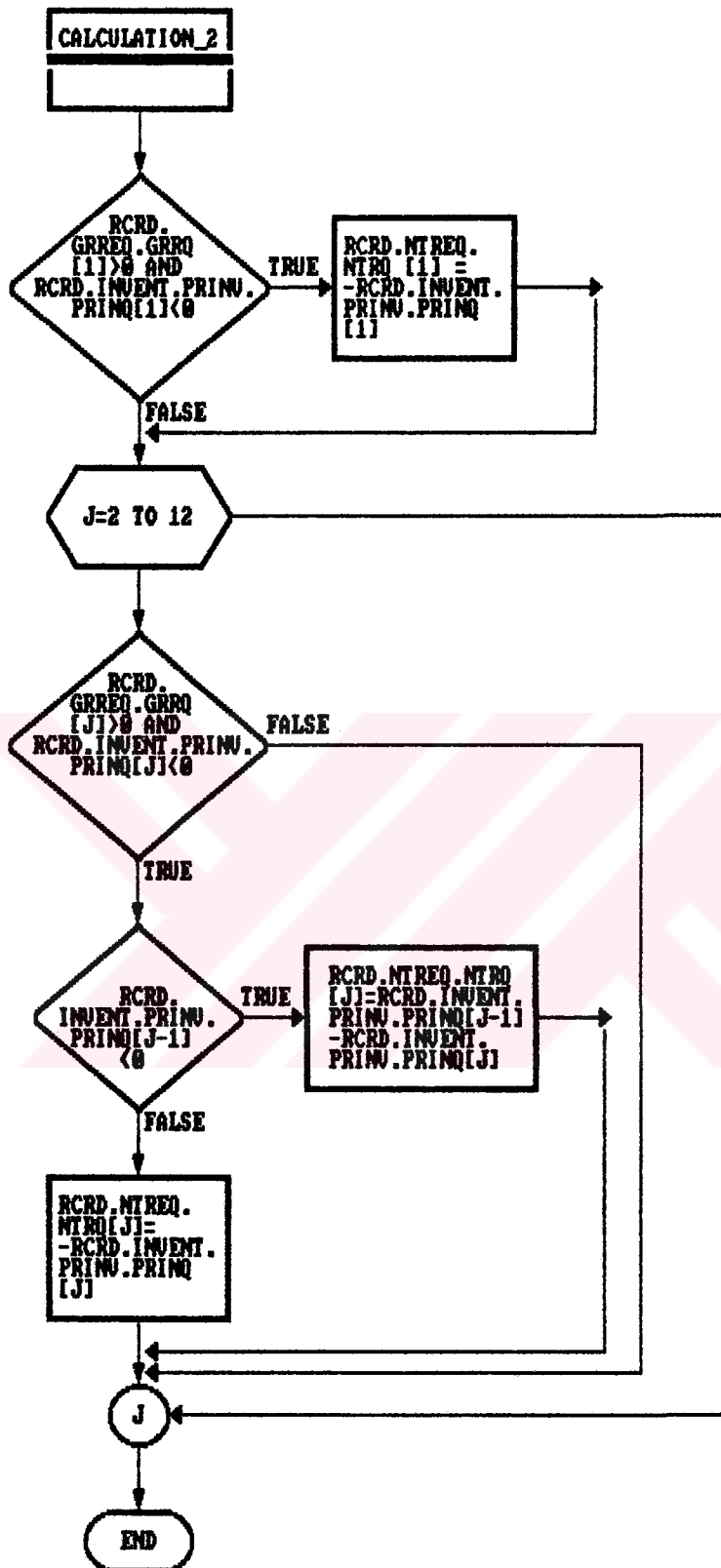
FLOWCHART OF THE PROCEDURE GR_CALCULATION



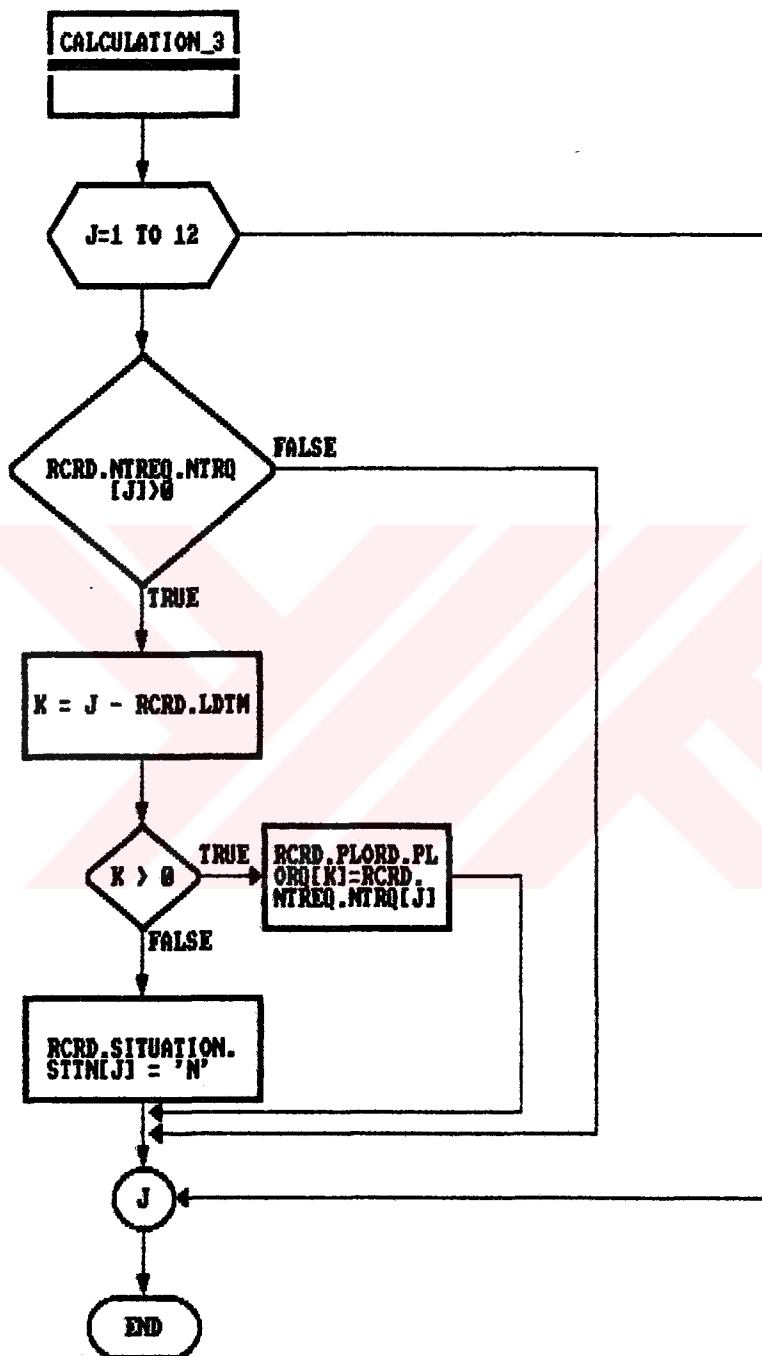
FLOWCHART OF THE PROCEDURE CALCULATION



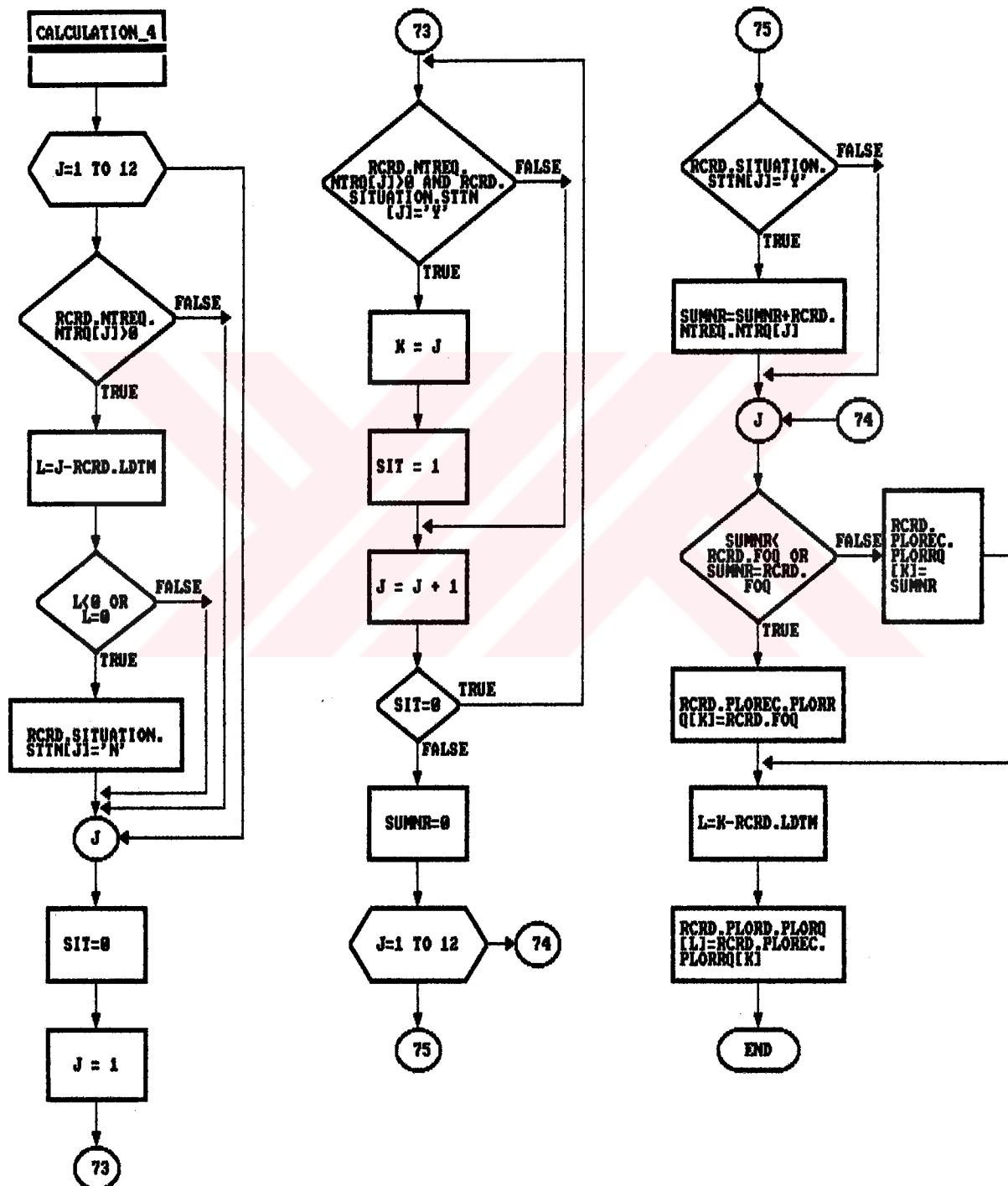
FLOWCHART OF THE PROCEDURE CALCULATION_1



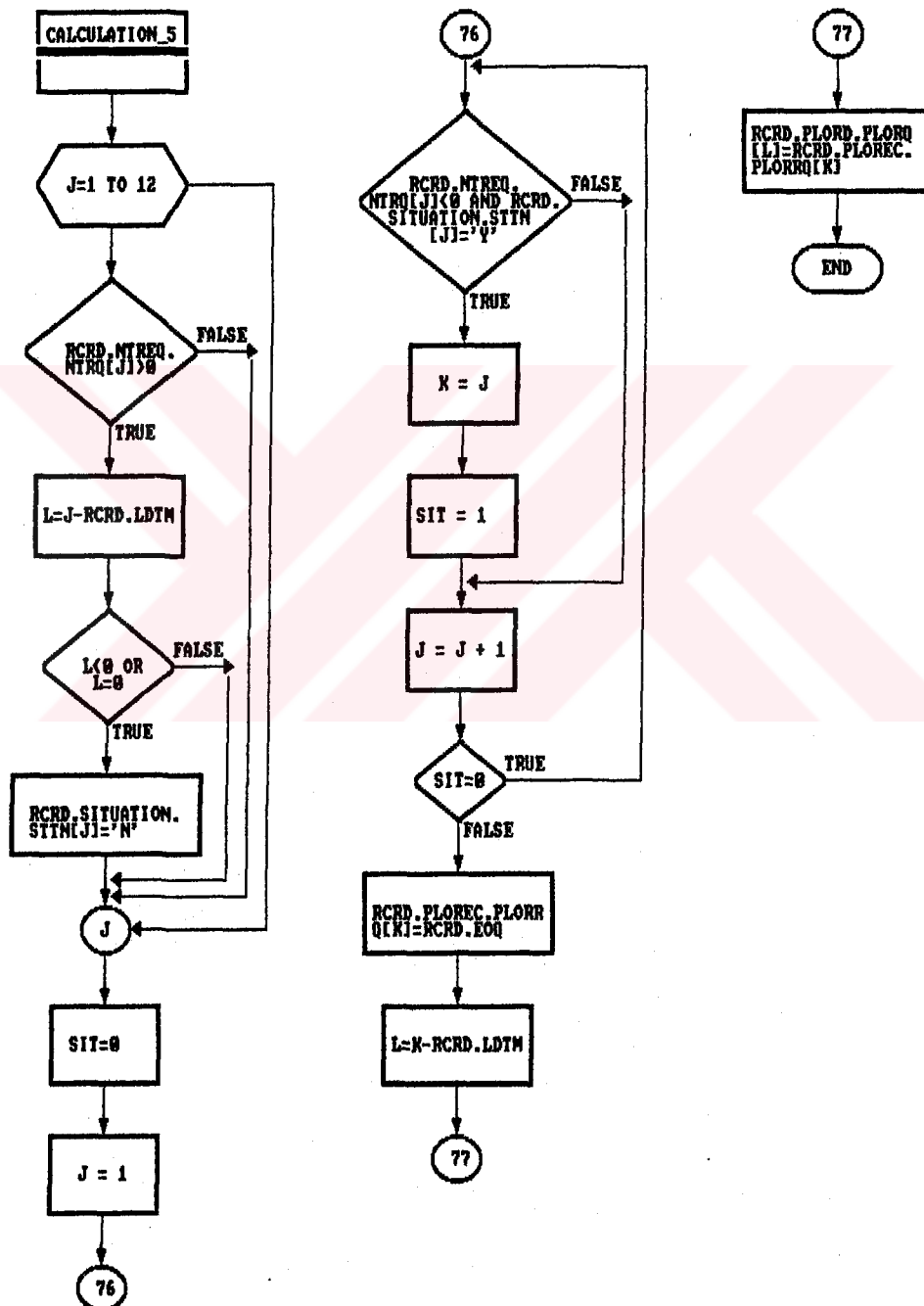
FLOWCHART OF THE PROCEDURE CALCULATION_2



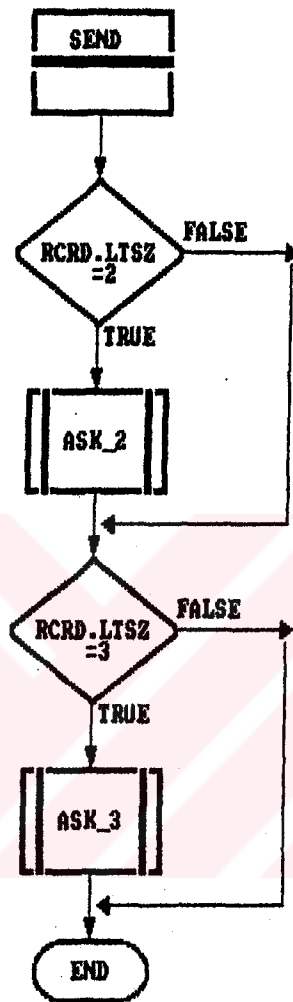
FLOWCHART OF THE PROCEDURE CALCULATION_3



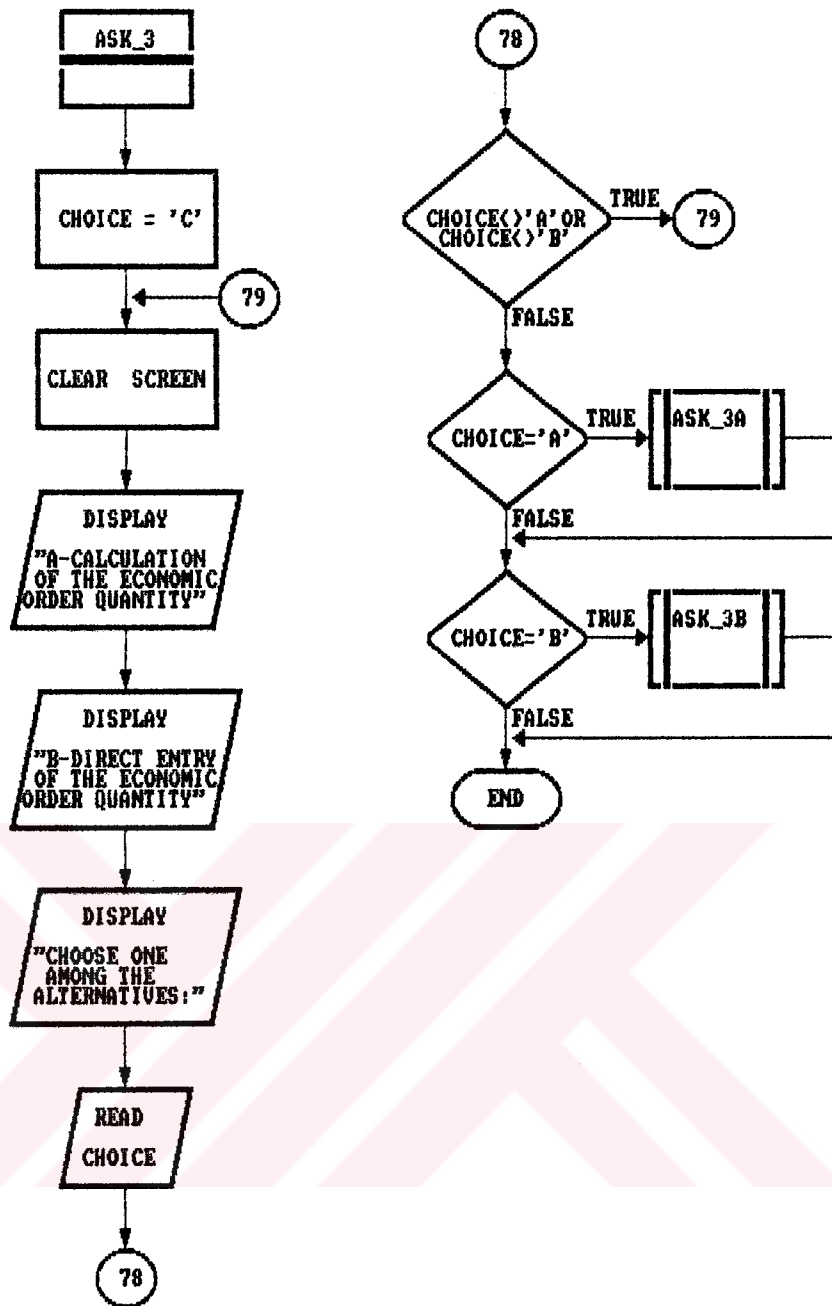
FLOWCHART OF THE PROCEDURE CALCULATION_4



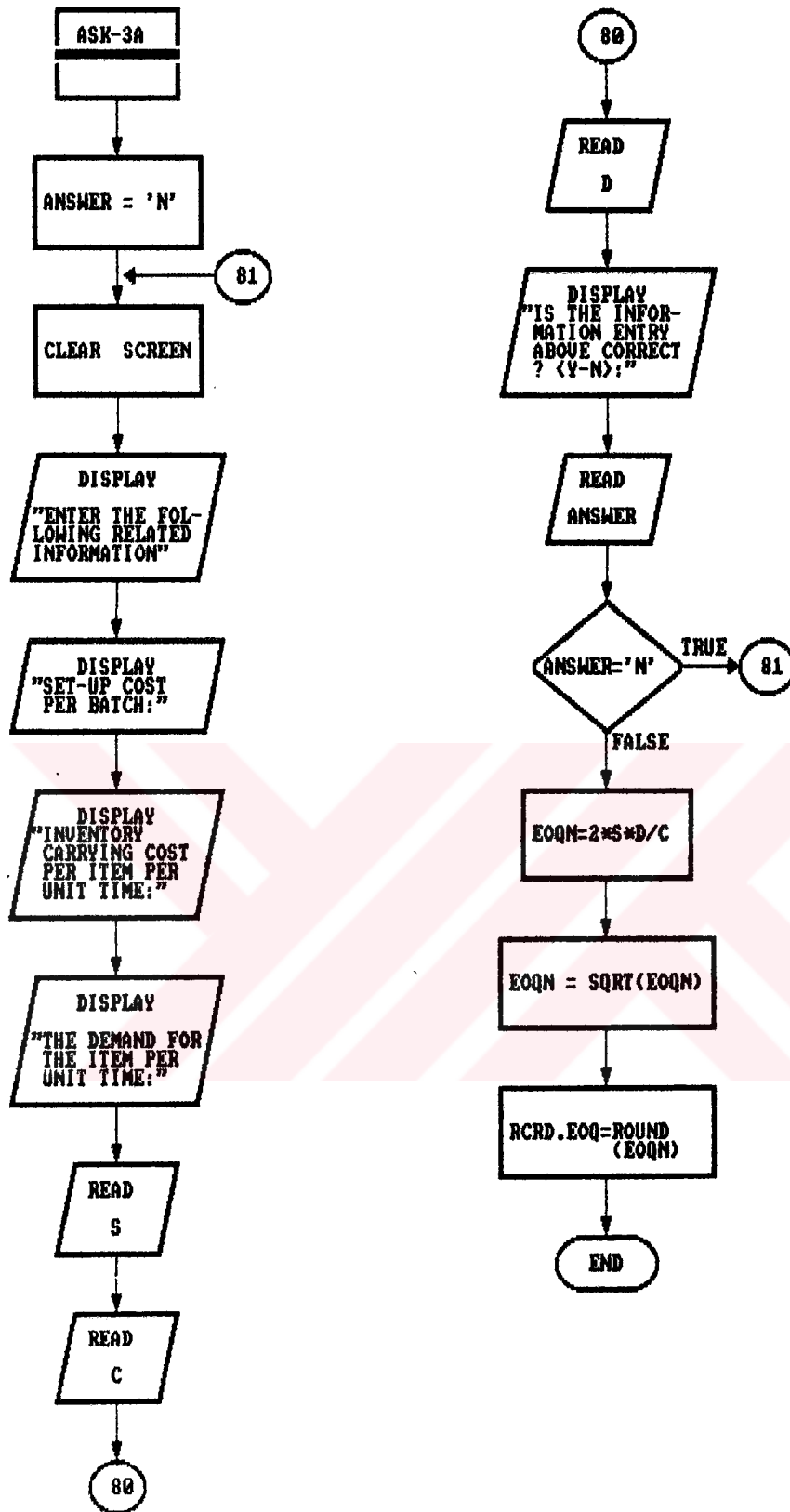
FLOWCHART OF THE PROCEDURE CALCULATION_5



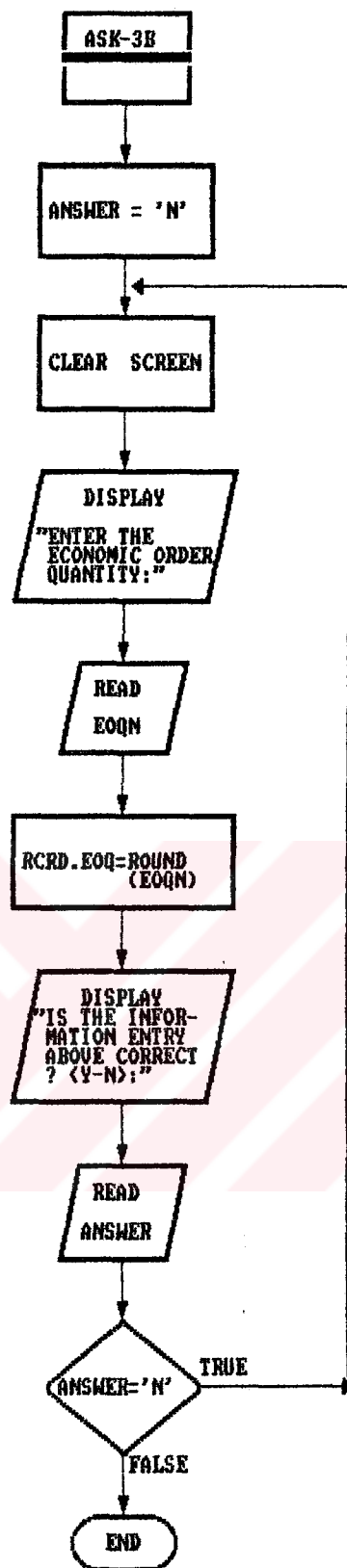
FLOWCHART OF THE PROCEDURE SEND



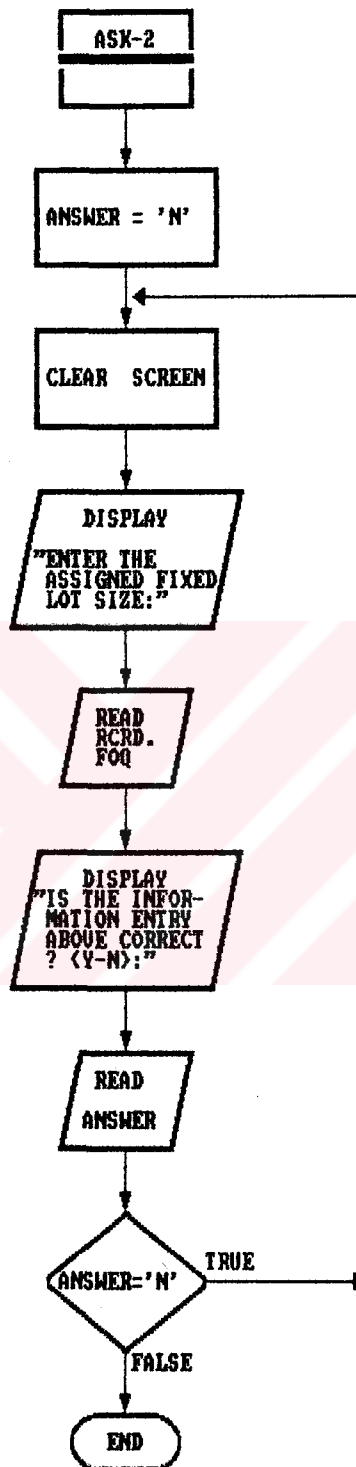
FLOWCHART OF THE PROCEDURE ASK_3



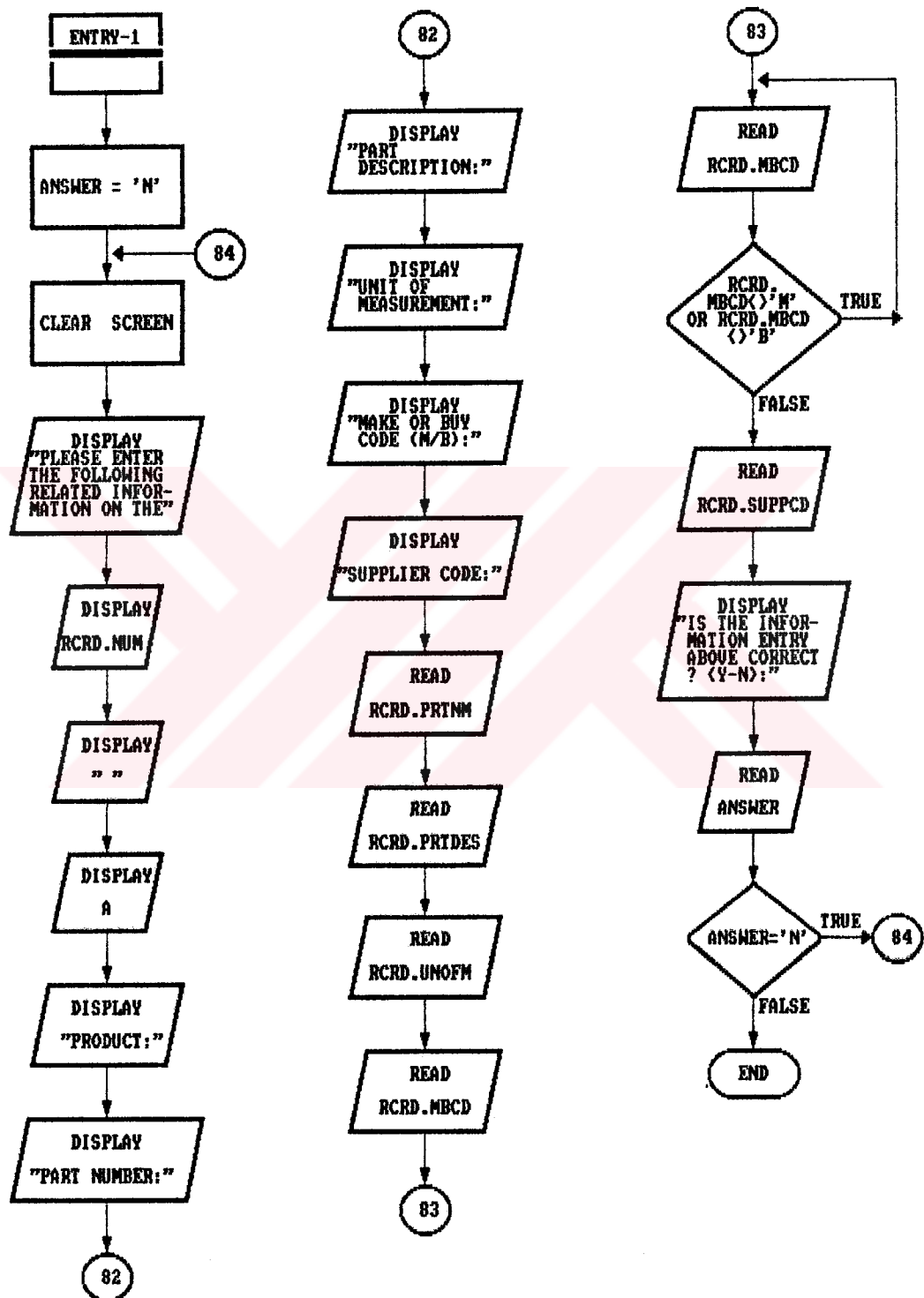
FLOWCHART OF THE PROCEDURE ASK_3A



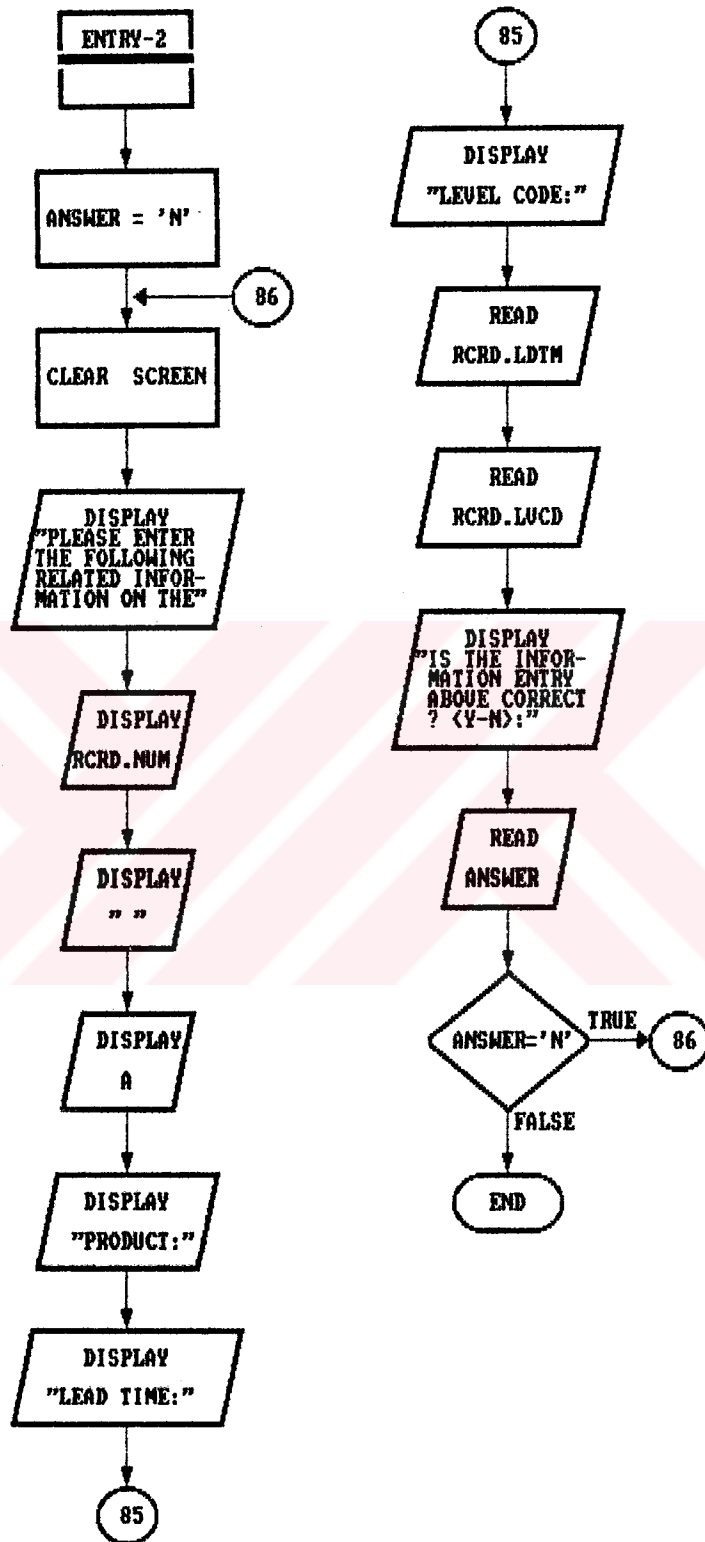
FLOWCHART OF THE PROCEDURE ASK_3B



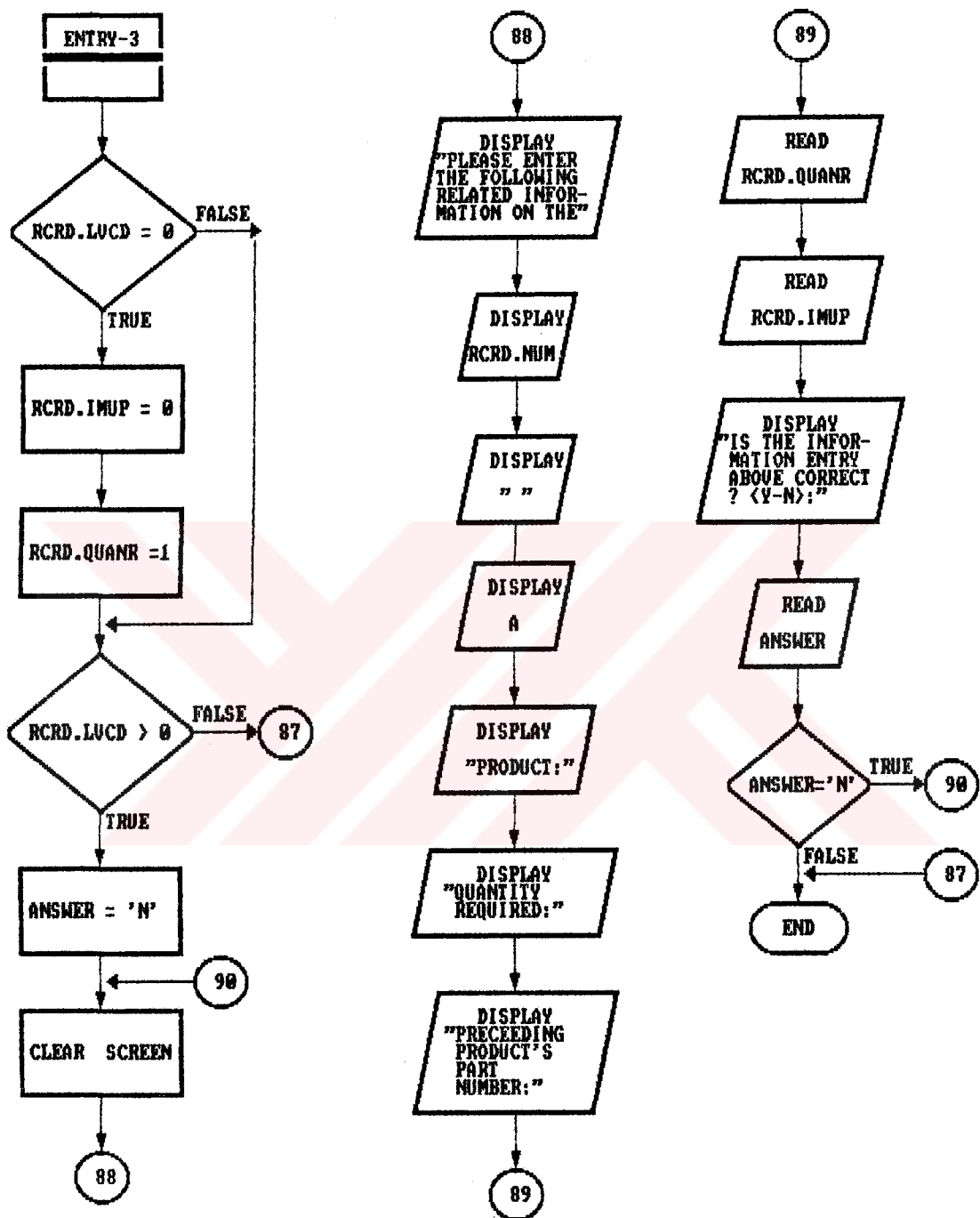
FLOWCHART OF THE PROCEDURE ASK_2



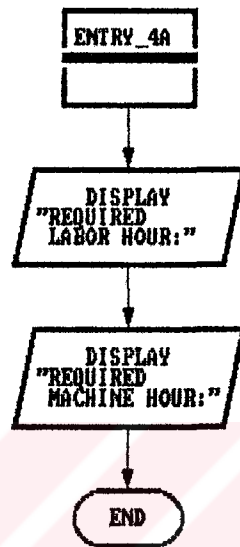
FLOWCHART OF THE PROCEDURE ENTRY_1



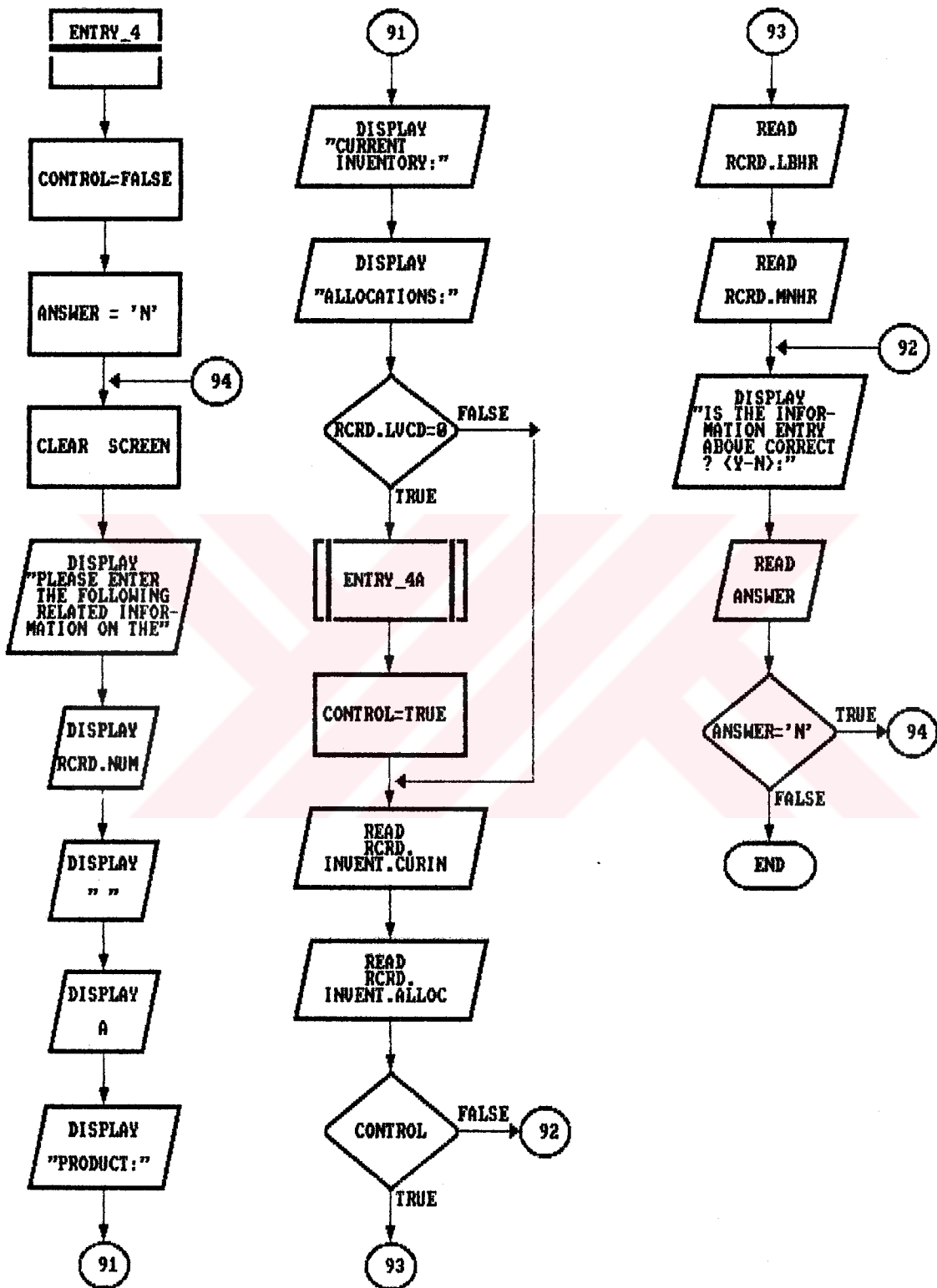
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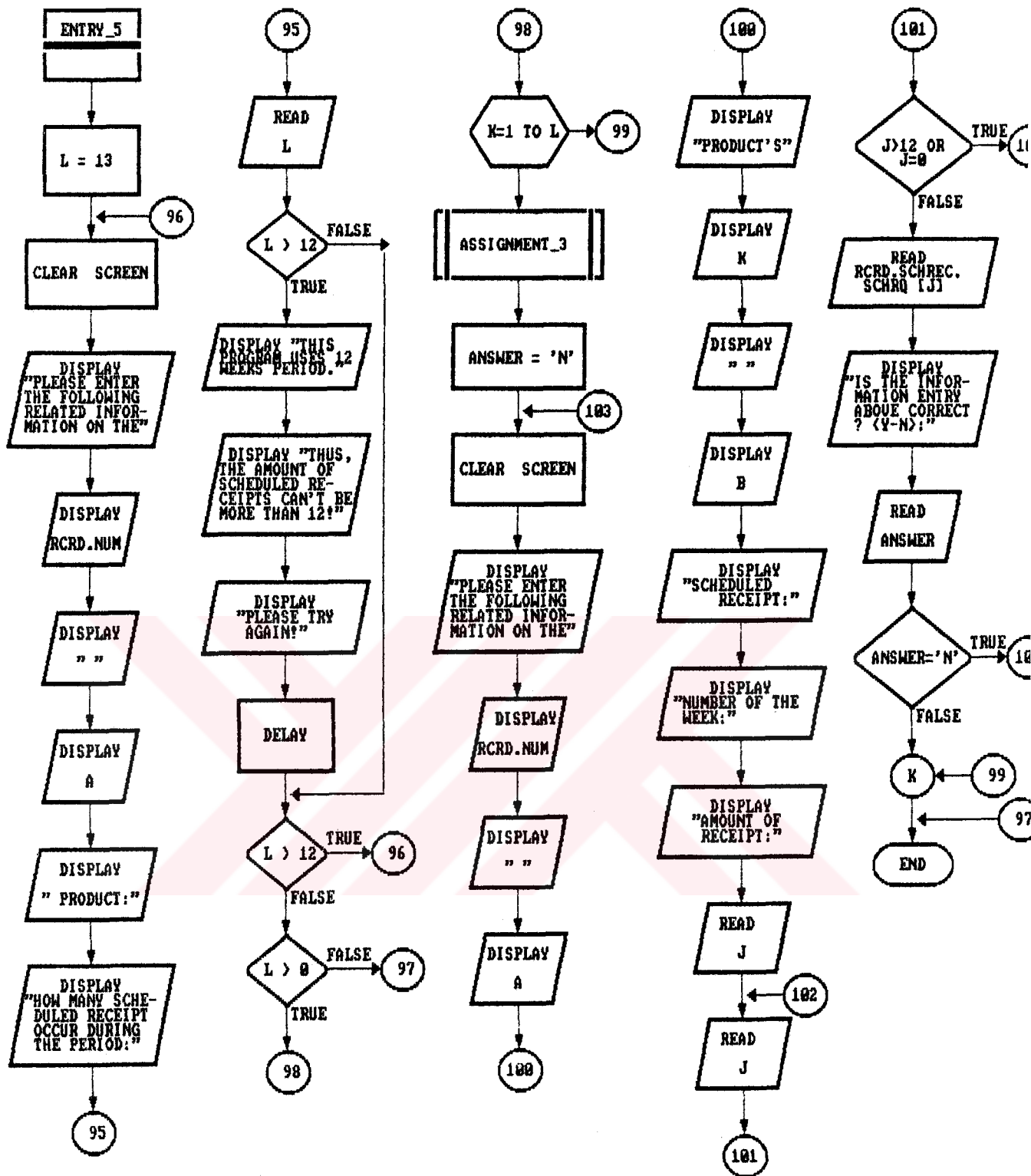
FLOWCHART OF THE PROCEDURE ENTRY_3



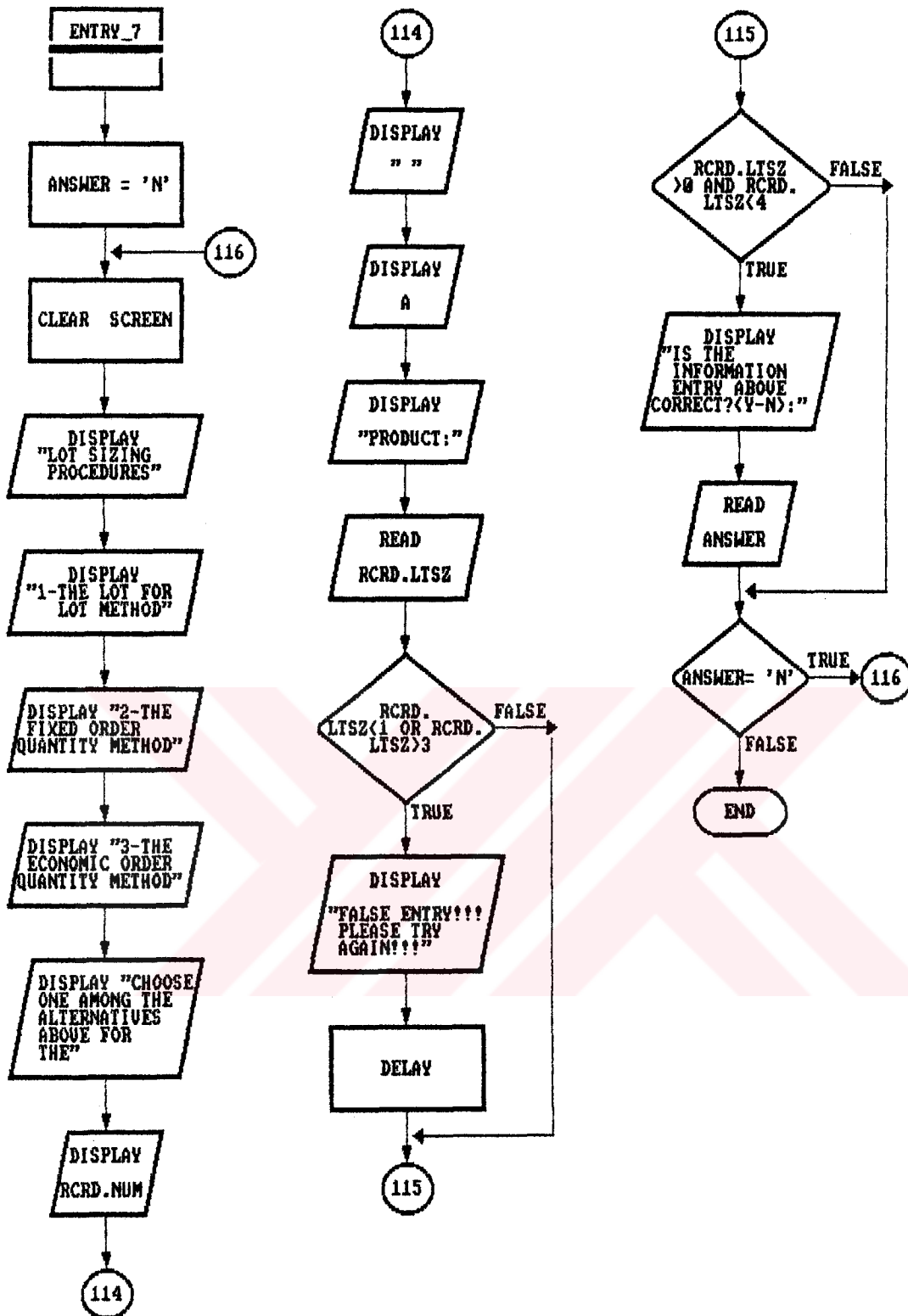
FLOWCHART OF THE PROCEDURE ENTRY_4A



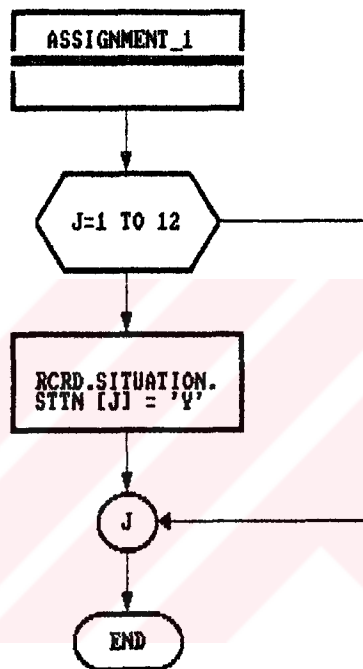
FLOWCHART OF THE PROCEDURE ENTRY_4A



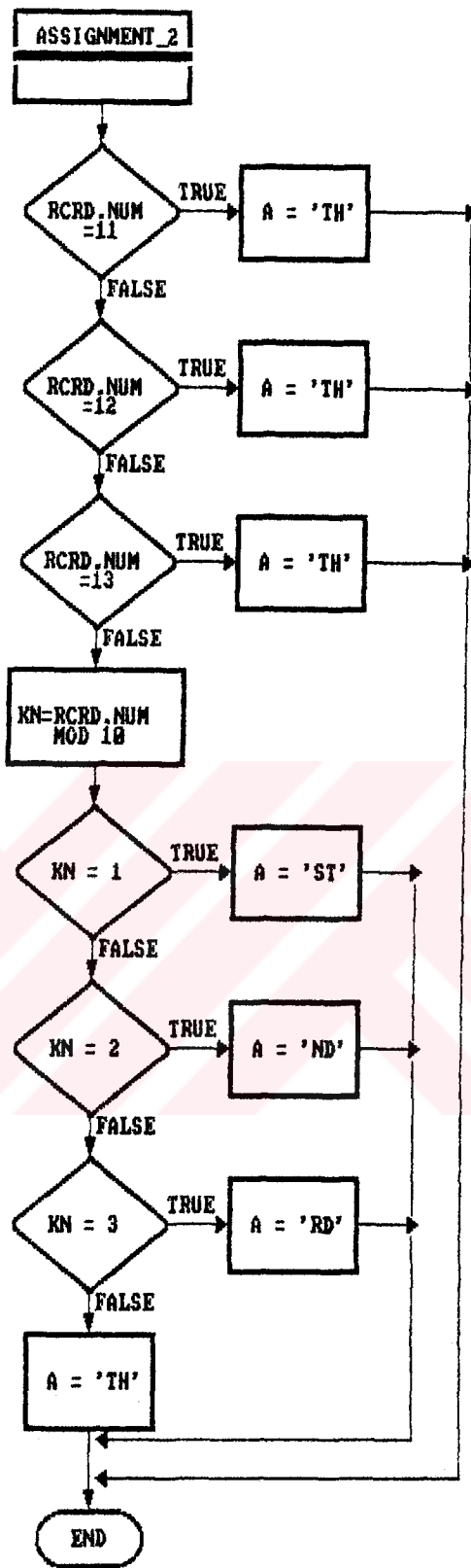
FLOWCHART OF THE PROCEDURE ENTRY_5



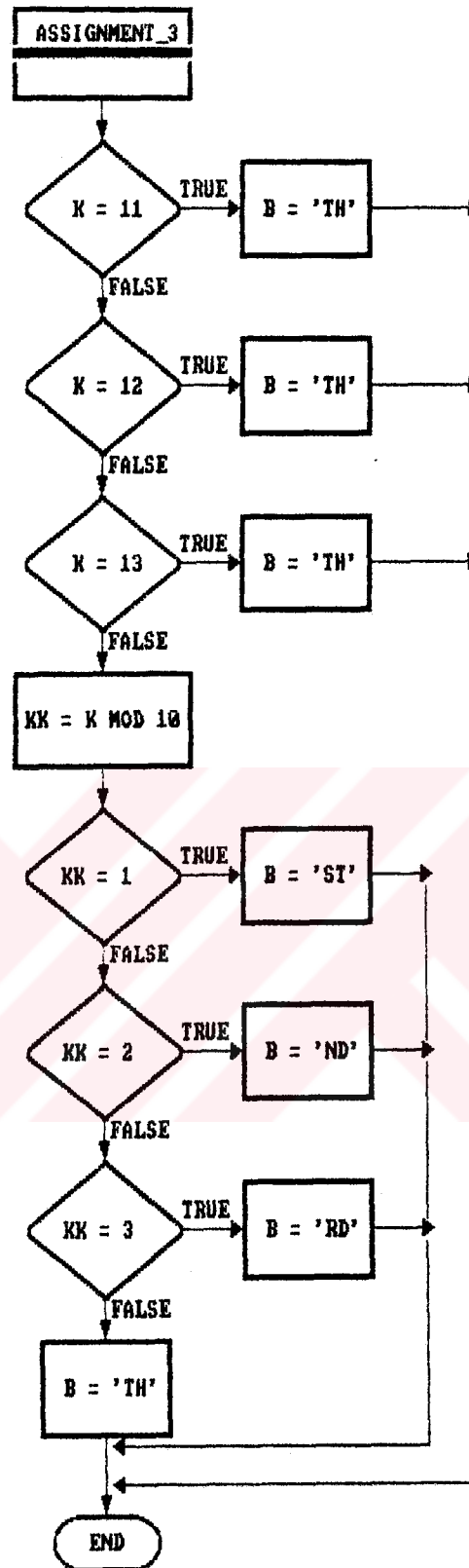
FLOWCHART OF THE PROCEDURE ENTRY_7



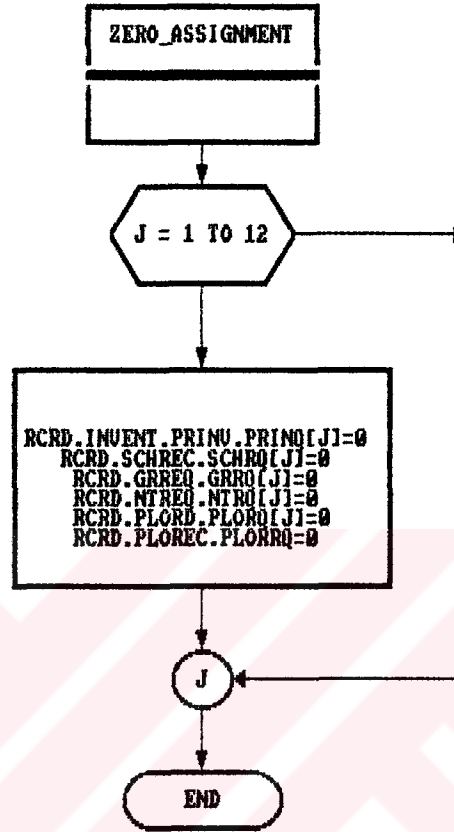
FLOWCHART OF THE PROCEDURE ASSIGNMENT_1



FLOWCHART OF THE PROCEDURE ASSIGNMENT_2



FLOWCHART OF THE PROCEDURE ASSIGNMENT_3



FLOWCHART OF THE PROCEDURE ZERO_ASSIGNMENT