T-4181

AN APPLICATION OF PROBABILISTIC INVENTORY ANALYSIS, ECONOMIC EVALUATION AND COMMON SENSE, TO AN EXISTING FACILITY

by

Brian W. Lauritzen

T-4181

A thesis submitted to the Faculty and board of Trustees of the Colorado School of Mines in partial fulfillment of the requirements for the degree of Master of Science (Mathematics).

Golden, Colorado

Date 10 MAR 92

Signed: Brian W. Lauritzen
Brian W. Lauritzen

Approved: R.E.D. Woolsey
Dr. R.E.D. Woolsey
Thesis Advisor

Golden, Colorado

Date 3\10\92

Ardel J. Boes
Dr. Ardel J. Boes
Professor and Head,
Department of Mathematics

ABSTRACT

Determining proper inventory levels is a very real concern for many organizations. The derivation of appropriate levels is made considerably more complex under conditions of uncertain demand. Regardless of the algorithm chosen to assist in the analysis, the suitability of the levels rests largely within managerial policy. Uncertain demand requires the consideration of desired service level and the costs associated with having too much or too little on hand. This thesis presents the analysis of a communication equipment spare parts warehouse functioning under uncertain demand conditions. Two models are presented to assist the decision makers in setting the various inventory levels. The thesis includes the development of the values attached to the variables in each model, a comparison of resulting figures, and a DCFROR cost analysis comparison of implementing either new system versus retaining the old system. The models have been implemented in the company's warehouse to provide a check and balance mechanism for controlling spare parts levels and to aid proposal bids for future contracts. Additionally, the thesis includes discussions regarding the benefits of hands-on operations research and the improvements to the company's non-technical system.

Table of Contents

List of Tables

ACKNOWLEDGEMENTS

I would like to express sincere appreciation to the many persons responsible for providing guidance and advice in completing this thesis. The first group consists of the professors who served on my committee. Dr. R.E.D. Woolsey, who accompanied me on the initial visit to Denro, the company providing the subject matter for this thesis. Dr. Woolsey's straight-shooting demeanor and international credibility, in the field of operations research, paved the way for me to complete my thesis with Denro in a challenging real world environment. Additionally, Dr. Woolsey readily gave technical and practical advice for the development of the inventory models and the final outbrief to Denro. Dr. Franklin J. Stermole, who served as committee chairman and provided expert and tireless assistance with the economic analysis and content review. And, to professor William Astle whose expertise with mathematics and statistics goes well beyond CSM. Professor Astle particularly assisted with the focus of the statistical applications and provided invaluable feedback on thesis content.

The second group includes the managers and other employees with Denro. While the list is quite large, those most responsible for the success of the thesis include: the president of Denro, Mr. Edward C. Hanna, the chairman of the process action team, Mr. Roger Adam, and the remaining members of the process action team and the field support/depot repair personnel.

DEDICATION

I wish to dedicate this thesis first to my loving wife Anne, whose devotion and perseverance on **our** behalf provided the composure to accept those conditions that could not be changed, the strength to change those conditions we could, and the wisdom to choose between the two.

I want also to dedicate this thesis to my parents who provided the moral and character support that has brought me to this point in my life and career. And, to my in-laws who provided the opportunity to serve with Denro and do this real world thesis and who provided my logistical base of operations on my numerous trips to Denro.

INTRODUCTION

Inventory analysis is the study and resolution of systems requiring the stocking of quantities of items under constrained operating policies. The constraints of a given system include costs associated with carrying an item in inventory, costs resulting from having too few items relative to demand, costs due to meeting certain standards of performance, and the inherent physical constraints of storage and handling. The real world operates on the premise that these constraints do indeed exist. Therefore, it is often necessary to evaluate a system relative to its operating structure and determine the most appropriate inventory operating policy.

Operations research practitioners generally deal with the technical aspects of inventory analysis. They analyze the pattern of demand and the cost factors to determine an optimal level of materials that minimizes total expected cost. A fundamental aspect of operations analysis is the actual participation of the analyst in the system being studied. All too often practitioners forget that the resolution of a technical problem can easily be uncovered within the framework of the personnel operating structure. In this light, it is pertinent to address the methodology of operations research used in this thesis. The most adequate reference for the techniques employed is a *hands on* approach. Fundamental to this approach is understanding that it is not merely enough to watch the system in operation. The analyst must become part of the system and perform system tasks where practical. Once the analyst is comfortable and proficient (as measured by personnel in the organization), in the company's current operating structure, he can begin focusing his analysis and searching for areas of improvement.

In an inventory analysis scenario it is necessary to separate the areas of analysis. The first area deals with inventory control. In this thesis we define *inventory control* as the technique of maintaining stockkeeping items at desired levels. In a manufacturing environment, the focus is on a physical product and therefore on material control (Adam and Ebert 1989). The concern under inventory control involves the actual handling of the stocked items. Handling of stocked items occurs either through packaging and shipping an item to a customer or through receiving and storing the item in a warehouse.

The second area of analysis deals with the inventory management. *Inventory management* includes the technique of establishing an operating doctrine and monitoring the inventory relative to the system's operating parameters. The operating parameters are generally the reorder points and reorder quantities for each item. The parameters may also require that the organization not exceed associated costs and maintain a desired service level.

The next stage in the analysis process deals with the modeling of the system. The first step is to determine the nature of the system. Is the system a deterministic or a stochastic operation? In a deterministic situation, the demand per period is known and occurs at a constant rate per year. The *lead time* is constant and independent of demand. The introduction of uncertainty leads the analyst toward a stochastic modeling situation.

In a stochastic situation, some or all of the parameter values are unknown and predicted values are generally based on historical data (Adam and Ebert 1989). Probabilistic inventory models are used to handle situations involving uncertainty and randomness. An important concern of management is maintaining an adequate service level in the face of uncertain demand. Uncertain demand raises the possibility of a stockout (Heizer and Render 1988).

The purpose of this thesis is threefold. The first portion deals with the presentation of an existing warehouse belonging to Denro, a company in Gaithersburg, Maryland. The modeling of Denro's warehouse inventory operation required the application of probabilistic inventory theory. The second portion of the thesis addresses the author's role as a member of a process action team working in the company. The final portion presents both the application of the selected probabilistic models to Denro's system and some non-technical recommendations for improvement.

Chapter 1

DENRO AND TOTAL QUALITY MANAGEMENT

DENRO, a wholly owned subsidiary of FIRAN, is a leading manufacturer of integrated voice communication switching systems (IVCSS) for air traffic control; military test and training ranges; and command and control applications. Denro currently receives about 70% of it's business from the FAA. The remaining 30% is divided roughly 20% to U.S. military contracts and 10% to international market applications. Denro has over 600 operational systems worldwide. The primary focus is to provide installation, training, documentation, and maintenance support to each of its customers.

Denro was founded in 1967 and won its first contract from the U.S. Navy to develop telephone interfaces for the Navy's air traffic control system. Denro introduced solid state switching systems in 1972 and replaced the Navy's rotary switches. The same technology was sold to the U.S. Air Force in 1974. Between 1975 and 1980 Denro installed over 300 solid state systems world wide in transportable shelters, aircraft carriers, and radar towers. In the 1980's Denro became the leader in the microprocessor design and secured the bulk of the FAA's business.

In December of 1988, ALLTEL acquired CP National Corporation. As part of the acquisition, ALLTEL acquired Denro, a non-regulated subsidiary. ALLTEL sold Denro to FIRAN and Denro management in August 1990.

Denro manufactures customized systems to meet each customer's specific needs. This is believed to be an important advantage in securing contracts. In addition to design flexibility, Denro enjoys a high degree of availability due to its distributive processor

architecture. The distributive processor concept allows continued system operation neglecting the failure of one of the system components. This is in contrast to the more common centralized processor designs.

Denro's major product is the Model 400 Communication Switching System, first introduced in 1981. The installation of the 400 marked the beginning of the relationship with the FAA. Denro has continually updated the Model 400 along with introducing several variations of the system, the smaller 466 and the military oriented 400C. The 400D is the newest and most technologically advanced version.

In December of 1990, I had the opportunity to visit Denro. During the visit I mentioned that the Operations Research program under Drs. Woolsey and Maurer usually expects the completion of a master's thesis done in a real world environment. Denro appeared to have considerable opportunity for applying subjects studied in the CSM master's program for mathematics/operations research. Upon further inquiry, I learned that Denro was conducting a Total Quality Management program under which Denro personnel evaluate various aspects of the company for potential improvement . Total Quality Management or TQM is also a very active program within the military.

The quality aspect of TQM is defined by the customers. The customers can be either internal customers or external customers. Internal customers either work in the system being studied or require data input from the system. The external customers are essentially the users of the products of the system. The study processes use statistical thinking and quantitative methods where possible. The actual study and problem solving aspects are approached by a team referred to as a process action team (PAT).

The methodology used by the PAT includes understanding the quality improvement requirements, learning the system, generating and selecting solutions, and

implementing the solutions. The TQM program very closely resembles the hands-on operations research techniques mentioned earlier. Since my academic area of interest is in operations research and mathematics, and because TQM is a current practice in the military, I considered Denro an excellent thesis opportunity. In May, 1991 I was invited to participate in the program and serve as a member of a Process Action Team (PAT) evaluating internal depot repair and warehouse two inventory management.

Chapter 2

LEARNING THE SYSTEM

The author's thesis research included 208 hours logged working, researching and briefing on site in Denro and several weeks synthesizing analysis and data at CSM. The on site work included gathering information and where feasible, actually performing specific worker tasks. The areas worked in include: The customer support section, responsible for handling incoming calls requesting replacement spare parts; the depot receiving section, responsible for receiving defective/failed parts from the field and placing them in the queue for repair; the repair/test section, responsible for inspection, testing, and repair of failed parts and approving the return of the parts to the warehouse two inventory, and finally; the inventory control section, responsible for maintaining accountability of the warehouse two inventory and for shipping replacement spares to various field locations.

The initial objective was to learn by doing rather than merely observing the various tasks pertinent to the current system. I was able to conclude that the depot repair/field support process is considerably more complex than necessary. The system in place in Denro is based on an arbitrary value of 10%. Essentially, Denro maintains a total of 10% spares for all Line Replaceable Units (switch cards, processor boards, headsets etc.). The policy is to provide 5% spares on site with the user and keep the remaining 5% in Denro stored in warehouse two. Demand for replacement spare parts begins when a call comes in from a field site requesting a replacement spare Line Replaceable Unit (LRU). The receiving clerk records the caller's site name, site number,

suspected deficiency, name of caller, number of parts needed, and date/time of the call. This information is entered on a call data sheet (CDS), see appendix A. Four separate documents are then completed to prepare the replacement part for shipment. Examples of these documents are found in appendices B, C, D, and E. The part is then pulled from its shelf in warehouse two and sent to the test section. Once the part is verified as operational it is then packaged and shipped. All work to this point has been done by manual means. None of the documents are generated automatically nor are they formatted in the computer for ease of entry. The inventory transaction is then entered into the IBM system 36 MAPICS. The defective part arrives from the field (contractually within 3 days, but usually within 7-10 days). The key here is that Denro's resupply system is based solely on receiving the failed parts from field sites so they can be repaired and returned to stock in warehouse two.

At the end of his shift the receiving clerk prints a listing of all transactions for that day. The clerk then hand carries this listing to another clerk who enters the same data into a separate network system. Meanwhile, the defective part is making its way through the test and repair process ultimately returning to a shelf in warehouse two.

Work and research in Denro indicates a lead time of 45 days until a part is finally returned to stock. *Lead time* is defined as the time from receipt of a call reporting a failed part until the part arrives at Denro, is repaired, and then placed in warehouse two. Replenishment stock is not ordered from a manufacturer as in a standard inventory scenario. The lead time can be reduced by receipt of a like part from another site, however 45 days is the agreed upon figure used for the analysis of the inventory models in this thesis.

The demand for replacement spare parts is a very uncertain figure. The value depends both on the total number of systems in operation and the failure rate of the parts in use. The number of systems Denro has in operation corresponds to the number of contracts delivered up to a given point in time. The failure rate currently corresponds to the number of requests received for replacement spare LRU's. While this failure rate value is probably high relative to actual failures, it still accurately represents Denro's requirement to fill a demand.

The significant degree of uncertain demand and the evolving nature of Denro's contractual operations, are distinct characteristics of stochastic inventory systems. The decision was therefore made to develop the analysis around probabilistic inventory theory. The focus of the thesis is to assist Denro in developing a single system model to track and record activities in the field support process, and to provide recommended techniques for setting stock levels for spares maintained in warehouse two.

Chapter 3

PROCESS ACTION TEAM GOALS AND THE AUTHOR'S ROLE

The key to the success of a company's total quality management (TQM) program lies in the support given to, and the dedication of, the process action teams (PAT). Once the team has been chosen, Acquilano and Chase (1991) describe five key elements for ensuring the success of the program. The first is a total focus on the needs of the customers. As mentioned earlier, the customers are both internal members of the company and the usual external customers. The success in this area is measured by how well the company acts on the information and provides the desired products and services. The PAT goal under this first element was to provide a description of a single system model. The model must provide an accounting records tool for the value of inventory and cost of processing an LRU. The model must track items throughout the system from each site through depot repair. Finally, to support the external customers, the single system model must perform configuration management. Configuration management involves the management of the various arrays of LRU's at any given field location. One of Denro's advantages is that they provide customized configurations for each customer and each site.

The second element of a successful TQM program is the application of process management principles and improvement techniques to the studied process. The key to developing this element lies in how well the PAT can embrace the workers who are

critical to the process. Members of the process action team must experience, first hand, the responsibilities of the workers who are critically involved in the process. This experience can be gained through interaction with the workers in interviews and questionnaires, but the most valuable experience comes from actually assuming the role of the worker. The author's primary mission as part of the PAT was to gain experience by becoming part of the system and learning the worker tasks by doing them himself.

The third element in attaining total quality is employee empowerment. Employee empowerment addresses the issue of giving the employees the authority to improve processes without seeking bureaucratic approval. This level of empowerment goes beyond the participative philosophy. It is founded in the idea that the company trusts its employees to make the right decision. The role of the PAT is not only to identify improvement areas, but to recommend solutions that will be completely accepted by the employees responsible for the process.

A fourth key to quality is the elimination of waste in time, material, effort and potential. The final element of total quality follows from the fourth and it is the continuous insistence on improvement.

Within the framework of these last four principle elements of successful TQM lie the remaining goals of the PAT and this thesis. The recommended inventory model must provide the description of a formula for determining proper inventory levels. There must be a flow diagram for the process procedures depicting the system as both a manual and automated process. The last goal requires the description of the new or modified system

and implementation guidelines. In this area, the author provides a suggested operating doctrine relative to the probabilistic inventory models. The system implementation includes proposing the inventory management operating doctrine and recommending a time line for implementing the process improvements.

Finally, it was necessary to establish the criteria that would determine the successful goal attainment. The first criterion requires that there be a single system in place for the process. Secondly, the status of a given LRU in the depot repair process must be readily available. The third criterion requires that Denro have an analytically based and defensible inventory management system. One of the requirements made by the president of Denro was that they be able to challenge customers who fail to return parts in a timely manner. With the arbitrary 10% spares policy, there is no way to hold customers accountable in the event of a stockout.

Chapter 4

THE INVENTORY ANALYSIS

In modeling the inventory system, it is important to note once again that Denro's warehouse "two" is not a standard supply/demand set-up. Warehouse two stores the spare finished goods for all the systems fielded by Denro. The replenishment of the warehouse two inventory relies solely on the receipt of failed parts from field sites that have been processed through Denro's repair system. Typically, when an inventory system reaches a minimum level or reorder point, an order is placed to replenish stock. In Denro's case, the ordering process would equate to having their production department make finished goods for stock. While the production method becomes a solution when a stockout occurs, Denro's operating policy is to minimize the use of production to replenish spares.

Denro's spare parts inventory policy has always been to maintain a 10% level of spare line replaceable units (LRU). This 10% level means that for a given LRU, if one-hundred exist in the field, then Denro provides ten spares (five in warehouse two and five on site). Because of the nature of the contracts, the spare parts, in warehouse two and on site, belong to Denro. For this reason it is important for Denro to determine how many spares are actually needed. If the level is too low relative to the need (based on failures), then the new quantity must be included as part of the updated contract. If the level is too high then Denro stands to realize a savings by reducing the excess inventory.

While lead time does in fact vary, 45 days is based on observed intervals and the experience of field technicians and technicians in Denro doing the return and repair. This analysis uses the simpler constant lead time model since no accurate records exist to capture the variable lead time distribution.

Based on the uncertainty of demand for replacement spare parts, Denro is considered a stochastic inventory process with some deterministic features. Accordingly, in Adam and Ebert (1989), the model most appropriate for Denro's warehouse two is one for variable demand, constant lead time and a specified service level. In Tersine (1982), this model is a variation of the Optional Replenishment Inventory System or min-max system. Stock levels in this system are reviewed on a regular basis (cycle counts), but replenishment occurs only at predetermined levels. Since Denro's warehouse "two" replenishment normally occurs by the repair of failed parts, the decision to replenish by producing additional LRU's is a managerial decision. The minimum and maximum inventory levels become operating parameters (bounds) to assist the decision makers. The primary goal of the min-max system is to restore inventory levels up to but not exceeding the max figure.

The model in mathematical terms/symbols is as follows:

Q = economic order quantity based on average demand;

C = Denro's cost to fill an order;

H = holding rate for spares inventory;

P = manufacturing (purchase) cost to Denro;

D = average annual demand based on empirical data;

d = average monthly demand;

S = safety stock based on management's desired service level;

z = number of standard deviations needed for specified service level (based on Normal distribution);

sigma (σ) = standard deviation of monthly demand;

t = lead time in months;

u = lead time demand = ($d \times t$);

sigma modified = standard deviation during lead time;

S = $z \times$ (sigma modified);

min stock level = S + u; and

max stock level = min stock level + Q.

Developing the variable values requires the examination of some key relationships. First, it is necessary to establish safety stocks that are adequate for providing a specified service level to the customers. To do this, the warehouse must maintain at least a quantity equal to the sum of the safety stock and the expected lead time demand. Secondly, since the model considers lead time as constant, the expected lead time demand equals the expected demand times the lead time. Thirdly, the safety stock is simply a protection device for providing a specified service level to the customers. The safety stock is z standard deviates of protection for a given variability of demand during lead time. Therefore, by substitution, the reorder point R, or in Denro's case, the minimum

stock level becomes:

min stock level = (d × t) + [z × (sigma modified)] = u + S.

The formula for Q is the standard economic order quantity formula substituting the average annual demand. The use of average demand is appropriate for this model regardless of the shape of the demand distribution. Because of its variable nature, demand may take on many shapes. It may be an unconventional empirical distribution, or it may be normally distributed, (Adam and Ebert 1989). There is some evidence that the normal distribution describes many inventory situations at the production level; the negative exponential describes many at the wholesale and retail levels; and the Poisson describes many retail situations (Buchan and Koenigsberg 1963).

The use of expected demand is a principle that permeates virtually all stochastic inventory control applications. The motivation for using the expected value is that inventory control problems are generally ongoing problems. Decisions are made repetitively.

From a technical stand point, the law of large numbers from probability theory says that the arithmetic average of many observations of a random variable will converge to the expected value of that random variable. The specific law is attributed to Khintchin and is referred to as Khintchin's law of large numbers. The maximum level of inventory is derived from the sum of the minimum level and Q. In the literature the maximum value is referred to as Imax = R + Q (Buffa 1980). For our model, since R is actually the minimum stock level, the maximum (Imax) = minimum + Q.

In making any decision that will affect inventory size, the analyst and ultimately the managers must consider several costs. The first cost is associated with manufacturing the item. The model will refer to this value as the *purchase cost* (p). Every time Denro fills a contract and builds spares to cover the maintenance portion, they incur a purchase (manufacture) cost. Additionally, whenever a shortage is solved by producing more spares the company absorbs an additional purchase cost.

The next costs are referred to as *ordering costs* (C). These costs include the managerial and clerical costs associated with processing a request from a customer to replace a failed part. The cost of the call charged to Denro's 800 service, the cost of shipping and packaging, and the costs associated with clerk time are all part of the ordering cost.

The *holding cost (rate)* (H) refers to the costs associated with capital, insurance, taxes, handling, storage, and obsolescence. Capital costs account for the opportunity cost of not otherwise investing the funds spent for inventory.

The inventory analysis procedures require determining the values of these cost figures as accurately as possible and applying them to the selected model. There is considerable difficulty in determining the exact value of each of the cost factors. Generally speaking, the values used in the model are best guess figures. A technique the author has chosen to deal with data inaccuracies involves sensitivity analysis. That is, we can analyze the effects of error by changing the variable values and observing the effect on total cost.

Evaluating the model relative to the input variables will indicate suggested min or max inventory levels for a selected line replaceable unit (LRU). Any amount of on hand inventory above the max level is considered excessive and available for savings opportunities. Discounted cash flow rate of return (DCFROR) techniques will be used to determine the value of the savings and the most economically feasible alternatives for savings. Additionally, an analysis of the operating strategy will determine the amount of potential savings realized from implementing one of the recommended strategies.

Completing the analysis requires the gathering of the pertinent data (historical demand, on hand inventory, total system inventory and cost factors). Historical demand data was gathered for a thirty month period (May 1989-November 1991) for six selected LRU's. The six selected items were considered Denro's "A" classified parts. The "A" classification signifies that these parts are considered the most important. In the 18th century, Villefredo Pareto, in a study of wealth in Milan, found that 20% of the people controlled 80% of the wealth. The logic of the few having the greatest importance and the many having the least importance is referred to as the *Pareto Principle* (Heizer and Render 1988). The ABC classification system divides inventory items into three groupings: high dollar volume (A), moderate dollar volume (B), and low dollar volume (C). Dollar volume serves as a measure of importance. An item low in cost but high in volume can be more important than a high cost item with low volume (Acquilano and Chase 1991). In Denro's case, six items were identified as high dollar volume items. Additionally, through work experience in Denro the author was able to observe that these

same six parts receive the bulk of Denro's daily attention. Further discussions with workers, technicians and managers in Denro confirmed the choice of these parts as the focus for the inventory analysis.

A summary of the data follows:

1. The thirty-month historical demand indicates a good fit to the Normal distribution (confirmed by Chi-Square goodness of fit test using a .05 level of significance). See appendix F for an example of a transaction history file for part #401012 and appendix G for the corresponding Chi-Square calculations.

2. The mean monthly demand and standard deviation were determined for each of the 6 selected LRU's using the statistical software MINITAB. See appendix H for an example of the MINITAB calculations for part #401012.

3. The purchase (manufacture) cost (P) was determined for each LRU.

4. The holding rate (H) based primarily on the opportunity cost of capital was set at 10% for initial runs of the model. Denro is not taxed by the State of Maryland for holding inventory nor can their insurance costs be extracted for spares inventory. Obsolescence costs are still vague since engineering changes occur as part of the repair process.

5. The ordering cost (C) was determined to be $17.04 per LRU (rounded to $20 for model evaluation). By rotating through each of the clerical positions in the Field Support sections, the author was able to capture the clerk time and the handling and packaging costs of processing a request for a replacement part. An inspection of the accounting

department's telephone bill records revealed the cost of Denro's 800 service.

6. Warehouse "two" on hand inventory was determined for each of the six LRU's by a physical count done by the author and members of Denro.

The software package STORM uses a stochastic inventory model with some deterministic features for inventory management and was therefore the program of choice for this analysis. Several assumptions in applying the STORM model are:

- All parameters are known except that average annual demand is substituted for a known demand
- The inventory carrying charges (holding costs) are linear
- The inventory positions are monitored continuously
- Changes to the inventory are reported instantaneously

STORM provides results for the Optional Replenishment (min, max) model as follows: The minimum stock level equates to the value in the reorder point column and the maximum level equates to the sum of the reorder point and the order size columns. See appendix I for an example output of a STORM run applying the method of the Optional Replenishment model. Appendix J shows an example of the sensitivity analysis results. Table 4.2 shows how the STORM output columns are modified to fit the optional replenishment model.

The first step however, was to do all computations manually using the stochastic model detailed earlier. An important note concerns the factor of service level which dictates the amount of on hand safety stock. The service level is a value set by Denro

based on how well they want to respond to customer needs. The initial runs of the model use a level of 95%. This 95% service level equates to a standard normal z value of 1.65. Also, it is important to realize that the primary goal is to establish a percentage level for the spares inventory. The numbers represent the current inventory levels and are used to simplify expressions. The nature of Denro's operating structure includes an increasing level of existing LRU's based on the award of new contracts. A significant error could occur if levels were set based on current total system inventory and not adjusted as new contracts are awarded and the system inventory increases. Establishing percentage spares inventory levels allows for the evolving nature of the system inventory.

An example of the manual computations follows:

part # 401012 (processor board)

d (average monthly demand) = 75.53; D (average annual demand) = 906; sigma (standard deviation of monthly demand) = 15.61; sigma mod (standard deviation of demand during lead time) = 19.12;

C (ordering cost) = 20; H (holding rate) = .10; P (Denro's cost to produce the part) = 157; t (lead time) = 45 days = 1.5 months (the unit of lead time for the model) computations:

Q (economic order quantity using average annual demand) = sqrt [(2 × D × C)/(H × P)] = sqrt [(2 × 906 × 20)/(.1 × 157)] = sqrt (36240/15.7) = sqrt (2308) = 48

S (amount of safety stock) = (sigma mod) × z = 19.12 × 1.65 = 32

u (demand during lead time) = d × t = 75.53 × 1.5 = 113

min stock level = u + S = 145

max stock level = min + Q = 145 + 48 = 193

The potential operating strategy arises from the computations. Use the min--max model and keep 193 items on hand, when/if the quantity ever drops to 145 then shift priority of repair to this part. If the quantity waiting repair/test is at zero, have production make the required 48. Again, it should be emphasized that the decision to activate production is management's responsibility not a system requirement.

Further research and discussions with Dr. Woolsey revealed that yet another model has application. This model is referred to as the EOQ for uncertain demand, shortages allowed, discrete units (Woolsey and Swanson 1975) and is called Inventory Model III in its original reference, *Introduction to Operations Research,* by Churchman, Ackoff, and Arnoff. The requirements to apply this model include: knowing the manufacturing cost of the part, the holding rate, and the probability distribution of demand. An example computation follows:

part # 401012 (processor board)

manufacture cost = P = 157 holding rate = H = .10

ratio = P / (H × P) + P = 157 / (15.7) + 157 = 157/172.7 = .909 which means that the target minimum stock level corresponds to the level when the cumulative probability of demand equals .909.

probability distribution of demand:

# needed = S	50	60	70	80	90	100	110	120
probability of needing (r)	.087	.174	.3	.174	.174	.04	0	.04
probability of needing r</=S	.087	.261	.561	.735	.909	.949	.949	.989

The probability of demand is derived by setting up a histogram of equal intervals over the range of periodic demands. The model assumes we are operating on 1 unit of lead time but we are actually estimating lead time at 1.5 units. It is therefore necessary to multiply the derived stock level by 1.5. Additionally, the model is based on the ratio of manufacturing cost to shortage cost. If the holding rate stays constant at 10% as in our example, the recommended stock level will always be 90.9%. The recommendation would be to stock (90 × (t)) of part # 401012 and order the EOQ whenever the stock level drops below this point. To equate this model to the operating doctrine of the min, max model the results would be as follows:

90 × (1.5) = 135 min stock level

135 + 48 = 183 max stock level

Reviewing our model figures we have:

Optional Replenishment (min max)	Quick & Dirty
minimum level: 145	135
maximum level: 193	183

Remembering that the optional replenishment model was calculated based on a 95% service level and the Quick & Dirty model suggests a 90.9% level we must now substitute the 90.9% value into the Optional Replenishment model. The figures then become:

min stock level = u + S = 113 + 26 = 139

max stock level = 139 + 48 = 187 and the comparison becomes:

OPT REP MODEL	QUICK & DIRTY
min level 139	135
max level 187	183

Savings can be realized in two different fashions. First, a reduction of excess inventory results in current dollar savings. Implementing an analytically based, experience managed inventory strategy results in savings over time. Surplus inventory can result in excessive costs due to perpetual holding costs. Any losses on surplus inventory are charged off against income, thereby reducing income taxes (Tersine 1982). Denro currently maintains 888 spares for part #401012 (444 on-site spares and 444 in warehouse two). By reducing this inventory to 193, recommended by the optional replenishment model with a 95% service level, Denro realizes a savings of $109,115 for this one part. The operating policy would be to keep 97 in the field and 96 in warehouse two. If this is too difficult to implement with the FAA then focus solely on the warehouse two inventory.

The savings would then be computed as follows: 444 - 96 = 348; 348 × $157 (cost of part) = $54,636.

Another example deals with implementing the same strategy over time. By simulating the demand pattern for this part over five thirty-month time periods, we can determine a savings figure. The random demand generated by the software MINITAB shows monthly demand not exceeding the 193 level during the five thirty-month periods. The simulation was performed by allowing MINITAB to randomly generate five 30 period listings of Normally distributed values. The listings were assigned the same mean and standard deviation as indicated by the empirical data. See appendix K for an example of the simulation listing. The results indicate the following savings potential:

Current System	New System
444 × 157 × .10(holding rate) = 6970.8	97 × 157 × .10 = 1522.9

The number of stockouts for both systems is zero, therefore the periodic savings is 6970.8 - 1522.9 = $5447.9 for this one part.

To implement the spares percentage policy, simply convert current values to a percentage of total spares as follows:

If we can assume that 888 is a 10% spares level, then there must be 8880 part #401012 in use. 193 / 8880 equates to a percentage level of 2.2%. Therefore, the operating policy would be to maintain 2.2% spares rather than 10% for this particular part.

Again, it is important to note that the MINITAB random number generation is only a simulation of a demand pattern. In fact, each iteration of the random generation could produce varying results.

Table 4.1 shows the results of evaluating the probability distributions for the remaining five parts using the Quick & Dirty model as referenced in Woolsey and Swanson (1975).

Table 4.1

Quick and Dirty Model Results

Pt #407102

DEMAND	10	15	20	25	30	35	40	45
Prob.	.04	.09	.22	.35	.09	.04	.09	.09
Cumul.	.04	.13	.35	.70	.79	.83	.92	1.0

Min stock level: 40 × 1.5 = 60 Max level = 81

Pt #408001

DEMAND	120	140	160	180	200	220	240
Prob.	.174	.174	.3	.13	.13	0	.09
Cumul.	.174	.348	.648	.78	.91	.91	1

Min stock level: 200 × 1.5 = 300 Max level = 410

Pt #409001

DEMAND	10	20	30	40	50	60	70	80	90	100
Prob.	.04	0	.09	.09	.22	.30	.13	.04	.04	.04
Cumul.	.04	.04	.13	.22	.44	.74	.87	.91	.95	.99

Min stock level: 80 × 1.5 = 120 Max level = 184

Pt# 457002

DEMAND	2	4	6	8	10	12	14	16	18	20	22	24
Prob.	.04	.13	0	.13	.04	.09	.04	.13	.09	.09	.17	.04
Cumul.	.04	.17	.17	.30	.34	.43	.47	.60	.69	.78	.95	.99

Min stock level: 22 × 1.5 = 33 Max level = 48

Pt #003005

DEMAND	10	20	30	40	50	60	70	80
Prob.	.043	0	.13	.174	.30	.13	.13	.09
Cumul.	.043	.043	.173	.347	.65	.78	.91	1

Min stock level: 70 × 1.5 = 105 Max level = 150

Table 4.2

Modification of STORM Output

Part #	Order Size	Reorder Point	Maximum Stock Level
401012	48	139	187
407102	21	57	78
408001	108	303	411
409001	64	117	181
457002	15	36	51
003005	45	103	148

Table 4.3

Optional Replenishment vs. Quick and Dirty

	Optional Replenishment Model	Quick & Dirty
PART # 401012		
MIN LEVEL	139	135
MAX LEVEL	187	183
PART # 407102		
MIN LEVEL	57	60
MAX LEVEL	78	81
PART #408001		
MIN LEVEL	303	300
MAX LEVEL	413	410
PART # 409001		
MIN LEVEL	117	120
MAX LEVEL	181	184
PART # 457002		
MIN LEVEL	36	33
MAX LEVEL	51	48
PART # 003005		
MIN LEVEL	103	105
MAX LEVEL	148	150

Table 4.4

Comparison of Current vs. Proposed Stock Levels

PART #	CURRENT STOCK LEVEL 10%	OPT REP	REVISED STOCK LEVEL (%)	Q & D
401012	888	187	(2.1%)	183
407102	113	78	(6.8%)	81
408001	461	413	(9.0%)	410
409001	595	181	(3.0%)	184
457002	147	51	(3.4%)	48
003005	66	148	(22.4%)	150

These comparisons are based on evaluating the Optional Replenishment Model using the percentage stock levels recommended by the Quick and Dirty model.

The values in the current system column refer to the level of spare parts currently maintained for each part. Current policy sets these levels at 10%. The proposed models show the revised percentage stock levels.

One method of evaluating potential savings for a reduction of excess inventory is to use the working capital approach. In Stermole and Stermole 1990, working capital is referred to as the cost required to generate raw material inventories, in-process inventories, product inventories and parts and supplies inventories. With regard to Denro's situation, we are only concerned about finished goods or product inventories held as spare parts in warehouse two. As inventories are used and product sold, working capital cost items become allowable tax deductions as operating costs through the cost of goods sold calculation (Stermole and Stermole 1990).

In Denro's case, the value of the spare parts inventory of the six selected LRU's is treated as the cost of goods available for sale. This figure is represented by the relationship:

P (Denro's manufacturing cost) times the on-hand quantity for each LRU.

The inventory value at the end of the year (assuming we allow one year to remove surplus inventory) is represented in the equation: (Year-end on-hand quantity) times P (Denro's cost). The year-end on-hand quantity corresponds to the maximum inventory level recommended by either the Quick and Dirty or the Optional Replenishment model.

The difference between the *cost of goods available* and the *year-end inventory value* represents the *cost of goods sold* and is deductible as an annual operating cost (Stermole and Stermole 1990). Table 4.5 shows the resulting calculations for the six selected LRU's.

Table 4.5

Calculation of Cost of Goods Sold for Reducing Excess Inventory

On-hand Quantity (beginning of year)		Denro $ Cost	Value
PART # 401012	888	157	139416
PART # 407102	113	288	32544
PART # 408001	461	65	29965
PART # 409001	595	67	39865
PART # 457002	147	292	42924
PART # 003005	66	120	7920
		Costs of Goods Available =	$292,634

Model Recommended Year-end Quantity		Denro $ Cost	Value
PART # 401012	187	157	29359
PART # 407102	78	288	22464
PART # 408001	413	65	26845
PART # 409001	181	67	12127
PART # 457002	51	292	14892
PART # 003005	148	120	17760
		Year-end Inventory Value =	$123,447

Cost of Goods Sold = 292,634 - 123,447 = 169,187 and upon applying the Single Payment Present-Worth Factor (P/F) we have a present value equation as follows:

Using Denro's holding rate = .10 the PW factor for one year is 1/1.1 = .9091 and we have: 292,634 - (.9091) × 123,447 = **$180,408** deductible as an operating expense.

Another means by which to evaluate the inventory alternatives is to apply discounted cash flow rate of return (DCFROR) analysis. In order to perform DCFROR analysis on Denro's situation it is necessary to set some parameters. First, we set the revenue and hold it constant for both alternatives. We are assuming that Denro makes a one time sale of the quantities currently in use and receives the revenue throughout the first year. Since Denro's actual revenue figures change annually, based on contract awards, we will use the value of the parts in use plus a mark up of 15% as the revenue figure.

Secondly, we assume operating expenses for year one to equal the sum of the holding costs and the costs of manufacturing the parts. The operating expenses for years two through five will be just the holding costs. Scenarios are included as Table 4.11 - 4.18 that neglect any holding costs as operating expenses.

Next we will use a five year project life and the modified accelerated cost recovery system (ACRS) depreciation rates starting in year zero for the initial spare parts inventory investment (Stermole and Stermole 1990). Inventory cannot be depreciated until it is committed for use. We assume Denro's warehouse two inventory committed for use since it was built as a contractual requirement. The tax rate is set at 40%. Table 4.7 shows the revenue and operating cost calculations and Tables 4.9 and 4.10 show the cash flow calculations. Additionally, in Tables 4.17 and 4.18 calculations are done reflecting cash flows without depreciation. Depreciation in Tables 4.11 through 4.16 begins in year 1.

Table 4.6

Product Price and Operating Cost Information

Part #	Selling Price	Operating Cost
401012	181	157
407102	331	288
408001	75	65
409001	77	67
457002	336	292
003005	138	120

The selling price values represent a mark-up of 15%. The operating cost is an average based on transaction history.

Table 4.7
Revenue and Operating Costs

The revenue total corresponds to the value of the parts sold plus a mark up of 15%.

PART #	# Sold	Cost	15% mark up	Revenue
401012	8880	157	181	1603284
407102	1130	288	331	374256
408001	4610	65	75	344598
409001	5950	67	77	458448
457002	1470	292	336	493626
003005	660	120	138	91080

Revenue Total = 3,365,292

Operating costs for year one correspond to the cost of parts sold in year one plus holding costs for spares kept in warehouse two and on site (since Denro owns all spares). Operating costs for years two through five are simply the spares inventory holding costs. The revenue figures and the cost figures assume Denro sells parts one time for a five year life. The actual life is much longer, however for the example cases we use a five year life to simplify cash flow calculations.

PART #	# Sold	Cost	Current System holding costs	Revised system holding costs
401012	8880	1394160	13942	2952
407102	1130	325440	3254	2218
408001	4610	299650	2997	2685
409001	5950	398650	3987	1213
457002	1470	429240	4292	1402
003005	660	79200	792	1776
		*2926340	$29,263	12,244

Year one operating costs = (# sold × cost) + system holding cost = 2926340 + 29263 = $2.96 mil (current) and 2926340 + 12244 = $2.94 mil (revised)

*This figure is referred to as the Cost of Goods Sold (COGS) and is reflected in cash flow calculations in Tables 4.11 through 4.18.

Table 4.8

Production and Inventory Information (units only)

Part #	Units Produced*	Units Sold	Change in Inventory	Cumulative Inventory**	Cost $
401012	9768	8880	8880	888	1533576
407102	1243	1130	1130	113	357984
408001	5071	4610	4610	461	329615
409001	6545	5950	5950	595	438515
457102	1617	1470	1470	147	472164
003005	726	660	660	66	87120
					$3,218,974

*For scenarios 1, 2, and 4 the total cost is divided half in year 0 and half in year 1 and expensed in the Cost of Goods Sold and Working Capital calculations.

**The cumulative inventory figures represent the amount currently maintained in the system as spare parts.

Table 4.9

Discounted Cash Flow Rate of Return Calculations

Revised Inventory Management (Values in Millions)

Year	0	1	2	3	4	5
Revenue		3.2 mil				
-Oper Costs		2.94 mil	.012244	.012244	.012244	.012244
-Deprec	.024488	.039181	.023508	.014105	.014105	.007053
Taxable	-.024488	.220819	-.035752	-.026349	-.026349	-.019297
-Tax 40%	.009795	-.088328	.014301	.010540	.010540	.007719
Net Inc	-.014693	.132491	-.021451	-.015809	-.015809	-.011578
+ Deprec	-.024488	.039181	.023508	.014105	.014105	.007053
-Capital	-.122440					
C F	-.112645	.171672	.002057	-.001704	-.001704	-.004525

DCFROR Analysis

PW Cost Modified ROR PW eq: 112645 + 1704 (P/F 10%, 3) + 1704 (P/F 10%, 4) + 4525 (P/F 10%, 5) = 171672 (P/F i, 1) + 2057 (P/F i, 2) and we have that 117,899 = 171672 (P/F i, 1) + 2057 (P/F i,2)

i = Modified ROR = 47%

NPV @ 10% = -112645 + 171672(.909) + 2057(.8264) - 1704(.7513) - 1704(.6830) - 4525(.6209) = +.039851 million

Table 4.10

Discounted Cash Flow Rate of Return Calculations

Current Inventory Management (Values in Millions)

Year	0	1	2	3	4	5
Revenue		3.2 mil				
-Oper Costs		2.96 mil	.029263	.029263	.029263	.029263
-Deprec	.058527	.093643	.056186	.033711	.033711	.016856
Taxable	-.058527	.146357	-.085449	-.062974	-.062974	-.046119
-Tax 40%	.023411	-.058543	.034180	.025190	.025190	.018448
Net Inc	-.035116	-.087814	-.051269	-.037784	-.037784	-.027671
+ Deprec	.058527	.093643	.056186	.033711	.033711	.016856
-Capital	-.292634					
C F	-.269223	.181457	.004917	-.004073	-.004073	-.010815

DCFROR Analysis

PW Cost Modified ROR PW eq: 269223 + 4073 (P/F 10%, 3) + 4073 (P/F 10%, 4) + 10815 (P/F 10%, 5) = 181457 (P/F i, 1) + 4917 (P/F i, 2) and we have that 281780 = 181457 (P/F i, 1) + 4917 (P/F i,2)

i = Modified ROR = -36%

NPV @ 10% = -.112772 million

The results displayed in Tables 4.9 and 4.10 indicate a significant economic difference between the two alternatives. While the parameters for the analyses are somewhat hypothetical, the outcomes overwhelmingly support the revised operating system. Tables 4.11 through 4.18 represent various scenarios for evaluating the economics of inventory management strategies. The key point of the cash flow calculations for these scenarios is in using the cost of goods sold and working capital figures. No holding costs are included as operating expenses. Depreciation in scenarios 1 through 3 is taken on the value of the initial investment in the warehouse two spare parts inventory corresponding to either the current or the revised system.

Table 4.11

Cash Flows Using Cost Of Goods Sold (COGS) and Working Capital

Scenario 1 (current system): Revenues and costs occur throughout the first year and are reflected as half occurring in year 0 and half in year 1. All values in millions.

Year	0	1	2	3	4	5
Revenue	1.6825	1.6825	0	0	0	0
-COGS	1.465	1.465	0	0	0	0
-Deprec	0	.058527	.093643	.056186	.033711	.033711
-Deprec Writeoff						.016856
Taxable Inc	.2175	.159	-.093643	-.056186	-.033711	-.050567
-Tax @ 40%	.087	.064	+.03746	+.0225	+.0135	+.0202
Net Income	.1305	.095	-.0562	-.0337	-.0202	-.0304
+ Deprec	0	.058527	.093643	.056186	.033711	.033711
-Working Cap	.145	.145				
Cash Flow	-.0145	.008527	.03744	.02249	.0135	.0033

Net Present Value @ 10% = $.062860 million or $62,860

Net Present Value @ 15% = $.053900 million or $53,900

Net Present Value @ 20% = $.046260 million or $46,260

*Cost of Goods Sold = Value of units produced and sold in tax year

Working Capital = Cost of Goods Produced - Cost of Goods Sold

*See Table 4.5 for COGS calculation

Table 4.12

Cash Flows For Scenario 1 (Revised System)

Year	0	1	2	3	4	5
Revenue	1.6825	1.6825				
-COGS	1.465	1.465				
-Deprec	0	.024488	.039181	.023508	.014105	.014105
-Deprec Writeoff						.007053
Taxable Inc	.2175	.193	-.039181	-.023508	-.014105	-.021158
-Tax @ 40%	.087	.077	+.01567	+.0095	+.00564	+.00846
Net Income	.1305	.116	-.0235	-.014	-.00846	-.0127
+ Deprec	0	.024488	.039181	.023508	.014105	.021158
-Working Cap	.059	.059				
Cash Flow	.0715	.0185	.0157	.0095	.00564	.00846

Net Present Value @ 10% = $.174800 million or $174,800

Net Present Value @ 15% = $.167900 million or $167,900

Net Present Value @ 20% = $.161900 million or $161,900

Cost of Goods Sold = Value of units produced and sold in tax year

*Working Capital = Cost of Goods Produced - Cost of Goods Sold

*The Working Capital figure under the revised system for each scenario reflects a Cost of Goods Produced assuming the recommended percentage stock levels as listed in Table 4.4.

Table 4.13

Cash Flows For Scenario 2 (Current System)

In scenario 2 expenses occur throughout the first year, but revenue happens in year 1 only.

Year	0	1	2	3	4	5
Revenue		3.365	SAME	AS	SCENARIO	1
-COGS	1.465	1.465	"			"
-Deprec		.058527	"			"
-Deprec Writeoff			"			"
Taxable Inc	-1.465	1.84	-.093643	SAME AS	SCENARIO	1
-Tax @ 40%	+.586	.7367	+.03746	"		"
Net Income	-.879	1.1	SAME	AS	SCENARIO	1
+ Deprec	0	.05827	"			"
-Working Cap	.145	.145	"			"
Cash Flow	-1.024	1.017	.03744	.0225	.0135	.0202

Net Present Value @ 10% = $-.030000 million or $-30,000

Net Present Value @ 15% = $-.078752 million or $-78,752

Net Present Value @ 20% = $-.122885 million or $-122,885

Cost of Goods Sold = Value of units produced and sold in tax year

Working Capital = Cost of Goods Produced - Cost of Goods Sold

Table 4.14

Cash Flows For Scenario 2 (Revised System)

Year	0	1	2	3	4	5
Revenue		3.365	SAME	AS	SCENARIO	1
-COGS	1.465	1.465	"			"
-Deprec	0	.024488	"			"
-Deprec Writeoff			"			"
Taxable Inc	-1.465	1.8755	SAME	AS	SCENARIO	1
-Tax @ 40%	+.586	.75	"			"
Net Income	-.879	1.125	SAME	AS	SCENARIO	1
+ Deprec	0	.024488	"			"
-Working Cap	.059	.059	"			"
Cash Flow	-.938	1.09	.0157	.0095	.00564	.00846

Net Present Value @ 10% = $.082000 million or $82,000

Net Present Value @ 15% = $.035412 million or $35,412

Net Present Value @ 20% = $-.007183 million or $-7,183

Cost of Goods Sold = Value of units produced and sold in tax year

Working Capital = Cost of Goods Produced - Cost of Goods Sold

Table 4.15

Cash Flows For Scenario 3 (Current System)

In Scenario 3 all expenses and revenues occur in year one.

Year	0	1	2	3	4	5
Revenue		3.365	SAME	AS	SCENARIO	1
-COGS		2.93	"			"
-Deprec		.058527	"			"
-Deprec Writeoff			"			"
Taxable Inc		.37647	SAME	AS	SCENARIO	1
-Tax @ 40%		.1506	"			"
Net Income		.226	SAME	AS	SCENARIO	1
+ Deprec		.058527	"			"
-Working Cap	.145	.145	"			"
Cash Flow	-.145	.139	.03744	.0225	.0135	.0202

Net Present Value @ 10% = $.050960 million or $50,960

Net Present Value @ 15% = $.036739 million or $36,739

Net Present Value @ 20% = $.024477 million or $24,477

Cost of Goods Sold = Value of units produced and sold in tax year

Working Capital = Cost of Goods Produced - Cost of Goods Sold

Table 4.16

Cash Flows For Scenario 3 (Revised System)

Year	0	1	2	3	4	5
Revenue		3.365	SAME	AS	SCENARIO	1
-COGS		2.93	"			"
-Deprec		.024488	"			"
-Deprec Writeoff			"			"
Taxable Inc		.4105	SAME	AS	SCENARIO	1
-Tax @ 40%		.1642	"			"
Net Income		.2463	SAME	AS	SCENARIO	1
+ Deprec		.024488	"			"
-Working Cap	.059	.059	"			"
Cash Flow	-.059	.2118	.0157	.0095	.00564	.00846

Net Present Value @ 10% = $.162740 million or $162,740

Net Present Value @ 15% = $.150730 million or $150,730

Net Present Value @ 20% = $.140013 million or $140,013

Cost of Goods Sold = Value of units produced and sold in tax year

Working Capital = Cost of Goods Produced - Cost of Goods Sold

Table 4.17

Cash Flows For Scenario 4 (Current System)

In scenario 4 we treat expenses and revenues the same as scenario 1, except no depreciation is allowed for capital invested in the spare parts inventory.

Year	0	1	2	3	4	5
Revenue	1.6825	1.6825				
-COGS	1.465	1.465				
Taxable Inc	.2175	.2175				
-Tax @ 40%	.087	.087				
Net Income	.1305	.1305				
+ Deprec	0	0				
-Working Cap	.145	.145				
Cash Flow	-.0145	-.0145				

Net Present Value @ 10% = $-.027680 million or $-27,680

Cost of Goods Sold = Value of units produced and sold in tax year

Working Capital = Cost of Goods Produced - Cost of Goods Sold

Table 4.18

Cash Flows For Scenario 4 (Revised System)

Year	0	1	2	3	4	5
Revenue	1.6825	1.6825				
-COGS	1.465	1.465				
Taxable Inc	.2175	.2175				
-Tax @ 40%	.087	.087				
Net Income	.1305	.1305				
+ Deprec	0	0				
-Working Cap	.059	.059				
Cash Flow	.0715	.0715				

Net Present Value @ 10% = $.136494 million or $136,494

Cost of Goods Sold = Value of units produced and sold in tax year

Working Capital = Cost of Goods Produced - Cost of Goods Sold

Chapter 5

THE NON-TECHNICAL INVENTORY CONTROL SYSTEM

The analysis of any inventory system is never complete until management establishes specific control policies. These policies must be documented and understood not only by the supervisors, but by the clerks and workers. The selection of the control system is a top management responsibility. The system should establish the rules for handling routine and non-routine situations. In Tersine (1982), four parameters are enumerated for assessing the effectiveness of an inventory control system. The first two parameters deal with establishing appropriate levels of items to keep available. The final two parameters focus on getting timely and accurate reports to management and the various *internal* customers. The reports must serve as the tools for properly managing the organization's inventory related activities. Until now, the emphasis of this thesis has been on addressing the parameters dealing with inventory levels. This chapter addresses the inventory handling and reporting system in Denro and how it can be tailored to better serve the organizational needs. Again, regardless of the system chosen, unless it is documented, understood, and enforced, the concept of control will be fleeting.

The development and implementation of an inventory control system to meet the needs of an organization is a customizing exercise. If a revised system is planned for an existing company, the period of change can be traumatic. The introduction of a new system, may cause a change in operational procedures. Changes in forms and reporting

techniques, and changes in employee work patterns may result in an initial loss of efficiency.

The challenge for the operations analyst and ultimately the management, is to minimize the adverse effects of system change. The author's approach, and that of the process action team, as prescribed by the principles of hands-on operations research, was to include the system workers in the actual development of the revisions. In support of this approach, Tersine (1982) makes the salient point that both resistance to change and implementation difficulties are best avoided by including the affected sections in the design process.

In evaluating the non-technical aspects of Denro's field support operation, the criterion for improvement was the implementation of a single system model. This model must provide data to the users of the system and be a tracking device for Denro's support operations.

One of the first steps, after learning the current process, was to develop a flow chart of the system to identify streamlining opportunities. Appendix L shows the system flow chart before revision and appendix M shows the revised system flow chart. The key to the flow-charting process is in the exhaustive nature of depicting the steps in the system. The workers in the field support system were asked to design the process from their perspectives and include each step no matter how trivial. The revised flow chart was then developed from the workers' design. This revised system has been adopted and enthusiastically embraced by management and the workers.

The next step was to design a manual system that could easily be automated, but could also be used interim to automation. As mentioned earlier, in Chapter 2, the field support process is initiated by a telephone call and the use of Denro's call data sheet (CDS). Experience gained through working in the field support section, showed that the current system required too much paperwork and did not meet the needs of Denro's *internal customers*. After gathering the desires of the workers and the internal customers, a two-sided call data sheet was devised. The beauty of the single two-sided sheet is that it replaces several tags and forms and can easily be formatted for automated use. Appendix N shows an example of the old CDS and Appendix O is the revised single system version. Appendix P shows the group of forms replaced by the revised call data sheet. Again, this form has been implemented as a manual version of the single system model and as of 6 January 1992 Denro began the steps toward automation of the form and the system.

To this point in the analysis of the non-technical inventory system we have examined the tactical areas of inventory management. Completion of the analysis requires examination of strategic inventory management principles (Heizer and Render 1988). The strategic principles consider the areas of location, layout, and human resource strategies.

The author's experience with Denro, both as a worker and as an observer, revealed a strong company commitment to providing a quality work-life. The skill of Denro's work force and their commitment to excellence are indicative of money well invested in human resources.

The location and layout strategies are somewhat dictated by operations, but perfectly meet the criterion of being close to suppliers and internal customers as outlined by Heizer and Render (1988). With one final comment about the layout strategy, the author will relate a principle espoused by Dr. Woolsey. The principle simply requires that those who seek solutions to problem systems ask the workers in the system what they ***really*** want.

The inventory management system in this thesis deals with managing spare parts. The problems are generally assumed to lie in the area of spare parts control and an elegant mathematical approach is usually conceived as a solution. While working with Denro, the author perceived that some managers found deficiencies in the storage and handling of the spare parts in warehouse two. Many solutions were offered to the author as fixes for warehouse two's storage and handling deficiencies. Management's suggestions ranged from relabeling the shelves to getting additional clerks. The author finally decided to ask the parts clerk what ***he*** wanted. The clerk replied he would like to use a different door to access the warehouse and put the lock on it instead of the door he currently used. The change was made the next day (19 July 1991) and no further complaints were heard about storage and handling deficiencies.

Chapter 6

BENEFITS, RECOMMENDATIONS AND CONCLUSIONS

The revised inventory management system was accepted for implementation on 14 November 1991 (see Appendix Q for letter from President of Denro). It is interesting to note that Denro accepted the revised methodology even before learning of the significance of the discounted cash flow differences as outlined in Chapter 4. Denro was able to derive several benefits from the efforts of the depot repair and field support study. This chapter will discuss those benefits, the recommended implementation strategies, and some precautionary measures regarding inventory analysis. The cautions are meant to acquaint the reader with potential pitfalls in searching for panaceas in operations research.

As a direct result of the study, Denro now has an analytically based method for inventory management. The key to the success of this method is in maintaining proactive supervisory involvement. Denro's operating environment requires significant technical orientation, but the overall success of the system lies in managing the people who perform the technical functions. In this light, it is emphasized that the inventory control system is one tool to assist the managers. In Plossl and Wight 1967, the point is made that the production and inventory system must be an integrated concept. The system essentially helps the managers take advantage of marketing opportunities, control financial investment, and run the facilities to make a profit.

The additional benefits to Denro center around the development of the single system model. The revised call data sheet and its eventual automation will permit labor and material tracking. Denro will now be able to capture reliability data down to sub-assembly level and actually know part status at any time.

One of the end results of the revised system is the better utilization of manpower. For example, Denro's field support section can now be task organized to handle repair priorities and respond to potential system changes rather than waiting until critical shortages occur. The intent is to allow Denro to be proactive in resolving potential shortages and trouble spots rather than be reactive to actual problems.

In a course curriculum based on practical application, it is indeed exciting to test acquired skills. The author benefited considerably from the opportunity to work with Denro and serve on the process action team. The initial benefit was in the practice of total quality management. Since TQM recently became popular in the military, being able to complete such a project, helps the transition to a military operations research position.

Often, there is a complaint that algorithms are taught in the classroom regardless of how poorly they fit an existing situation. The preface to the author's education concerning these algorithms, was that the algorithms are the building blocks. The glue to assemble the blocks remains in making exhaustive use of common sense and gaining acceptance within the organization. Denro is no different than case studies examined in the author's course material. The company has a mission. Many technical activities

occur simultaneously during daily operations. External resources are available to evaluate perceived problem areas. When the final verdict is in however, the solutions still require the commitment of the leaders and often the input from the workers.

The two recommendations from the study are to implement the inventory management system and phase in the automation of the single system model. The preliminary steps require planning the implementation and testing the revised systems. Table 6.1 lists the major steps in implementation.

Table 6.1

Implementation of Test Plan

Step	Description	Estimated Cost*	Estimated Time
1	Integrate current system into single system model	N/A	1 Week
2	Automate single system model	$8700	3 Weeks
3	Train key personnel	N/A	2 Weeks
4	Purchase Location Lot Management**	$6000	2 Weeks**
5	Set Warehouse 2 Inventory levels	N/A	2 Weeks
6	Integrate Bar code Application***	N/A	1 Week
7	Purchase AS400 MAPICS Database****	$90,000	Future Goal

* Cost figures were determined by Denro's Management Information System's personnel.

** The Location Lot Management is a Denro desire to help the automation process. It requires a phased sequence for fielding.

*** Denro already uses bar coding in their production control.

**** Denro's long range goal is to install a completely automated production and inventory control system over the next 3 years.

One word of caution deals with the issue of the appropriateness of the chosen model. As addressed in Porteus 1985, a primary weakness of the model is in its assumption that the lead time is deterministic. The validity of deterministic lead time however, is supported by its being derived by the technicians and field support personnel in Denro. The sensitivity analysis approach as exemplified in Appendix J, is a rather painless way to discover the effects of variability. Additionally, in Ehrhardt 1984, the fixed lead time model is manipulated using hypothetical distributions and what is referred to as the Power Approximation to show how closely the fixed lead time model compares with the "optimal" stochastic version. The theory behind these manipulations is beyond the scope of this thesis. The comparisons of cost differences however, between stochastic and deterministic lead time models is relatively insignificant (Ehrhardt 1984). It may still prove fruitful to do the analysis for the stochastic lead time scenario once Denro establishes a variable lead time data base.

The decision to institute a materials management system is equally as important as which models to use in the system evaluation. A major pitfall lies in adapting an organization to a mathematical model rather than the model to the organization. In this thesis, the emphasis is on management's retention of the decision regarding system replenishment. The model does not dictate policy, it is a tool to assist the policy makers. It is the analyst's job to tread the narrow path between oversimplification and complexity (Tersine 1982).

Perhaps the most aptly put summary of the challenges of inventory analysis lies in O.W. Wight's poem, *The Production Control Experts.*

The Production Control Experts

It was six men of management
To learning much inclined
Who discoursed on production control
And the answers they did find
---from experience, and the lessons
That reward an inquiring mind.

"Order to mins and maximums,"
The first was heard to say,
"You'll have neither too much nor too little
When production's controlled this way."

"But the answer lies in a forecast,"
Said the second man in line,
"Just anticipate your sales,
And everything will be fine,

"I doubt it" said the third one,
"You've forgotten the EOQ.
With balanced setups and inventories,
What problems can ensue?"

The fourth one said: "Use order points
To get the desired control.
When you order materials soon enough,
You'll never be in the hole."

"But you really need a computer."
Said the fifth---" P.C.'s a dream
With loads run from last week's payroll cards
And exception reports by the ream.

Said the sixth, "Materials management
Is a concept to which I'm devoted---
Instead of learning production control,
I've escaped by getting promoted!"

So study each book and seminar,
Attend every one you can, sir!
You'll find a thousand experts
---each with **PART** of the answer.

O.W. Wight

REFERENCES CITED

Adam, Everett E. Jr. and Ronald J. Ebert. 1989. Production and Operations Management. 4th ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Acquilano, Nicholas J. and Richard B. Chase. 1991. Fundamentals of Operations Management. Homewood: Richard D. Irwin, Inc.

Buchan, J. and E. Koenigsberg. 1963. Scientific Inventory Control. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Buffa, Elwood S. 1980. Modern Production/Operations Management. 6th ed. New York: John Wiley and Sons.

Ehrhardt, Richard. 1984. "(s,S) Policies for a Dynamic Inventory Model With Stochastic Lead Time." Operations Research. Vol. 32, No. 1. 121-131.

Heizer, Jay and Barry Render. 1988. Production and Operations Management. Boston: Allyn and Bacon, Inc.

Plossl, G.W. and O.W. Wight, 1967, Production and Inventory Control. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Porteus, Evan L. 1985. "Numerical Comparisons of Inventory Policies for Periodic Review Systems." Operations Research. Vol. 33, No. 1. 134-151.

Stermole, Franklin J. and John M. Stermole. 1990. Economic Evaluation and Investment Decision Methods. 7th ed. Golden, Colorado: Investment Evaluations Corporation.

Tersine, Richard J. 1982. Principles of Inventory and Materials Management. 2nd ed. New York: North-Holland.

Walpole, Ronald E. and Raymond H. Myers. 1989. Probability and Statistics for Engineers and Scientists. 4th ed. New York: Macmillan Publishing Company.

Woolsey, Robert E.D. and Huntington S. Swanson. 1975. Operations Research for Immediate Application. New York: Harper and Row Publishers.

APPENDIX A

DENRO'S CALL DATA SHEET

TECHNICAL ASSISTANCE CENTER PHONE CALL DATA SHEET			
1. Site:		2. Date:	3. Duty CSR:
4. Caller:		5. Time Call Received:	
6. Phone Number:		7. Time Sheet Completed:	
8. Call Out:	9. On Site:	10. Repaired:	11. Off Site:
12. Details of Problem:			
13. Corrective Action:			
14. Date Corrected:		15. Time spent on phone:	

16. Failed Parts			
Part Number	Serial Number	Rev	Nomenclature
Returned by:	Date:		Method:

17. Parts Installed in System			
Part Number	Serial Number	Rev	Nomenclature

18. Parts Order Number _____ - _____			
Part Number	Qty.	Notes	Nomenclature
19. Material Transfer Completed By:			20. Shipping #

APPENDIX B

SHIPPING REPORT

DENRO
9318 Gaither Road, Gaithersburg, Maryland 20877
(301) 840-1597

[illegible]

SOLD TO

SHIP TO

DATE ENTERED	CUSTOMER ORDER NUMBER	[illegible]	[illegible]	DATE SHIPPED
			☐ PPD. ☐ COLL.	

ITEM	QUANTITY ORDERED	PART NUMBER	REV.	PART DESCRIPTION	ORDERED	SHIPPED

APPENDIX C

PACKING LIST

DENRO Inc.
9318 Gaither Road
Gaithersburg, MD 20877

PACKING LIST

DATE SHIPPED: JANUARY 27, 1992

SHIP TO:	SOLD TO:
DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION MANASSAS AIRPORT 1ST FLOOR, TELCO ROOM MANASSAS, VIRGINIA 02274	DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION PROCUREMENT BRANCH AEA-55B FIRZGERALD FEDERAL BUILDING #111 JFK INTERNATIONAL AIRPORT JAMAICA, NEW YORK 11430

JOB NUMBER	CONTRACT NUMBER	ORDER NUMBER	REQ REF NUMBER
468	GS00K91AGS0719	DTFA05-91-F-40564	1808061

NO. OF PIECES	SHIP VIA:	BL: SHIPPER NUMBER
8 7 BOXES 1 RACK 36" 545.0 LBS. TOTAL APPROX. WT.	MOTOR FREIGHT DENRO PERSONNEL	G - 1952 INVOICE NUMBER

DESCRIPTION

SYSTEM MODEL 466 ICSS

System Consists of:
1 RACK
4 POSITIONS
Plus Ancillary Equipment and Spares.

APPENDIX D

DAILY ACTIVITY REPORT

DAILY ACTIVITY REPORT
LOGISTICS
JANUARY 27, 1992

DAILY ACTIVITY REPORT FOR JANUARY 27, 1992

SITE	PROBLEM

TYPE III-IA ACTIVITY

TYPE III ACTIVITY

MODEL 466 ACTIVITY

GSA 400 ACTIVITY

No calls.

INSTALLATION

No calls.

APPENDIX E

MATERIAL TRANSFER

31940

Material Transfer DENRO	From	Account No.		To	
		Sales No.			
		Work Order No.			

Item No.	Part No.	Quantity	Description	Standard Matl. Cost	Extension
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Req. By DATE	Approved By DATE	TOTAL $
Recd. By DATE	Posted By DATE	Extended By DATE

APPENDIX F

TRANSACTION HISTORY FILE

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	164.2500 164.2500	5/25/90		
120401-012	2	IS	1	EA	151.8900 151.8900	8/08/90		
120401-012	2	IS	2	EA	295.7612	7/11/89		
120401-012	2	IS	1	EA	147.8806	7/11/89		
120401-012	2	IS	1	EA	147.8806	7/11/89		
120401-012	2	IS	1	EA	147.8806	7/11/89		
120401-012	2	IS	1	EA	147.8806	7/11/89		
120401-012	2	IS	1	EA	147.8806	7/11/89		
120401-012	2	IS	1	EA	147.8806	7/11/89		
120401-012	2	IS	1	EA	147.8806	7/13/89		
120401-012	2	IS	1	EA	147.8806	7/13/89		
120401-012	2	IS	1	EA	147.8806	7/13/89		
120401-012	2	IS	1	EA	147.8806	7/13/89		
120401-012	2	IS	1	EA	147.8806	7/13/89		
120401-012	2	IS	2	EA	315.1490	7/18/89		
120401-012	2	IS	1	EA	157.5745	7/18/89		
120401-012	2	IS	1	EA	157.5745	7/18/89		
120401-012	2	IS	3	EA	472.7235	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/20/89		
120401-012	2	IS	2	EA	315.1490	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/20/89		
120401-012	2	IS	1	EA	157.5745	7/24/89		
120401-012	2	IS	1	EA	157.5745	7/25/89		
120401-012	2	IS	6	EA	945.4470	7/25/89		
120401-012	2	IS	1	EA	157.5745	7/25/89		
120401-012	2	IS	1	EA	157.5745	7/27/89		
120401-012	2	IS	1	EA	157.5745	7/27/89		
120401-012	2	IS	1	EA	157.5745	7/27/89		
120401-012	2	IS	1	EA	157.5745	7/27/89		
120401-012	2	IS	2	EA	315.1490	7/27/89		
120401-012	2	IS	1	EA	157.5745	7/27/89		
120401-012	2	IS	3	EA	464.3934	8/01/89		
120401-012	2	IS	3	EA	464.3934	8/01/89		
120401-012	2	IS	1	EA	154.7978	8/01/89		
120401-012	2	IS	2	EA	309.5956	8/01/89		
120401-012	2	IS	1	EA	154.7978	8/01/89		
120401-012	2	IS	4	EA	619.1912	8/03/89		
120401-012	2	IS	1	EA	154.7978	8/03/89		
120401-012	2	IS	2	EA	309.5956	8/03/89		
120401-012	2	IS	1	EA	154.7978	8/03/89		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	154.7978	8/03/89		
120401-012	2	IS	1	EA	154.9297	8/07/89		
120401-012	2	IS	1	EA	154.9297	8/07/89		
120401-012	2	IS	1	EA	154.9297	8/07/89		
120401-012	2	IS	1	EA	154.9297	8/07/89		
120401-012	2	IS	1	EA	154.9297	8/08/89		
120401-012	2	IS	1	EA	154.9297	8/08/89		
120401-012	2	IS	4	EA	619.7188	8/10/89		
120401-012	2	IS	1	EA	154.9297	8/10/89		
120401-012	2	IS	3	EA	464.7891	8/10/89		
120401-012	2	IS	1	EA	154.9297	8/10/89		
120401-012	2	IS	2	EA	309.8594	8/14/89		
120401-012	2	IS	3	EA	462.8934	8/15/89		
120401-012	2	IS	2	EA	308.5956	8/22/89		
120401-012	2	IS	5	EA	771.4890	8/22/89		
120401-012	2	IS	1	EA	154.2978	8/22/89		
120401-012	2	IS	2	EA	308.5956	8/22/89		
120401-012	2	IS	1	EA	154.2978	8/24/89		
120401-012	2	IS	1	EA	154.2978	8/24/89		
120401-012	2	IS	2	EA	308.5956	8/24/89		
120401-012	2	IS	1	EA	154.2978	8/24/89		
120401-012	2	IS	1	EA	158.6045	8/29/89		
120401-012	2	IS	1	EA	158.6045	8/29/89		
120401-012	2	IS	1	EA	158.6045	8/29/89		
120401-012	2	IS	1	EA	158.6045	8/29/89		
120401-012	2	IS	3	EA	475.8135	8/29/89		
120401-012	2	IS	1	EA	158.6045	8/29/89		
120401-012	2	IS	2	EA	317.2090	8/29/89		
120401-012	2	IS	1	EA	158.6045	8/29/89		
120401-012	2	IS	2	EA	317.2090	8/31/89		
120401-012	2	IS	1	EA	158.6045	8/31/89		
120401-012	2	IS	1	EA	158.6045	8/31/89		
120401-012	2	IS	1	EA	159.4580	9/05/89		
120401-012	2	IS	3	EA	478.3740	9/05/89		
120401-012	2	IS	1	EA	159.4580	9/08/89		
120401-012	2	IS	1	EA	159.4580	9/08/89		
120401-012	2	IS	1	EA	159.4580	9/08/89		
120401-012	2	IS	1	EA	159.4580	9/08/89		
120401-012	2	IS	3	EA	478.3740	9/08/89		
120401-012	2	IS	1	EA	159.4580	9/08/89		
120401-012	2	IS	1	EA	159.4580	9/08/89		
120401-012	2	IS	9	EA	1,435.1220	9/08/89		
120401-012	2	IS	1	EA	159.4580	9/08/89		
120401-012	2	IS	1	EA	159.3648	9/12/89		
120401-012	2	IS	2	EA	318.7300	9/14/89		
120401-012	2	IS	1	EA	159.3600	9/14/89		
120401-012	2	IS	9	EA	1,434.2800	9/14/89		
120401-012	2	IS	1	EA	159.3600	9/15/89		
120401-012	2	IS	1	EA	159.3600	9/15/89		
120401-012	2	IS	2	EA	318.7300	9/15/89		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	4	EA	637.4600	9/15/89		
120401-012	2	IS	1	EA	157.6500	9/19/89		
120401-012	2	IS	1	EA	157.6500	9/19/89		
120401-012	2	IS	2	EA	315.3000	9/19/89		
120401-012	2	IS	1	EA	157.6500	9/19/89		
120401-012	2	IS	1	EA	157.6500	9/19/89		
120401-012	2	IS	1	EA	157.6500	9/20/89		
120401-012	2	IS	5	EA	788.2500	9/20/89		
120401-012	2	IS	1	EA	157.6500	9/20/89		
120401-012	2	IS	2	EA	315.3000	9/21/89		
120401-012	2	IS	1	EA	157.6500	9/22/89		
120401-012	2	IS	1	EA	158.2200	9/26/89		
120401-012	2	IS	1	EA	158.2200	9/26/89		
120401-012	2	IS	1	EA	158.2200	9/26/89		
120401-012	2	IS	1	EA	158.2200	9/26/89		
120401-012	2	IS	1	EA	158.2200	9/29/89		
120401-012	2	IS	2	EA	316.4400	9/29/89		
120401-012	2	IS	2	EA	316.4400	9/29/89		
120401-012	2	IS	1	EA	158.2200	10/03/89		
120401-012	2	IS	1	EA	158.2200	10/03/89		
120401-012	2	IS	1	EA	158.2200	10/03/89		
120401-012	2	IS	1	EA	158.2200	10/03/89		
120401-012	2	IS	2	EA	316.4400	10/03/89		
120401-012	2	IS	1	EA	158.2200	10/03/89		
120401-012	2	IS	1	EA	158.2200	10/03/89		
120401-012	2	IS	1	EA	158.2200	10/06/89		
120401-012	2	IS	1	EA	158.2200	10/06/89		
120401-012	2	IS	1	EA	158.2200	10/06/89		
120401-012	2	IS	1	EA	158.6200	10/10/89		
120401-012	2	IS	1	EA	158.6200	10/10/89		
120401-012	2	IS	1	EA	158.6200	10/12/89		
120401-012	2	IS	1	EA	158.6200	10/12/89		
120401-012	2	IS	1	EA	158.6200	10/12/89		
120401-012	2	IS	1	EA	158.6200	10/12/89		
120401-012	2	IS	1	EA	158.6200	10/13/89		
120401-012	2	IS	1	EA	158.6200	10/13/89		
120401-012	2	IS	1	EA	158.6200	10/13/89		
120401-012	2	IS	3	EA	473.4600	10/16/89		
120401-012	2	IS	2	EA	315.6400	10/16/89		
120401-012	2	IS	1	EA	157.8200	10/16/89		
120401-012	2	IS	1	EA	157.8200	10/17/89		
120401-012	2	IS	3	EA	473.4600	10/17/89		
120401-012	2	IS	1	EA	157.8200	10/19/89		
120401-012	2	IS	1	EA	157.8200	10/19/89		
120401-012	2	IS	1	EA	157.8200	10/20/89		
120401-012	2	IS	1	EA	157.8200	10/20/89		
120401-012	2	IS	1	EA	157.8200	10/20/89		
120401-012	2	IS	1	EA	157.8200	10/20/89		
120401-012	2	IS	1	EA	157.8200	10/24/89		
120401-012	2	IS	1	EA	157.8200	10/30/89		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	4	EA	631.2800	10/30/89		
120401-012	2	IS	1	EA	157.8200	10/30/89		
120401-012	2	IS	4	EA	631.2800	10/30/89		
120401-012	2	IS	1	EA	157.8200	10/30/89		
120401-012	2	IS	1	EA	157.8200	10/30/89		
120401-012	2	IS	1	EA	157.8200	10/30/89		
120401-012	2	IS	1	EA	157.8200	11/02/89		
120401-012	2	IS	1	EA	157.8200	11/02/89		
120401-012	2	IS	3	EA	473.4600	11/02/89		
120401-012	2	IS	2	EA	315.6400	11/02/89		
120401-012	2	IS	1	EA	157.8200	11/02/89		
120401-012	2	IS	1	EA	157.8200	11/07/89		
120401-012	2	IS	1	EA	157.8200	11/07/89		
120401-012	2	IS	1	EA	157.8200	11/07/89		
120401-012	2	IS	1	EA	157.8200	11/07/89		
120401-012	2	IS	1	EA	157.8200	11/07/89		
120401-012	2	IS	1	EA	157.8200	11/09/89		
120401-012	2	IS	1	EA	157.8200	11/10/89		
120401-012	2	IS	1	EA	158.0000	11/13/89		
120401-012	2	IS	3	EA	474.0000	11/14/89		
120401-012	2	IS	2	EA	316.0000	11/16/89		
120401-012	2	IS	1	EA	158.0000	11/16/89		
120401-012	2	IS	1	EA	158.0000	11/17/89		
120401-012	2	IS	1	EA	158.0000	11/17/89		
120401-012	2	IS	1	EA	158.0000	11/21/89		
120401-012	2	IS	1	EA	158.0000	11/21/89		
120401-012	2	IS	1	EA	158.0000	11/21/89		
120401-012	2	IS	1	EA	158.0000	11/21/89		
120401-012	2	IS	2	EA	316.0000	11/21/89		
120401-012	2	IS	1	EA	156.9100	11/28/89		
120401-012	2	IS	2	EA	313.8200	11/28/89		
120401-012	2	IS	1	EA	156.9100	11/28/89		
120401-012	2	IS	1	EA	156.9100	11/28/89		
120401-012	2	IS	2	EA	313.8200	11/28/89		
120401-012	2	IS	2	EA	313.8200	11/28/89		
120401-012	2	IS	1	EA	156.9100	11/28/89		
120401-012	2	IS	1	EA	156.9100	11/28/89		
120401-012	2	IS	1	EA	156.9100	11/30/89		
120401-012	2	IS	1	EA	156.9100	11/30/89		
120401-012	2	IS	2	EA	313.8200	12/01/89		
120401-012	2	IS	1	EA	156.9100	12/01/89		
120401-012	2	IS	1	EA	156.9100	12/01/89		
120401-012	2	IS	1	EA	156.9100	12/01/89		
120401-012	2	IS	1	EA	156.9100	12/01/89		
120401-012	2	IS	1	EA	156.9100	12/04/89		
120401-012	2	IS	1	EA	156.9100	12/05/89		
120401-012	2	IS	1	EA	156.9100	12/05/89		
120401-012	2	IS	1	EA	156.9100	12/05/89		
120401-012	2	IS	1	EA	156.9100	12/05/89		
120401-012	2	IS	1	EA	156.9100	12/05/89		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	156.9100	12/05/89		
120401-012	2	IS	1	EA	156.9100	12/05/89		
120401-012	2	IS	1	EA	155.1000	12/07/89		
120401-012	2	IS	1	EA	154.8600	12/11/89		
120401-012	2	IS	2	EA	309.7200	12/13/89		
120401-012	2	IS	1	EA	154.8600	12/13/89		
120401-012	2	IS	1	EA	154.8600	12/13/89		
120401-012	2	IS	1	EA	154.8600	12/13/89		
120401-012	2	IS	1	EA	154.8600	12/13/89		
120401-012	2	IS	1	EA	154.8600	12/18/89		
120401-012	2	IS	1	EA	154.8600	12/18/89		
120401-012	2	IS	1	EA	154.8600	12/19/89		
120401-012	2	IS	1	EA	154.8600	12/19/89		
120401-012	2	IS	4	EA	619.4400	12/20/89		
120401-012	2	IS	1	EA	154.8600	12/20/89		
120401-012	2	IS	2	EA	309.7200	12/20/89		
120401-012	2	IS	1	EA	154.8600	12/21/89		
120401-012	2	IS	1	EA	154.8600	12/21/89		
120401-012	2	IS	1	EA	154.8600	12/26/89		
120401-012	2	IS	2	EA	309.7200	12/26/89		
120401-012	2	IS	2	EA	309.7200	12/26/89		
120401-012	2	IS	1	EA	154.8600	12/27/89		
120401-012	2	IS	1	EA	154.8600	12/27/89		
120401-012	2	IS	1	EA	154.8600	12/28/89		
120401-012	2	IS	1	EA	154.6100	1/02/90		
120401-012	2	IS	1	EA	154.6100	1/02/90		
120401-012	2	IS	1	EA	154.6100	1/02/90		
120401-012	2	IS	4	EA	618.4400	1/02/90		
120401-012	2	IS	1	EA	154.6100	1/04/90		
120401-012	2	IS	1	EA	154.6100	1/04/90		
120401-012	2	IS	1	EA	154.6100	1/09/90		
120401-012	2	IS	1	EA	154.6100	1/09/90		
120401-012	2	IS	1	EA	154.6100	1/09/90		
120401-012	2	IS	1	EA	154.6100	1/11/90		
120401-012	2	IS	1	EA	154.6100	1/11/90		
120401-012	2	IS	1	EA	154.6100	1/11/90		
120401-012	2	IS	2	EA	309.2200	1/11/90		
120401-012	2	IS	1	EA	154.6100	1/11/90		
120401-012	2	IS	1	EA	154.6100	1/11/90		
120401-012	2	IS	1	EA	154.6100	1/15/90		
120401-012	2	IS	1	EA	154.6100	1/15/90		
120401-012	2	IS	1	EA	154.6100	1/15/90		
120401-012	2	IS	1	EA	154.6100	1/15/90		
120401-012	2	IS	2	EA	309.2200	1/16/90		
120401-012	2	IS	1	EA	154.6100	1/17/90		
120401-012	2	IS	1	EA	154.6100	1/18/90		
120401-012	2	IS	1	EA	154.6100	1/19/90		
120401-012	2	IS	4	EA	618.4400	1/19/90		
120401-012	2	IS	1	EA	154.6100	1/19/90		
120401-012	2	IS	1	EA	154.6100	1/19/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	154.6100	1/19/90		
120401-012	2	IS	1	EA	154.6100	1/22/90		
120401-012	2	IS	1	EA	154.6100	1/23/90		
120401-012	2	IS	1	EA	154.6100	1/23/90		
120401-012	2	IS	3	EA	463.8300	1/23/90		
120401-012	2	IS	3	EA	463.8300	1/23/90		
120401-012	2	IS	1	EA	154.6100	1/24/90		
120401-012	2	IS	3	EA	463.8300	1/24/90		
120401-012	2	IS	1	EA	154.6100	1/25/90		
120401-012	2	IS	1	EA	154.2700	1/29/90		
120401-012	2	IS	1	EA	154.2700	1/29/90		
120401-012	2	IS	1	EA	154.2700	1/29/90		
120401-012	2	IS	1	EA	154.2700	1/29/90		
120401-012	2	IS	1	EA	154.2700	1/30/90		
120401-012	2	IS	1	EA	154.2700	1/30/90		
120401-012	2	IS	1	EA	154.2700	2/01/90		
120401-012	2	IS	1	EA	154.2700	2/01/90		
120401-012	2	IS	2	EA	308.5400	2/01/90		
120401-012	2	IS	1	EA	154.2700	2/02/90		
120401-012	2	IS	1	EA	154.2700	2/05/90		
120401-012	2	IS	3	EA	462.8100	2/06/90		
120401-012	2	IS	1	EA	154.2700	2/06/90		
120401-012	2	IS	3	EA	462.8100	2/06/90		
120401-012	2	IS	4	EA	617.0800	2/06/90		
120401-012	2	IS	1	EA	154.2700	2/06/90		
120401-012	2	IS	1	EA	154.2700	2/06/90		
120401-012	2	IS	1	EA	155.6200	2/08/90		
120401-012	2	IS	1	EA	155.6200	2/12/90		
120401-012	2	IS	1	EA	155.6200	2/12/90		
120401-012	2	IS	2	EA	311.2500	2/12/90		
120401-012	2	IS	1	EA	155.6200	2/12/90		
120401-012	2	IS	1	EA	155.6200	2/12/90		
120401-012	2	IS	1	EA	155.6200	2/12/90		
120401-012	2	IS	1	EA	155.6200	2/12/90		
120401-012	2	IS	1	EA	155.6200	2/12/90		
120401-012	2	IS	1	EA	155.6200	2/13/90		
120401-012	2	IS	1	EA	155.6200	2/14/90		
120401-012	2	IS	1	EA	155.6200	2/14/90		
120401-012	2	IS	1	EA	155.6200	2/14/90		
120401-012	2	IS	1	EA	156.9000	2/21/90		
120401-012	2	IS	1	EA	156.9000	2/21/90		
120401-012	2	IS	1	EA	156.9000	2/21/90		
120401-012	2	IS	1	EA	156.9000	2/21/90		
120401-012	2	IS	1	EA	156.9000	2/21/90		
120401-012	2	IS	1	EA	156.9000	2/25/90		
120401-012	2	IS	1	EA	156.9000	2/25/90		
120401-012	2	IS	1	EA	156.9000	2/28/90		
120401-012	2	IS	2	EA	313.8000	2/28/90		
120401-012	2	IS	1	EA	156.9000	2/28/90		
120401-012	2	IS	1	EA	156.9000	2/28/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	156.9000	2/28/90		
120401-012	2	IS	1	EA	156.9000	2/28/90		
120401-012	2	IS	1	EA	156.9000	3/01/90		
120401-012	2	IS	1	EA	164.6200	3/05/90		
120401-012	2	IS	2	EA	329.2300	3/08/90		
120401-012	2	IS	1	EA	164.6200	3/08/90		
120401-012	2	IS	1	EA	164.6200	3/08/90		
120401-012	2	IS	2	EA	329.2300	3/08/90		
120401-012	2	IS	1	EA	164.6200	3/08/90		
120401-012	2	IS	1	EA	164.6200	3/08/90		
120401-012	2	IS	1	EA	164.6200	3/08/90		
120401-012	2	IS	1	EA	164.6200	3/08/90		
120401-012	2	IS	1	EA	164.6200	3/09/90		
120401-012	2	IS	3	EA	493.8500	3/09/90		
120401-012	2	IS	1	EA	164.7500	3/12/90		
120401-012	2	IS	1	EA	164.7500	3/12/90		
120401-012	2	IS	2	EA	329.5100	3/13/90		
120401-012	2	IS	1	EA	164.7500	3/13/90		
120401-012	2	IS	1	EA	164.7500	3/13/90		
120401-012	2	IS	1	EA	164.7500	3/13/90		
120401-012	2	IS	2	EA	329.5100	3/13/90		
120401-012	2	IS	1	EA	164.7500	3/15/90		
120401-012	2	IS	1	EA	164.7500	3/16/90		
120401-012	2	IS	1	EA	164.7500	3/16/90		
120401-012	2	IS	1	EA	164.7500	3/16/90		
120401-012	2	IS	1	EA	164.7500	3/16/90		
120401-012	2	IS	1	EA	164.7500	3/20/90		
120401-012	2	IS	2	EA	329.5100	3/20/90		
120401-012	2	IS	1	EA	164.7500	3/21/90		
120401-012	2	IS	1	EA	164.7500	3/26/90		
120401-012	2	IS	1	EA	164.7500	3/26/90		
120401-012	2	IS	1	EA	164.7500	3/26/90		
120401-012	2	IS	1	EA	164.7500	3/26/90		
120401-012	2	IS	1	EA	164.7500	3/26/90		
120401-012	2	IS	2	EA	329.5100	3/26/90		
120401-012	2	IS	1	EA	164.7500	3/29/90		
120401-012	2	IS	1	EA	164.7500	3/29/90		
120401-012	2	IS	1	EA	164.7500	3/29/90		
120401-012	2	IS	1	EA	164.7500	3/29/90		
120401-012	2	IS	1	EA	164.7500	3/29/90		
120401-012	2	IS	1	EA	164.7500	3/29/90		
120401-012	2	IS	2	EA	329.5100	3/30/90		
120401-012	2	IS	1	EA	164.7500	4/01/90		
120401-012	2	IS	1	EA	164.7500	4/01/90		
120401-012	2	IS	1	EA	164.7500	4/02/90		
120401-012	2	IS	1	EA	164.7500	4/02/90		
120401-012	2	IS	1	EA	164.7500	4/02/90		
120401-012	2	IS	1	EA	164.7500	4/06/90		
120401-012	2	IS	1	EA	164.7500	4/06/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	164.7500	4/06/90		
120401-012	2	IS	1	EA	164.7500	4/09/90		
120401-012	2	IS	1	EA	164.7500	4/09/90		
120401-012	2	IS	1	EA	164.7500	4/09/90		
120401-012	2	IS	1	EA	164.7500	4/09/90		
120401-012	2	IS	1	EA	164.7500	4/09/90		
120401-012	2	IS	1	EA	164.7500	4/11/90		
120401-012	2	IS	1	EA	164.7500	4/12/90		
120401-012	2	IS	1	EA	164.7500	4/13/90		
120401-012	2	IS	1	EA	164.7500	4/16/90		
120401-012	2	IS	1	EA	164.7500	4/17/90		
120401-012	2	IS	1	EA	164.7500	4/19/90		
120401-012	2	IS	1	EA	164.7500	4/19/90		
120401-012	2	IS	1	EA	164.7500	4/19/90		
120401-012	2	IS	1	EA	164.7500	4/19/90		
120401-012	2	IS	1	EA	164.7500	4/23/90		
120401-012	2	IS	3	EA	494.2600	4/23/90		
120401-012	2	IS	1	EA	164.7500	4/24/90		
120401-012	2	IS	1	EA	164.7500	4/24/90		
120401-012	2	IS	1	EA	164.7500	4/25/90		
120401-012	2	IS	1	EA	164.6600	4/26/90		
120401-012	2	IS	1	EA	164.6600	4/30/90		
120401-012	2	IS	3	EA	493.9700	4/30/90		
120401-012	2	IS	1	EA	164.6600	5/01/90		
120401-012	2	IS	1	EA	164.6600	5/02/90		
120401-012	2	IS	1	EA	164.6600	5/02/90		
120401-012	2	IS	1	EA	164.6600	5/03/90		
120401-012	2	IS	1	EA	164.6600	5/07/90		
120401-012	2	IS	1	EA	164.6600	5/08/90		
120401-012	2	IS	1	EA	164.6600	5/11/90		
120401-012	2	IS	1	EA	164.6600	5/11/90		
120401-012	2	IS	1	EA	164.6600	5/14/90		
120401-012	2	IS	1	EA	164.6600	5/15/90		
120401-012	2	IS	2	EA	329.3100	5/16/90		
120401-012	2	IS	2	EA	329.3100	5/16/90		
120401-012	2	IS	1	EA	164.6600	5/16/90		
120401-012	2	IS	2	EA	329.3100	5/17/90		
120401-012	2	IS	1	EA	164.6600	5/17/90		
120401-012	2	IS	1	EA	164.6600	5/17/90		
120401-012	2	IS	1	EA	164.6600	5/18/90		
120401-012	2	IS	1	EA	164.6600	5/18/90		
120401-012	2	IS	1	EA	164.6600	5/18/90		
120401-012	2	IS	1	EA	164.2500	5/23/90		
120401-012	2	IS	1	EA	164.2500	5/23/90		
120401-012	2	IS	2	EA	328.5100	5/23/90		
120401-012	2	IS	1	EA	164.2500	5/23/90		
120401-012	2	IS	1	EA	164.2500	5/25/90		
120401-012	2	IS	1	EA	164.2500	5/30/90		
120401-012	2	IS	1	EA	164.2500	5/30/90		
120401-012	2	IS	1	EA	164.2500	5/31/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	164.2500	5/31/90		
120401-012	2	IS	1	EA	164.2500	5/31/90		
120401-012	2	IS	1	EA	164.2500	5/31/90		
120401-012	2	IS	1	EA	164.2500	5/31/90		
120401-012	2	IS	2	EA	328.5100	5/31/90		
120401-012	2	IS	1	EA	164.2500	6/04/90		
120401-012	2	IS	2	EA	328.5100	6/05/90		
120401-012	2	IS	1	EA	164.2500	6/06/90		
120401-012	2	IS	2	EA	328.5100	6/06/90		
120401-012	2	IS	1	EA	164.2500	6/07/90		
120401-012	2	IS	1	EA	164.2500	6/11/90		
120401-012	2	IS	1	EA	164.2500	6/11/90		
120401-012	2	IS	1	EA	164.2500	6/12/90		
120401-012	2	IS	1	EA	164.2500	6/12/90		
120401-012	2	IS	1	EA	164.2500	6/12/90		
120401-012	2	IS	1	EA	164.2500	6/12/90		
120401-012	2	IS	1	EA	164.2500	6/13/90		
120401-012	2	IS	2	EA	328.5100	6/13/90		
120401-012	2	IS	1	EA	160.6800	6/14/90		
120401-012	2	IS	1	EA	160.6800	6/14/90		
120401-012	2	IS	2	EA	321.3600	6/14/90		
120401-012	2	IS	1	EA	160.6800	6/18/90		
120401-012	2	IS	2	EA	321.3600	6/18/90		
120401-012	2	IS	1	EA	160.6800	6/19/90		
120401-012	2	IS	1	EA	160.6800	6/19/90		
120401-012	2	IS	1	EA	160.6800	6/19/90		
120401-012	2	IS	1	EA	160.6800	6/19/90		
120401-012	2	IS	1	EA	160.6800	6/19/90		
120401-012	2	IS	2	EA	321.3600	6/20/90		
120401-012	2	IS	2	EA	321.3600	6/22/90		
120401-012	2	IS	1	EA	160.6800	6/22/90		
120401-012	2	IS	2	EA	321.3600	6/25/90		
120401-012	2	IS	1	EA	160.6800	6/25/90		
120401-012	2	IS	1	EA	160.6800	6/25/90		
120401-012	2	IS	1	EA	160.6800	6/25/90		
120401-012	2	IS	1	EA	160.6800	6/25/90		
120401-012	2	IS	1	EA	160.6800	6/25/90		
120401-012	2	IS	1	EA	160.6800	6/26/90		
120401-012	2	IS	2	EA	321.3600	6/27/90		
120401-012	2	IS	2	EA	321.3600	6/27/90		
120401-012	2	IS	1	EA	160.6800	6/28/90		
120401-012	2	IS	3	EA	482.0400	6/28/90		
120401-012	2	IS	1	EA	160.6800	6/28/90		
120401-012	2	IS	2	EA	304.1800	7/02/90		
120401-012	2	IS	2	EA	304.1800	7/02/90		
120401-012	2	IS	1	EA	152.0900	7/02/90		
120401-012	2	IS	1	EA	152.0900	7/03/90		
120401-012	2	IS	1	EA	152.0900	7/03/90		
120401-012	2	IS	2	EA	304.1800	7/03/90		
120401-012	2	IS	1	EA	152.0900	7/05/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	152.0900	7/05/90		
120401-012	2	IS	1	EA	152.0900	7/06/90		
120401-012	2	IS	1	EA	152.0900	7/06/90		
120401-012	2	IS	3	EA	456.2700	7/06/90		
120401-012	2	IS	1	EA	152.0900	7/09/90		
120401-012	2	IS	1	EA	152.0900	7/09/90		
120401-012	2	IS	2	EA	304.1800	7/09/90		
120401-012	2	IS	2	EA	304.1800	7/09/90		
120401-012	2	IS	2	EA	304.1800	7/10/90		
120401-012	2	IS	1	EA	152.0900	7/11/90		
120401-012	2	IS	2	EA	303.7700	7/16/90		
120401-012	2	IS	1	EA	151.8900	7/16/90		
120401-012	2	IS	1	EA	151.8900	7/16/90		
120401-012	2	IS	1	EA	151.8900	7/16/90		
120401-012	2	IS	1	EA	151.8900	7/16/90		
120401-012	2	IS	1	EA	151.8900	7/17/90		
120401-012	2	IS	2	EA	303.7700	7/18/90		
120401-012	2	IS	2	EA	303.7700	7/19/90		
120401-012	2	IS	2	EA	303.7700	7/19/90		
120401-012	2	IS	2	EA	303.7700-	7/19/90		
120401-012	2	IS	2	EA	303.7700	7/21/90		
120401-012	2	IS	1	EA	151.8900	7/23/90		
120401-012	2	IS	1	EA	151.8900	7/23/90		
120401-012	2	IS	1	EA	151.8900	7/23/90		
120401-012	2	IS	1	EA	151.8900	7/24/90		
120401-012	2	IS	1	EA	151.8900	7/26/90		
120401-012	2	IS	1	EA	151.8900	7/26/90		
120401-012	2	IS	1	EA	151.8900	7/30/90		
120401-012	2	IS	1	EA	151.8900	7/30/90		
120401-012	2	IS	1	EA	151.8900	7/31/90		
120401-012	2	IS	2	EA	303.7700	7/31/90		
120401-012	2	IS	.	EA	151.8900	8/01/90		
120401-012	2	IS	2	EA	303.7700	8/02/90		
120401-012	2	IS	1	EA	151.8900	8/03/90		
120401-012	2	IS	1	EA	151.8900	8/06/90		
120401-012	2	IS	1	EA	151.8900	8/06/90		
120401-012	2	IS	1	EA	151.8900	8/06/90		
120401-012	2	IS	1	EA	151.8900	8/06/90		
120401-012	2	IS	2	EA	303.7700	8/07/90		
120401-012	2	IS	4	EA	607.5500	8/07/90		
120401-012	2	IS	1	EA	151.8900	8/07/90		
120401-012	2	IS	1	EA	151.8900	8/08/90		
120401-012	2	IS	2	EA	303.7700	8/08/90		
120401-012	2	IS	1	EA	151.8500	8/09/90		
120401-012	2	IS	2	EA	303.6900	8/13/90		
120401-012	2	IS	1	EA	151.8500	8/14/90		
120401-012	2	IS	1	EA	151.8500	8/15/90		
120401-012	2	IS	2	EA	303.6900	8/15/90		
120401-012	2	IS	1	EA	151.8500	8/15/90		
120401-012	2	IS	1	EA	151.8500	8/15/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	151.8500	8/15/90		
120401-012	2	IS	1	EA	151.8500	8/16/90		
120401-012	2	IS	1	EA	151.8500	8/16/90		
120401-012	2	IS	1	EA	151.8500	8/16/90		
120401-012	2	IS	1	EA	151.8500	8/17/90		
120401-012	2	IS	1	EA	151.8500	8/21/90		
120401-012	2	IS	1	EA	151.8500	8/21/90		
120401-012	2	IS	5	EA	759.2700	8/22/90		
120401-012	2	IS	2	EA	303.7100	8/22/90		
120401-012	2	IS	1	EA	151.8500	8/23/90		
120401-012	2	IS	1	EA	150.7600	8/27/90		
120401-012	2	IS	1	EA	150.7600	8/27/90		
120401-012	2	IS	1	EA	150.7600	8/27/90		
120401-012	2	IS	1	EA	150.7600	8/28/90		
120401-012	2	IS	1	EA	150.7600	8/28/90		
120401-012	2	IS	1	EA	150.7600	8/28/90		
120401-012	2	IS	1	EA	150.7600	8/28/90		
120401-012	2	IS	3	EA	452.2900	8/29/90		
120401-012	2	IS	1	EA	150.7600	8/29/90		
120401-012	2	IS	1	EA	150.7600	8/29/90		
120401-012	2	IS	1	EA	147.9600	8/31/90		
120401-012	2	IS	1	EA	147.9600	9/04/90		
120401-012	2	IS	1	EA	147.9600	9/04/90		
120401-012	2	IS	1	EA	147.9600	9/05/90		
120401-012	2	IS	1	EA	147.9600	9/05/90		
120401-012	2	IS	3	EA	443.8900	9/07/90		
120401-012	2	IS	1	EA	147.9600	9/07/90		
120401-012	2	IS	1	EA	147.9600	9/10/90		
120401-012	2	IS	1	EA	147.9600	9/11/90		
120401-012	2	IS	1	EA	147.9600	9/12/90		
120401-012	2	IS	1	EA	147.9600	9/14/90		
120401-012	2	IS	1	EA	147.9600	9/17/90		
120401-012	2	IS	1	EA	147.9600	9/18/90		
120401-012	2	IS	2	EA	295.9200	9/19/90		
120401-012	2	IS	1	EA	147.9600	9/19/90		
120401-012	2	IS	1	EA	147.9600	9/19/90		
120401-012	2	IS	1	EA	147.9600	9/20/90		
120401-012	2	IS	1	EA	147.9600	9/20/90		
120401-012	2	IS	1	EA	147.9600	9/20/90		
120401-012	2	IS	1	EA	147.9600	9/20/90		
120401-012	2	IS	1	EA	147.9600	9/20/90		
120401-012	2	IS	1	EA	147.9600	9/20/90		
120401-012	2	IS	1	EA	147.9600	9/21/90		
120401-012	2	IS	1	EA	147.9600	9/21/90		
120401-012	2	IS	1	EA	147.9600	9/21/90		
120401-012	2	IS	1	EA	147.9600	9/21/90		
120401-012	2	IS	1	EA	147.9600	9/24/90		
120401-012	2	IS	2	EA	295.9200	9/24/90		
120401-012	2	IS	1	EA	147.9600	9/24/90		
120401-012	2	IS	1	EA	147.9600	9/25/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	147.9600	9/26/90		
120401-012	2	IS	1	EA	147.9600	9/26/90		
120401-012	2	IS	1	EA	147.9600	9/26/90		
120401-012	2	IS	3	EA	443.8900	9/26/90		
120401-012	2	IS	1	EA	147.9600	9/27/90		
120401-012	2	IS	1	EA	147.9600	9/27/90		
120401-012	2	IS	1	EA	147.9600	9/27/90		
120401-012	2	IS	1	EA	147.9600	9/27/90		
120401-012	2	IS	1	EA	147.9600	9/27/90		
120401-012	2	IS	9	EA	1,331.6600	10/01/90		
120401-012	2	IS	1	EA	147.9600	10/01/90		
120401-012	2	IS	2	EA	295.9200	10/02/90		
120401-012	2	IS	2	EA	295.9200	10/02/90		
120401-012	2	IS	1	EA	147.9600	10/03/90		
120401-012	2	IS	1	EA	147.9600	10/03/90		
120401-012	2	IS	1	EA	147.9600	10/05/90		
120401-012	2	IS	1	EA	147.9600	10/05/90		
120401-012	2	IS	1	EA	152.4500	10/09/90		
120401-012	2	IS	1	EA	152.4500	10/09/90		
120401-012	2	IS	1	EA	152.4500	10/11/90		
120401-012	2	IS	1	EA	152.4500	10/11/90		
120401-012	2	IS	1	EA	152.4500	10/11/90		
120401-012	2	IS	1	EA	152.4500	10/11/90		
120401-012	2	IS	1	EA	152.4500	10/15/90		
120401-012	2	IS	1	EA	152.4500	10/15/90		
120401-012	2	IS	1	EA	152.4500	10/15/90		
120401-012	2	IS	2	EA	304.9000	10/15/90		
120401-012	2	IS	1	EA	152.4500	10/15/90		
120401-012	2	IS	1	EA	152.4500	10/15/90		
120401-012	2	IS	1	EA	152.4500	10/15/90		
120401-012	2	IS	1	EA	152.4500	10/16/90		
120401-012	2	IS	1	EA	152.4500	10/16/90		
120401-012	2	IS	1	EA	152.4500	10/17/90		
120401-012	2	IS	1	EA	152.4500	10/17/90		
120401-012	2	IS	1	EA	152.4500	10/17/90		
120401-012	2	IS	1	EA	152.4500	10/19/90		
120401-012	2	IS	1	EA	152.4500	10/19/90		
120401-012	2	IS	1	EA	152.4500	10/22/90		
120401-012	2	IS	1	EA	152.4500	10/22/90		
120401-012	2	IS	1	EA	152.4500	10/22/90		
120401-012	2	IS	1	EA	152.4500	10/22/90		
120401-012	2	IS	1	EA	152.4500	10/22/90		
120401-012	2	IS	1	EA	152.4500	10/23/90		
120401-012	2	IS	1	EA	152.4500	10/23/90		
120401-012	2	IS	3	EA	457.3600	10/23/90		
120401-012	2	IS	1	EA	152.4500	10/23/90		
120401-012	2	IS	1	EA	152.4300	10/24/90		
120401-012	2	IS	1	EA	152.4300	10/24/90		
120401-012	2	IS	1	EA	152.4300	10/24/90		
120401-012	2	IS	1	EA	152.4300	10/26/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	152.4300	10/26/90		
120401-012	2	IS	1	EA	152.4300	10/26/90		
120401-012	2	IS	1	EA	152.3500	10/30/90		
120401-012	2	IS	1	EA	152.3500	10/31/90		
120401-012	2	IS	1	EA	152.3500	10/31/90		
120401-012	2	IS	1	EA	152.3500	10/31/90		
120401-012	2	IS	2	EA	304.6900	11/01/90		
120401-012	2	IS	1	EA	152.3500	11/01/90		
120401-012	2	IS	1	EA	152.3500	11/02/90		
120401-012	2	IS	2	EA	304.6900	11/02/90		
120401-012	2	IS	6	EA	914.2500	11/05/90		
120401-012	2	IS	1	EA	152.3700	11/05/90		
120401-012	2	IS	1	EA	152.3700	11/05/90		
120401-012	2	IS	3	EA	457.1200	11/05/90		
120401-012	2	IS	1	EA	152.3700	11/05/90		
120401-012	2	IS	3	EA	457.1200	11/06/90		
120401-012	2	IS	1	EA	152.3700	11/07/90		
120401-012	2	IS	1	EA	152.3700	11/07/90		
120401-012	2	IS	1	EA	152.3700	11/09/90		
120401-012	2	IS	1	EA	152.3700	11/09/90		
120401-012	2	IS	1	EA	152.3700	11/13/90		
120401-012	2	IS	1	EA	152.3700	11/13/90		
120401-012	2	IS	1	EA	152.3700	11/14/90		
120401-012	2	IS	1	EA	152.3700	11/14/90		
120401-012	2	IS	1	EA	152.3700	11/14/90		
120401-012	2	IS	1	EA	152.3700	11/15/90		
120401-012	2	IS	1	EA	152.3700	11/15/90		
120401-012	2	IS	1	EA	152.3700	11/16/90		
120401-012	2	IS	1	EA	152.3700	11/19/90		
120401-012	2	IS	1	EA	152.3700	11/19/90		
120401-012	2	IS	1	EA	152.3700	11/19/90		
120401-012	2	IS	2	EA	304.7500	11/20/90		
120401-012	2	IS	1	EA	152.3700	11/21/90		
120401-012	2	IS	1	EA	152.3700	11/21/90		
120401-012	2	IS	1	EA	152.3700	11/21/90		
120401-012	2	IS	1	EA	152.3700	11/26/90		
120401-012	2	IS	1	EA	152.3700	11/26/90		
120401-012	2	IS	1	EA	152.3700	11/26/90		
120401-012	2	IS	1	EA	152.3700	11/26/90		
120401-012	2	IS	1	EA	152.3700	11/26/90		
120401-012	2	IS	1	EA	152.3700	11/26/90		
120401-012	2	IS	1	EA	152.3700	11/26/90		
120401-012	2	IS	3	EA	457.1200	11/27/90		
120401-012	2	IS	1	EA	152.3700	11/27/90		
120401-012	2	IS	3	EA	457.1200	11/27/90		
120401-012	2	IS	1	EA	152.3700	11/28/90		
120401-012	2	IS	1	EA	152.3700	11/28/90		
120401-012	2	IS	1	EA	152.3700	11/29/90		
120401-012	2	IS	1	EA	152.3700	11/29/90		
120401-012	2	IS	1	EA	152.3700	11/30/90		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	152.4000	12/03/90		
120401-012	2	IS	1	EA	152.4000	12/03/90		
120401-012	2	IS	1	EA	152.4000	12/03/90		
120401-012	2	IS	1	EA	152.4000	12/03/90		
120401-012	2	IS	1	EA	152.4000	12/04/90		
120401-012	2	IS	2	EA	304.8000	12/04/90		
120401-012	2	IS	1	EA	152.4000	12/05/90		
120401-012	2	IS	1	EA	152.4000	12/06/90		
120401-012	2	IS	1	EA	152.4000	12/06/90		
120401-012	2	IS	1	EA	152.4200	12/10/90		
120401-012	2	IS	2	EA	304.8300	12/10/90		
120401-012	2	IS	1	EA	152.4200	12/10/90		
120401-012	2	IS	2	EA	304.8300	12/10/90		
120401-012	2	IS	1	EA	152.4200	12/12/90		
120401-012	2	IS	2	EA	304.8300	12/12/90		
120401-012	2	IS	1	EA	152.4200	12/13/90		
120401-012	2	IS	1	EA	152.4900	12/17/90		
120401-012	2	IS	1	EA	152.4900	12/17/90		
120401-012	2	IS	1	EA	152.4900	12/17/90		
120401-012	2	IS	1	EA	152.4900	12/18/90		
120401-012	2	IS	1	EA	152.4900	12/19/90		
120401-012	2	IS	1	EA	152.4900	12/20/90		
120401-012	2	IS	5	EA	762.4400	12/20/90		
120401-012	2	IS	2	EA	304.9800	12/20/90		
120401-012	2	IS	30	EA	4,574.6500	12/21/90		
120401-012	2	IS	3	EA	457.6600	12/27/90		
120401-012	2	IS	1	EA	152.5500	12/27/90		
120401-012	2	IS	1	EA	152.5500	12/27/90		
120401-012	2	IS	1	EA	152.5500	12/27/90		
120401-012	2	IS	3	EA	457.6600	12/27/90		
120401-012	2	IS	1	EA	152.5500	12/27/90		
120401-012	2	IS	3	EA	457.6600	12/27/90		
120401-012	2	IS	2	EA	305.1100	12/27/90		
120401-012	2	IS	1	EA	152.5500	12/27/90		
120401-012	2	IS	1	EA	152.5500	12/28/90		
120401-012	2	IS	1	EA	152.5500	12/28/90		
120401-012	2	IS	1	EA	152.5500	1/03/91		
120401-012	2	IS	1	EA	152.5500	1/03/91		
120401-012	2	IS	1	EA	152.5500	1/03/91		
120401-012	2	IS	1	EA	152.5500	1/03/91		
120401-012	2	IS	1	EA	152.5500	1/03/91		
120401-012	2	IS	1	EA	152.5500	1/04/91		
120401-012	2	IS	1	EA	152.5500	1/04/91		
120401-012	2	IS	1	EA	152.5500	1/04/91		
120401-012	2	IS	1	EA	152.5500	1/04/91		
120401-012	2	IS	1	EA	152.5500	1/07/91		
120401-012	2	IS	1	EA	152.5500	1/07/91		
120401-012	2	IS	1	EA	152.5500	1/08/91		
120401-012	2	IS	1	EA	152.5500	1/09/91		
120401-012	2	IS	1	EA	152.5500	1/10/91		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	152.5500	1/14/91		
120401-012	2	IS	1	EA	152.5500	1/14/91		
120401-012	2	IS	1	EA	152.5500	1/14/91		
120401-012	2	IS	1	EA	152.5500	1/14/91		
120401-012	2	IS	1	EA	152.5500	1/14/91		
120401-012	2	IS	1	EA	152.5500	1/14/91		
120401-012	2	IS	1	EA	152.5500	1/15/91		
120401-012	2	IS	1	EA	152.5500	1/15/91		
120401-012	2	IS	1	EA	152.5500	1/15/91		
120401-012	2	IS	1	EA	152.5500	1/15/91		
120401-012	2	IS	1	EA	152.5500	1/15/91		
120401-012	2	IS	2	EA	305.1100	1/15/91		
120401-012	2	IS	1	EA	152.5500	1/16/91		
120401-012	2	IS	1	EA	152.5500	1/16/91		
120401-012	2	IS	2	EA	305.1100	1/16/91		
120401-012	2	IS	1	EA	152.5500	1/22/91		
120401-012	2	IS	1	EA	152.5500	1/23/91		
120401-012	2	IS	1	EA	152.5500	1/23/91		
120401-012	2	IS	1	EA	152.5500	1/23/91		
120401-012	2	IS	1	EA	152.5500	1/23/91		
120401-012	2	IS	2	EA	305.1100	1/23/91		
120401-012	2	IS	1	EA	152.5500	1/23/91		
120401-012	2	IS	1	EA	152.5500	1/23/91		
120401-012	2	IS	1	EA	152.5500	1/24/91		
120401-012	2	IS	3	EA	457.6600	1/24/91		
120401-012	2	IS	1	EA	152.5500	1/24/91		
120401-012	2	IS	1	EA	152.5500	1/25/91		
120401-012	2	IS	1	EA	152.5500	1/25/91		
120401-012	2	IS	3	EA	457.8000	1/28/91		
120401-012	2	IS	1	EA	152.6000	1/28/91		
120401-012	2	IS	1	EA	152.6000	1/29/91		
120401-012	2	IS	1	EA	152.6000	1/29/91		
120401-012	2	IS	1	EA	152.6000	1/30/91		
120401-012	2	IS	1	EA	152.6000	1/30/91		
120401-012	2	IS	1	EA	152.6000	1/30/91		
120401-012	2	IS	2	EA	305.2000	1/31/91		
120401-012	2	IS	1	EA	152.6000	1/31/91		
120401-012	2	IS	1	EA	152.6000	1/31/91		
120401-012	2	IS	1	EA	152.6000	2/04/91		
120401-012	2	IS	1	EA	152.6000	2/04/91		
120401-012	2	IS	1	EA	152.6000	2/04/91		
120401-012	2	IS	1	EA	152.6000	2/05/91		
120401-012	2	IS	2	EA	305.2000	2/05/91		
120401-012	2	IS	2	EA	305.2000	2/06/91		
120401-012	2	IS	1	EA	152.6000	2/06/91		
120401-012	2	IS	4	EA	610.4000	2/06/91		
120401-012	2	IS	1	EA	152.6000	2/06/91		
120401-012	2	IS	1	EA	152.6000	2/06/91		
120401-012	2	IS	1	EA	152.6000	2/07/91		
120401-012	2	IS	1	EA	152.6000	2/07/91		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	152.6000	2/07/91		
120401-012	2	IS	1	EA	152.6000	2/08/91		
120401-012	2	IS	1	EA	152.6000	2/11/91		
120401-012	2	IS	1	EA	152.6000	2/11/91		
120401-012	2	IS	1	EA	152.6000	2/11/91		
120401-012	2	IS	2	EA	305.2000	2/11/91		
120401-012	2	IS	1	EA	152.6000	2/11/91		
120401-012	2	IS	1	EA	152.6000	2/12/91		
120401-012	2	IS	1	EA	152.6000	2/13/91		
120401-012	2	IS	2	EA	305.2000	2/13/91		
120401-012	2	IS	3	EA	457.8000	2/13/91		
120401-012	2	IS	1	EA	152.6000	2/13/91		
120401-012	2	IS	1	EA	152.6000	2/14/91		
120401-012	2	IS	1	EA	152.6000	2/15/91		
120401-012	2	IS	1	EA	152.6000	2/15/91		
120401-012	2	IS	3	EA	457.8000	2/19/91		
120401-012	2	IS	1	EA	152.6000	2/20/91		
120401-012	2	IS	1	EA	152.6000	2/20/91		
120401-012	2	IS	1	EA	152.6000	2/20/91		
120401-012	2	IS	4	EA	610.4000	2/21/91		
120401-012	2	IS	1	EA	152.6000	2/21/91		
120401-012	2	IS	2	EA	305.2000	2/21/91		
120401-012	2	IS	1	EA	152.6000	2/22/91		
120401-012	2	IS	1	EA	152.6000	2/22/91		
120401-012	2	IS	1	EA	152.6000	2/22/91		
120401-012	2	IS	1	EA	152.6000	2/22/91		
120401-012	2	IS	1	EA	152.6000	2/25/91		
120401-012	2	IS	1	EA	152.6000	2/25/91		
120401-012	2	IS	4	EA	610.4000	2/27/91		
120401-012	2	IS	1	EA	152.6000	2/27/91		
120401-012	2	IS	1	EA	152.6000	2/27/91		
120401-012	2	IS	1	EA	152.6000	2/27/91		
120401-012	2	IS	1	EA	152.6000	2/27/91		
120401-012	2	IS	1	EA	152.6000	2/28/91		
120401-012	2	IS	1	EA	152.6000	3/01/91		
120401-012	2	IS	1	EA	152.8900	3/04/91		
120401-012	2	IS	2	EA	305.7800	3/04/91		
120401-012	2	IS	1	EA	152.8900	3/04/91		
120401-012	2	IS	1	EA	152.8900	3/04/91		
120401-012	2	IS	1	EA	152.8900	3/06/91		
120401-012	2	IS	1	EA	152.8900	3/06/91		
120401-012	2	IS	2	EA	305.7800	3/06/91		
120401-012	2	IS	1	EA	152.8900	3/07/91		
120401-012	2	IS	1	EA	152.8900	3/07/91		
120401-012	2	IS	1	EA	152.8900	3/11/91		
120401-012	2	IS	1	EA	152.8900	3/12/91		
120401-012	2	IS	1	EA	152.8900	3/13/91		
120401-012	2	IS	1	EA	152.8900	3/13/91		
120401-012	2	IS	1	EA	152.8900	3/13/91		
120401-012	2	IS	1	EA	152.8900	3/14/91		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	152.8900	3/15/91		
120401-012	2	IS	1	EA	153.0300	3/18/91		
120401-012	2	IS	1	EA	153.0300	3/18/91		
120401-012	2	IS	3	EA	459.0800	3/20/91		
120401-012	2	IS	1	EA	153.0300	3/20/91		
120401-012	2	IS	1	EA	153.0300	3/20/91		
120401-012	2	IS	3	EA	459.0800	3/20/91		
120401-012	2	IS	1	EA	153.0300	3/20/91		
120401-012	2	IS	3	EA	459.0800	3/20/91		
120401-012	2	IS	1	EA	153.0300	3/21/91		
120401-012	2	IS	1	EA	153.0300	3/21/91		
120401-012	2	IS	1	EA	153.0300	3/21/91		
120401-012	2	IS	1	EA	153.0300	3/22/91		
120401-012	2	IS	1	EA	153.0300	3/22/91		
120401-012	2	IS	1	EA	153.0300	3/22/91		
120401-012	2	IS	1	EA	153.0300	3/22/91		
120401-012	2	IS	1	EA	153.4800	3/25/91		
120401-012	2	IS	1	EA	153.4800	3/25/91		
120401-012	2	IS	1	EA	153.4800	3/26/91		
120401-012	2	IS	1	EA	153.4800	3/28/91		
120401-012	2	IS	1	EA	153.4800	3/28/91		
120401-012	2	IS	4	EA	613.9400	3/28/91		
120401-012	2	IS	1	EA	153.5000	4/01/91		
120401-012	2	IS	1	EA	153.5000	4/02/91		
120401-012	2	IS	1	EA	153.5000	4/02/91		
120401-012	2	IS	1	EA	153.5000	4/02/91		
120401-012	2	IS	3	EA	460.5100	4/03/91		
120401-012	2	IS	2	EA	307.0100	4/03/91		
120401-012	2	IS	1	EA	153.5000	4/03/91		
120401-012	2	IS	1	EA	153.5000	4/03/91		
120401-012	2	IS	1	EA	153.5000	4/04/91		
120401-012	2	IS	1	EA	153.5000	4/04/91		
120401-012	2	IS	1	EA	153.5000	4/04/91		
120401-012	2	IS	2	EA	307.0100	4/05/91		
120401-012	2	IS	1	EA	154.5400	4/08/91		
120401-012	2	IS	1	EA	154.5400	4/08/91		
120401-012	2	IS	1	EA	154.5400	4/08/91		
120401-012	2	IS	2	EA	309.0900	4/09/91		
120401-012	2	IS	1	EA	154.5400	4/10/91		
120401-012	2	IS	1	EA	154.5400	4/10/91		
120401-012	2	IS	2	EA	309.0900	4/10/91		
120401-012	2	IS	1	EA	154.5400	4/10/91		
120401-012	2	IS	1	EA	154.5400	4/10/91		
120401-012	2	IS	1	EA	154.5400	4/11/91		
120401-012	2	IS	1	EA	154.5400	4/11/91		
120401-012	2	IS	1	EA	154.5400	4/12/91		
120401-012	2	IS	3	EA	463.6300	4/12/91		
120401-012	2	IS	1	EA	154.3200	4/15/91		
120401-012	2	IS	1	EA	154.3200	4/16/91		
120401-012	2	IS	1	EA	154.3200	4/16/91		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

USER ID RLA

ITEM NUMBER	WH SE	TRANSACTION CDE	QUANTITY	U/M	AMOUNT	POSTING DATE	ORDER NO	CMP CD
120401-012	2	IS	1	EA	154.3200	4/18/91		
120401-012	2	IS	1	EA	154.3200	4/19/91		
120401-012	2	IS	1	EA	154.3200	4/19/91		
120401-012	2	IS	1	EA	154.3200	4/19/91		
120401-012	2	IS	1	EA	154.3200	4/22/91		
120401-012	2	IS	1	EA	154.3200	4/22/91		
120401-012	2	IS	1	EA	154.3200	4/23/91		
120401-012	2	IS	1	EA	154.3200	4/23/91		
120401-012	2	IS	1	EA	154.3200	4/23/91		
120401-012	2	IS	1	EA	154.3200	4/23/91		
120401-012	2	IS	1	EA	154.3200	4/23/91		
120401-012	2	IS	1	EA	154.3200	4/24/91		
120401-012	2	IS	2	EA	308.6300	4/24/91		
120401-012	2	IS	1	EA	154.3200	4/25/91		
120401-012	2	IS	1	EA	154.3200	4/25/91		
120401-012	2	IS	1	EA	154.3200	4/26/91		
120401-012	2	IS	6	EA	925.9000	4/26/91		
120401-012	2	IS	1	EA	154.3200	4/26/91		
120401-012	2	IS	2	EA	309.6300	4/29/91		
120401-012	2	IS	1	EA	154.8200	4/30/91		
120401-012	2	IS	1	EA	154.8200	4/30/91		
120401-012	2	IS	2	EA	309.6300	4/30/91		
120401-012	2	IS	5	EA	774.0800	4/30/91		
120401-012	2	IS	1	EA	154.8200	4/30/91		
120401-012	2	IS	1	EA	154.8200	4/30/91		
120401-012	2	IS	1	EA	154.8200	5/01/91		
120401-012	2	IS	1	EA	154.8200	5/02/91		
120401-012	2	IS	2	EA	309.6300	5/02/91		
120401-012	2	IS	2	EA	309.6300	5/02/91		
120401-012	2	IS	1	EA	154.8200	5/02/91		
120401-012	2	IS	1	EA	154.8200	5/03/91		
120401-012	2	IS	1	EA	154.8200	5/03/91		
120401-012	2	IS	1	EA	154.8200	5/06/91		
120401-012	2	IS	2	EA	309.6300	5/07/91		
120401-012	2	IS	1	EA	154.8200	5/07/91		
120401-012	2	IS	1	EA	154.8200	5/07/91		
120401-012	2	IS	1	EA	154.8200	5/09/91		
120401-012	2	IS	1	EA	154.8200	5/09/91		
120401-012	2	IS	1	EA	154.8200	5/09/91		
120401-012	2	IS	1	EA	154.8200	5/09/91		
120401-012	2	IS	1	EA	154.8200	5/09/91		
120401-012	2	IS	1	EA	154.8200	5/09/91		
120401-012	2	IS	1	EA	155.2600	5/13/91		
120401-012	2	IS	1	EA	155.2600	5/14/91		
120401-012	2	IS	1	EA	155.2600	5/14/91		
120401-012	2	IS	1	EA	155.2600	5/14/91		
120401-012	2	IS	1	EA	155.2600	5/15/91		
120401-012	2	IS	1	EA	155.2600	5/15/91		
120401-012	2	IS	1	EA	155.2600	5/15/91		
120401-012	2	IS	1	EA	155.2600	5/16/91		

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	WH	Cod	Quantity	U/M	Amount	Posted	Order	Cmp	User
120401-012	2	PH	1	EA	154.8159	5/01/91			
120401-012	2	RC	18	EA	2,786.6900	5/01/91			
120401-012	2	IS	1	EA	154.8200	5/01/91			
120401-012	2	RC	13	EA	2,012.6100	5/02/91			
120401-012	2	IS	1	EA	154.8200	5/02/91			
120401-012	2	IS	2	EA	309.6300	5/02/91			
120401-012	2	IS	2	EA	309.6300	5/02/91			
120401-012	2	IS	1	EA	154.8200	5/02/91			
120401-012	2	IS	3	EA	464.4500	5/02/91			
120401-012	2	IS	1	EA	154.8200	5/03/91			
120401-012	2	IS	1	EA	154.8200	5/03/91			
120401-012	2	RC	5	EA	774.0800	5/03/91			
120401-012	2	IS	1	EA	154.8200	5/06/91			
120401-012	2	IS	2	EA	309.6300	5/06/91			
120401-012	2	IS	2	EA	309.6300	5/07/91			
120401-012	2	IS	1	EA	154.8200	5/07/91			
120401-012	2	IS	1	EA	154.8200	5/07/91			
120401-012	2	PH	1-	EA	154.8159-	5/08/91			
120401-012	2	IS	1	EA	154.8200	5/09/91			
120401-012	2	IS	1	EA	154.8200	5/09/91			
120401-012	2	IS	1	EA	154.8200	5/09/91			
120401-012	2	IS	1	EA	154.8200	5/09/91			
120401-012	2	IS	1	EA	154.8200	5/09/91			
120401-012	2	IS	1	EA	154.8200	5/09/91			
120401-012	2	IS	1	EA	155.2600	5/13/91			
120401-012	2	IS	1	EA	155.2600	5/13/91			
120401-012	2	IS	1	EA	155.2600	5/13/91			
120401-012	2	IS	1	EA	155.2600	5/14/91			
120401-012	2	IS	1	EA	155.2600	5/14/91			
120401-012	2	IS	1	EA	155.2600	5/14/91			
120401-012	2	PH	0	EA	.0000	5/15/91			
120401-012	2	IS	3	EA	465.7700	5/15/91			
120401-012	2	IS	1	EA	155.2600	5/15/91			
120401-012	2	IS	1	EA	155.2600	5/15/91			
120401-012	2	IS	1	EA	155.2600	5/15/91			
120401-012	2	IS	1	EA	155.2600	5/15/91			
120401-012	2	IS	1	EA	155.2600	5/16/91			
120401-012	2	RC	18	EA	2,833.9000	5/20/91			
120401-012	2	IS	1	EA	157.4400	5/20/91			
120401-012	2	IS	1	EA	157.4400	5/20/91			
120401-012	2	IS	1	EA	157.4400	5/20/91			
120401-012	2	IS	1	EA	157.4400	5/20/91			
120401-012	2	IS	1	EA	157.4400	5/21/91			
120401-012	2	IS	1	EA	157.4400	5/21/91			
120401-012	2	IS	3	EA	472.3200	5/21/91			
120401-012	2	PH	0	EA	.0000	5/22/91			
120401-012	2	IS	2	EA	314.8800	5/22/91			
120401-012	2	IS	3	EA	472.3200	5/22/91			
120401-012	2	IS	1	EA	157.4400	5/22/91			
120401-012	2	IS	1	EA	157.4400	5/22/91			
120401-012	2	IS	1	EA	157.4400	5/23/91			
120401-012	2	IS	1	EA	157.4400	5/23/91			
120401-012	2	IS	2	EA	314.8800	5/24/91			
120401-012	2	IS	1	EA	157.4400	5/24/91			
120401-012	2	IS	1	EA	157.4400	5/24/91			
120401-012	2	IS	1	EA	157.9900	5/28/91			

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	WH	Cod	Quantity	U/M	Amount	Posted	Order	Cmp	User
120401-012	2	IS	2	EA	315.9700	5/28/91			
120401-012	2	PH	0	EA	.0000	5/29/91			
120401-012	2	IS	1	EA	157.9900	5/29/91			
120401-012	2	IS	1	EA	157.9900	5/29/91			
120401-012	2	IS	2	EA	315.9700	5/30/91			
120401-012	2	IS	3	EA	473.9600	5/30/91			
120401-012	2	RC	12	EA	1,895.8500	5/31/91			
120401-012	2	IS	1	EA	157.7100	6/03/91			
120401-012	2	IS	1	EA	157.7100	6/03/91			
120401-012	2	IS	1	EA	157.7100	6/03/91			
120401-012	2	IS	1	EA	157.7100	6/03/91			
120401-012	2	IS	1	EA	157.7100	6/04/91			
120401-012	2	IS	2	EA	315.4200	6/04/91			
120401-012	2	RC	4	EA	630.8400	6/04/91			
120401-012	2	PH	0	EA	.0000	6/05/91			
120401-012	2	RC	1	EA	157.7100	6/05/91			
120401-012	2	IS	3	EA	473.1300	6/05/91			
120401-012	2	IS	1	EA	157.7100	6/05/91			
120401-012	2	RC	12	EA	1,892.5100	6/06/91			
120401-012	2	IS	3	EA	473.1300	6/06/91			
120401-012	2	RC	4	EA	631.9300	6/07/91			
120401-012	2	IS	1	EA	157.9800	6/07/91			
120401-012	2	IS	1	EA	157.9800	6/07/91			
120401-012	2	RC	12	EA	1,895.7800	6/07/91			
120401-012	2	RC	10	EA	1,579.8200	6/07/91			
120401-012	2	IS	1	EA	157.9800	6/10/91			
120401-012	2	RC	24	EA	3,791.5700	6/11/91			
120401-012	2	IS	2	EA	315.9600	6/11/91			
120401-012	2	PH	0	EA	.0000	6/12/91			
120401-012	2	RC	12	EA	1,895.7800	6/12/91			
120401-012	2	IS	1	EA	157.9800	6/12/91			
120401-012	2	IS	1	EA	157.9800	6/12/91			
120401-012	2	IS	1	EA	157.9800	6/12/91			
120401-012	2	RC	10	EA	1,579.8200	6/12/91			
120401-012	2	IS	1	EA	157.9800	6/12/91			
120401-012	2	IS	1	EA	157.9800	6/14/91			
120401-012	2	IS	1	EA	157.9800	6/14/91			
120401-012	2	RC	12	EA	1,895.7800	6/14/91			
120401-012	2	IS	1	EA	155.1500	6/17/91			
120401-012	2	IS	1	EA	155.1500	6/17/91			
120401-012	2	IS	1	EA	155.1500	6/17/91			
120401-012	2	IS	1	EA	155.1500	6/17/91			
120401-012	2	IS	1	EA	155.1500	6/17/91			
120401-012	2	IS	1	EA	155.1500	6/17/91			
120401-012	2	IS	2	EA	310.2980	6/17/91			
120401-012	2	RC	2	EA	310.2980	6/17/91			
120401-012	2	RC	1	EA	155.1500	6/17/91			
120401-012	2	IS	3	EA	465.4400	6/18/91			
120401-012	2	RC	11	EA	1,706.6000	6/18/91			
120401-012	2	IS	4	EA	620.5800	6/18/91			
120401-012	2	PH	0	EA	.0000	6/19/91			
120401-012	2	IS	1	EA	155.1500	6/19/91			
120401-012	2	IA	1	EA	155.1500	6/19/91			
120401-012	2	IS	1	EA	155.1500	6/20/91			
120401-012	2	IS	3	EA	465.4400	6/20/91			
120401-012	2	IS	1	EA	155.1500	6/20/91			

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	WH	Cod	Quantity	U/M	Amount	Posted	Order	Cmp	User
120401-012	2	RC	1	EA	155.1500	6/20/91			
120401-012	2	RC	10	EA	1,551.4500	6/20/91			
120401-012	2	IS	1	EA	155.5200	6/21/91			
120401-012	2	IS	3	EA	466.5500	6/21/91			
120401-012	2	IS	1	EA	155.5200	6/21/91			
120401-012	2	IS	1	EA	155.5200	6/24/91			
120401-012	2	RC	15	EA	2,332.7400	6/25/91			
120401-012	2	IS	1	EA	155.5200	6/25/91			
120401-012	2	IS	1	EA	155.5200	6/25/91			
120401-012	2	IS	1	EA	155.5200	6/25/91			
120401-012	2	IS	3	EA	466.5500	6/25/91			
120401-012	2	PH	0	EA	.0000	6/26/91			
120401-012	2	IS	1	EA	155.5200	6/26/91			
120401-012	2	IS	3	EA	466.5500	6/26/91			
120401-012	2	RC	2	EA	311.0300	6/27/91			
120401-012	2	RC	1	EA	155.5200	6/27/91			
120401-012	2	IS	1	EA	155.5200	6/27/91			
120401-012	2	IS	11	EA	1,710.6700	6/27/91			
120401-012	2	IS	1	EA	155.5200	6/27/91			
120401-012	2	RC	9	EA	1,399.6400	6/28/91			
120401-012	2	IS	1	EA	155.5200	6/28/91			
120401-012	2	IS	1	EA	155.1300	7/01/91			
120401-012	2	IS	2	EA	310.2700	7/01/91			
120401-012	2	RC	12	EA	1,861.6000	7/01/91			
120401-012	2	IS	1	EA	155.1300	7/02/91			
120401-012	2	PH	0	EA	.0000	7/03/91			
120401-012	2	IS	1	EA	155.1300	7/03/91			
120401-012	2	RC	1	EA	155.0200	7/08/91			
120401-012	2	IS	1	EA	155.0200	7/08/91			
120401-012	2	IS	1	EA	155.0200	7/08/91			
120401-012	2	IS	1	EA	155.0200	7/08/91			
120401-012	2	IS	6	EA	930.1200	7/08/91			
120401-012	2	IS	1	EA	155.0200	7/08/91			
120401-012	2	IS	1	EA	155.0200	7/08/91			
120401-012	2	IS	2	EA	310.0400	7/08/91			
120401-012	2	IS	1	EA	155.0200	7/08/91			
120401-012	2	IS	1	EA	155.0200	7/08/91			
120401-012	2	IS	2	EA	310.0400	7/09/91			
120401-012	2	IS	1	EA	155.0200	7/09/91			
120401-012	2	PH	0	EA	.0000	7/10/91			
120401-012	2	IS	1	EA	155.0200	7/10/91			
120401-012	2	IS	1	EA	155.0200	7/10/91			
120401-012	2	IS	1	EA	155.0200	7/10/91			
120401-012	2	RC	12	EA	1,860.2300	7/10/91			
120401-012	2	RC	10	EA	1,550.1900	7/11/91			
120401-012	2	IS	2	EA	310.0400	7/11/91			
120401-012	2	IS	1	EA	155.0200	7/12/91			
120401-012	2	IS	1	EA	155.0200	7/12/91			
120401-012	2	IS	1	EA	155.0200	7/12/91			
120401-012	2	RC	8	EA	1,240.1500	7/12/91			
120401-012	2	IS	1	EA	154.9300	7/15/91			
120401-012	2	IS	1	EA	154.9300	7/16/91			
120401-012	2	IS	2	EA	309.8600	7/16/91			
120401-012	2	IS	1	EA	154.9300	7/16/91			
120401-012	2	IS	1	EA	154.9300	7/16/91			
120401-012	2	IS	1	EA	154.9300	7/16/91			

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	WH	Cod	Quantity	U/M	Amount	Posted	Order	Cap	User
120401-012	2	IS	2	EA	309.8600	7/16/91			
120401-012	2	IS	1	EA	154.9300	7/16/91			
120401-012	2	IS	1	EA	154.9300	7/16/91			
120401-012	2	PH	0	EA	.0000	7/17/91			
120401-012	2	IS	2	EA	309.8600	7/17/91			
120401-012	2	RC	7	EA	1,084.5100	7/17/91			
120401-012	2	IS	2	EA	309.8600	7/18/91			
120401-012	2	IS	5	EA	774.6500	7/18/91			
120401-012	2	IS	3	EA	464.7900	7/18/91			
120401-012	2	IS	3	EA	464.7900	7/18/91			
120401-012	2	RC	8	EA	1,239.4400	7/18/91			
120401-012	2	IS	2	EA	309.8600	7/21/91			
120401-012	2	IS	1	EA	154.9300	7/22/91			
120401-012	2	IS	1	EA	154.9300	7/22/91			
120401-012	2	IS	3	EA	464.7900	7/22/91			
120401-012	2	IS	4	EA	619.7200	7/22/91			
120401-012	2	PH	0	EA	.0000	7/24/91			
120401-012	2	IS	1	EA	154.9300	7/24/91			
120401-012	2	IS	2	EA	309.8600	7/24/91			
120401-012	2	IS	1	EA	154.9300	7/24/91			
120401-012	2	RC	15	EA	2,323.9400	7/24/91			
120401-012	2	IS	1	EA	154.9300	7/25/91			
120401-012	2	IS	1	EA	154.9300	7/25/91			
120401-012	2	IS	1	EA	154.9300	7/26/91			
120401-012	2	IS	2	EA	309.8600	7/26/91			
120401-012	2	IS	1	EA	154.7700	7/29/91			
120401-012	2	IS	1	EA	154.7700	7/29/91			
120401-012	2	IS	1	EA	154.7700	7/29/91			
120401-012	2	IS	3	EA	464.3200	7/30/91			
120401-012	2	IS	3	EA	464.3200	7/30/91			
120401-012	2	IS	1	EA	154.7700	7/30/91			
120401-012	2	PH	1	EA	154.7717	7/31/91			
120401-012	2	RC	5	EA	773.8600	8/01/91			
120401-012	2	RC	14	EA	2,166.8000	8/01/91			
120401-012	2	IS	1	EA	154.7700	8/01/91			
120401-012	2	IS	1	EA	154.7700	8/01/91			
120401-012	2	IS	1	EA	154.7700	8/01/91			
120401-012	2	IS	2	EA	309.5400	8/01/91			
120401-012	2	RC	6	EA	928.6300	8/01/91			
120401-012	2	IS	1	EA	154.7700	8/05/91			
120401-012	2	IS	1	EA	154.7700	8/05/91			
120401-012	2	IS	1	EA	154.7700	8/05/91			
120401-012	2	IS	1	EA	154.7700	8/05/91			
120401-012	2	RC	12	EA	1,857.2600	8/05/91			
120401-012	2	IS	1	EA	154.7700	8/05/91			
120401-012	2	RC	11	EA	1,702.4900	8/05/91			
120401-012	2	IS	2	EA	309.5400	8/06/91			
120401-012	2	IS	1	EA	154.7700	8/06/91			
120401-012	2	IS	1	EA	154.7700	8/06/91			
120401-012	2	PH	0	EA	.0000	8/07/91			
120401-012	2	IS	2	EA	309.5400	8/07/91			
120401-012	2	IS	1	EA	154.7700	8/07/91			
120401-012	2	IS	1	EA	154.7700	8/07/91			
120401-012	2	IS	1	EA	154.7700	8/08/91			
120401-012	2	IS	1	EA	154.7700	8/08/91			
120401-012	2	IS	1	EA	154.7700	8/09/91			

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	WH	Cod	Quantity	U/M	Amount	Posted	Order	Cmp	User
120401-012	2	IS	1	EA	154.7700	8/09/91			
120401-012	2	IS	1	EA	154.7700	8/09/91			
120401-012	2	IS	1	EA	154.7700	8/09/91			
120401-012	2	RC	1	EA	154.7700	8/09/91			
120401-012	2	IS	1	EA	155.1400	8/12/91			
120401-012	2	IS	1	EA	155.1400	8/12/91			
120401-012	2	IS	1	EA	155.1400	8/12/91			
120401-012	2	IS	2	EA	310.2700	8/13/91			
120401-012	2	IS	2	EA	310.2700	8/13/91			
120401-012	2	IS	1	EA	155.1400	8/13/91			
120401-012	2	IS	1	EA	155.1400	8/13/91			
120401-012	2	PH	0	EA	.0000	8/14/91			
120401-012	2	IS	1	EA	155.1400	8/15/91			
120401-012	2	IS	1	EA	155.1400	8/15/91			
120401-012	2	IS	1	EA	154.4400	8/16/91			
120401-012	2	IS	2	EA	308.8900	8/16/91			
120401-012	2	IS	1	EA	154.4400	8/16/91			
120401-012	2	IS	1	EA	154.4400	8/16/91			
120401-012	2	IS	1	EA	154.4400	8/19/91			
120401-012	2	IS	2	EA	308.8900	8/19/91			
120401-012	2	IS	2	EA	308.8900	8/19/91			
120401-012	2	IS	2	EA	308.8900	8/19/91			
120401-012	2	IS	2	EA	308.8900	8/20/91			
120401-012	2	IS	1	EA	154.4400	8/20/91			
120401-012	2	PH	0	EA	.0000	8/21/91			
120401-012	2	IS	1	EA	154.4400	8/21/91			
120401-012	2	IS	1	EA	154.4400	8/21/91			
120401-012	2	IS	1	EA	154.4400	8/21/91			
120401-012	2	IS	1	EA	154.4400	8/21/91			
120401-012	2	IS	1	EA	154.4400	8/21/91			
120401-012	2	RC	11	EA	1,698.8700	8/21/91			
120401-012	2	IS	1	EA	154.4400	8/21/91			
120401-012	2	IS	1	EA	154.4400	8/21/91			
120401-012	2	IS	1	EA	154.4400	8/21/91			
120401-012	2	IS	7	EA	1,081.1000	8/22/91			
120401-012	2	IS	1	EA	154.4400	8/22/91			
120401-012	2	IS	1	EA	154.4400	8/22/91			
120401-012	2	IS	1	EA	154.4400	8/22/91			
120401-012	2	RC	3	EA	463.3300	8/22/91			
120401-012	2	IS	1	EA	154.4400	8/23/91			
120401-012	2	IS	1	EA	154.4400	8/23/91			
120401-012	2	RC	4	EA	617.7700	8/23/91			
120401-012	2	IS	1	EA	166.9800	8/26/91			
120401-012	2	IS	1	EA	166.9800	8/26/91			
120401-012	2	RC	8	EA	1,335.8700	8/26/91			
120401-012	2	IS	1	EA	166.9800	8/27/91			
120401-012	2	IS	1	EA	166.9800	8/27/91			
120401-012	2	IS	2	EA	333.9700	8/27/91			
120401-012	2	PH	0	EA	.0000	8/28/91			
120401-012	2	IS	2	EA	333.9700	8/28/91			
120401-012	2	IS	1	EA	166.9800	8/28/91			
120401-012	2	IS	1	EA	166.9800	8/28/91			
120401-012	2	IS	3	EA	500.9500	8/29/91			
120401-012	2	IS	1	EA	166.9800	8/29/91			
120401-012	2	IS	1	EA	166.9800	9/03/91			
120401-012	2	IS	1	EA	166.9800	9/03/91			

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	WH	Cod	Quantity	U/M	Amount	Posted	Order	Cmp	User
120401-012	2	IS	1	EA	166.9800	9/03/91			
120401-012	2	IS	1	EA	166.9800	9/03/91			
120401-012	2	IS	1	EA	166.9800	9/03/91			
120401-012	2	IS	1	EA	166.9800	9/03/91			
120401-012	2	IS	1	EA	166.9800	9/03/91			
120401-012	2	IS	1	EA	166.9800	9/04/91			
120401-012	2	IS	1	EA	166.9800	9/05/91			
120401-012	2	IS	1	EA	166.9800	9/05/91			
120401-012	2	IS	1	EA	166.9800	9/05/91			
120401-012	2	IS	1	EA	166.9800	9/06/91			
120401-012	2	IS	1	EA	166.9800	9/06/91			
120401-012	2	IS	1	EA	166.9800	9/06/91			
120401-012	2	IS	1	EA	166.7000	9/09/91			
120401-012	2	IS	1	EA	166.7000	9/09/91			
120401-012	2	IS	1	EA	166.7000	9/10/91			
120401-012	2	IS	1	EA	166.7000	9/10/91			
120401-012	2	IS	4	EA	666.8000	9/10/91			
120401-012	2	IS	1	EA	166.7000	9/10/91			
120401-012	2	PH	0	EA	.0000	9/11/91			
120401-012	2	IS	1	EA	166.7000	9/11/91			
120401-012	2	IS	2	EA	333.4000	9/11/91			
120401-012	2	RC	12	EA	2,000.4000	9/11/91			
120401-012	2	IS	1	EA	166.7000	9/12/91			
120401-012	2	IS	1	EA	166.7000	9/12/91			
120401-012	2	IS	2	EA	333.4000	9/12/91			
120401-012	2	IS	1	EA	166.7000	9/12/91			
120401-012	2	IS	2	EA	333.4000	9/13/91			
120401-012	2	IS	1	EA	166.7000	9/13/91			
120401-012	2	IS	1	EA	166.6800	9/16/91			
120401-012	2	IS	1	EA	166.6800	9/16/91			
120401-012	2	IS	1	EA	166.6800	9/17/91			
120401-012	2	IS	1	EA	166.6800	9/17/91			
120401-012	2	PH	0	EA	.0000	9/18/91			
120401-012	2	IS	1	EA	166.6800	9/18/91			
120401-012	2	IS	1	EA	166.6800	9/18/91			
120401-012	2	IS	2	EA	333.3700	9/18/91			
120401-012	2	IS	1	EA	166.6800	9/19/91			
120401-012	2	IS	1	EA	166.6800	9/19/91			
120401-012	2	IS	1	EA	166.6800	9/19/91			
120401-012	2	IS	1	EA	166.6800	9/19/91			
120401-012	2	IS	2	EA	333.3700	9/20/91			
120401-012	2	IS	2	EA	333.3700	9/20/91			
120401-012	2	IS	5	EA	833.4100	9/20/91			
120401-012	2	IS	1	EA	166.6800	9/20/91			
120401-012	2	IS	1	EA	166.6800	9/20/91			
120401-012	2	IS	1	EA	166.6900	9/23/91			
120401-012	2	IS	1	EA	166.6900	9/23/91			
120401-012	2	IS	1	EA	166.6900	9/24/91			
120401-012	2	IS	1	EA	166.6900	9/24/91			
120401-012	2	IS	1	EA	166.6900	9/24/91			
120401-012	2	IS	2	EA	333.3800	9/24/91			
120401-012	2	IS	1	EA	166.6900	9/24/91			
120401-012	2	IS	1	EA	166.6900	9/24/91			
120401-012	2	IS	4	EA	666.7700	9/24/91			
120401-012	2	PH	0	EA	.0000	9/25/91			
120401-012	2	IS	1	EA	166.6900	9/25/91			

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	WH	Cod	Quantity	U/M	Amount	Posted	Order	Cmp	User
120401-012	2	IS	4	EA	666.7700	9/25/91			
120401-012	2	IS	1	EA	166.6900	9/25/91			
120401-012	2	IS	1	EA	166.6900	9/25/91			
120401-012	2	IS	1	EA	166.6900	9/25/91			
120401-012	2	RC	10	EA	1,666.9200	9/25/91			
120401-012	2	IS	1	EA	166.6900	9/26/91			
120401-012	2	IS	1	EA	166.6900	9/26/91			
120401-012	2	RC	2	EA	333.3800	9/26/91			
120401-012	2	IS	1	EA	166.6900	9/27/91			
120401-012	2	IS	1	EA	166.6900	9/27/91			
120401-012	2	RC	12	EA	2,000.3000	9/27/91			
120401-012	2	IS	1	EA	166.6700	9/30/91			
120401-012	2	IS	1	EA	166.6700	9/30/91			
120401-012	2	IS	1	EA	166.6700	10/01/91			
120401-012	2	RC	13	EA	2,166.7400	10/01/91			
120401-012	2	PH	0	EA	.0000	10/02/91			
120401-012	2	IS	2	EA	333.3400	10/02/91			
120401-012	2	IS	2	EA	333.3400	10/02/91			
120401-012	2	IS	1	EA	166.6700	10/02/91			
120401-012	2	IS	1	EA	166.6700	10/03/91			
120401-012	2	IS	1	EA	166.6700	10/03/91			
120401-012	2	IS	1	EA	166.6700	10/03/91			
120401-012	2	IS	1	EA	166.6700	10/03/91			
120401-012	2	RC	2	EA	333.3400	10/03/91			
120401-012	2	IS	1	EA	166.6700	10/04/91			
120401-012	2	IS	4	EA	666.6900	10/04/91			
120401-012	2	IS	2	EA	333.3400	10/04/91			
120401-012	2	IS	2	EA	326.1700	10/07/91			
120401-012	2	IS	3	EA	489.2500	10/07/91			
120401-012	2	IS	1	EA	163.0800	10/07/91			
120401-012	2	IS	1	EA	163.0800	10/08/91			
120401-012	2	PH	0	EA	.0000	10/09/91			
120401-012	2	IS	1	EA	163.0800	10/09/91			
120401-012	2	IS	1	EA	163.0800	10/09/91			
120401-012	2	IS	3	EA	489.2500	10/09/91			
120401-012	2	IS	1	EA	163.0800	10/09/91			
120401-012	2	IS	1	EA	163.0800	10/09/91			
120401-012	2	IS	1	EA	163.0800	10/09/91			
120401-012	2	IS	1	EA	163.0800	10/10/91			
120401-012	2	IS	2	EA	326.1700	10/10/91			
120401-012	2	IS	1	EA	163.0800	10/10/91			
120401-012	2	IS	3	EA	489.2500	10/11/91			
120401-012	2	IS	1	EA	163.0800	10/11/91			
120401-012	2	IS	1	EA	163.0800	10/11/91			
120401-012	2	IS	2	EA	326.1700	10/11/91			
120401-012	2	IS	1	EA	163.0800	10/11/91			
120401-012	2	RC	3	EA	489.2500	10/11/91			
120401-012	2	RC	1	EA	163.0800	10/11/91			
120401-012	2	RC	1	EA	163.0800	10/11/91			
120401-012	2	PH	0	EA	.0000	10/16/91			
120401-012	2	IS	1	EA	160.9400	10/16/91			
120401-012	2	IS	1	EA	160.9400	10/16/91			
120401-012	2	RC	2	EA	321.8800	10/16/91			
120401-012	2	IS	1	EA	160.9400	10/16/91			
120401-012	2	IS	1	EA	160.9400	10/17/91			
120401-012	2	RC	9	EA	1,448.4600	10/17/91			

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	MM	Cod	Quantity	U/M	Amount	Posted	Order	Cmp	User
120401-012	2	IS	1	EA	163.3000	10/21/91			
120401-012	2	IS	1	EA	163.3000	10/21/91			
120401-012	2	IS	1	EA	163.3000	10/21/91			
120401-012	2	IS	1	EA	163.3000	10/21/91			
120401-012	2	IS	1	EA	163.3000	10/21/91			
120401-012	2	IS	1	EA	163.3000	10/21/91			
120401-012	2	IS	1	EA	163.3000	10/21/91			
120401-012	2	IS	2	EA	326.6000	10/22/91			
120401-012	2	RC	11	EA	1,796.2800	10/22/91			
120401-012	2	RC	1	EA	163.3000	10/22/91			
120401-012	2	PH	0	EA	.0000	10/23/91			
120401-012	2	IS	2	EA	326.6000	10/23/91			
120401-012	2	IS	1	EA	163.3000	10/23/91			
120401-012	2	IS	1	EA	163.3000	10/23/91			
120401-012	2	IS	1	EA	163.3000	10/23/91			
120401-012	2	IS	2	EA	326.6000	10/23/91			
120401-012	2	IS	2	EA	326.6000	10/24/91			
120401-012	2	RC	23	EA	3,755.8600	10/25/91			
120401-012	2	IS	1	EA	163.2000	10/28/91			
120401-012	2	IS	1	EA	163.2000	10/28/91			
120401-012	2	IS	2	EA	326.4100	10/29/91			
120401-012	2	IS	1	EA	163.2000	10/29/91			
120401-012	2	IS	2	EA	326.4100	10/29/91			
120401-012	2	PH	0	EA	.0000	10/30/91			
120401-012	2	RC	1	EA	163.2000	10/30/91			
120401-012	2	IS	1	EA	163.2000	10/30/91			
120401-012	2	IS	2	EA	326.4100	10/30/91			
120401-012	2	IS	2	EA	326.4100	10/30/91			
120401-012	2	IS	6	EA	979.2200	10/31/91			
120401-012	2	IS	1	EA	163.2000	10/31/91			
120401-012	2	IS	1	EA	163.2000	10/31/91			
120401-012	2	IS	2	EA	326.4100	10/31/91			
120401-012	2	IS	1	EA	163.2000	10/31/91			
120401-012	2	IS	2	EA	326.4100	10/31/91			
120401-012	2	IS	1	EA	163.2000	11/01/91			
120401-012	2	RC	16	EA	2,518.6600	11/04/91			
120401-012	2	IS	1	EA	157.4200	11/04/91			
120401-012	2	IS	3	EA	472.2500	11/04/91			
120401-012	2	IS	1	EA	157.4200	11/05/91			
120401-012	2	IS	1	EA	157.4200	11/05/91			
120401-012	2	IS	6	EA	944.5000	11/05/91			
120401-012	2	IS	1	EA	157.4200	11/05/91			
120401-012	2	IS	3	EA	472.2500	11/05/91			
120401-012	2	PH	0	EA	.0000	11/06/91			
120401-012	2	IS	2	EA	314.8300	11/06/91			
120401-012	2	IS	1	EA	157.4200	11/06/91			
120401-012	2	IS	1	EA	157.4200	11/06/91			
120401-012	2	IS	1	EA	157.4200	11/07/91			
120401-012	2	IS	1	EA	157.4200	11/07/91			
120401-012	2	RC	13	EA	2,046.4100	11/07/91			
120401-012	2	RC	20	EA	3,148.3200	11/07/91			
120401-012	2	IS	1	EA	157.4200	11/08/91			
120401-012	2	IS	2	EA	314.8300	11/08/91			
120401-012	2	IS	1	EA	156.4700	11/11/91			
120401-012	2	IS	1	EA	156.4700	11/11/91			
120401-012	2	IS	1	EA	156.4700	11/12/91			

DENRO INC. TRANSACTION HISTORY MULTIPLE ITEMS

Item Number	WH	Cod	Quantity	U/M	Amount	Posted	Order	Cmp	User
120401-012	2	IS	2	EA	312.9500	11/12/91			

TOTAL NUMBER OF RECORDS SELECTED 449

APPENDIX G

CHI-SQUARE COMPUTATIONS

Appendix G

CHI-SQUARE COMPUTATIONS

The *Chi-square* goodness of fit test consists of using the sample of 30 monthly demand points for each part and assuming we do not know the probability density function. The observed demands are then arrayed in a frequency histogram having *k* class intervals. We let *Oi* be the observed frequency in the *i*th class interval. For the purposes of the optional replenishment inventory model, we hypothesize the probability distribution to be Normal and compute the expected frequencies *Ei* based on the normal distribution. The test statistic is:

$$X^2 = \text{the sum from i=1 to k of } (Oi - Ei)^2 / Ei$$

The example computation will be for part #401012 with a monthly demand for 30 months as follows:

67 88 86 84 59 58 64 74 72 46 79 55 65 80 47

70 100 94 74 78 67 116 90 71 76 87 84 84 91 60

mean = 75.53 std dev. = 15.61

Table G.1 shows the observed and expected frequencies of demand assuming normality using the MINITAB histogram from page 102.

Table G.1

Observed and Expected Frequencies

Class Interval	Oi	Ei*
45-55	2	2.04
55-65	5	4.7
65-75	8	7.08
75-85	7	7.3
85-95	6	4.96
95-105	1	2.29
105-115	0	.7
115-125	1	.147

* The expected frequencies are calculated by multiplying the area under the normal curve corresponding to the class interval (using mean 75.53 and standard deviation 15.61) by sample size 30.

An example of the expected frequency calculations is as follows for class 3:

$\frac{65 - 75.53}{15.61} = -.675 = z$ and $\frac{75 - 75.53}{15.61} = -.034 = z$

Area = P (-.675 < z < -.034) = P(z < -.034) - P(z < -.675) = .4860 - .25 = .236

and the expected frequency is 30 * .236 = 7.08.

*The complete X^2 calculation becomes:

$$X^2 = \frac{(7-6.74)^2}{6.74} + \frac{(8 - 7.08)^2}{7.08} + \frac{(7 - 7.3)^2}{7.3} + \frac{(8 - 8.1)^2}{8.1} = .143$$

The chi-square value for 4 - 1 = 3 degrees of freedom at .05 level of significance is 7.815 (Walpole and Myers 1989).

7.815 is greater than .143 so we do not reject the hypothesis that the probability distribution of demand for part #401012 follows the Normal distribution.

* Consecutive observed frequency values are combined until each cell has at least 5 observations.

APPENDIX H

MINITAB OUTPUT

```
MTB > print '401012'

401012
    67      88      86      84      59      58      64      74      72      46      79
    55      65      80      47      70     100      94      74      78      67     116
    90      71      76      87      84      84      91      60

MTB > describe '401012'

                N     MEAN   MEDIAN   TRMEAN    STDEV   SEMEAN
401012         30    75.53    75.00    75.27    15.61     2.85

               MIN      MAX       Q1       Q3
401012       46.00   116.00    64.75    86.25

MTB > histogram '401012'

Histogram of 401012   N = 30

Midpoint   Count
      50       2  **
      60       5  *****
      70       8  ********
      80       7  *******
      90       6  ******
     100       1  *
     110       0
     120       1  *

MTB > nopaper
```

APPENDIX I

STORM OUTPUT

STORM DATA SET LISTING
DETAILED PROBLEM DATA LISTING FOR
DENRO

ROW LABEL	ITEM ID	DEMAND/PD	UNIT VALUE	ORDR/SETUP
ITEM 1	401012	75.53	157.	.
ITEM 2	407102	26.3	288.	.
ITEM 3	408001	162.7	67.	.
ITEM 4	409001	56.17	65.	.
ITEM 5	457002	13.65	292.	.
ITEM 6	3005	49.7	120.	.

STORM DATA SET LISTING
DETAILED PROBLEM DATA LISTING FOR
DENRO

ROW LABEL	SIGMA(PD)	LEAD TIME	SERV LEVEL	PACKAGING
ITEM 1	15.61	1.5	90.9	1
ITEM 2	9.51	1.5	92.	1
ITEM 3	35.49	1.5	91.	1
ITEM 4	20.01	1.5	91.	1
ITEM 5	6.96	1.5	95.	1
ITEM 6	16.92	1.5	91.	1

DENRO
ORDERING INFORMATION

Item Name	Item ID	Orders / Setups	Order Size	Reorder Point
ITEM 1	401012	18.9	48	139
ITEM 2	407102	15.0	21	57
ITEM 3	408001	18.1	108	303
ITEM 4	409001	10.5	64	117
ITEM 5	457002	10.9	15	36
ITEM 6	3005	13.3	45	103

APPENDIX J

STORM SENSITIVITY ANALYSIS

DENRO
ORDERING INFORMATION

Item Name		Item ID	Orders / Setups	Order Size	Reorder Point
ITEM	1	401012	26.7	34	139
ITEM	2	407102	21.1	15	57
ITEM	3	408001	25.7	76	303
ITEM	4	409001	14.7	46	117
ITEM	5	457002	14.9	11	36
ITEM	6	3005	18.7	32	103

Holding Rate changed from 10% to 20%

DENRO
ORDERING INFORMATION

Item Name		Item ID	Orders / Setups	Order Size	Reorder Point
ITEM	1	401012	13.3	68	139
ITEM	2	407102	10.5	30	57
ITEM	3	408001	12.8	153	303
ITEM	4	409001	7.4	91	117
ITEM	5	457002	7.8	21	36
ITEM	6	3005	9.5	63	103

Order Cost changed from $20 to $40

DENRO
ORDERING INFORMATION

Item Name		Item ID	Orders / Setups	Order Size	Reorder Point
ITEM	1	401012	18.9	48	97
ITEM	2	407102	15.0	21	40
ITEM	3	408001	18.1	108	211
ITEM	4	409001	10.5	64	83
ITEM	5	457002	10.9	15	26
ITEM	6	3005	13.3	45	73

Lead Time changed from 1.5 months to 1.0 month

APPENDIX K

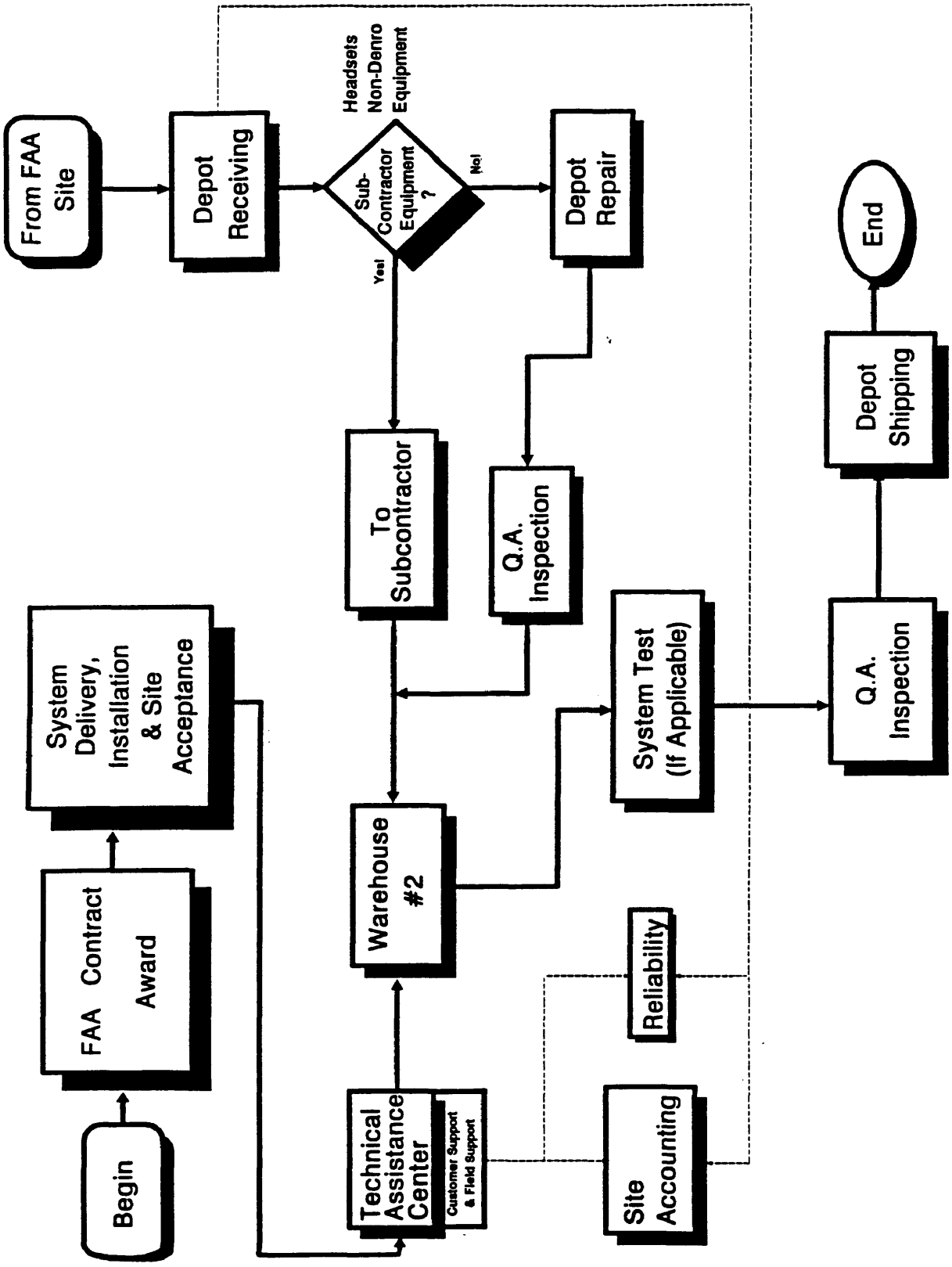
MINITAB RANDOM DEMAND

```
MTB > random 30 c1-c5;
SUBC> norm 75.53 15.61.
MTB > print c1-c5
```

ROW	C1	C2	C3	C4	C5
1	58.297	67.627	52.450	67.506	80.067
2	71.447	84.853	89.881	96.148	82.602
3	75.914	87.086	63.440	88.436	54.754
4	123.504	72.271	49.381	88.509	105.767
5	73.211	80.099	66.163	77.160	75.044
6	66.031	71.607	61.694	74.233	80.070
7	74.160	75.433	90.100	85.198	66.679
8	62.385	75.720	53.456	86.864	59.438
9	76.226	61.468	65.198	69.656	99.037
10	84.487	75.985	75.361	91.071	82.804
11	93.330	67.544	84.038	76.992	55.083
12	76.598	81.956	51.551	62.066	45.534
13	68.707	106.995	66.158	81.301	57.673
14	67.875	71.136	76.143	69.856	74.886
15	76.001	72.450	52.190	83.175	89.020
16	73.564	91.979	70.524	41.315	80.680
17	48.703	84.384	56.989	71.899	75.128
18	40.275	99.334	67.797	94.985	25.316
19	92.545	98.795	85.073	77.562	89.348
20	72.039	63.867	98.946	84.022	85.698
21	60.192	76.274	76.791	80.116	67.642
22	60.161	90.798	89.923	84.227	69.016
23	53.720	104.389	89.151	118.069	100.944
24	67.883	56.032	88.124	63.036	73.499
25	79.518	34.630	52.590	56.471	48.812
26	51.816	85.003	90.798	74.880	66.360
27	68.893	96.965	56.472	75.980	76.195
28	102.481	75.119	100.428	78.775	69.433
29	83.960	81.911	78.312	87.394	81.508
30	57.547	71.733	63.917	61.593	65.425

APPENDIX L

DENRO'S SYSTEM FLOWCHART

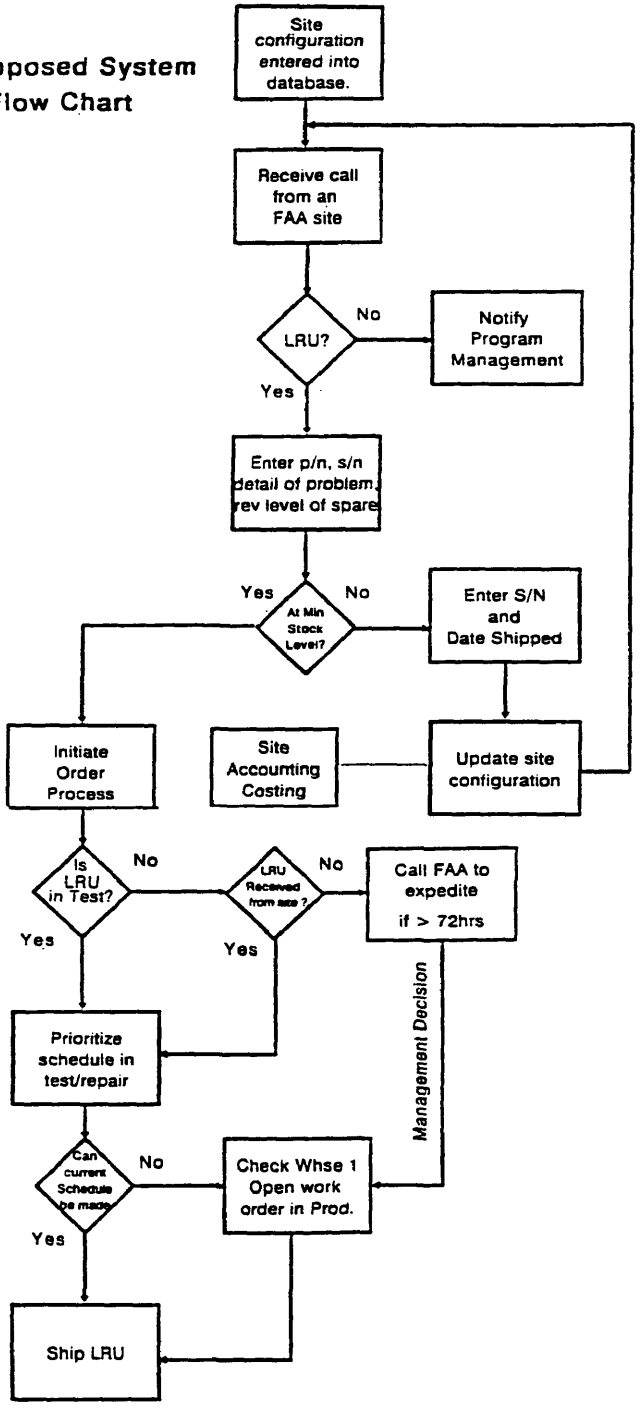

From FAA Site
Depot Receiving
Headsets Non-Denro Equipment
Sub-Contractor Equipment ?
Yes
No
Depot Repair
End
Depot Shipping
To Subcontractor
Q.A. Inspection
System Delivery, Installation & Site Acceptance
System Test (If Applicable)
Q.A. Inspection
FAA Contract Award
Warehouse #2
Reliability
Begin
Technical Assistance Center
Customer Support & Field Support
Site Accounting

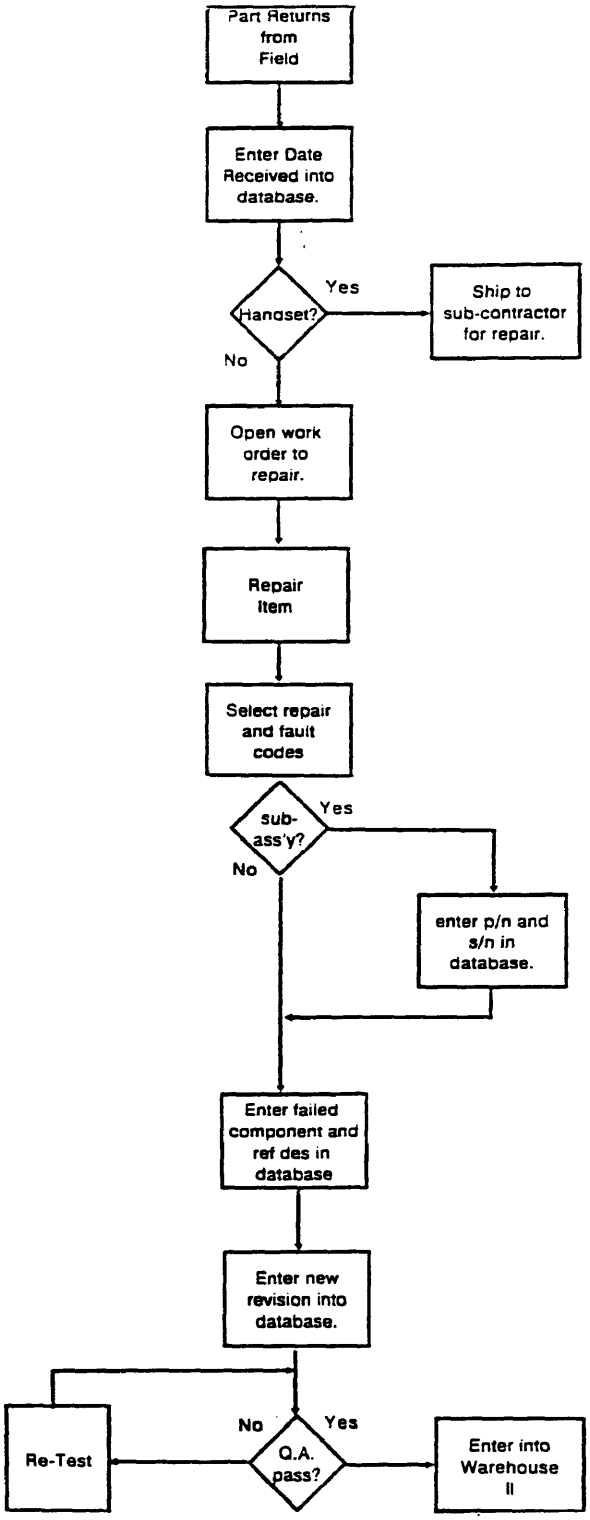
APPENDIX M

THE REVISED

SYSTEM FLOWCHART

Proposed System Flow Chart




Part Returns from Field
Enter Date Received into database.
Handset?
Yes
Ship to sub-contractor for repair.
No
Open work order to repair.
Repair Item
Select repair and fault codes
sub-ass'y?
Yes
No
enter p/n and s/n in database.
Enter failed component and ref des in database
Enter new revision into database.
Re-Test
No
Q.A. pass?
Yes
Enter into Warehouse II

APPENDIX N

DENRO'S CALL DATA SHEET

TECHNICAL ASSISTANCE CENTER PHONE CALL DATA SHEET			
1. Site:		2. Date:	3. Duty CSR:
4. Caller:		5. Time Call Received:	
6. Phone Number:		7. Time Sheet Completed:	
8. Call Out:	9. On Site:	10. Repaired:	11. Off Site:
12. Details of Problem:			
13. Corrective Action:			
14. Date Corrected:		15. Time spent on phone:	

16. Failed Parts			
Part Number	Serial Number	Rev	Nomenclature
Returned by:	Date:		Method:

17. Parts Installed in System			
Part Number	Serial Number	Rev	Nomenclature

18. Parts Order Number _____ - _____			
Part Number	Qty.	Notes	Nomenclature
19. Material Transfer Completed By:			20. Shipping #

APPENDIX O

THE REVISED CALL

DATA SHEET

INCOMING

Caller:
Site:

* Site #:

Part #: _____

Serial #: _____

* Description of part

* Date originally shipped to site:

Revision level of on-site spare_____

* Revision level:

* Report #/RMA:

* Date/Time:

* LRU: Yes __ No __

* Date Original Shipped:

* Page 1 OF X

* **Will be generated automatically**

Details of problem: _____

SHIPPING

* Quantity in stock warehouse #2

* Minimum Inventory Level

* Rev. level (out)

* Shipping part part order #

Serial # (out): _____
Date shipped: _____

DEPOT RECEIVE

Date received: _____

Print Tag

REPAIR

Date to depot repair: _____
Work Order: _____

Repair Code: _____

REPAIR CODES

1 - No defect found
2 - Update only
3 - Repair only
4 - Repair and update
5 - Scrapped

FAULT CODES

C - Components

1 - Wrong
2 - Missing
3 - Loose
4 - Shorted
5 - Open
6 - Physical damage
7 - Parametric

H - Hardware

1 - Missing
2 - Loose
3 - Defective finish
4 - Wrong

S - Solder Joints

1 - Unsoldered
2 - Excess solder
3 - Insuff. solder
4 - Improper wrap
5 - Cold solder

W - Wiring

1 - Missing
2 - Wrong Conn.
3 - Not Conn.
4 - Excess bare wire
5 - Insul. damaged
6 - Broken wire
7 - Pinched wire
8 - Improper crimp

P - Printed Circuitry

1 - Lifted circuit
2 - Broken circuit
3 - Damaged circuit or plating (peeling, pitted, holes, etc.)

SPECIFIC FAULT CODE	SUBASSEMBLY/ (SERIAL NUMBER)	COMPONENTS & REF. DESGINATION
1 _____	_____	_____
2 _____	_____	_____
3 _____	_____	_____
4 _____	_____	_____
5 _____	_____	_____
6 _____	_____	_____
7 _____	_____	_____
8 _____	_____	_____

GENERAL COMMENTS:

NEW REVISION LEVEL:

INITIALS/DATE	QUANTITY/DATE
QA INSPECTED: _____	**WAREHOUSE #2** _____

APPENDIX P

FORMS REPLACED BY REVISED

CALL DATA SHEET

REPAIR REPORT

INSP. SIDE ONE

RR # 45557

SITE

DATE REC'D | P/N

DESCRIPTION | C/N

REV | DATE TO MFG | RESPONSIBILITY DENRO _____ CUST _____

REASON FOR RETURN

VISUAL INSPECTION

INSP

DATE FROM MFG | REV | DELIVER TO STOCK _____ CUST _____

SCRAP _____ OTHER _____

COMMENTS

REPAIR REPORT

TEST SIDE TWO

RR # 45557

ITEMS REPLACED PART NUMBER	REF DES	DEF CODE	DESCRIPTION

REASON

REASON

REASON

REASON

REASON

REASON

RETEST TEST SPEC

RESULTS ACCEPT _____ REJECT _____ OTHER _____

PREPARED BY

TITLE | DATE

COMMENTS

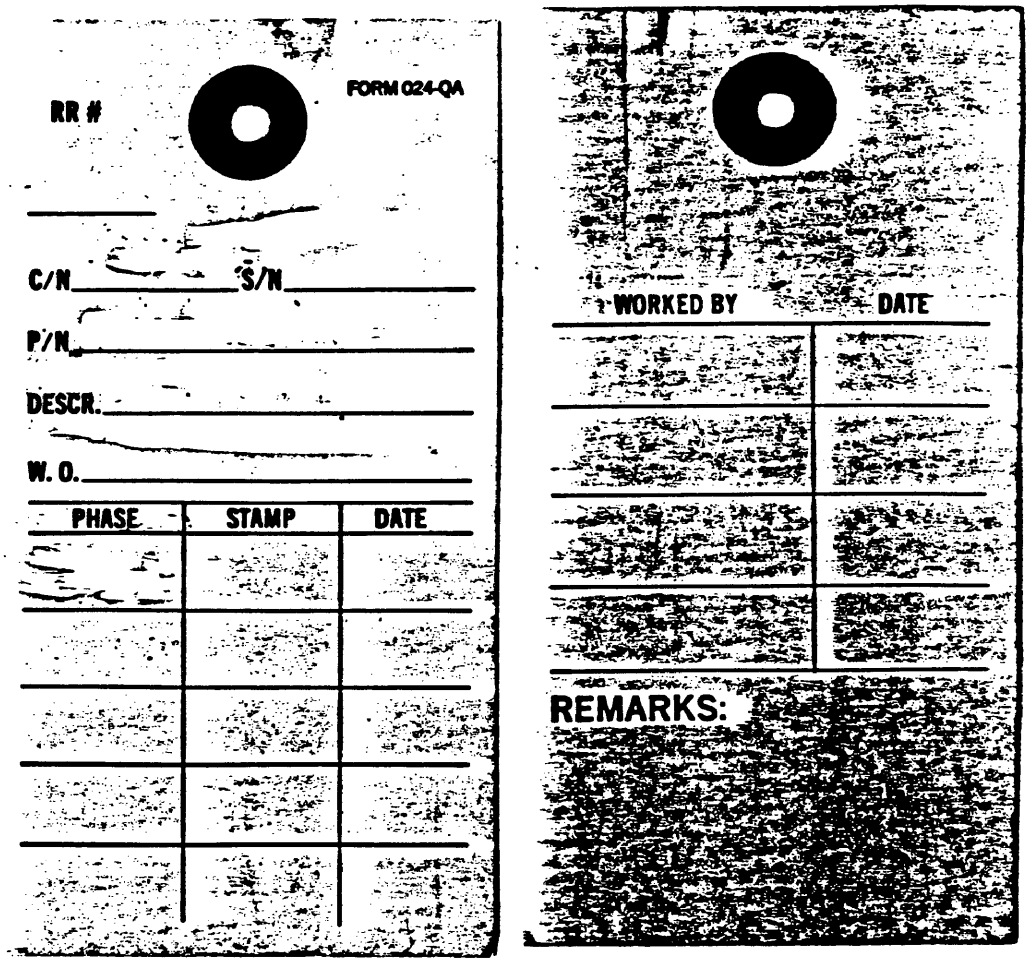
STAMP

FIELD RETURNS BY SITE NAME

01/01/91 Thru 07/01/91

SITE	SITE No.	Rcv'd	Part No.	Description	D/N	RR No	TO MFG.	FROM MFG.
ATLANTIC CITY,NJ	100401-642	01/18/91	120401-012	CCA, PROCESSOR	A318	34737	01/18/91	02/28/91
ATLANTIC CITY,NJ	100401-642	01/29/91	120401-012	CCA, PROCESSOR	T9685	34985	01/29/91	03/01/91
ATLANTIC CITY,NJ	100401-642	01/29/91	120401-012	CCA, PROCESSOR	T9692	34983	01/29/91	03/06/91
ATLANTIC CITY,NJ	100401-642	01/29/91	120401-012	CCA, PROCESSOR	T9763	34984	01/29/91	03/01/91
ATLANTIC CITY,NJ	100401-642	03/28/91	120401-012	CCA, PROCESSOR	T9313	36570	03/28/91	/ /
ATLANTIC CITY,NJ	100401-642	03/28/91	120401-012	CCA, PROCESSOR	T9645	36571	03/28/91	05/02/91
ATLANTIC CITY,NJ	100401-642	04/12/91	120401-012	CCA, PROCESSOR	A581	37002	04/12/91	06/28/91
ATLANTIC CITY,NJ	100401-642	04/12/91	120401-012	CCA, PROCESSOR	T9530	37000	04/12/91	06/20/91

TOTAL ITEMS = 8


RR #
FORM 024-QA
C/N
S/N
P/N
DESCR.
W. O.
PHASE
STAMP
DATE
WORKED BY
DATE
REMARKS:

APPENDIX Q

LETTER FROM PRESIDENT OF DENRO

DENRO

9318 Gaither Road
Gaithersburg, Maryland 20877

November 20, 1991

Dr. R. E. D. Woolsey
Director of Operations Research
Department of Mathematics
Colorado School of Mines
Golden, Colorado 80401

Dear Dr. Woolsey:

As you are aware, Brian Lauritzen recently completed work with a Denro "Process Action Team" (PAT), which was chartered to improve the current system, inventory levels, and inventory control in our field service repair operations.

The PAT recommendations were recently adopted and are in the process of being tested and implemented. Brian was singularly responsible for the adoption of the algorithm setting the number of components to be kept in the warehouse. We are pleased with Brian's superior work product and his dedication to getting the job done. Whether or not his degree program is completed, Brian has volunteered to review the results from our test period and to recommend modifications, if necessary. We would welcome the opportunity to demonstrate the improvements, if your schedule permits.

I thank you, Dr. Woolsey, for your program, your time, and your concern. And I hope that Denro and the Colorado School of Mines can again participate in a similar project in the future.

Sincerely,

Edward C. Hanna

Edward C. Hanna
President

ECH:cgk

Telephone (301) 840-1597 Facsimile (301) 869-3192