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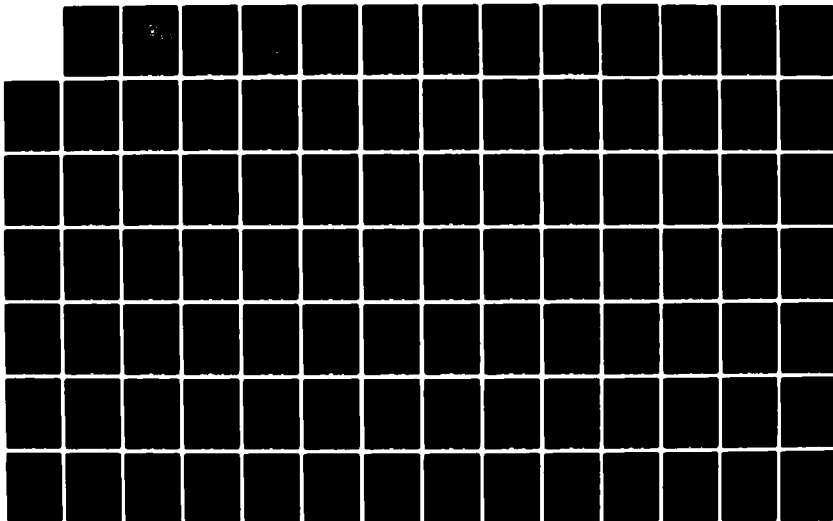
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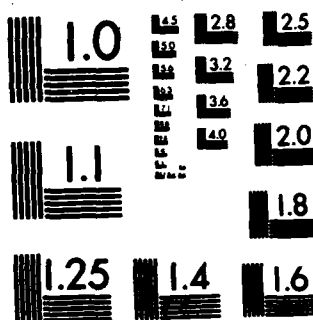
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METEOR:
A Tool for Evaluating Multi-Echelon
Inventory Models and Material Readiness

by

Thomas Allen Bunker

March 1983

Thesis Advisor:

F. R. Richards

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**METEOR: A Tool for Evaluating Multi-Echelon
Inventory Models and Material Readiness**

by

Thomas Allan Bunker
Lieutenant Commander, Supply Corps, United States Navy
B.S., University of Minnesota, 1972

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

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ABSTRACT

There are many multi-echelon inventory models in use within the Department of Defense. These models have been used primarily to determine inventory levels at various echelons of supply for complex, multi-indentured, hardware systems. Their objective is, generally, to maximize some measure of equipment readiness, subject to budgetary constraints. These models vary in their structure, assumptions, mathematical objectives, and optimization procedures.

This thesis examines the characteristics of these models and offers an alternative simulation model, Multi-Echelon Technique for Evaluating Operational Readiness (METEOR), which can be used as a common framework from which to compare and evaluate the analytic models. In the examination of other simulation models used by the Navy, it is believed that METEOR is unique in its ability to accomplish this purpose. METEOR may also be used to evaluate the impact of changes in supply related policy on equipment readiness.

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I. INTRODUCTION

Commercial enterprise has traditionally regarded profit as a primary motivating factor in decision making. Decisions to make or buy, sell or lease, invest or spend, are usually guided by the notion of profit. By using profit, or a suitable surrogate, as a measure of effectiveness, decision alternatives are readily quantified. In regard to matters relating to logistics support, and inventories in particular, businesses have generally sought to minimize their costs. Cost minimization is a reasonable surrogate measure of effectiveness in this instance, in that reduced costs in an overhead account are tantamount to increased profits -- the underlying objective.

Historically, the Department of Defense has used the same general models as industry to establish inventory levels at their numerous inventory stock points. Clearly, the objectives of the Department of Defense are not profit oriented. This obvious fact has been duly recognized in the recent past and policies have shifted accordingly. The following excerpt from the FY78 Defense Authorization Act is evidence to this fact.

The budget of the Department of Defense submitted to Congress for Fiscal Year 1979 and subsequent fiscal years shall include data projecting the effect of the appropriations requested for material readiness requirements.

Logistic support of complex weapon systems is a large part of the resources to readiness problem addressed above. This, together with other high level directives and policy guidance, has provided the impetus for the development of inventory models that measure hardware performance and mission readiness characteristics.

Additionally, when seeking the most effective utilization of resources, one must know where those resources should be placed to have the greatest affect on the total force readiness structure. Optimizing at each hierarchical level of an organization will rarely result in an optimal strategy for the whole. In response to this need, inventory models have been developed which encompass the entire supply system rather than individual levels, or echelons, which make up the supply distribution network.

A general class of models has evolved which feature both equipment related performance objectives and multi-echelon supply optimization. Unfortunately, the complex modeling issues involved prohibit the use of exact mathematical representations and closed form analytic solutions. It is, therefore, extremely difficult to objectively evaluate the relative merits of these models. In this thesis, one approach is offered. It is a simulation that features a multi-indenture, equipment oriented model, Multi-Echelon Technique for Evaluating Operational Readiness (METEOR), that generates demand on an integrated, multi-echelon supply system.

Chapter II provides a brief background and some common characteristics of multi-echelon models. An objective shared by many such models, operational availability, is discussed in some detail. Chapter III outlines the primary multi-echelon simulation models currently in use by the Navy. It concludes that METEOR is unique in its ability to assess multi-echelon inventory models and the supply system's impact on weapon system performance in a shipboard environment.

In Chapter IV, the equipment related aspects of METEOR are presented. The hardware system, its operation and measured performance, is modeled through the use of TIGER, a product of the Naval Sea Systems Command. TIGER's operating

characteristics and options are reviewed and discussed. Chapter V offers a detailed presentation of the METEOR simulation. The potential user of METEOR is provided, in the appendices, with the documentation necessary to understand and exercise the simulation.

Finally, in Chapters VI and VII, the reader is provided with model validation results, concluding remarks, and recommendations for future research.

II. MULTI-ECHELON INVENTORY MODELS

A. A BRIEF HISTORY

Classical, analytic inventory models have been in use in both the public and private sectors for many years. The earliest and perhaps most well known model is Wilson's Economic Order Quantity (EOQ) formula. The field now abounds with a multitude of variations on that model, but at the heart of each, two considerations are generally implicit: (1) the objective function minimizes the total variable cost of inventory, and (2) given a hierarchical supply network, an individual inventory stock point acts (optimizes) independently of its source of supply, lateral counterparts and customers in terms of system-wide inventory levels.

The term "multi-echelon" first appeared in the literature in 1958 in a research memorandum by A. J. Clark of Rand Corporation working under contract to the Air Force. The model used dynamic programming techniques in pursuit of optimality but made no claim that optimal solutions would be achieved. Most importantly, however, there was a perceived need to integrate the inventory stockage policies of complex, hierarchical supply systems. During the ensuing decade, Rand Corporation continued research in the field of multi-echelon systems, and, in 1965, Craig C. Sherbrooke published "METRIC: A Multi-Echelon Technique for Recoverable Item Control" [Ref. 1]. It was purported to be the first multi-echelon, multi-item model proposed for implementation. A notable feature of this model was a shift in emphasis on the objective function from one of cost minimization through arbitrarily assigned backorder costs to

that of system performance maximization. As Sherbrooke stated [Ref. 1],

Instead of computing stock levels on the basis of artificial estimates of holding cost rate and backorder cost, this approach focuses management attention on the entire weapons system so that an appropriate combination of system effectiveness and system cost can be selected.

There have been several multi-echelon models developed since that time. In the Department of Defense, each service has adopted different models. Although each service has employed more than one such model, the following three deserve mention:

1. Availability Centered Inventory Model (ACIM) - Navy
2. Multi-Echelon Technique for Recoverable Item Control; Modified (Mod-METRIC) - Air Force
3. Selective Stockage for Availability, Multi-Echelon (SESAME) - Army

Some of the common characteristics and features of these models are discussed in the paragraphs that follow.

B. CHARACTERISTICS

The models referred to above have been developed primarily for use as tools to be used in the determination of inventory levels at various supply echelons for complex equipments and/or hardware systems. The number of echelons represented can be as few as two, or in some cases, may be theoretically unlimited. A typical supply echelon structure is shown in Figure 2.1.

The hardware systems are typically modeled as a hierarchical series of components and subsystems, commonly referred to as indenture levels. Again, the number of indenture levels representable by any particular model varies, but is generally limited to two or three. In most

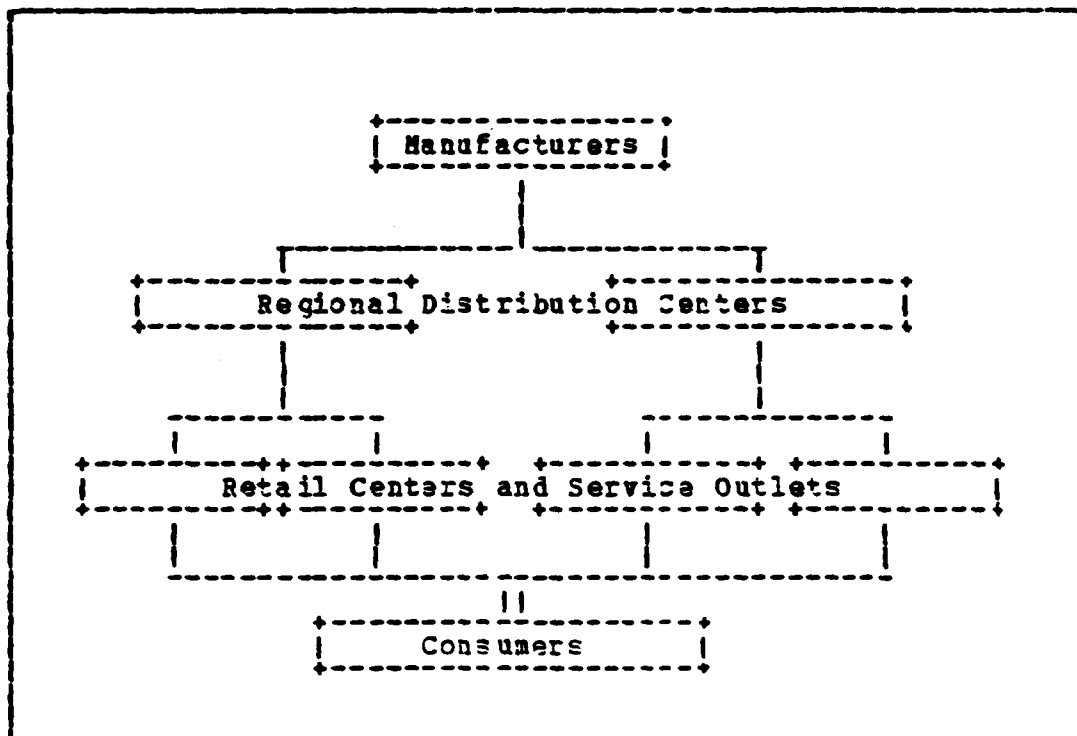


Figure 2.1 Typical Supply Echelon Structure.

cases, the components are treated as being connected in series in a reliability sense and, therefore, a failure of a component results in failure of the system.

Because of the extreme analytic complexity inherent in multi-echelon modeling, closed-form solutions to the problem are impractical for implementation. Therefore, most models in use today rely on analytic, highly structured, solution techniques primarily through mathematical programming.

Another characteristic common to many multi-echelon models is their assumption that reordering is done on a one-for-one basis, and that an echelon may only be resupplied from a higher level (i.e., no lateral resupply). As in any modeling effort, assumptions like these are made to enhance the model's tractability. However, these two

particular assumptions are clearly violated in real world practices. In general, reordering is done with economic order quantities of some sort, and critical equipment failures will invariably result in lateral resupply if necessary and feasible. The effect of these assumptions has not been made clear in the literature.

The relative merits and limitations of multi-echelon models versus 'conventional' single echelon models is not at issue in this paper. However, the following points deserve consideration. One characteristic common to these models that has limited their use to isolated cases rather than full scale adaptation, is their requirement for a detailed, and accurate data base. Generally, the data required by these models is not readily available and an entire management information system (MIS) would have to be structured and implemented to support a multi-echelon inventory model. On the other hand, these models, as a class, possess an extremely strong intuitive and analytic appeal. Not only do they integrate the supply system so as to represent the various interactions between echelons, but, they also focus management attention on the impact of a supply system on weapon systems instead of piece part support.

There has been a trend, in recent years, to emphasize the relationship between readiness and resources. These models endeavor to provide a framework from which to analyze that relationship. For this reason alone, they warrant further development, study, and investigation.

The next section discusses the measures of effectiveness used by the multi-echelon models.

C. THE OBJECTIVE FUNCTION

1. Operational Availability: Discussion

Historically, the most common measure of supply performance has been requisition effectiveness* and an associated measure of stockout risk. For a given item, it is possible to calculate the probability that the item will be available at any arbitrary time. Thus, it is possible to determine inventory levels by minimizing the total variable cost of having an item in inventory subject to a specified stockout risk, or, to solve the dual problem of minimizing stockout risk subject to a cost constraint.

Multi-echelon models, on the other hand, generally purport to measure system effectiveness vice requisition effectiveness. The most common vehicle for this measurement is operational availability (A_0). Operational availability has been defined by the following equation:

$$A_0 = \frac{MTBF}{MTBF + MTTR + MLDT} \quad (2.1)$$

where,

MTBF is mean time between failure

MTTR is mean time to repair the equipment
subsequent to failure

MLDT is mean logistics delay time

In words, operational availability is, in the long run, the probability that an equipment will be available when needed. It is here that a controversy arises.

*Requisition effectiveness may be defined as the probability that a requisition will be satisfied when presented to a stock point activity.

This measure has been criticized for its total dependence upon mean times, which may or may not be relevant to the mission at hand. For example, assume that an equipment is to be evaluated on the basis of its operational availability where an acceptable level is 0.90. Given that the equipment has a demonstrated MTBF of 100 hours, MTTR of 1 hour, and MLDT of 9 hours, the calculated A is 0.92. The equipment would be evaluated as having an acceptable A_0 . However, consider that the equipment will be used in mission scenarios which have 120 hour durations and that all failures are catastrophic and result in mission abort. The acceptability of this equipment is now open to question.

Second, one of the key assumptions made in arriving at the steady state formula given by equation 2.1, is that unlimited spares are available to effect repairs to the equipment. This seems somewhat incongruous in light of the fact that the formula is used to determine the number of spares to be allocated to achieve a stated operational availability.

Third, although equation 2.1 is the "accepted" definition of operational availability, the definition may be applied differently depending on the scenario at hand, when applied to hardware systems and their component subsystems. Kaplan presents two such cases [Ref. 2, p. 18]. In both cases it is assumed that a component failure results in system failure. Consider Case A, wherein it is also assumed that no other subsystem or component can fail when a system is down. In this case, the formula for A_0 is as shown in equation 2.1, and may be calculated with the following equations:

$$A_0 = \left[1 + \sum_{i=1}^n \frac{MTTR_i + MLDT_i}{MTBF_i} \right]^{-1} \quad (2.2)$$

where, i represents the i -th system component.

In Case B it is assumed that component failures are not affected by the status of the system. The resultant operational availability for the system is then:

$$A_0 = \prod_{i=1}^n \frac{MTBF_i}{MTBF_i + MTTR_i + MLDT_i} \quad (2.3)$$

where, i represents the i -th system component.

On applying both formulas to four test problems, Kaplan found that there was no significant difference in A_0 calculated by the two methods. However, inspection of the two formulas reveals the potential for significant differences.

The preceeding paragraphs are offered to demonstrate that there is a need to seriously consider and evaluate the manner in which the objectives are quantified in any given model. As a matter of practical concern, however, the operational availability measure has been, and is being used, with varying degrees of success in many applications. The following paragraphs will demonstrate its application in the three specific models mentioned previously: ACIM, Mod-METRIC, and SESAME.

2. Operational Availability: Application

Given the operational availability definition provided in equation 2.1, it is readily apparent that when holding MTBF and MTTR fixed, A_0 is maximized by minimizing MLDT. Therefore, the most common form of the objective

function for a supply model is to minimize some measure of requisition delay time (e.g., time-weighted backorders) subject to a constraint on investment. There is only a very subtle difference in this regard between ACIM and Mod-METRIC, as evidenced by their objective functions which appear in Appendix A. Mod-METRIC minimizes time-weighted backorders, and ACIM minimizes time-weighted backorders per demand. Both models are constrained by investment. The SESAME model is somewhat different. The objective is to minimize total variable inventory costs (i.e., ordering and holding costs) with a constraint on the expected number of backorders. The constraint is placed in the objective function and the associated Lagrangian multiplier represents a backorder penalty cost. From the expected number of backorders, SESAME calculates the overall "average logistics downtime" and uses this calculation as the MLDT for input to the A_0 formula. An explicit formulation for the SESAME objective function appears in Appendix A.

3. Other Measures

Although operational availability, or some form thereof (e.g., time-weighted backorders), is the prevalent measure of effectiveness in multi-echelon, multi-item modeling, other objectives have been proposed for use. The Air Force has shifted its emphasis in some of their more recent models, toward a measure which reflects the maximum number of sorties which are capable of being flown at any given time. Another measure which is used in a commercial multi-echelon package, OPUS, [Ref. 3], is termed "mission effectiveness", and can be thought of as a measure of system reliability. OPUS also employs other measures of effectiveness such as A_0 , risk of shortage, and waiting times, in its various applications.

III. MULTI-ECHELON SIMULATION

A. INTRODUCTION

The analytic models discussed in the previous chapter generally serve to provide actual inventory levels for each echelon of supply, and the resultant 'readiness' measures associated with these levels. Multi-echelon simulations have been developed, in large part, to evaluate the sensitivity and effects of changing various parameters upon readiness. Generally, simulations are developed to represent systems and events which are too complex to analyze analytically. The analytic multi-echelon models in use today are not exact treatments; they are heuristic and, therefore, may not provide globally optimal solutions to the problems they endeavor to solve. When additional constraints and embellishments are added, even a heuristic treatment often becomes intractable.

By their nature, simulations only provide estimates to the performance measures of interest. Repeated sampling improves upon this estimate, but even with a very detailed model that is run many times, there is no guarantee that the estimate will be an accurate representation of the real world. The objective, rather, is to have the facility to compare many systems and/or policies under controlled conditions. These conditions should represent the salient characteristics of the environment in which those systems and policies will be operating.

In the next section of this chapter, four multi-echelon simulations which have been developed for, and used by the Navy are examined. In the final section, the need for another such model is established, and a new model, METEOR:

Multi-Echelon Technique for Evaluating Operational Readiness, is introduced.

B. CURRENT MODELS

1. General

Multi-echelon simulations have been developed as tools to aid in the evaluation of alternative supply policies which affect the material readiness of hardware systems. At issue may be the determination of various inventory and reorder levels, transportation methodologies, budgets or any other number of supply related parameters. In this context, the systems being supported may range from relatively simple equipments to entire fleets of ships or aircraft. In a quest to quantify its readiness posture, the U.S. Navy has sponsored and/or developed a number of readiness assessment type simulations. In general, these may be partitioned into two groups: equipment and supply. The two groups are distinguished by their measures of effectiveness which are characteristically equipment-oriented in one case and supply-oriented in the other. All models discussed are Monte Carlo, discrete event simulations.

2. Ships Supply Support Study (S4)

This simulation was developed in the early 1970's in response to a Chief of Naval Operations (CNO) call for an automated model which would relate dollar outlays to fleet capabilities. Surface forces of the Sixth Fleet form the basis and operating scenario for the model. Four echelons of supply are represented and modeled in great detail. Each discrete echelon model embodies the actual forecasting and replenishment routines that were in current use by the Navy. Each echelon, however, is treated independently of the others. They are linked together only in the final analysis

by means of a synthesizer which computes system performance statistics as a function of the output of each echelon. The output offers various measures of supply effectiveness. S4 did not model an equipment repair process or pipeline. Because of the detail modeled at each echelon, the data base required was extensive and, consequently, the model has been considered cumbersome and limiting.

3. Aviation Afloat and Ashore Allowance Analyzer (5A)

The 5A simulation was a follow-on to the S4 study. It was also sponsored by the CNO to evaluate resources and their impact on readiness. This effort shifted the scenario from a shipboard environment to the Naval aviation supply community. The 5A study modeled three echelons to reflect typical Seventh Fleet aviation resupply, transportation, and communication channels. As with the S4 study the echelons are treated independently being linked together by means of a synthesizer. Output is supply oriented and data base requirements are extensive. The individual echelon models may be used independently for analysis of problems at any particular echelon desired. A major difference between 5A and S4, is 5A's explicit treatment of repairable material and the repair pipeline.

4. SPECTRUM

Unlike the supply oriented S4 and 5A simulators, the Simulation Package for Evaluation of Carrier Techniques, Readiness, Utilization and Maintenance (SPECTRUM), is equipment and system oriented. It models an equipment's configuration in terms of its components and provides output in the form of equipment availability and reliability. It was developed under sponsorship of the Naval Air Systems Command, Readiness Improvement Office.

SPECTRUM is a highly complex, modularized, discrete event simulation designed to project readiness values for Naval airborne weapons systems as a function of their total logistics support system and operational employment. The modules are classified in two groups, PRISM and RETINA. The PRISM group simulates organizational and intermediate level maintenance and local aviation supply. RETINA simulates depot level maintenance and its associated supply and distribution network. The PRISM group consists of the following modules which can be run either independently or collectively:

IMAGE - encompasses the material, physical, personnel and procedural processes involved with aviation intermediate level maintenance

PEER - simulates removal of aircraft engines and the handling of the failed engine and its replacement.

OPTICS - simulates the effect of organizational level maintenance and supply. Includes aircraft handling, squadron manpower, supply responses, equipment reliability and operational requirements.

LASER - models and analyzes supply performance as a function of initial stock levels, demand and supply policies.

The level of detail in SPECTRUM permits studies of a very specific nature. Changes to personnel, test equipments, supply, reliability, maintainability, operating characteristics and budget constraints can be evaluated and their impact on readiness predicted.

SPECTRUM is generally considered to be a maintenance model. Technically, however, it may be considered also a multi-echelon supply model due to the fact that it models

the end use echelon which is supported by a conglomerated 'higher' echelon. However, specific requisition channels are not employed and its usefulness as a multi-echelon model is therefore limited.

5. SIMULATION OF A LOGISTICS SUPPORT SYSTEM

This simulation was developed in a research effort by the George Washington University Logistics Research Project under sponsorship of the Navy Special Projects Office. The simulation is more specific in nature than those preceding in that it deals exclusively with the Polaris weapon system. Although the simulation uses actual outfitting allowances as an input to the model, it does no configuration modeling and should therefore be considered supply oriented.

Unlike 5A and S4, however, this model recognizes the inherent dependence among supply echelons and models the supply system accordingly. The four echelons modeled include up to nine end use activities (submarines), a submarine tender, an ashore depot, and the ultimate sources of supply -- the manufacturer and repair facility. It offers three alternative modes of operation. In the first, the submarine echelon may be studied independently of the others. Second, to estimate readiness degradation as a function of time, submarines may be supported by the higher echelons for a specified time, after which all resupply from upper echelons is terminated. Third, it is possible to vary depot stocks during the simulation in an effort to simulate policies associated with the budgeting process.

C. PROPOSED MODEL: METEOR

1. Purpose and Objectives

Initially, there was but one intended purpose for the development of a new multi-echelon simulation; to provide a common framework from which to analyze and compare the various analytic models discussed in Chapter II. It was shown that those models vary in their assumptions, their structure, and their objectives, and that simulation is an acceptable vehicle for performing side-by-side comparisons of these models. Furthermore, it was demonstrated in Chapter II.C.1. that the prime objective of those models is equipment oriented. That is, they attempt to reflect the interrelationships of the components which comprise the system. Supply performance is then measured by its ability to keep the system operational. The author is unaware of any current simulation that combines both hierarchical equipment configuration data and multiple supply echelons with enough detail to accurately assess equipment readiness in a multi-echelon supply environment.

Another basic purpose for the use and development of this simulation came to light in the course of this research. The Navy does not currently have a model that will evaluate the impact of changes in supply related parameters on shipboard weapon system 'readiness'. The SPECTRUM model has a wide range of variable input parameters, including supply, and has been used successfully in the assessment of hardware system readiness. However, its lack of multi-echelon supply realism has been noted and, furthermore, the simulation is very much limited to airborne weapon system applications. In its current state, METEOR is capable of assessing weapon system readiness as a function of the system configuration, the equipment reliability, the repair process, the mission, and the logistics support

system. With the enhancements outlined in Chapter VII, this capability could be greatly expanded.

2. Type and Structure

Similar to the simulation models discussed above, METEOR is a Monte Carlo, discrete event simulation. The simulation code is written in the FORTRAN IV programming language. It has two primary units: the equipment configuration and hardware system evaluation unit, and the multi-echelon supply and supply effectiveness unit.

The first unit, equipment configuration, is named TIGER. It is the product of previous work done by the Naval Sea Systems Command (NAVSEA) Readiness Branch in 1979 [Ref. 4].

TIGER is a generic name for a family of computer programs which can be used to evaluate, by simulation, a complex system in order to estimate various readiness measures. TIGER is being used on a stand alone basis by NAVSEA to evaluate Reliability, Maintainability, Availability (RMA) performance characteristics of new ship classes [Ref. 5]. TIGER will allow virtually an unlimited range of equipment configurations to be modeled, from very broad system representations to the minute details of piece parts. A more detailed analysis of the TIGER model is provided in Chapter IV.

The second unit, multi-echelon supply (MULTE), was developed to satisfy the objectives outlined in Section 1, above. Basically, it models up to five echelons of supply, which can be varied to suit the user's scenario. It is capable of modeling up to 30 end-use activities (i.e., ships). From one to 15 ships may be positioned on the east or west coast. Requisition channels are determined by the ship's coast and its operating mode, of which there are three: (1) operations within the continental United States

(CONUS), (2) operations outside CONUS without Mobile Logistic Support Force (MLSF) support, and (3) operations outside CONUS with MLSF support. A generic repair facility and the associated repair pipeline is modeled for each coast.

The two units are combined to form METEOR. TIGER generates equipment component failures (demands) and accumulates equipment readiness statistics based on the equipment's operational status. Given a demand, MULTE will process the requirement through the supply echelons, order replacements for stock when necessary, and return a supply response time (SRT) to TIGER. The component is restored to operational status when the replacement is received and installed. A detailed analysis of METEOR, in particular the multi-echelon unit, is contained in Chapter V.

3. Advantages

METEOR is unique. There are similarities between METEOR and SPECTRUM, however, they are designed around two very different supply and maintenance networks. The Navy has no other simulations which integrate a hierarchical system configuration with a multi-echelon supply system.

METEOR has a significant capability for modeling flexibility, as will be seen in the following two chapters. The potential user has an extremely wide range of modeling options which may be employed to build a detailed scenario. Indeed, the number of user options are so great that this 'advantage' may actually be a hindrance to the uninitiated user when first attempting to exercise the simulation.

The primary advantage of METEOR, however, lies in the fact that it provides a tool that heretofore did not exist. It will allow the interested analyst to make direct comparisons and to evaluate the relative performance of analytic multi-echelon inventory models.

IV. TIGER

A. INTRODUCTION

This chapter provides an overview of the NAVSEA TIGER simulation and the modifications resulting from integrating the multi-echelon supply simulation. Excellent documentation for TIGER in its stand-alone form may be found in the TIGER Manual [Ref. 6]. TIGER was amended for use on the Naval Postgraduate School computer in 1980 by Leather [Ref. 7]. It was further modified, for application on the IBM System 3033, by O'Reilly [Ref. 8]. O'Reilly's work necessitated some minor adjustments to TIGER output to facilitate his particular application. These adjustments have been removed to keep TIGER in basically its original form. For random number generation, TIGER calls on the LLRANDOMII random number generator [Ref. 9]. The complete set of computer programs which comprise TIGER, and a comprehensive variable listing, are contained in Appendices B and D to Reference 7 respectively. Portions of the TIGER program which have been changed to implement METEOR are included in Appendix E of this thesis.

B. OPERATION

1. General

In TIGER, a string of random numbers is used to generate simulated equipment times to failure (TTF) and times to repair (TTR). Based on the system configuration of component equipments, the system 'up' and 'down' times are determined, and various readiness measures are calculated. The simulated mission is repeated a number of times. The

readiness measures are aggregated for each mission, and an average is calculated to provide a statistical estimate of the actual system performance characteristics.

Failure and repair times are drawn from exponential distributions with parameters being mean time between failure (MTBF) and mean time to repair (MTTR) for the given equipment. At the beginning of each mission, all equipments are assigned TTF's based on their MTBF's and a random draw. The TTF's are placed chronologically in an event queue. The first time to failure is accessed and the simulation clock is advanced to the corresponding event time. A TTR is generated for this equipment again, based on its assigned MTTR and a random draw. The TTR is added to the current time (and flagged to identify it as a repair time), and this new event time is placed chronologically in the event queue. This process continues until the next event time exceeds the end of mission time, at which point the current mission is terminated and a new one is started.

The number of missions to be run is determined by the user in one of two ways. In the first case, he may specify a fixed number of missions to be run (from 50-1000 in increments of 50). In the second case, the user specifies a target and lower confidence limit for the system reliability performance measure. Missions are run in increments of 50, and system reliability is computed after each increment. If the target is achieved prior to a specified number of missions, the system meets reliability requirements, and execution is terminated. If the system does not attain the lower confidence limit prior to the specified maximum number of missions, the system fails its reliability requirement, and execution is terminated.

2. Equipment Characteristics and System Configuration

The hardware system under scrutiny is divided into subsystems, and the subsystems further divided into any level necessary to depict the system in accord with the user's requirements. The lowest level identified is termed an "equipment type" and must be assigned a MTBF, MTR, and the percent of time it will be used in the system. The most convenient method for depicting the system is to construct a reliability block diagram such as that shown in figure 4.1. Each block in this diagram can be identified as being in either an up or down state at any given time. By tracing through the various component states, it is possible to determine the overall system status as being either 'up' or 'down'.

3. Mission Timeline

Each mission is made up of a sequence of operational phases of user specified duration that describe the mission scenario. In each phase, the equipment may be configured differently and operated under various conditions. TIGER will recognize up to six different phase types in a mission. Up to 91 phase types may be strung together in any order desired to represent the mission to be completed. For example, if the user desires to represent a mission that consists of transit, alert, and engagement phases, it would be possible for TIGER to vary the weapon system's operating mode during each phase type. This feature provides TIGER the capability for modeling complex mission scenarios.

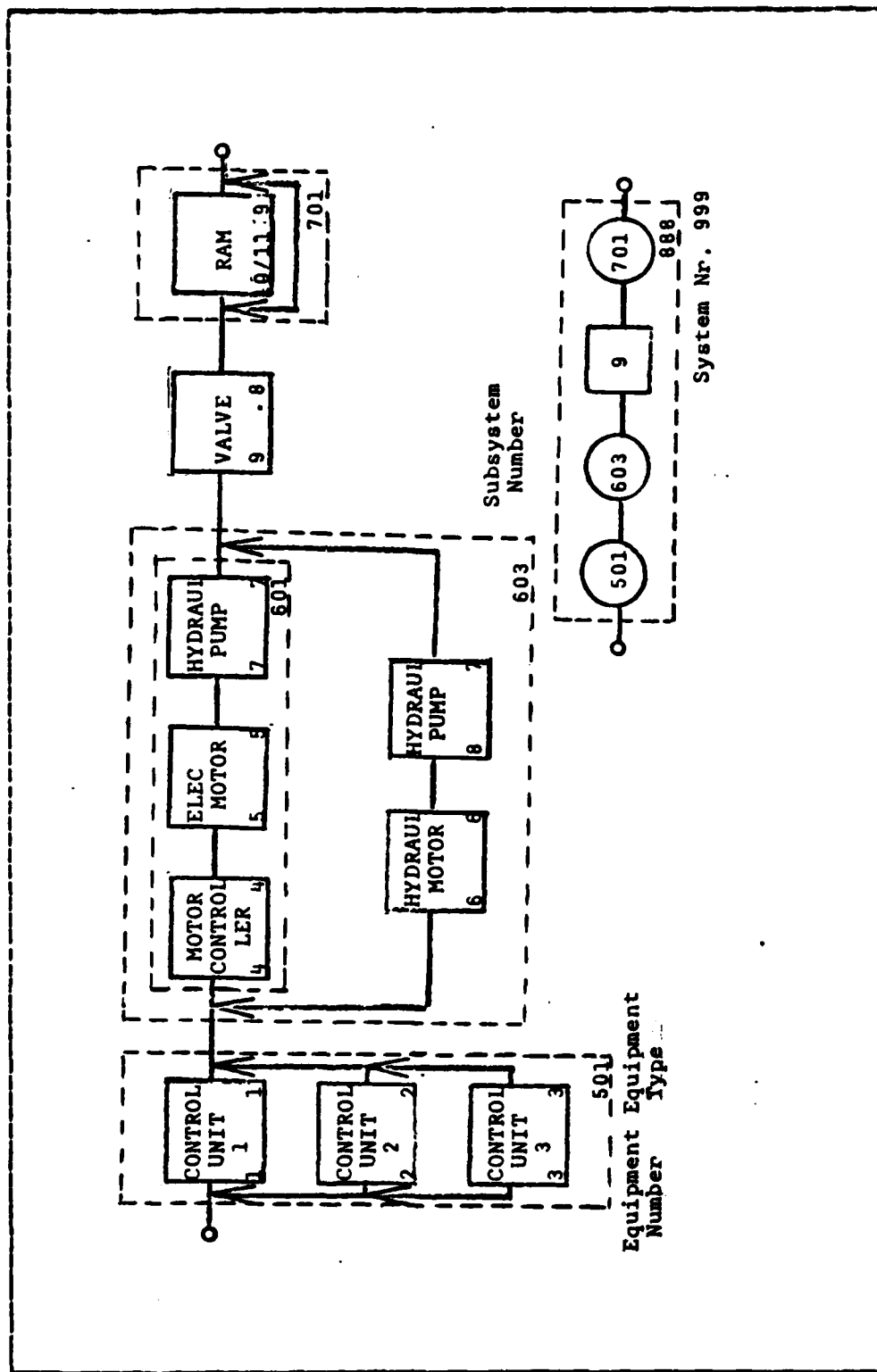


Figure 4.1 Sample Reliability Block Diagram.

C. PERFORMANCE MEASURES

Over the course of each mission, TIGER accumulates various statistics which are used to compute four performance estimators. They are:

1. Reliability

Estimated reliability is the probability that a system will perform satisfactorily for an entire mission.

$$REL(estimate) = 1 - \frac{\text{Nr. of Mission Failures (Aborts)}}{\text{Total Nr. of Simulated Missions}} \quad (4.1)$$

2. Instantaneous Availability

Estimated instantaneous availability is one of two availability measures used in TIGER. Instantaneous availability is the probability that a system will be in an up state at a specific point in time. It is calculated at the beginning and end of each phase.*

$$AVA\ INST = \frac{\text{Number of Missions Up at Time (t)}}{\text{Total Number of Missions Simulated}} \quad (4.2)$$

3. Average Availability

Estimated average availability is the probability the system will be in an up state at a random point in time. This measure corresponds to the operational availability measure discussed in paragraph II.C.1.

$$AVA\ AVERAGE = \frac{\text{Total System Uptime}}{\text{Total Mission Time for all Simulations}} \quad (4.3)$$

4. Readiness

Estimated readiness is defined in TIGER as the probability that the system will be in satisfactory operating condition at a random point in time. Satisfactory operating

*Although one phase begins where a previous ends, the instantaneous availability value may be different if the system states are different in the two phase types.

condition is considered to be when there is neither a mission abort nor a system down. When a mission abort occurs, the system will not recover to an up state for the remainder of the mission.

$$\text{RED (Estimate)} = \frac{\text{Downtime Prior to Mission Abort} + \text{Time after Mission Abort}}{\text{Total Mission Time for all Simulations}} \quad (4.4)$$

Figure 4.2 provides sample calculations for reliability, availability, and readiness performance measures.

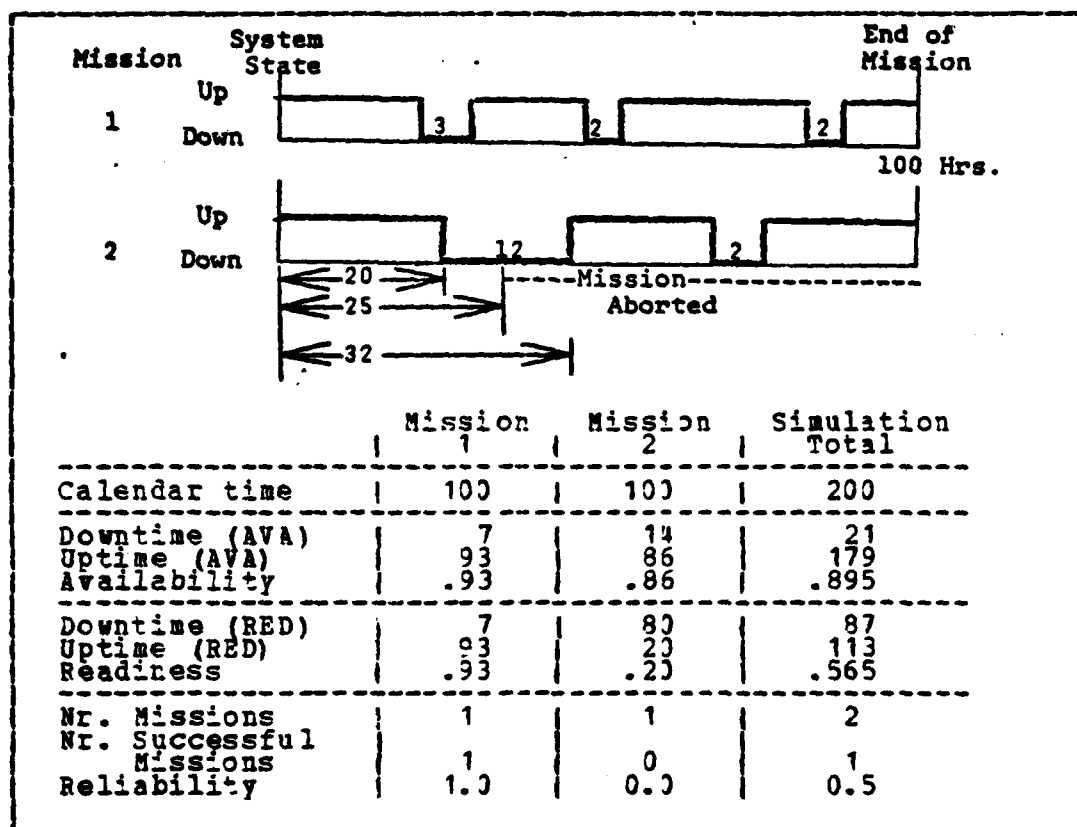


Figure 4.2 Performance Measures: Sample Calculations.

D. OPTIONS AND SPECIAL FEATURES

TIGER has a number of user options that allow for added realism in scenario development. Some of these features have been exercised in the course of this research, while others have been held constant or suppressed. Following, are brief descriptions of the available features. The TIGER Manual should be consulted for additional details.

- 1) Logistic System. In its stand alone mode, TIGER allows for spares to be drawn from three levels of supply. Inventory levels and delay times for shipment from one echelon to another are input parameters. Unlimited spares is also an option. This is not to be construed as a multi-echelon supply system, as there is no interaction between echelons and no reorder capability.
- 2) TIGER/MANNING. A separate program is available to measure the effects of manning levels and maintenance personnel on equipment performance. This option was not used and is not included in the current simulation package.
- 3) Variable Duty Cycle and Variable MTTR. The variable duty cycle option allows the user to assign different MTBF's in different mission phases for the same equipment. Variable MTTR is essentially the same option for repair times.
- 4) MTBF and MTTR Multipliers. These options change MTBF or MTTR across the entire mission timeline and are useful in sensitivity analysis and in determining lower and upper bounds on simulation estimators.

- 5) **Equipment Operating Rules.** The user has the option, when establishing the equipment configuration for each phase, to place equipments in either an operating or standby condition. Equipments can only fail when they are operating. These rules also offer the facility to more realistically model the system, subsystems, and equipments as they would function when connected in series or parallel fashion.
- 6) **Allowable Downtime.** This option allows the system and/or subsystems to be functionally operative for a period of time even though the group has changed to a down state. During this time, if repairs are made, system performance measures will not be degraded. There are two values assigned to allowable downtime. The first applies to phase type only and controls transitions from up to down state during that phase's duration. The second is mission allowable downtime and is assigned only once during the mission. If cumulative mission downtime exceeds this value, the mission is aborted.

E. MODIFICATIONS TO TIGER

Every effort was made to minimize the number of changes to TIGER in adding the multi-echelon supply simulation. Those changes that were necessary are identified in Appendix F, the TIGER program listing. The user does have the option to exercise TIGER in its stand alone form. If this option is desired, all changes will be ignored.

V. THE MULTI-ECHELON SUPPLY SIMULATION MODEL (MULTE)

A. DESCRIPTION AND MODELING CONSIDERATIONS

The following sections outline the operating characteristics of the multi-echelon simulation subroutines that have been developed to complement TIGER. A description of various user options which may be employed in the simulation is also included.

1. Terminology

For simplicity, the system to be evaluated by TIGER is hereafter known as the "weapon system". The lowest indenture level of the weapon system, as configured by the user, will be called "equipments". If two or more equipments have exactly the same salient characteristics, they will be said to be of the same "equipment type". A series of equipments which constitute a subsystem or repair part in its own right, will be termed a "group".

2. General Operation

All equipment types in TIGER are assigned a mean time between failure (MTBF), and it is assumed that all equipments fail independently and at an exponential rate. Based on the mechanics of discrete event simulation, a failure time is initially assigned to each equipment and placed in an event queue. The first failure time is examined, a time to repair that equipment is generated, and that time is placed back in the queue. When that repair time becomes the current event, a new time to failure for the equipment is generated, and so forth.

The multi-echelon supply simulation is invoked when the time to repair a failed equipment is to be generated. The supply system must now react to provide a replacement for the failed unit.* On-hand stocks for that equipment are checked at applicable support activities in the supply network and a replacement is issued to the end user by the first activity having the part. Depending on from where the part was issued, a supply response time (SRT) will be generated and sent to TIGER. TIGER generates a random time to repair and adds to it the SRT. Statistics are then generated by TIGER, as before, to determine the availability and reliability of the weapon system based on the failure and repair of its components.

3. Scenario

The multi-echelon simulation subroutines have been developed to provide the user significant latitude in establishing the desired operating environment. Up to 30 ships may have the weapon system installed on board. The weapon system configuration need not be the same on any two ships and outfitting may also vary from ship to ship (input requirements are simplified, however, when this is not the case). Up to 15 of the 30 ships may be assigned to the east coast and up to 15 assigned to the west coast. The user determines under what conditions the ships are operating and, as a result, specifies the requisition channels to be employed. Three operating environments are recognized: CONUS operations, overseas operations with MLSF support, and overseas operations without MLSF support. Figure 5.1 summarizes the requisition channels used for each of these

*Note the assumption that an equipment failure assumes that a replacement part is necessary to repair the failed equipment. The validity of this assumption depends upon the level of detail employed by the user in modeling the weapon system configuration.

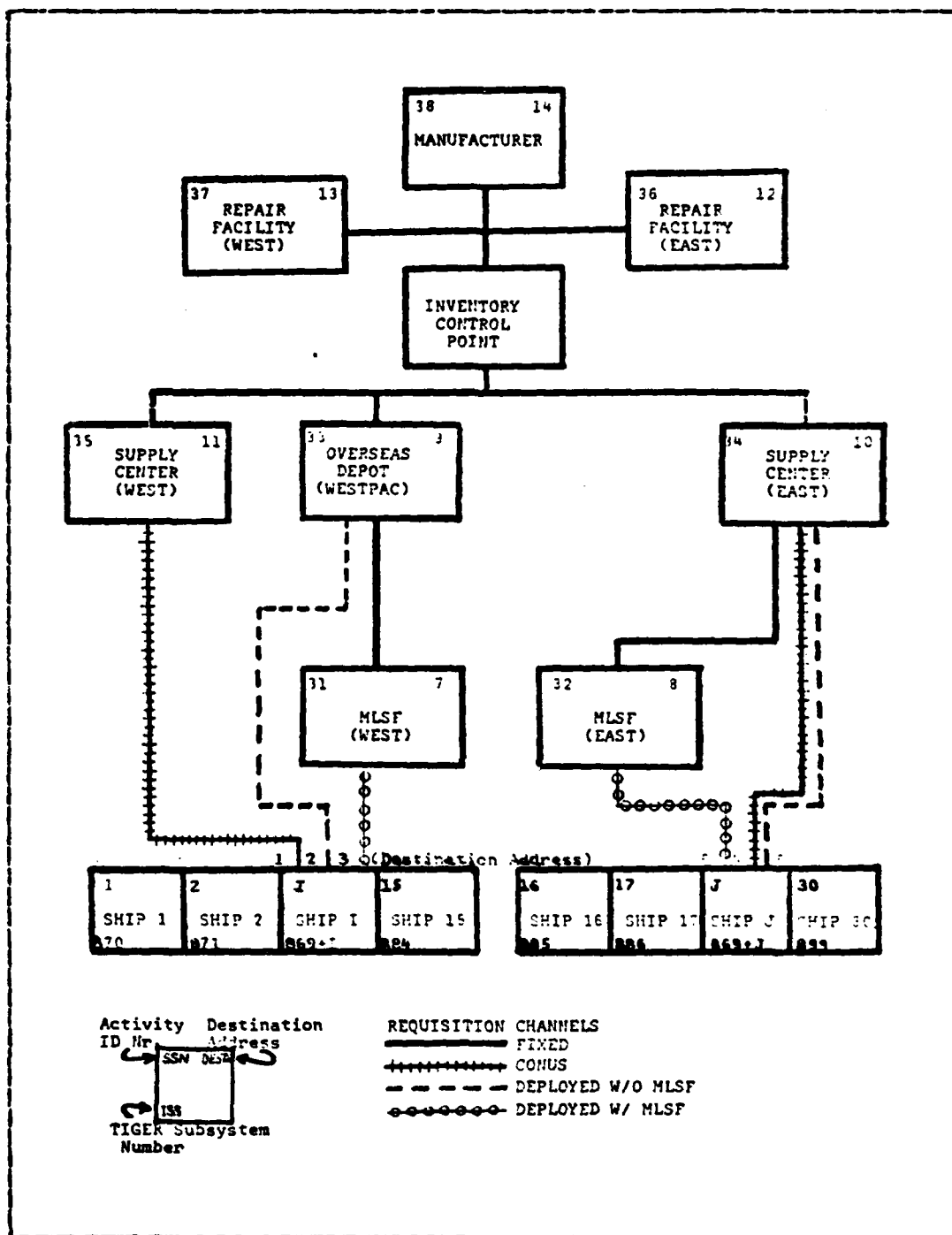


Figure 5.1 METEOR Requisition Channels.

conditions.

Although TIGER allows up to six different phase types and 91 different phases to be employed over the course of a specified mission, it should be noted that requisition channels will be fixed over the entire mission timeline.

4. Requisitioning, Issue, and Reorder Procedures

When a weapon system equipment fails, the end use activity (ship) checks to determine if spares are carried and are on-hand for that particular equipment type. If so, the part is issued from ship's stock and a user specified issue delay constant is returned to TIGER as the SRT. The end user then checks his inventory position to determine if the reorder point for that equipment type has been reached and orders for stock as appropriate. If the part was not available from ship stock, the requisition is passed to the next supply echelon in accordance with the requisition channels in effect. All other activities in the supply network operate in essentially the same manner. If no echelon is capable of providing the required replacement, an order is placed with the manufacturer for procurement. Refer to the system flowchart, Appendix D, for a more detailed process analysis.

It should be noted that the reorder process for the supply depot and two supply centers is controlled solely by the inventory control point (ICP). When the ICP's inventory position reaches the reorder point, an order is generated to either the manufacturer or repair facility as appropriate. The acquired assets are divided between the three activities (based on their current deficiencies) and shipped based on a randomized procurement or repair lead time. The lead times are generated from a gamma distribution with a user specified mean and shape parameter. As in TIGER, the times so generated are placed in an event queue. Thus, each time an

activity is called upon to check its on-hand balance, it must first look at the event queue to ascertain if any material that had been requisitioned for stock, is due in at the current time.

5. Repairable Material

In TIGER, equipment may be designated as being not-repairable during a given time frame. If so, even though an equipment fails, no repair time is established. Similarly, a user may specify a probability that repairs will not be accomplished during a given phase. These options are eliminated if the multi-echelon supply simulation is in effect, since it is unrealistic to assume that a spare would not be requisitioned simply because repairs were impeded.

The multi-echelon simulation does, however, allow the user to designate equipment as 'repairable'. These are items that are required to be turned in to a repair facility and are not authorized for shipboard repairs. When a failure of this type occurs, the end-use activity must turn in the carcass (failed unit) to a generic east or west coast repair activity. The user may specify a positive probability that carcass attrition will take place. If the failed unit arrives at the repair facility and is determined to be economically repairable (both are determinants of the attrition rate), it is held there until either the number of carcasses on-hand equals or exceeds the economic repair quantity for that equipment type, or the ICP directs a repair action to satisfy an immediate requirement.

The ICP inventory position for repairable material is decremented only when attrition occurs. Repairables are procured from the manufacturer when the number of failed units and ready-for-issue material in the system is less than the system reorder point or, to satisfy an end-use requirement when no carcasses are available for repair.

6. Priority Shipments

The multi-echelon simulation does not currently allow for prioritized shipments of critical materials. There are, however, three routines which are used to improve supply response times. They are, in order of precedence:

a) Redistribution between ICP stock points.

When a request for material is received at one of the three ICP stock point activities (i.e., depot and two supply centers) from a lower echelon, and the material is unavailable at that stock point, the ICP will redistribute assets laterally or downward through the echelons. For example, a requisition received by the east coast supply center which cannot be filled, will be passed to and filled by the west coast supply center if stock is available there. However, the ICP will not redistribute assets from the overseas depot to fill an east coast requirement since that would constitute upward redistribution.

b) Substitution due-in-for-stock item for end-use requirement.

Whenever an item is issued from a higher echelon to an end use activity to satisfy a repair requirement, an SRT is established. However, before passing the SRT back to TIGER, the end use activity's due-in-for-stock event queue will be checked to ascertain if an item for stock is due in prior to the SRT. If so, that item will be used to satisfy the repair requirement and the other will be diverted to stock.

c) Substitution of due-in-for-stock items at ICP stock point activities for lower echelon requirements.

When the stock point activities cannot produce material required by a lower echelon, the item(s) will be obtained from the manufacturer or repair facility as appropriate. If, however, an ICP controlled activity, on the requisitioner's coast, has a stock item due in and can ship it there faster than the established procurement or repair lead time, the stock item will be diverted to the lower echelon while the lower echelon's material will be sent to the supplying activity for stock.

B. INPUT REQUIREMENTS

1. General

Input requirements and formats for the TIGER simulator are well-documented in References 6 and 7. These references should be read carefully by the user prior to exercising the simulator. Significant changes to the TIGER equipment configuration data are discussed below. Noteworthy input requirements of the supply simulator are also addressed, while detailed requirements and formats for the entire input deck are contained in Appendix B.

2. TIGER Configuration Data

The TIGER simulation, by itself, models and evaluates a single weapon system. The user may configure that weapon system to virtually any desired level of detail in accordance with the provisions of reference 6. Basically, it requires the formation of equipments into "groups" that are connected in either series or parallel. The groups are connected into "subsystems" and finally, the subsystems are connected in series to form the "system".

In order to integrate the supply system and TIGER simulations, it was necessary to exploit this configuration arrangement. The TIGER subsystems become individual ship-board weapon systems in the METEOR simulation, and the TIGER "system" may be then conceptualized as a fleet-wide composite of such weapon systems. The specific subsystem/ship numbering conventions to be used in METEOR are contained in the input formats, Appendix B. Figure 5.2 depicts a typical configuration scheme which has been used in the TIGER simulation with the multi-echelon supply system option in effect. Note the subtle differences between Figure 4.1 and Figure 5.2.

3. Multi-Echelon Simulator

The potential uses of METEOR were discussed in Chapter III.C.1. The degree of detail required in the input file will be dependent on the objectives of the user.

For a real-world scenario, the multi-echelon simulator requires a relatively large and extensive input file. Ideally, METEOR would calculate provisioning levels (or stocking objectives) for each activity using various multi-echelon provisioning models as subroutines. Similarly, it would be a convenient and useful feature to have optional reorder level computations imbedded in the simulator. The level of complexity and computer storage and run time considerations however, render these options impractical at this time. It is incumbent on the user, therefore, to obtain data from existing provisioning and replenishment models prior to exercising METEOR for these purposes.

In those cases where the user desires to assess basic supply policy alternatives or perform sensitivity analysis in regard to parameters imbedded in METEOR, it would be feasible to contrive a realistic control data set that would measure the relative merits of these alternatives

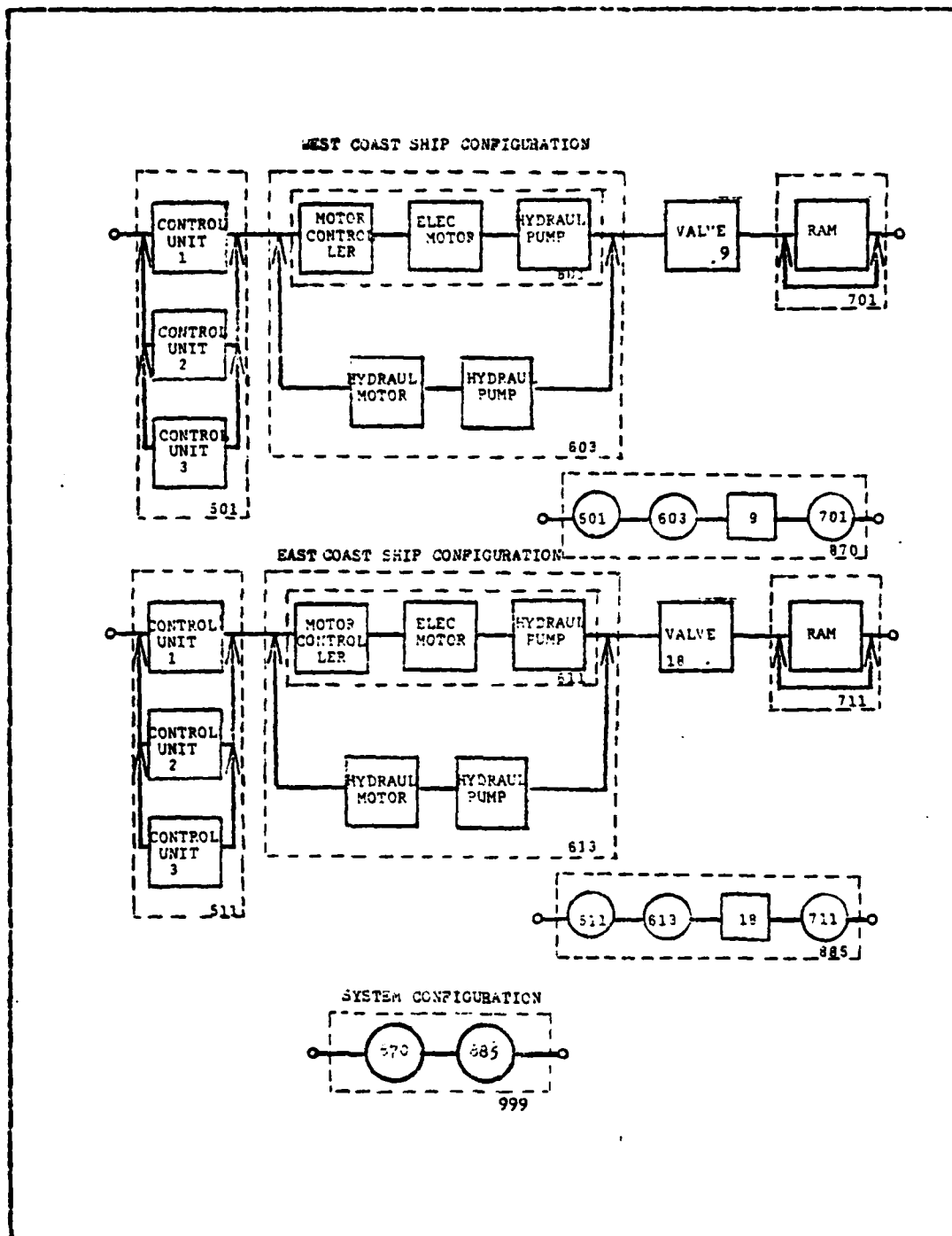


Figure 5.2 Sample Configuration Scheme.

and parameters. Data input in these cases is greatly simplified. For each equipment type, the user has the option to establish the same stocking objective and reorder point on all ships. This option serves to further simplify the input task. An example of a data input file of this type is shown in Figure B.1.

C. SIMULATION OUTPUT: STATISTICS AND SUMMARIES

1. General

The TIGER simulation offers several output options when used on a stand alone basis. The four measures of effectiveness, discussed in Chapter IV, are calculated and printed after each 50 mission increment. In addition, when the system exceeds its allowable downtime criteria, TIGER will print a mission abort message which summarizes the status of all down equipments at the time of the abort. For detailed analyses, the user has the option to review all changes to equipment, subsystem, and system status. The user will select the desired TIGER output from the options provided on the Printout Option input card (see Appendix B).

When TIGER is used in conjunction with the multi-echelon supply simulation, output format and content are altered significantly. In exploiting the equipment configuration scheme employed by TIGER, the individual ships simulated in METEOR are necessarily connected in series. Therefore, if one ship's hardware system is 'down', TIGER considers the entire fleet of ships to be 'down'. Unfortunately, this inaccuracy is reflected in all measures of effectiveness calculated by TIGER. Except for very unlikely mission scenarios, wherein all ships would be required to be fully operational for a given mission, the measures of effectiveness calculated by TIGER have little practical meaning. It is therefore recommended that only

TIGER input parameters be printed, when exercising the METEOR simulation.

Various examples of the output formats available from METEOR may be found in Appendix E.

2. Equipment Related Output

In METEOR, two of the TIGER equipment-related measures of effectiveness have been reconstructed to provide meaningful measures of equipment performance. The measures, average (operational) availability and reliability, are calculated for each ship in the simulation and then averaged across all ships to provide an aggregate measure for the weapon system under study. The two measures are calculated for the individual ships just as TIGER did for the entire system (Equations 4.1 and 4.3 refer).

To compare analytic multi-echelon inventory models, the average availability should be used as the standard since this is the measure they generally purport to optimize. As shown in the following chapter, availability is a function of time. To obtain steady state results the user must therefore ensure that the specified mission time is made suitably long.

Conversely, mission reliability is a measure which would be useful when assessing the likelihood of successfully surviving a mission of specified duration. Clearly, reliability is extremely sensitive to mission length in relation to the system's mean time to failure.*

*The user may choose to modify the reliability measure by setting the ship's system allowable downtime parameter to some value greater than zero. In so doing, the ship's system will not fail until it has exceeded the allowable downtime value. Hence, there will be fewer mission aborts, a greater likelihood for mission success, and 'improved' reliability.

To evaluate the effectiveness of supply performance over time, most scenarios of interest in METEOR will incorporate relatively long mission durations. In this regard, system reliability will necessarily be driven toward zero, while average availability will tend to achieve its steady state value.

3. Supply Related Output

Detailed, event driven, supply related output is available at the user's option. Subsequent to every equipment failure, a printed summary is generated reflecting the supply system's actions resulting from the demand. This output is voluminous and, consequently, should be selected with with care. The following information is included:

- Supply Response Time. The amount of time required to satisfy the end-user's demand for material to effect repairs to the failed unit.
- Issuing Activity. Identification number** of the activity that issues the end use requirement.
- Orders For Stock. As a result of the issue, all subsequent orders for stock are displayed with the following information: ordering activity, issuing activity, and the time that the stock is due in at the ordering activity.
- Carcasses Lost Through Attrition. If the equipment that fails has been designated as a repairable item, the end use activity is required to ship the failed carcass to the nearest repair facility. If the turn-in is lost through attrition, a message will be displayed to that effect.

**A cross reference to identification numbers is provided at the end of Appendix C, Figure C.1, and is reflected in the echelon structure depicted in Figure 5.1. These references should be consulted when analyzing METEOR output.

- Repair Inductions. If the number of carcasses on hand at either repair facility is greater than or equal to the ERQ, a message will be printed, stating that an induction was initiated, to whom the items will be shipped upon completion of repair, and the time due in to the stocking activity.

Upon completion of all simulation runs, a summary analysis provides statistics pertaining to supply related costs and supply system performance. Rather than assigning arbitrary costs to supply actions, most 'costs' are given in terms of the number of actions taken vice actual dollar costs. The user may select to review the summary by supply echelon, by equipment type, or both. The following summaries are provided.

- Procurement Costs. The number of procurements per mission is given as an indication of the fixed cost of procurement at each echelon and for each equipment type. Also, the actual number of items procured is provided to reflect the variable costs associated with each order placed.
- Repair Costs. As with procurement costs, the fixed and variable costs of repair are presented in terms of the number of repair inductions and total number of items inducted. Also given is the total number of items shipped from end-use activities to repair facilities and the total number of repairable carcasses lost through attrition.
- Shipping Costs. The total number of shipments between individual activities is provided as a measure of shipping activity and the costs associated therewith. Since the cost of shipping to an end use activity (ship) will vary with its location, the ships are assigned six destination addresses that are defined in Table I below.

TABLE I
Destination Addresses

Destination Number	Ship Location
1	West Coast, Continental U.S.
2	Western Pacific, without MLSP
3	Western Pacific, with MLSP
4	East Coast, Continental U.S.
5	Atlantic/Mediterranean, without MLSP
6	Atlantic/Mediterranean, with MLSP

- Inventory costs. These costs are given in actual dollar values which are based on the equipment type costs and initial inventory levels input by the user. Two measures are displayed. First, initial provisioning costs are given to reflect the cost associated with provisioning all echelons up to their respective stocking objectives. Second, an average on-hand inventory value is calculated as a measure of inventory carrying costs. The average inventory is calculated by time weighting the inventory on-hand at each activity over the course of the simulation.
- Supply Performance. Supply performance is measured in terms of net and gross requisition effectiveness. Total demands are shown for each echelon and/or equipment type. All requisitions that cannot be satisfied are counted as not-in-stock (NIS) when the activity has an allowance for that item. If the activity has no allowance, it is counted as a not-carried (NC) demand. When the ICP redistributes assets between stock points to satisfy fleet demands, the effectiveness statistics are not affected.

VI. RESULTS

Because of the complexity inherent in a typical METEOR scenario, model validation was performed using very simple scenarios wherein it was analytically feasible to evaluate theoretical equipment performance. The scenarios were established with two ships having identical two-component

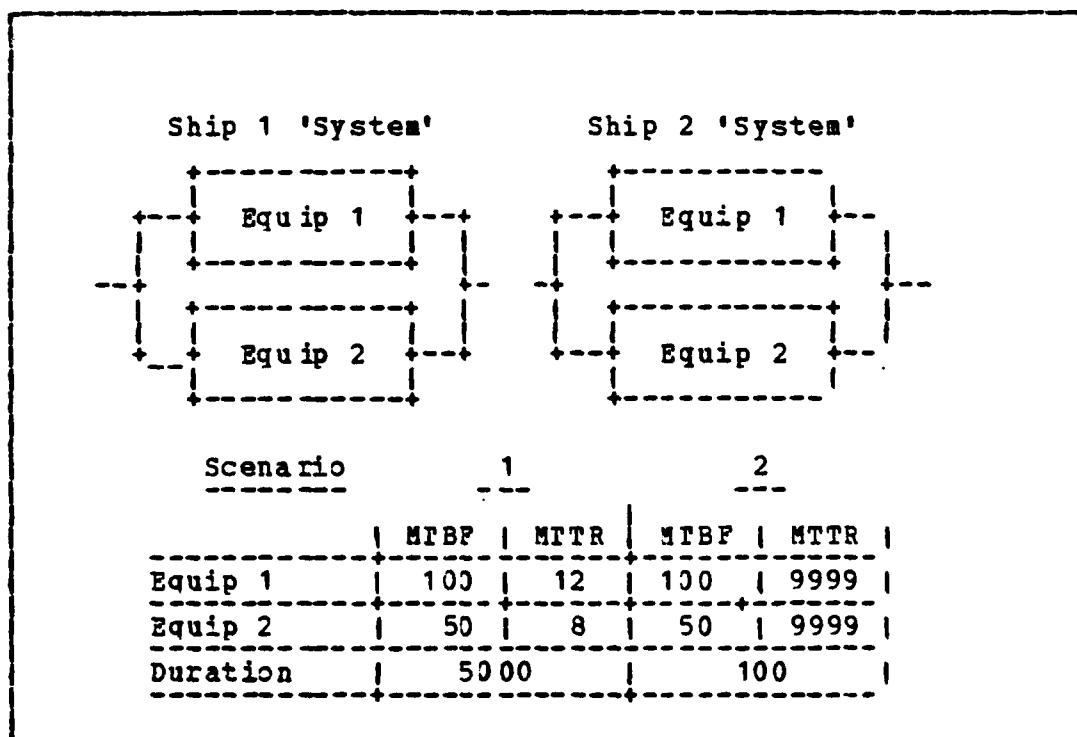


Figure 6.1 Validation Scenarios.

parallel systems, as shown in figure 6.1. Unlimited spares were available to the end-use activities and the mean logistic delay time was assumed to be zero. In the first scenario, mission duration was set to 5000 and allowable

mission downtime to zero. The intent of this scenario is to determine average operational availability over an extended mission duration. Reliability was validated under basically the same scenario, with the following exceptions. Mission duration was shortened to 100 to provide for the possibility of successful mission accomplishment; and, the equipment MTTR's were given large values (9999) to preclude repairs on the equipments during the mission. Three random number seeds were used and 100 missions were repeated for each seed.

The theoretical operational availability for this system can be expressed in terms of the following equations: [Ref. 10],

$$\text{Average Availability} = \frac{1}{T} \int_0^T A(t) dt \quad (6.1)$$

From the system reliability diagram,

$$A(t) = A_1(t) + A_2(t) - A_1(t)A_2(t) \quad (6.2)$$

Where,

$$A_i(t) = \frac{MTBF_i}{MTBF_i + MTTR_i} + \frac{MTTR_i}{MTBF_i + MTTR_i} \text{EXP}(-(\lambda_i + \mu_i)t) \quad (6.3)$$

The limiting results for average availability are:

$$\text{Limiting Average Availability} = A = \lim_{T \rightarrow \infty} \frac{1}{T} \int_0^T A(t) dt \quad (6.4)$$

$$= \frac{MTBF}{MTBF + MTTR} \quad (6.5)$$

For the system under study,

$$A = A_1 + A_2 - A_1 A_2 \quad (6.6)$$

Assuming no repair will be made to the system during the mission, theoretical reliability may be computed as follows:

$$R(t) = R_1(t) + R_2(t) - R_1(t)R_2(t) \quad (6.7)$$

Where $F(t)$ is the survival function for the system. Assuming exponential times to failure, the survival function for an equipment is:

$$R(t) = \text{EXP}(-\lambda t) \quad (6.8)$$

In scenario 1, theoretical availability is computed using the limiting results; equation (6.1) is used in scenario 2 due to the relatively short mission duration. A comparison of the computed and simulated values for availability and reliability is displayed in Table II .

The test results indicate that the model output closely approximates the expected theoretical values. It is recommended, in the following chapter, that further research be directed toward more extensive testing of the METEOR model to verify its performance over a wide range of possible scenarios.

TABLE II
Simulation Results

Scenario #1			
Run	Seed	Availability	Reliability
1	8720	.9855	0.0
2	1353	.9861	0.0
3	4534	.9853	0.0
Theoretical Values		.9853	0.0
Scenario #2			
4	7381	.7447	.4400
5	2268	.7570	.4750
6	8720	.7631	.4500
Theoretical Values		.7482	.4534

VII. SUMMARY AND RECOMMENDATIONS

A brief survey of multi-echelon models currently in use in the Department of Defense has been presented. It was shown that differences exist in their assumptions, their structure and objectives. To compare the relative merits of these models, therefore, a common frame of reference is needed to evaluate their performance over time and the costs associated with their implementation. Due to the inherent complexities of multi-echelon, multi-indenture models, an analytic comparison was regarded as impractical and simulation was suggested as a feasible alternative. To make a valid assessment of the multi-echelon, multi-indenture inventory models, a simulation with these same features is required.

Chapter III provided an overview of multi-echelon simulations currently in use by the Navy. With the possible exception of the SPECTRUM model, none of those reviewed were found to be adequate for use as a multi-echelon evaluation tool. Additionally, it was determined that no current simulation exists which offers multi-echelon, multi-indenture characteristics in a surface fleet environment. In light of these facts, a simulation model, METEOR, was developed to satisfy these needs.

METEOR is a multi-echelon supply model that incorporates a multi-indenture, equipment-related model, TIGER, to generate equipment failures and subsequent supply system demands. The METEOR model offers a wide range of possible user-developed scenarios and equipment configuration schemes. Its output consists of various measures of supply related costs and supply performance, as well as, the equipment performance measures of operational availability and reliability.

Chapter III stated that the primary motivation for building this model was to offer an evaluation tool that heretofore was unavailable. The actual use and employment of this model is left to future research. The interested student/analyst might consider the following recommendations and proposals:

1. Any new model must necessarily undergo the test of objective analysis prior to its acceptance and implementation in the field. In this regard, continued validation of the METEOR model is encouraged. Confidence in any model increases with its successful application under diverse scenarios, and when it is successfully exercised by different users. More detailed and varied scenarios than those found in Chapter IV have feasible analytic solutions which could be compared statistically to simulation results.
2. To accurately assess multi-echelon inventory models, the primary objective of METEOR, a relatively large and accurate data base is required. An actual operating hardware system should be the basis for model performance comparisons. Admittedly, a hypothetical system could be used. However, modeling an actual operating system would lend credence to the study effort and offer the historical parts related data necessary for model inputs. This data set would be the control factor in the evaluation process and provide inputs to all models under study, as well as the METEOR simulation. Each multi-echelon inventory model under consideration would need to be accessed and exercised with the control data set. The inventory levels generated by these models would serve as input to the initial provisioning levels in the METEOR simulation. The purported costs and equipment-related measures of effectiveness provided by each model should be recorded for use in the final analysis. Finally, it would be necessary to process the data through the Navy's current

repair and replenishment models to determine reorder levels and economic repair quantities. Provided with these inputs, METEOR should return an objective assessment of the relative performance of the models under study.

3. There is no reason to restrict the use of METEOR to the evaluation of multi-echelon models. In fact, the multi-echelon characteristics of METEOR make it an extremely useful tool in assessing the effect of parameter changes at any one echelon of the supply system, in that the impact of those changes will be reflected at all levels of the system.

4. METEOR might also be used as a resource-to-readiness evaluation model. The availability of investment capital is normally the binding constraint on inventory levels. By varying inventory levels at the stocking activities, a determination could be made as to the investment required to obtain a given level of material readiness. Additionally, some insight might also be gained as to which echelons offer the highest rate of return on investment.

5. In terms of model enrichment, there exist several areas where METEOR might be embellished. Some of the more important extensions would include the following.

- a) Prioritized shipments for critical material.
- b) Expansion of the model to allow for more than 500 total equipments to be modeled. This should be a user specified parameter.
- c) Parameters that exhibit large variations from their means should be made random variables if such action would significantly enhance model realism. METEOR uses average values for order and shipping times, and, does not model geographic proximity of the ships and MILSP. Depending on user requirements, it may be considered beneficial to model these as stochastic processes.

d) In the real world, not all equipment failures necessitate replacement of component pieces. A randomized determination of whether or not parts are required to effect repairs could be made by METEOR.

6. METEOR is a relatively easy model to implement. Once the input data is prepared, it takes only 4-8 seconds of CPU time on the IBM 3033 to run 1000 missions of duration 5000 hours. This offers an excellent opportunity to explore supply system interactions and parametric sensitivity in a multi-indenture, multi-echelon environment.

APPENDIX A

EXAMPLE OBJECTIVE FUNCTIONS

The following objective functions, ACIM, Mod-METRIC, and SESAME, are representative of those used in other multi-echelon inventory models. For more detailed treatment, consult the cited reference.

1. Availability Centered Inventory Model (ACIM) [Ref. 11].

$$\text{MIN } D_{eu}$$

$$\text{s.t. } \sum_k \sum_v c_k s_k = B$$

where,

D_{eu} = the expected delay time for equipment e, at operating site u, and

B = Total allowable budget

k = component of e

v = unit cost of k

s = stocking level of k

D, the expected delay per demand for item i, at stocking location v, can be expressed as:

$$-\frac{1}{\lambda_{iu}} \sum_{x=s_{iu}-1}^{\infty} (x-s_{iu}) p(x; \lambda_{iu}, T_{iu}) \quad u=(0,1,\dots)$$

where,

λ_{iu} = Expected number of demands for item i, at operating site u.

$p(x; \lambda_{iu}, T_{iu})$ = Probability of x units of stock reduction for item i, at operating site u.

T_{iu} = Mean resupply time.

2. Multi-Echelon Technique for Recoverable Item Control;
Modified (Mod-METRIC) [Ref. 12].

$$\text{MIN} \quad \sum_{i=1}^M \sum_{x_i=s_i+1}^{\infty} (x_i - s_i) p(x_i | \lambda_i T_i)$$

where,

M = Total number of bases.

s_i = Stock level of spare components at base i .

T_i = Average resupply time at base i .

λ_i = Removal rate of components at base i .

s.t.

$$\sum_{i=1}^M (c_e s_i + \sum_{j=1}^N c_j s_{ij}) + \sum_{j=1}^N c_j s_{0j} + c_e s_0 \leq C$$

where,

c_e = Cost of equipment

c_j = Unit cost of module j

N = Number of modules

s_0 = Number of spare modules at depot, 0

C = Total allowable budget

3. Selective Stockage for Availability, Multi-Echelon
(SESAME) [Ref. 2].

$$\text{MIN} \quad \sum_{i=1}^M \sum_{j=1}^E S_{ij} \cdot N_j P_i + \sum_{i=1}^M \sum_{j=1}^E EBO_{ij} + RDT_{ij} \cdot N_j PC$$

where,

M = Total number of items

E = Total number of echelons

S_{ij} = Stock level for item i , at echelon j

N_j = Number of stocking activities at echelon j

P_i = Unit price of item i

EBO_{ij} = Expected number of backorders for item i

at echelon j

RDT_{ij} = Demand for item i , at echelon j

PC = Backorder penalty cost

APPENDIX B

METEOR INPUT REQUIREMENTS AND FORMATS

Most input requirements applicable to the TIGER portion of the METEOR simulation remain unchanged from the formats provided in the TIGER Manual. However, there are some variations in user options and file organization. To facilitate the use of METEOR, therefore, formats for the entire input file are provided below. Annotations are provided, where necessary, to reflect file structure when exercising TIGER on a stand alone basis. A sample input file is provided at the end of this appendix.

All data is entered in 80 column, card/card-image format. Data types are integer, real and alphanumeric. All integer data fields must be right justified.

Card Type 1. METEOR Option Card.

The METEOR option will indicate that the multi-echelon supply simulation is to be invoked on this run, or, that TIGER is to be run on a stand alone basis. Depending on the option selected, some of the input cards that follow will not be required. Additionally, various input parameters and option settings will vary between the two simulations. These changes will be reflected in the notes that follow the card formats.

Column	Format	Variable Name	Description
1-4	I4	IOPTM	METEOR option switch = 0 to run TIGER only = 1 to run METEOR
5-8	I4	IOFTP	METEOR print option switch for supply performance summary statistics = 1 by equipment type = 2 by supply echelon = 3 by equipment type and supply echelon
9-12	I4	IOFTP1	METEOR print option switch to invoke or suppress printed record of all supply actions = 0 to suppress = 1 to invoke
13-16	I4	IRC	Requisitioning Channels = 1 CONUS operations = 2 deployed without MLSF = 3 deployed with MLSF
17-20	I4	NRSHPS	Total number of ships to be simulated
21-24	I4	ITOTEQ	Total number of equipments to be simulated
25-28	I4	NRWSC	Number of ships assigned to the West Coast
29-35	F7.0	SSADT	Ship's system allowable downtime.

Notes:

IOPTM -If only TIGER is desired to be exercised, all other entries on card, after IOPTM, may be ignored.

IOFTP1 -The record of all supply actions can be voluminous.

IRC -See Figure 5.1 for resulting requisition channels.

SSADT -This input replaces TIGER allowable downtime parameters found on input cards 4, 18, and 19.

Card Type 2. Ship (subsystem) Identification Numbers

This card is used to relate TIGER subsystem numbers to METEOR ship numbers. It must be omitted if IOPM is 0.

Column Format	Variable Name	Description
1-4 20I4	NUMSS (I)	Starting with the lowest numbered ship (i.e., 870 for west coast, 885 for east coast) and proceeding to the highest, identify all ships to be simulated. If more than 20 ships are to be simulated, follow with another card using same format.
5-8		
9-12		
Etc.		

Card Type 3. Timeline Iteration Card.

If TIGER is to be run on a stand-alone basis, it is possible to run more than one mission scenario (timeline). If METEOR is used, only one mission scenario is permissible.

Column Format	Variable Name	Description
1-4 I4	JCC	No. of timeline variations to be run from data deck. Set JCC = 1 if exercising METEOR.
5-80 19A4	RUNID	Alphanumeric run identifier.

Notes:
JCC -If running TIGER and JCC exceeds 1, only phase type and duration card(s) must be added in the back of the data deck, followed by a blank card.

Card Type 4. Statistical Parameter Card.

This card is used to govern the number of missions to be performed in the simulation. If METEOR is used, a predefined number of missions should be run (see notes below).

Column	Format	Variable Name	Description
1-4	I4	NMAX	Maximum number of missions to be run. Should be in multiples of 50 and must not exceed 1000.
5-8	I4	NOPT	Optimal number of missions (not to exceed NMAX).
9-12	F4.0	PL	Specification requirement for reliability.
13-16	F4.0	XK	Standard deviation to be used in calculating lower control limit.
17-20	I4	ISEED	Random number seed.
21-24	I4	NPH	No. of phase types, not to exceed 6.

Notes:

NMAX - To run a predefined number of missions, set PL = 1.0, and NOPT and NMAX to the desired number of missions. It may be convenient, when running METEOR, to run less than 50 missions. If so, refer to TIGER main program line labels 210 and 340. Change '50' to the desired number of missions to be run.

XK - A value of 1.28 corresponds to a 90% lower confidence limit (assuming normality). Inconsequential when running METEOR.

Card Type 5. Phase Type and Duration Card.

Phases are the key to constructing scenarios in TIGER. Up to 6 different phase types may be specified. The phase types may be put together in a sequence of up to 95 phases which comprise the mission to be exercised. For example, normal steaming may be simulated in one phase, while combat operations are simulated in another. Equipment related parameters may be varied, on the input cards that follow, to correspond to the type of operation modeled in any given phase. Note that requisitioning channels do not change with phase type.

Column	Format	Variable Name	Description
1-2	F2.0	XXT(1)	Phase type number for first simulation sequence.
3-10	F8.0	XXT(2)	Duration of first sequence.
11-12	F2.0	XXT(3)	Phase type number for second simulation sequence (if any).
13-20	F8.0	XXT(4)	Duration of second phase.

Note: Continue this format through card column 50, duration of fifth phase sequence (if needed). If more than five phase sequences are needed, continue on additional cards using the same fields.

Card Type 6. ***** Blank Card *****

Card Type 7. Printout Option Card.

This card is used to select the output options available from TIGER.

Column	Format	Variable Name	Description
1-4	I4	KOPT	Printout option switch. = 1 for management summary. = 2 for engineering summary. = 3 for complete details. (used for debugging only) = 4 to suppress printout of input data. = 5 to specify printout using KS variables (see below). = 6 for TIGER/MANNING complete details (debugging only).

If KOPT=5, select from the following output options as needed, otherwise leave fields blank.

5-8	I4	KS (1)	= 1 Input data
9-12	I4	KS (2)	= 1 Equipment down at time of mission failure.
13-16	I4	KS (3)	= 1 Down time at end of phase.
17-20	I4	KS (4)	= 1 Abort messages.
21-24	I4	KS (5)	= 1 All events.
25-28	I4	KS (6)	= 1 ETIME matrix (debugging only).
29-32	I4	KS (7)	= 1 Not used.
33-36	I4	KS (8)	= 1 Not used.
37-40	I4	KS (9)	= 1 Not used.
41-44	I4	KS (10)	= 1 System & subsystem status.
45-48	I4	KS (11)	= 1 TIGER/MANNING debugging
49-52	I4	KS (12)	= 1 Status of all groups
53-56	I4	KS (13)	= 1 Downtime message

Note: When running METEOR, KOPT = 5, KS (1) = 1 is recommended.

Card Type 8. Phase Repair Card.

This card is used to specify the repair option in effect for each phase type.

Column	Format	Variable Name	Description
1-4	I4	IFLAG (1)	Repair option for each phase type (up to six).
5-8	I4	IFLAG (2)	= 0 if on-board repair allowed.
9-12	I4	IFLAG (3)	= 1 if no on-board repair allowed.
			= 2 if on-board repair allowed, but failure inhibited. 13-16
I4		IFLAG (4)	
17-20	I4	IFLAG (5)	
21-24	I4	IFLAG (6)	

Notes: IFLAG = 1, will inhibit the ordering of repair parts even though an equipment has failed. This option is, therefore, not recommended when running METEOR.

Card Type 9. Repair Policy Card.

This card is used to determine the repair policy to be in effect during the simulation, by specifying the percentage of repairs to be performed at the organizational level. Additionally, the user may specify a period of time that the system may be down during the mission before the mission is aborted.

The MTBF and MTTR multipliers may be used to vary these parameters for a given simulation run and are, therefore, useful in sensitivity analysis.

Column	Format	Variable Name	Description
1-4	F4.0	REPOL	Decimal fraction of repairs to be performed aboard ship.
5-12	F8.2	TAD2	Mission allowable downtime.
13-16	F4.0	XM	MTBF multiplier.
17-20	F4.0	XT	MTTR multiplier.

Notes:
REPOL -In METEOR, the repair process is handled explicitly by designating equipments as repairable or consumable. If using METEOR, set REPOL = 1.0.

TAD2 -If using METEOR, set TAD2 = 100000.

Card Type 10. Equipment Type Cards.

All equipments in the simulation are given an equipment type number. If two or more equipments are essentially the same, (i.e., would have the same values for the eight parameters shown on this card, and would be treated as the same item by the supply system) they would be designated with the same equipment type. METEOR deals exclusively with equipment types in the provisioning and replenishment of inventories at the various echelons.

One card is required for each equipment type.

Column	Format	Variable Name	Description
1-4	I4	I	Equipment type number. Should be sequentially starting with 1, not to exceed 200.
5-20	4A4	F1	Equipment type nomenclature.
21-28	F8.0	XMTBF	Mean time between failure.
29-32	F4.0	XMTTR	Mean time to repair. Proceed by a negative sign and include the variable MTTR card, if this option is desired. Non-repairable is indicated by value of 9999.
33-36	F4.0	U	Duty cycle/Utilization (non-zero decimal fraction).
37-40	F4.0	V	Administrative delay time from tender to ship.
41-44	F4.0	W	Administrative delay time from depot to ship.
45-48	I4	IUI	If a variable duty cycle (VDC) is desired, assign a sequential number (between 1 and 200) and include the VDC card following. Otherwise leave this field blank.

Notes:

XMTTR - If an equipment type is given a XMTTR of 9999, it will not be ordered from the supply system in METEOR. This option, therefore, is not recommended.

V, W - Administrative delay time is not utilized in METEOR, these fields may be left blank when METEOR is being run.

Card Type 11. Variable Duty Cycle Card.

A variable duty cycle may be employed to vary the percentage of time that an equipment is utilized during a phase type. This is an optional input. If IUI on the previous card is non-zero, place this card immediately behind the type card to which it refers. A maximum of 50 VDC cards are allowed.

<u>Column</u>	<u>Format</u>	<u>Variable</u> <u>Name</u>	<u>Description</u>
1-4	I4	IV	VDC identifier-sequential number, same as the value of IUI on the preceding equipment type card.
5-8	F4.0	VDC(1)	Duty cycle/utilization of the equipment type during each phase type 1-6. These values override the value of U on the preceding card.
9-12	F4.0	VDC(2)	
13-16	F4.0	VDC(3)	
17-20	F4.0	VDC(4)	
21-24	F4.0	VDC(5)	
25-28	F4.0	VDC(6)	

Card Type 12. Variable Mean Time to Repair Card.

This card may be used to vary an equipment's mean time to repair between phase types. It is an optional card. If XMTTR is negative on the equipment type card, place this card behind the VDC card or Equipment Type Card as appropriate.

<u>Column</u>	<u>Format</u>	<u>Variable</u> <u>Name</u>	<u>Description</u>
1-4	F4.0	VMTTR(1)	MTTR values of the equipment type during each phase type 1-6. Non-repairable is indicated by 9999, but should not be so designated if METEOR is being run.
5-8	F4.0	VMTTR(2)	
9-12	F4.0	VMTTR(3)	
13-16	F4.0	VMTTR(4)	
17-20	F4.0	VMTTR(5)	
21-24	F4.0	VMTTR(6)	

Card Type 13. **** Blank Card ****

Card Type 14. Equipment Cards.

Equipment cards identify similar equipments to their equipment type. There may be no more than 500 equipments in total. Starting with the first equipment type, number each equipment in sequential order starting with number 1. Continue in unbroken sequence through all equipment types.

<u>Column</u>	<u>Format</u>	<u>Variable Name</u>	<u>Description</u>
1-4	I4	NTYPE	The Type Number associated with the equipment listed in the next field(s).
5-8	I4	LOAD (1)	Equipment numbers of those equipments which belong to the designated equipment type. Up to 19 may be designated per card. If more than 19 are associated with a given type, use additional equipment cards and repeat the same type number.
9-12	I4	LOAD (2)	
13-16	I4	LOAD (3)	
17-20	I4	LOAD (4)	
21-24	I4	LOAD (5)	
25-28	I4	LOAD (6)	
29-32	I4	LOAD (7)	
33-36	I4	LOAD (8)	
37-40	I4	LOAD (9)	
and so on to		LOAD (19)	

Card Type 15. ***** Blank Card *****

Card Type 16. Spare Option Card.

There are four options available to input spares into the simulation:

(1) If METEOR is being exercised, spares will be input in the MULTE input section, and this card must be omitted. If TIGER is being used in its stand-alone mode, the following three options apply.

(2) Use the literal "Unlimited Spares" in columns 1-16 to simulate unlimited spares (90,000 spares are internally assigned to each equipment type).

(3) If spares are to be input by the user, leave this card blank and enter spares data in the cards that follow. If a spare part sensitivity analysis is desired, enter a spare parts multiplier (SX) in columns 21-24 of this card. The multiplier will increase or decrease (depending on the value assigned) the spare parts levels that are specified on the following cards.

(4) Enter "999" in card columns 21-24 to invoke the SPARES subprogram. This will determine levels based on the calculations of the .25 FLSIP COSAL Model.

Card Type 17. Spares Card.

If METEOR is being exercised, this card must be omitted. For TIGER, these cards are only used if the allowances for spares are to be input directly (i.e., the previous card did not specify unlimited spares or invoke the SPARES subprogram). One card must be input for each equipment type.

<u>Column</u>	<u>Format</u>	<u>Variable</u>	<u>Description</u>
		<u>Name</u>	
1-4	I4	ISPARE(1)	Number of organizational level spares for the equipment type.
5-8	I4	ISPARE(2)	Number of spares at the tender for the equipment type.
9-12	I4	ISPARE(3)	Number of spares at the depot for the equipment type.

Card Type 18. System Card.

Card types 19-23 govern the hardware system configuration. Since that configuration may change from phase type to phase type, one complete set of these cards for each phase type must be placed sequentially in the data deck. An example of a reliability block diagram for METEOR appears in Figure 5.2. Starting with the individual components, groups are formed from subsets of components which are connected in either series or parallel. The groups are nested and combined with other equipments to form new groups. This process continues for each ship being simulated, until the hardware system on each ship can be represented by a single group. This group is called a 'subsystem' by TIGER. The individual subsystems (ships), are then combined in 'series' to form the overall 'system'.

Column	Format	Variable Name	Description
1-4	A4	ID	Any alphanumeric (i.e., the literal "FLR") used to identify the overall system.
5-8	I4	LL	Phase type number (sequential), from 1-6.
9-12	I4	NSS	Number of subsystems (ships) in the phase.
13-16	I4	ISS	System identification number. (Usually the last group number on the configuration matrix cards.)
17-24	F8.0	SSTIME	System allowable sustained downtime (should not be less than subsystem allowable downtime values). Should be less than or equal to TAD2 (Repair Policy Card). To inhibit aborts, use 100000.

Notes:

NSS - In METEOR, the number of subsystems (ships) must remain constant for each phase type.

SSTIME - Because ships are configured in series in METEOR, system allowable downtime has little meaning. The system would be considered 'down' anytime one or more of the individual ship's system was down. Therefore, SSTIME should be set to 100000.

Card Type 19. Subsystem Cards.

There must be one subsystem card for each ship/subsystem, being simulated. At least one ship or subsystem is required.

<u>Column</u>	<u>Format</u>	<u>Variable Name</u>	<u>Description</u>
1-4	A4	ID	Any alphanumeric (e.g., the "SHIP1").
5-8	I4	LL	Phase type number.
13-16	I4	ISS	Subsystem identification number. This will be a group number from a Configuration Matrix Card that follows.
17-24	F8.0	SSTIME(2)	Subsystem allowable sustained downtime. This value should be less than or equal to SSTIME on the System Card. To inhibit aborts, use a value of 100000.

Notes:

ISS -In METEOR, the ISS for ships must assigned sequentially, running from 370 to 884, for West Coast ships; from 885 to 899, for East Coast ships.

SSTIME -This downtime parameter will impact reliability and availability measures when METEOR is in use since all ships will not function is another is down. Set this value to 100000, and use the variable SSADT on card type 1, if an allowable downtime is desired.

Card Type 20. Equipment/Subsystem Cross Reference Card.

This card is required in METEOR to identify on which ship the equipment failure occurred. If IOPTM = 0, omit this card, otherwise one set will be required for each phase type.

Column	Format	Variable Name	Description
1-4	I4	NSSEQ (1)	Order ship numbers (ISS) from lowest to highest and assign each
5-8	I4	NSSEQ (2)	a sequential number starting with 1. Assign that number to NSSEQ(i), if
9-12	I4	NSSEQ (3)	equipment number 'i' is installed on that ship.
13-16	I4	NSSEQ (4)	If more than 18 equipments are modeled, use as many cards as
17-20	I4 Etc.	NSSEQ (5)	necessary in the same format.

Card Type 21. Configuration Matrix Cards.

These cards define the reliability block diagram configuration of the system under evaluation.

Column	Format	Variable Name	Description
1-4	I4	NRO	The number of members in the group defined on this card that are required to be operating for the system to be operational.
5-8	I4	IB (1)	The group number assigned to the group of members defined on this card. It may vary from 501 to 1000, in any order.
9-12	I4	IB (2)	The numbers of the equipments and groups which make up the group defined on this card. The maximum number of members in a group is unlimited; however, if there are more than 7, a continuation card is required, which is of the same format. The number required and master group number must be identical on all continuation cards.
13-16	I4	IB (3)	
17-20	I4	IB (4)	
21-24	I4	IB (5)	
25-28	I4	IB (6)	
29-32	I4	IB (7)	
33-36	I4	IB (8)	

Card Type 22. Equipment Operating Rule Cards.

These cards indicate the equipment operating rules for string or standby equipment. The string equipment operating rules cause shutdown of a designated series equipment upon failure of any of the other equipment or equipment groups on the card. The standby equipment operating rule, causes designated equipment to be energized upon failure of any of the other equipment or equipment groups on the card. This is an optional card which is placed immediately behind the Configuration Matrix Card which refers to the equipment and groups on this card. The maximum number of equipment operating rules is 49. (One rule defined per card.)

Column	Format	Variable Name	Description
1-4	I4	ISTB(1)	The designated equipment number. If it is a standby equipment, it must be preceded by a minus sign. The other equipment or equipment group numbers.
5-8	I4	ISTB(2)	
9-12	I4	ISTB(3)	Place any non-zero integer in this field (to distinguish Equipment Operating Cards from Configuration Cards.
13-16	I4	ISTB(4)	
17-20	I4	ISTB(5)	
21-24	I4	ISTB(6)	
25-28	I4	ISTB(7)	
29-32	I4	ISTB(8)	
33-36	I4	ISTB(9)	
37-40	I4	ISTB(10)	
41-44	I4	IRULE	

Card Type 23. ***** Blank Card *****

Card Type 24. METEOR Parameter Card

This card, and those that follow, are only required if the METEOR simulation option is in effect.

<u>Column</u>	<u>Format</u>	<u>Variable</u> <u>Name</u>	<u>Description</u>
1-5	I5	M1	Input option. = 1. If this option is selected supply input data for only one ship is required. All other ships will be configured with the same stocking objectives and reorder points. = 2. If this option is selected supply input data must be input separately for each ship.
6-15	F10.0	CRAR	Carcass return attrition rate. Enter decimal fraction of repairable carcasses that are lost due to attrition.
16-25	F10.0	MSDT	MLSP screening delay time. Enter the time required to process a NIS requisition through the MLSP, and refer the requisition to the next echelon.
26-35	F10.0	SSFT	The amount of time required to issue an item from shipboard stocks.
36-45	F10.0	ALFA1	Gamma distribution shape parameter for repairable item turnaround time.
46-55	F10.0	ALFA2	Gamma distribution shape parameter for procurement lead times.

Card Type 25. Supply Information Card.

The following 4 card types input supply related information for each equipment type. One set of these cards is required for each equipment type when M1 = 1. When M1 = 2, the set will consist of only card types 25 and 26.

<u>Column Format</u>	<u>Variable Name</u>	<u>Description</u>
1-10 I10	RPAIR	Repair Code. = 0 Consumable items. = 1 Repairable items. Cannot be repaired at organizational level. Upon failure, will be shipped to nearest repair facility.
11-20 F10.0	MPLT	Mean procurement lead time for this equipment.
21-30 F10.0	ECCST	Cost per item for this equipment type.

Card Type 26. Repairable Item Information Card.

This card will be placed immediately behind the supply information card whenever RPAIR = 1.

<u>Column Format</u>	<u>Variable Name</u>	<u>Description</u>
1-10 F10.0	MRT	Mean repair turnaround time for this equipment type.
11-20 I10	ERQ	Economic repair quantity for the repair facilities. When their on-hand balance of carcasses equals or exceeds ERQ an induction will be initiated.

Card Type 27. High Limit Card. (Option 1)

If M1 = 1, cards 27 and 28 are used to set activity high limits and reorder points. In this case, all ships will be given identical high limits and reorder points. If M1 = 2, these cards are omitted and cards 29 and 30 will be used to input high limits and reorder points.

Column	Format	Variable Name	Description
1-5	I5	HILIM(1)	Inventory high limit: Ships
6-10	I5	HILIM(2)	W. Coast MLSF
11-15	I5	HILIM(3)	E. Coast MLSF
16-20	I5	HILIM(4)	WESTPAC Overseas Depot
21-25	I5	HILIM(5)	E. CONUS Supply Center
26-30	I5	HILIM(6)	W. CONUS Supply Center
31-35	I5	HILIM(7)	Not Used
36-40	I5	HILIM(8)	Not Used
41-45	I5	HILIM(9)	ICP (Usually sum of HILIM(4,5,6))

Card Type 28. Reorder Point Card. (Option 1)

This card uses exactly the same format as the preceding card except the variable now is the activity's reorder point. This card will follow immediately behind Card 27.

Card Type 29. High Limit Card. (Option 2)

When read option 2 is in effect, high limits and reorder points must be individually input for all ships and activities in the simulation. Cards 29 and 30 will follow a complete set of Supply/Repairable Information Cards.

Use one High Limit Card (Option 2) for each activity in the simulation starting with the lowest numbered ship and proceeding through the highest. After all ships have been entered, Enter the remainder of the activities in the following order: W.Coast MLSF; E.Coast MLSF; WESTPAC Overseas Depot; E.CONUS Supply Center; W. CONUS Supply Center; E. Repair Facility; W. Repair Facility; ICP.

<u>Column</u>	<u>Format</u>	<u>Variable Name</u>	<u>Description</u>
1-5	I5	HILIM(1)	High limit for Equipment Type 1.
6-10	I5	HILIM(2)	High limit for Equipment Type 2.
11-15	I5	HILIM(3)	High limit for Equipment Type 3.
:		Continue same format to:	
76-80	I5	HILIM(16)	High limit for Equipment Type 16.

Note: Enter high limits for each equipment type in simulation. If the number of types exceeds 16, use as many cards as needed in same format.

Card Type 30. Reorder Point Card. (Option 2)

Reorder Point Cards (Option 2) follow immediately behind Card Type 28 for each activity. These cards have exactly the same format as Card Type 29 except the variable here is the activity's reorder point.

Card Type 31. Order and Shipping Time: Ship to Repair.

The following three cards refer to the shipping times between the various activities. This card inputs the time required to send a carcass from a given ship location to the nearest repair facility.

Column	Format	Variable Name	Description
			OSTSR(1-3) refers to West Coast ships sending carcasses to the West Coast repair facility.
1-7	F7.0	OSTSR(1)	Shipment time from ship in CONUS.
8-14	F7.0	OSTSR(2)	Shipment time from deployed ship without MLSF support.
15-21	F7.0	OSTSR(3)	Shipment time from deployed ship with MLSF support.
			OSTSR(4-6) refers to ships stationed on East Coast sending carcasses to East Coast (CONUS) repair facility.
22-28	F7.0	OSTSR(4)	Shipment time from ship in CONUS.
29-35	F7.0	OSTSR(5)	Shipment time from deployed ship without MLSF support.
36-42	F7.0	OSTSR(6)	Shipment time from deployed ship with MLSF support.

Card Type 32. Order and Ship Time: Manufacturer.

This card is used to input shipping times from the manufacturer to all other activities in the supply network. Note that these times are independent of procurement lead times.

Column	Format	Variable Name	Description
			From manufacturer to:
1-7	F7.0	OSTM(1)	W.Coast ship in CONUS
8-14	F7.0	OSTM(2)	W.Coast ship overseas without MLSF
15-21	F7.0	OSTM(3)	W.Coast ship overseas with MLSF
22-28	F7.0	OSTM(4)	E.Coast ship in CONUS
29-35	F7.0	OSTM(5)	E.Coast ship overseas without MLSF
36-42	F7.0	OSTM(6)	E.Coast ship overseas with MLSF
43-49	F7.0	OSTM(7)	E.Coast MLSF
50-56	F7.0	OSTM(8)	E.Coast MLSF
57-63	F7.0	OSTM(9)	WESTPAC overseas depot
64-70	F7.0	OSTM(10)	E.Coast supply center
71-77	F7.0	OSTM(11)	W.Coast supply center

Card Types 33-40. Order and Shipping Times.

A total of eight order and shipping cards will be input, each referring to a shipping activity. The entries on each card are of the exact same format as Card Type 34, and represent the order and shipping times from the shipping activity to a destination activity (as above). Note that it is clearly inappropriate for some activities to ship to others (e.g., MISF to supply center). In these cases, no entry is required. Cards must be input in the following order:

- Card 33. W.Ccast MLSF
- Card 34. W.Ccast overseas depot
- Card 35. W.Ccast supply center
- Card 36. W.Coast repair facility
- Card 37. E.Ccast MLSF
- Card 38. ** Blank Card **
- Card 39. E.Ccast supply center
- Card 40. E.Ccast repair facility

Card Type 41. Optional Output Card.

These are special TIGER options that have not been discussed in this report. They are included here for information only. For details, consult the TIGER Manual. The card may be omitted.

<u>Column</u>	<u>Format</u>	<u>Variable Name</u>	<u>Description</u>
1-4	A4	SPES	Place any alphanumeric in this field if a table of spares usage is desired. Note: will not be printed if METEOR is being run.
5-8	A4	APFL	Place any alphanumeric in this field if a summary table of equipment that caused mission failures and system downtimes is desired.
9-12	A4	GMMA	Place any alphanumeric in this field if the gamma distribution output is desired.

Sample HEREOR Input File

```

1 870 885 3 1 3 2 22 1 0.0 -METEOR Option Card
1 2-SHIP: STEERING SYSTM. TEST 1/1 -Ship Identification Card
100 100 1.0 1.08672 1 -Timeline Iteration Card
1. 5000 1 -Statistical Parameter Card
1.0 1000000. 1.0 1.0 -Phase Type and Duration Card
1 BRIDGE CONTROL 1.0 4.0 1. -Printout Option Card
2 ELECTRIC CONTROL 550.0 3.0 1. -Phase Repair Card
3 LOCAL CONTROL 900.0 8.5 1. -Repair Policy Card
4 MOTOR CONTROLLER 1750.0 5.0 1.
5 ELECTRIC MOTOR 500.0 8.0 1.
6 HYDRAULIC MOTOR 300.0 8.5 1.
7 HYDRAULIC PUMP 300.0 19.5 1.
8 VALVE 4500.0 24.0 1.
9 RAM 1000.0 50.0 1.

1 1 2 4 6 8 10 12 14 15 16
2 3 5 7 9 11 13 17 18 21 22
3 4 5 6 7 8 9

FLT 1 2 999 1000000.
SHR 1 1 870 1000000.
SHR 2 1 885 1000000.
SHR 3 1 885 1000000.

-System Card
-Subsystem Cards
-Equipment Cards
-Equipment Type Cards
-Equipment Crossreference Card

```

1501	13	1	3	5
601	13	3	9	13
609	13			
77	11	14		
602				
14	601	602		
11				
601				
601				
601				
701	19	20		17
870	501	603		701
603				
603				
511	2	4		6
511	2			
4	8	10		15
611	15			
10	15			
15	10	16		
8	12			
16				
12	611	612		
13				
611				
611				
711	21	22		18
885	511	613		711
885				
613				
613				
999	870	885		

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 104

[illegible]

APPENDIX C

VARIABLES USED IN METEOR

Table III provides a description of the variables used by the MULTE unit of METEOR, its associated subprograms, and those variables inserted in TIGER that interact with MULTE. Reference 5, Appendix B, provides a similar listing for those variables unique to TIGER. Note that the FORTRAN variable naming convention is not necessarily adhered to with MULTE variables. Variable type is noted in the listing that follows.

TABLE III
Variable Listing

Variable Name	Type	Description
A	R	Random number array.
AADV(i,j)	R	Average dollar value of inventory per mission for equipment i, echelon j.
AAGTV	R	Total average dollar value of inventory.
AARDV(i)	R	Average dollar value of inventory at echelon i.
ACT	I	Activity number designation.
ALFA1	R	Gamma distribution shape parameter (repair time).
ALFA2	R	Gamma distribution shape parameter (procurement lead time).
ASAVA	R	Average equipment availability per mission, per ship.
ASREL	R	Average equipment reliability per mission, per ship.
AVASS(i)	R	Average equipment availability per mission for ship i.
COAST	I	= 1 (West); =2 (East).
CRAR	R	Carcass return attrition rate.
CTIME	R	Current time.
DELOH(i)	I	Change in on-hand qty at level i, during current call to MULTE.
DESTN	I	Shipping destination of material.
DNUM	I	Activity designator of activity with minimum due-in time.
DTIME	R	Calculated due-in time for current requisition in process.
DTOT	I	Total nr. of due-in's established for stock during current call to MULTE.
DTSS1(i)	R	Running downtime of hardware system on ship i during current phase.
DTSS2(i)	R	Running downtime of hardware system on ship i during mission.
DUEA(i)	I	Activity designator of due-in nr. i.
DUEE(i)	I	Equipment type of due-in nr. i.
DUEN	I	Total number of due-in's.

DUEQ(i)	I	Quantity due in on due-in nr. i.
DUES	I	Due in material which is available at the current time. Added to on-hand quantity.
DUET(i)	R	Due-in time on due-in nr. i.
ECH	I	Echelon: 1-MLSF; 2-Depot; 3-Center; 4-Repair; 5-ICP
ECOST(i)	R	Cost of equipment type i
ENUSE	I	End use activity designator.
EQTYP	I	Equipment type number.
ERQ(i)	I	Economic repair quantity for equipment i.
HILIM(i,j)	I	Inventory high limit at activity i, for equipment type j.
IA	I	Issuing activity.
IASPT	I	SSN of activity issuing end-use requirement.
IDUEJ(i,j)	I	i = 1 SSN of ordering activity = 2 Due-in time at ordering activity = 3 SSN of issuing activity j = Sequential number of due-in's established during current call to MULTE.
IFLAG	I	Indicator variable.
IOPTI	I	Input option.
IOPTH	I	Multi-echelon supply simulation option.
IOPTP	I	Print option.
IOPTP1	I	Print option.
IP(i,j)	I	Inventory position of activity i, for equipment type j.
IRC	I	Requisition channel indicator. = 1 CONUS operations = 2 Overseas operations without MLSF = 3 Overseas operations with MLSF
ISHIP	I	Ship (subsystem) identification number.
ISSUE	I	Issue quantity for this requisition.
ITEMA	I	Activity number.
ITEMP	I	Temporary variable.
ITEMQ	I	Quantity required.
ITEMSS(i)	I	Indicates if current mission has been aborted for ship i. = 0 (no); = 1 (yes).
ITMSN	I	Total nr. of missions run.
IX_	I	Random number seeds.
IXD(i,j)	I	Initial provisioning level for equipment

i, at echelon j.

K	I	Counter.
KEQ	I	Failed component (passed from TIGER).
KM1	I	K minus 1
KR	I	Counter
L	I	Counter
LEQNR(i)	I	Last equipment nr. on ship i.
LEVEL(i)	I	= 1 (Ship) when, SSN i = 1-30 2 (MLSF) = 31-32 3 (Depot) = 33 4 (Center) = 34-35
MAXD	I	Maximum due-in vector size (1000).
MAXEQ	I	Maximum nr of equipment types (200).
MAXSS	I	Maximum nr of subsystems.
MFLAG	I	Signals start of new mission.
MIN	R	Minimum (Due-in time + OST).
MPLT(i)	R	Mean procurement lead time equipment i.
MRT(i)	R	Mean repair time equipment i.
MSD	R	MLSF screening delay.
MSDT	R	MLSF screening delay time.
MULTC	I	Nr. of calls to MULTZ.
N	I	Temporary variable for ORACT(1).
NEED	I	Stock point deficiencies for repairables.
NISS(i)	I	Nr. of issues of ship stock for equipment i.
NIST*	I	Total nr. of issues from ship stock.
NMFR(i,j,k)	I	Nr. of equipments, i, procured from manufacturer for level j; where, k = 1 Nr. of procurement actions k = 2 Nr. of items procured
NMFE(i,k)*I		Nr. of equipments, i, procured from mfr. K as above.
NMFL(j,k)*I		Nr. of equipments procured from mfr for level j. K as above.
NMPT(k)*I		Total nr. equipments procured. K as above.
NNN(i,j,k)*I		Nr. of demands at i, for equip j; where, k = 1 Total number of demands k = 2 Number NIS demands k = 3 Number Not Carried demands
NNNE(j,k)*I		Nr. of demands for equipment j. K as above.
NNNL(i,k)*I		Nr. of demands at level i. K as above.

NNNT(K) * I	Total nr. of demands. K as above.
NRA* I	Total nr. of carcasses lost through attrition.
NRFL(i,j,k) I	Nr. of equip, i, inducted by repair facilities for level j; where, k = 1 Nr. of inductions, k = 2 Nr. of items repaired
NRFE(j,k) * I	Nr. equipments inducted by repair facilities for level j. K as above.
NRFL(I,K) * I	Nr. equipments, i, inducted by repair facilities. K as above.
NRFT(K) * I	Total nr. equipments inducted for repair. K as above.
NRRT* I	Total nr. items turned in to repair facility.
NRSHPs I	Total nr. of ships in simulation.
NSHIP(i,j) * I	Nr. of shipments from i to j.
NSPT* I	Total nr. of shipments during mission.
NTY I	Nr. of equipment types being simulated.
NUMSS(i) I	Ship (subsystem) nr. of ship i.
ONHND(i,j) I	On-hand quantity of equipment type j, at activity i.
OQICP I	System stock deficiency at ICP.
OQREQ(i) I	Stock deficiencies at ICP stock points.
ORACT(i) I	SSN of ordering activity, requisition i.
ORDER(i) I	Order quantity for stock at ICP stock points.
ORDQT(i) I	Order quantity on requisition i.
OST__ R	(See below).
OTIME R	CTIME of last call to MULTE.
PLT R	Procurement lead time.
QTYD I	Quantity due.
RELSS(i) R	Average equipment reliability for ship i per mission.
REORD(i,j) I	Reorder level for activity i, equipment j.
REQN I	Nr. of requisitions currently in system.
RESON(i) I	=1 - end use; =2 - stock, for requisition i.
RORD I	Quantity to be repaired.
RP I	Issuing repair facility.
RPAIR(i) I	For equipment i, = 1 - repairable equipment = 2 - consumable equipment
RTIME R	Repair time.

SHIPR	I	Shipping activities address.
SHPR1	I	Shipping activities address.
SHPR	I	SSN of activity whose stock due-in is diverted to fill end use requirement.
SHLOC	I	Ship location (see below).
SRT	R	Supply response time.
SRT1	R	Temp holding variable for SRT.
SSADT	R	Ship's continuous allowable downtime.
SSN	I	Activity identification number (see below).
SSRT	R	Ship supply response time (time required to fill own requisition from shipboard stock).
ST	R	Shipping time.
SUMXD(i,j)	R	Current on-hand inventory level for equipment i, at echelon j.
T	R	Due-in time plus OST.
TO	I	Level of requisitioning activity.
TOTAVA	R	Summation of shipboard availabilities.
TOPREL	R	Summation of shipboard reliabilities.
TPM	R	Time per mission.
TMSN	R	Real value for total nr. of missions.
UP4SS(i)	R	Total system uptime for ship i.
XCUMSS(i)	R	Total number of successful missions for ship i.
XD(i,j)	R	Initial inventory investment for equipment type i, at echelon j.
XT(i)	R	Initial inventory investment at echelon i.
XG	R	Initial inventory investment.

* Indicates that when this variable is preceded by an 'A', it represents an average value based on the total nr. of missions run.

Explanatory Notes

The configuration requirements of TIGER, require each subsystem (ship) be assigned a unique number. MULTE will require that ship's on the West Coast be assigned numbers 870-884, and those on the East Coast 885-899. A corresponding SSN (1-30) will be assigned internally to each ship. SSN's 31-38 are assigned to each of the other activities in the supply network.

Each ship is assigned a ship location based on its coast and the requisition channels assigned by IRC. The ship's location will determine which order and shipping time is to be used. There are three order and shipping time variables.

OSTSR (i) From ship location i, to repair facility on corresponding coast.

OSTM (i) From manufacturer to location i.

OSP (i,j,k) From coast i, echelon k, to location j.
 where, k = 1 - MLSP
 k = 2 - Depot
 k = 3 - Center
 k = 4 - Manufacturer

Table IV displays the various designators assigned to activities in MULTE.

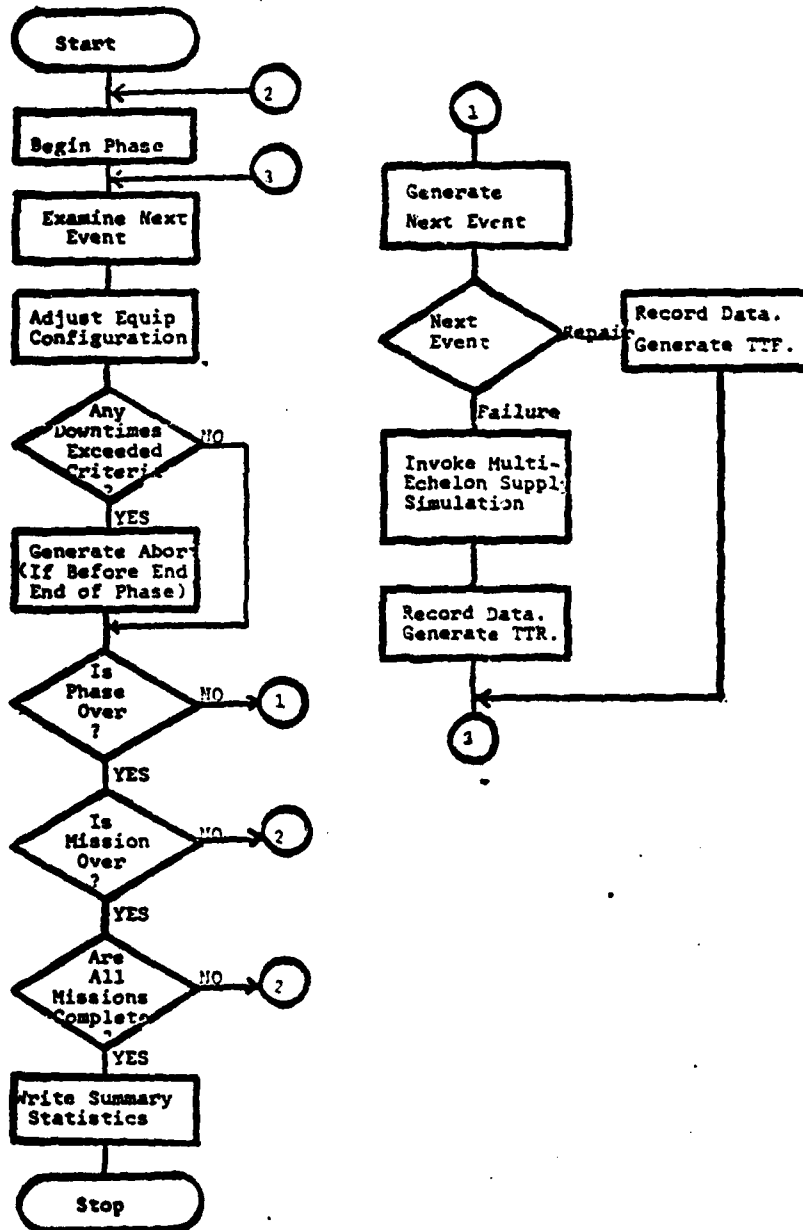
TABLE IV
Activity Designators

Activity	ISHIP	Designator		LEVEL	ECHELON
		SSN	DESTN		
West coast ships	870-884	1-15	1-3	1	-
East coast ships	885-899	16-30	4-6	1	-
MLSP:					
West	-	31	7	2	1
East	-	32	8	2	1
Depot (West)	-	33	9	3	2
Supply centers:					
East	-	34	10	4	3
West	-	35	11	4	3
Repair facility:					
East	-	36	12	-	-
West	-	37	13	-	-
Manufacturer	-	38	14	-	-

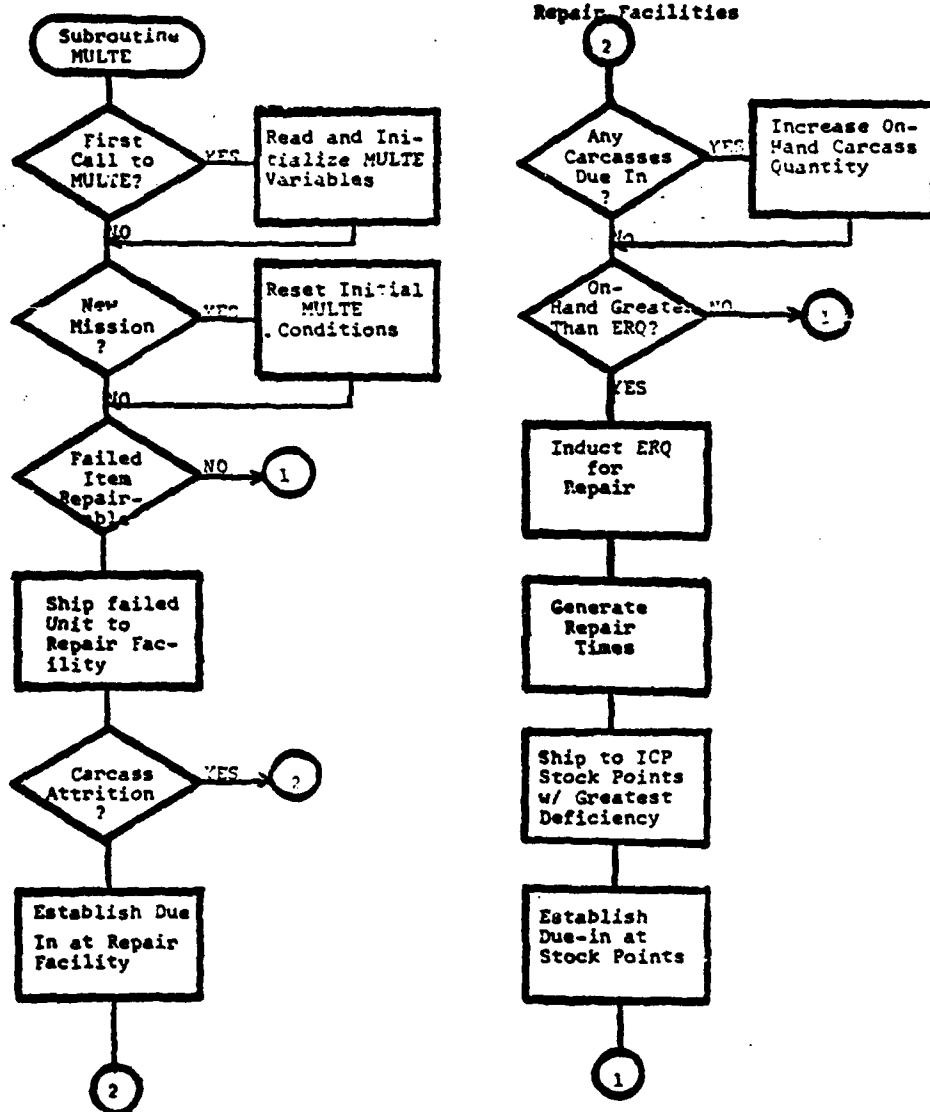
APPENDIX D
METEOR/HULTE PROCESS FLOW CHART

The process flow charts which follow are provided as an aid to the potential user in understanding how the multi-echelon supply system has been modeled. A similar flow chart for the TIGER portion of METEOR can be found in the TIGER Manual (page A3).

Flowchart: METEOR



Flowchart: MULTE Initialization



AD-A127 898

METEOR: A TOOL FOR EVALUATING MULTI-ECHOLON INVENTORY
MODELS AND MATERIAL READINESS(U) NAVAL POSTGRADUATE
SCHOOL MONTEREY CA T A BUNKER MAR 83

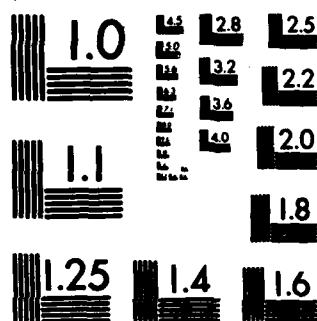
2/2

UNCLASSIFIED

F/G 15/5

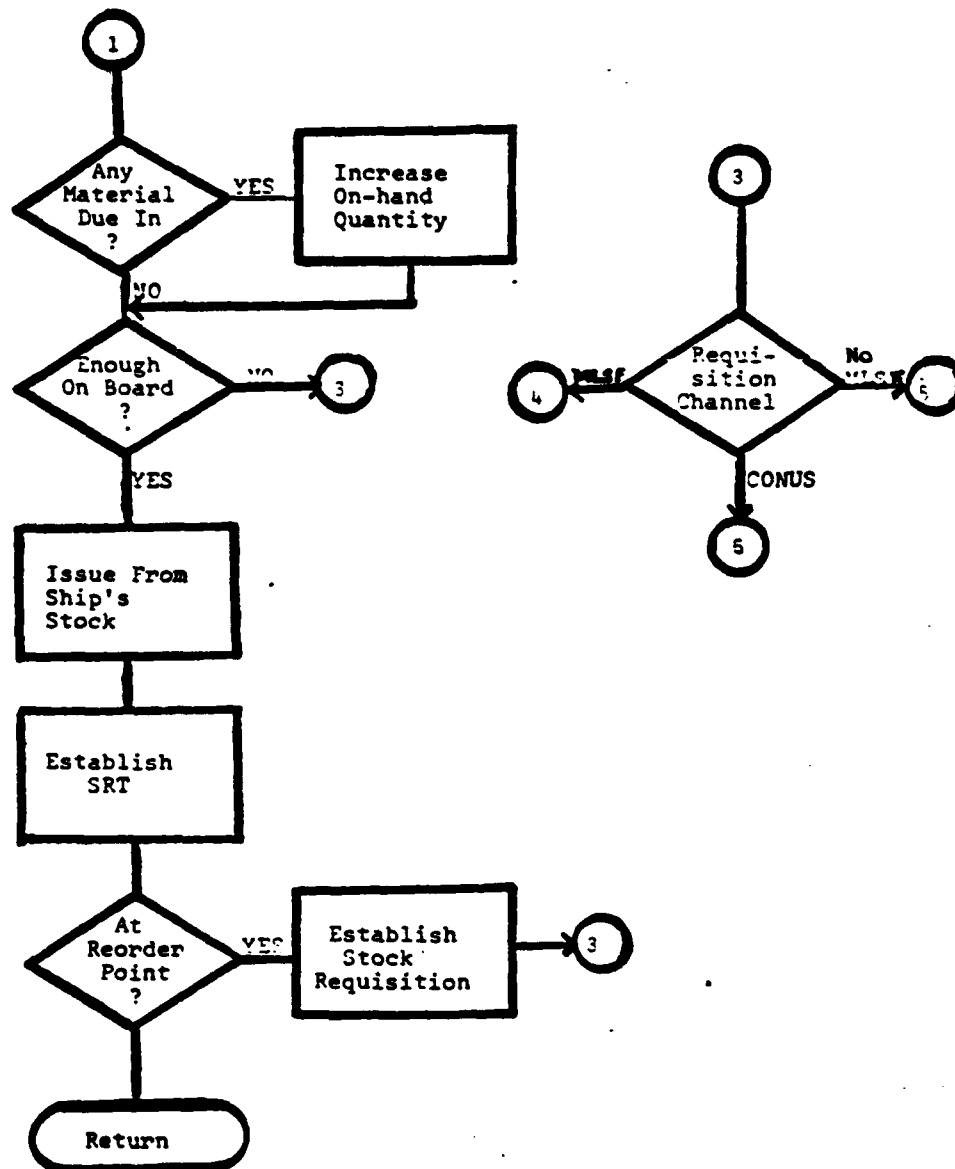
NL

END
DATE
FILMED
6-83
DTIC

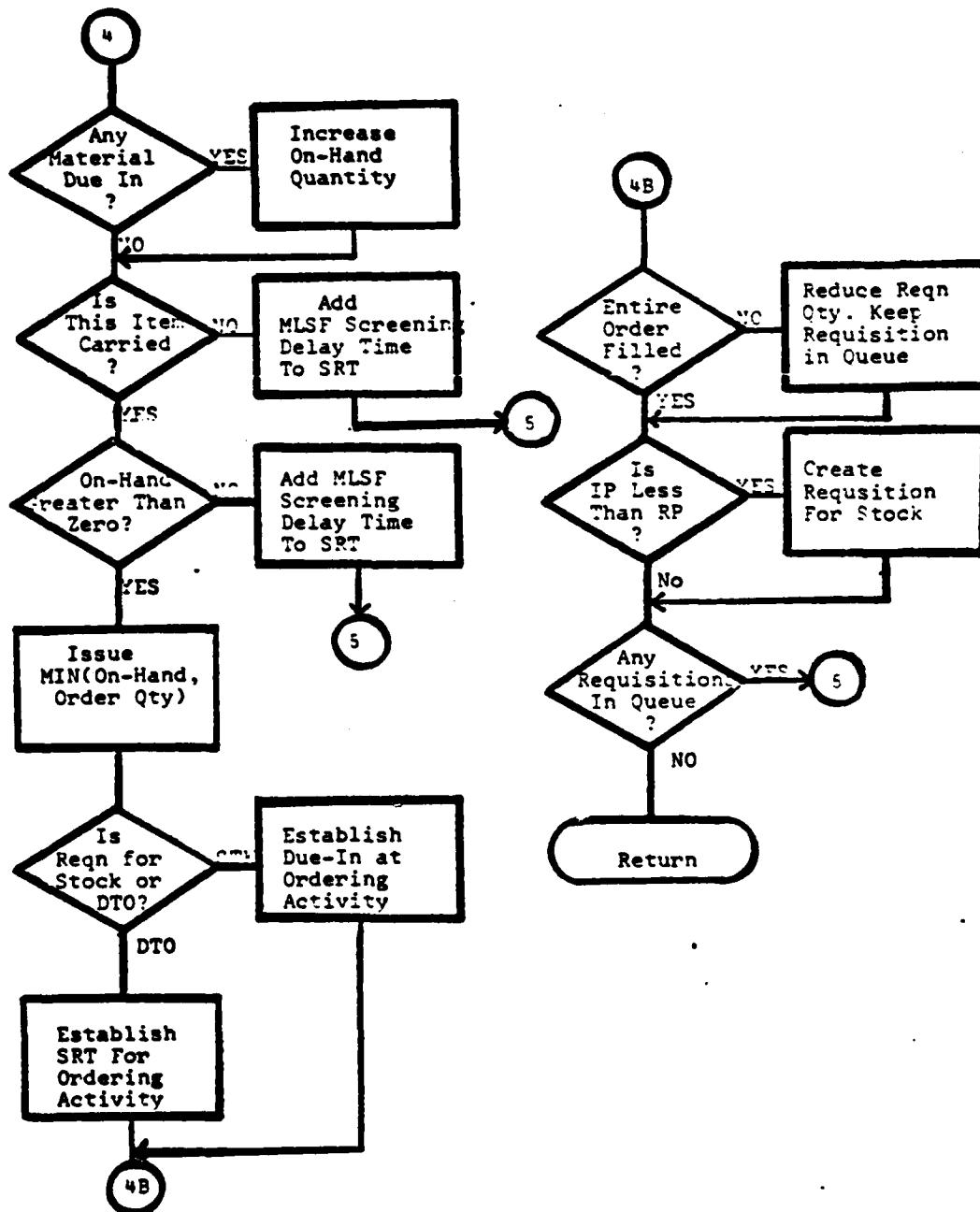


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

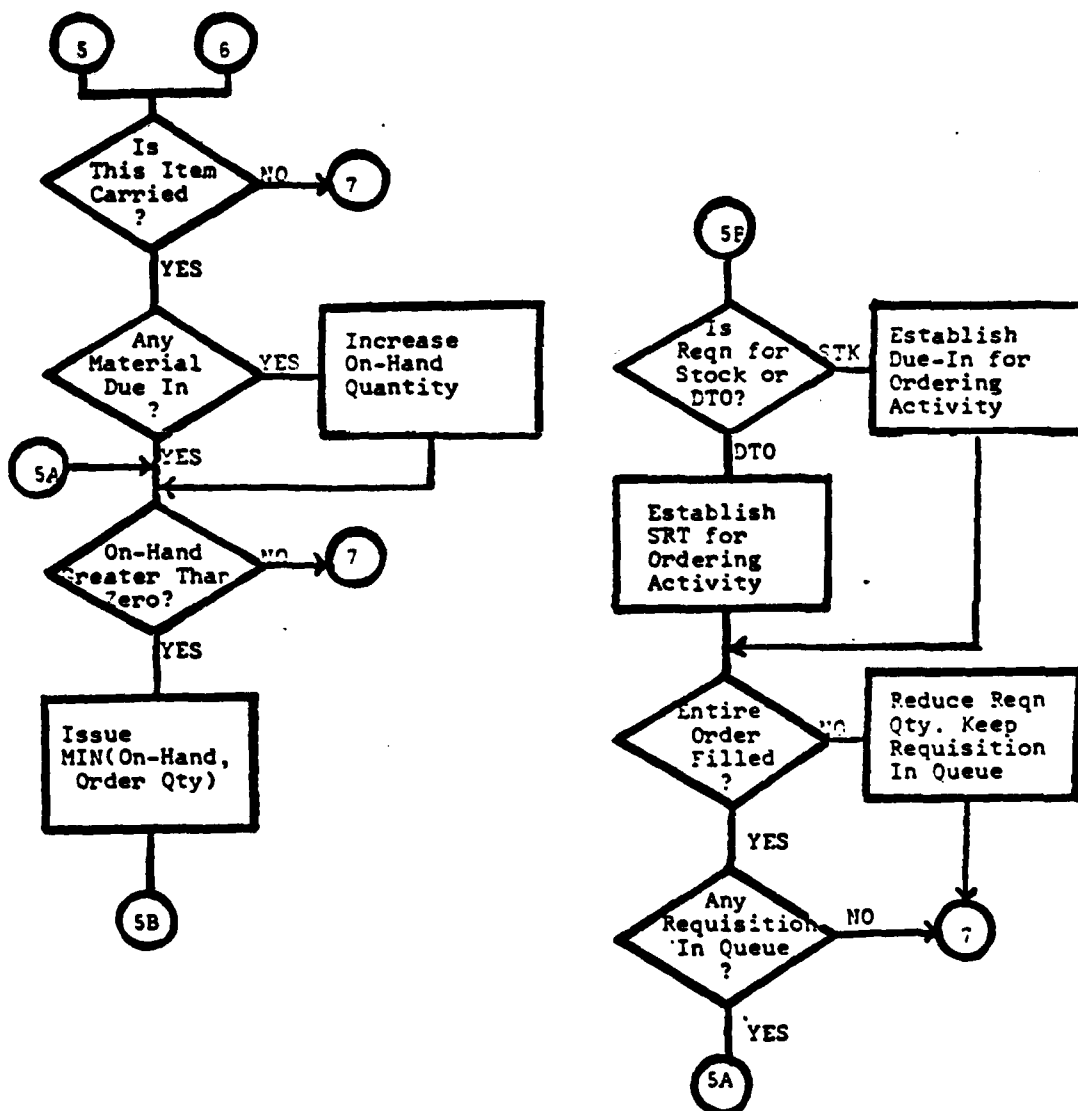
Flowchart: Ship Issue and Reorder Process



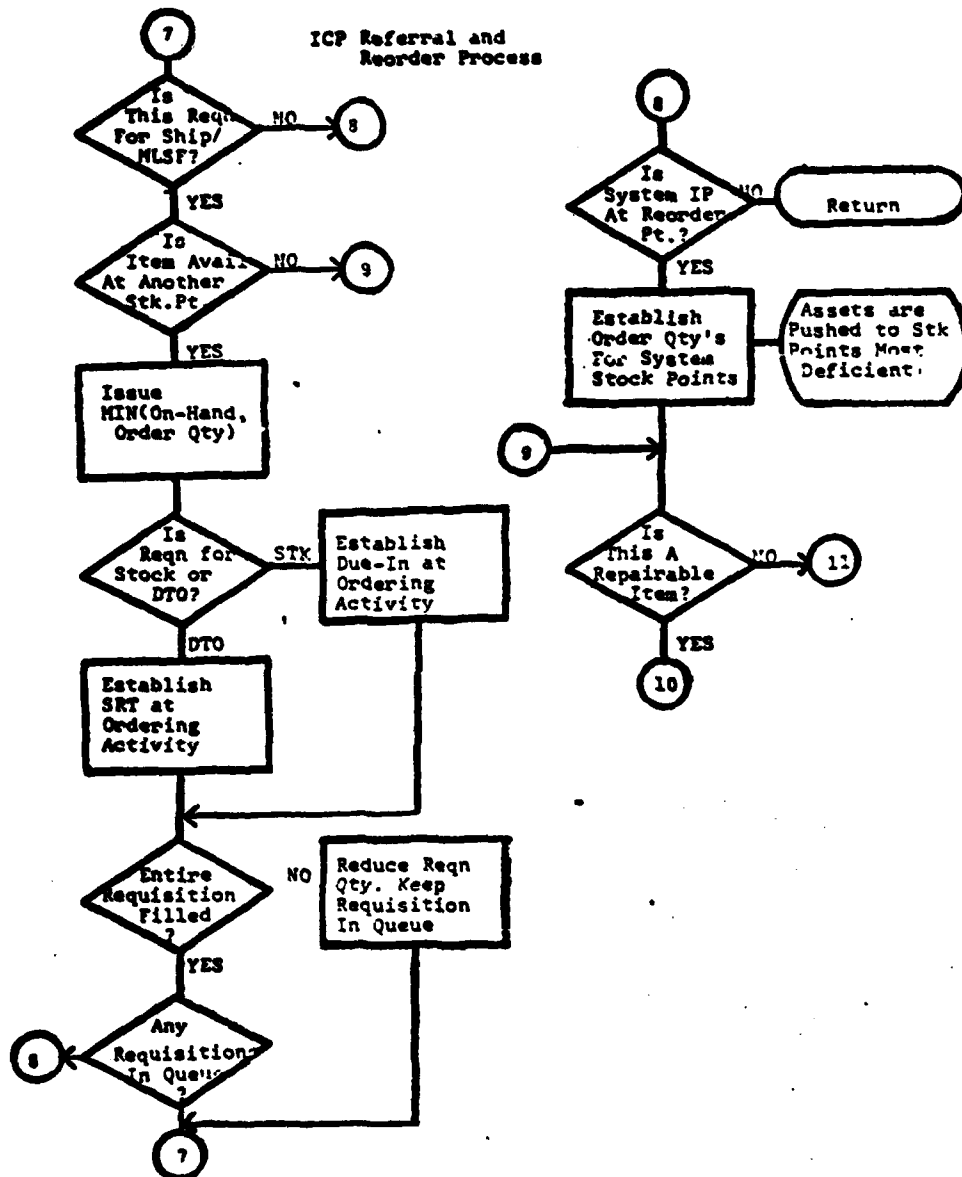
Flowchart: MLSF Issue and Reorder Process



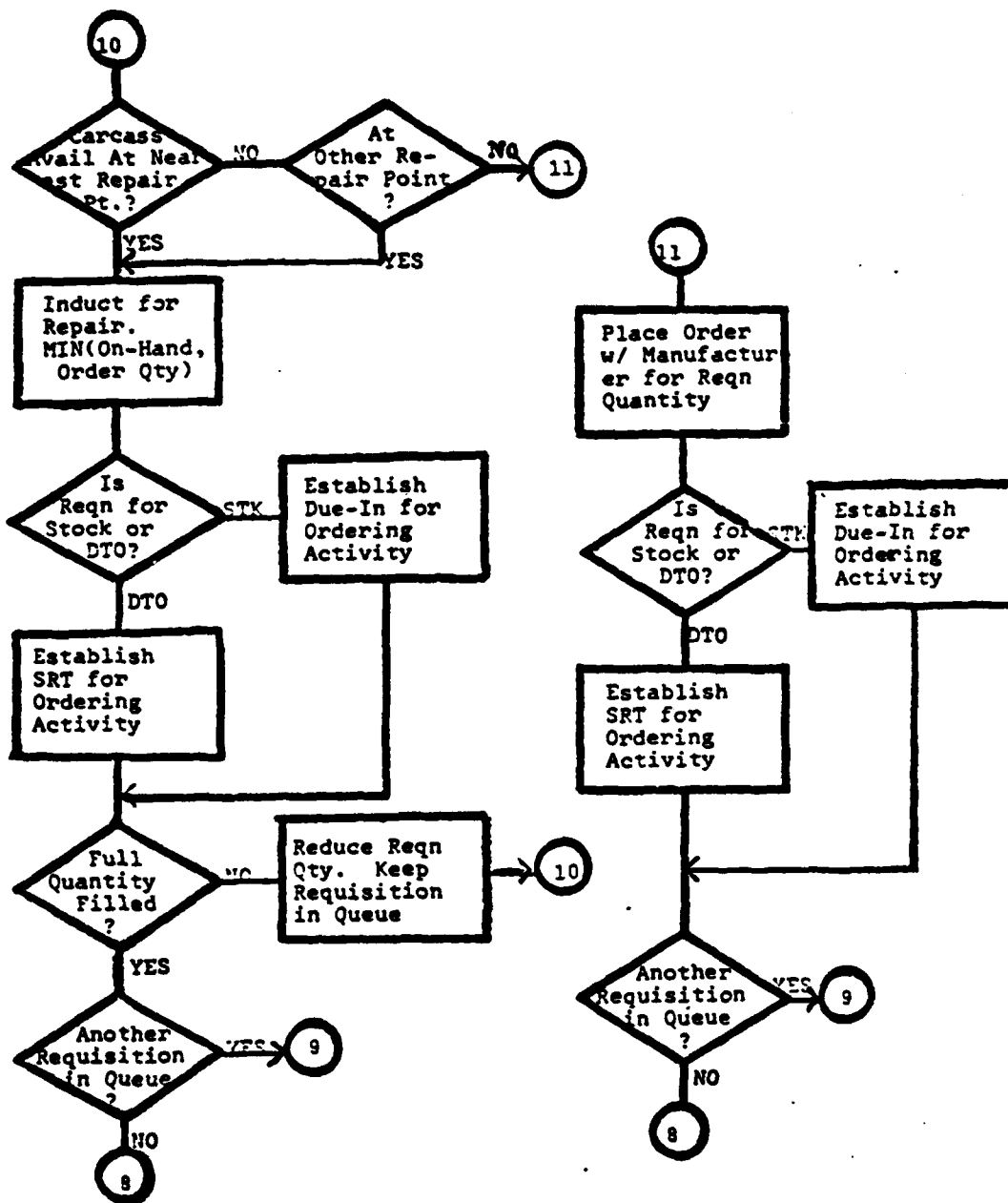
Flowchart: Depot and Supply Center Issue Process



Flowchart: ICP Redistribution and Reorder Process



Flowchart: ICP Repair and Procurement Process



APPENDIX E

SAMPLE METEOR OUTPUT MISSION: 2

(Event Driven Output)

FAILURE OF EQUIPMENT TYPE 6 CN SHIP 16 AT TIME 74,
RESULTED IN THE FOLLOWING SUPPLY ACTIONS:
END USE REQUIREMENT FILLED BY SSN 16. SUPPLY RESPONSE TIME IS: 12.
ORDERS FOR STOCK WERE GENERATED AS FOLLOWS:
REQUISITIONOR(SSN) DUE-IN AT TIME ISSUED FROM(SSN)
16 710 34

FAILURE OF EQUIPMENT TYPE 7 CN SHIP 1 AT TIME 167,
RESULTED IN THE FOLLOWING SUPPLY ACTIONS:
END USE REQUIREMENT FILLED BY SSN 35. SUPPLY RESPONSE TIME IS: 624.
ORDERS FOR STOCK WERE GENERATED AS FOLLOWS:
REQUISITIONOR(SSN) DUE-IN AT TIME ISSUED FROM(SSN)
35 458 38

FAILURE OF EQUIPMENT TYPE 4 CN SHIP 16 AT TIME 141,
RESULTED IN THE FOLLOWING SUPPLY ACTIONS:
END USE REQUIREMENT FILLED BY SSN 34. SUPPLY RESPONSE TIME IS: 624.
NO ORDERS FOR STOCK RESULTED FROM THIS ISSUE.

FAILURE OF EQUIPMENT TYPE 7 CN SHIP 16 AT TIME 311,
RESULTED IN THE FOLLOWING SUPPLY ACTIONS:
END USE REQUIREMENT FILLED BY SSN 35. SUPPLY RESPONSE TIME IS: 523.
NO ORDERS FOR STOCK RESULTED FROM THIS ISSUE.

FAILURE OF EQUIPMENT TYPE 2 CN SHIP 16 AT TIME 314,
RESULTED IN THE FOLLOWING SUPPLY ACTIONS:
END USE REQUIREMENT FILLED BY SSN 16. SUPPLY RESPONSE TIME IS: 12.
ORDERS FOR STOCK WERE GENERATED AS FOLLOWS:
REQUISITIONOR(SSN) DUE-IN AT TIME ISSUED FROM(SSN)
16 476 32

FAILURE OF EQUIPMENT TYPE 1 CN SHIP 1 AT TIME 370,
RESULTED IN THE FOLLOWING SUPPLY ACTIONS:
END USE REQUIREMENT FILLED BY SSN 1. SUPPLY RESPONSE TIME IS: 12.
ORDERS FOR STOCK WERE GENERATED AS FOLLOWS:
REQUISITIONOR(SSN) DUE-IN AT TIME ISSUED FROM(SSN)
1 333 31
33 333 31
33 333 31

FAILURE OF EQUIPMENT TYPE 6 CN SHIP 1 AT TIME 397,
RESULTED IN THE FOLLOWING SUPPLY ACTIONS:
END USE REQUIREMENT FILLED BY SSN 1. SUPPLY RESPONSE TIME IS: 12.
ORDERS FOR STOCK WERE GENERATED AS FOLLOWS:
REQUISITIONOR(SSN) DUE-IN AT TIME ISSUED FROM(SSN)
1 623 33

Sample Summary Output

DATA SUMMARY: MULTI-ECHELON SUPPLY SYSTEM

10 SIMULATED MISSIONS HAVE BEEN RUN. THE FOLLOWING SUMMARY STATISTICS ARE BASED ON AVERAGE NUMBERS PER MISSION.

I. PROCUREMENT COSTS

ECHELON SUMMARY

SHIPPED FROM MFR TO:	SHIPS	MLSP	DEPOT	SUPPLY CENTERS
NR. PROCUREMENTS	4.3	1.6	1.2	6.9
NR. ITEMS PROCURED	4.3	1.6	1.6	6.9

EQUIPMENT SUMMARY

EQUIPMENT NR.	1	2	3	4	5	6	7	8	9	0	0
NR. PROCUREMENTS	3.4	3.7	6.4	0.0	1.2	1.4	3.4	6.0	6.3	0.0	0.0
NR. ITEMS PROCURED	3.4	3.7	6.4	0.0	1.2	1.4	3.4	6.0	6.3	0.0	0.0

II. REPAIR COSTS

ECHELON SUMMARY

SHIPPED FR REPAIR FACILITY TO:	SHIPS	MLSP	DEPOT	SUPPLY CENTERS
NR. INDUCTIONS	0.7	0.0	0.1	0.0
NR. ITEMS INDUCED	0.7	0.0	0.1	0.0

EQUIPMENT SUMMARY

EQUIPMENT NR.	1	2	3	4	5	6	7	8	9	0	0
NR. INDUCTIONS	3.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NR. ITEMS INDUCED	3.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NR. ITEMS RETURNED BY SHIPS TO REPAIR FACILITIES: 2.4

NR. REPAIRABLE CARCASSES LOST DUE TO ATTRITION: 0.1

III. TRANSPORTATION COSTS (NR. SHIPMENTS)

DESTINATION ACTIVITY

(DESTINATIONS 1-6 REFER TO SHIP LOCATIONS)

	MLSP-M (1)	DEPOT (2)	CENTER-F (3)	REPAIR (4)	MFR (5)	1	2	3	4	5	6	7	8	9	0	0
MLSP-M (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEPOT (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CENTER-F (3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REPAIR (4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MFR (5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOTAL NR. OF ISSUES FROM SHIP STOCK: 11.9

IV. INVENTORY COSTS

EQUIPMENT	SHIPS	MLSF	DEPCT	CENTERS
1	1200.00	1000.00	0.00	1000.00
2	1000.00	1000.00	0.00	1000.00
3	1000.00	0.00	0.00	1000.00
4	0.00	0.00	0.00	0.00
5	1000.00	1000.00	2000.00	2000.00
6	2000.00	1000.00	1000.00	2000.00
7	2000.00	0.00	2000.00	2000.00
8	4000.00	0.00	2000.00	4000.00
9	19948.00	0.00	0.00	9994.00
TOTALS:	29848.00	2600.00	7250.00	23548.00

TOTALS:

29858.00

2600.C8

7250.CO

23548.00

AVERAGE ON-HAND INVENTORY COLLAR VALUE

EQUIPMENT	SHIPS	MLSF	DEPCT	CENTERS
447.73	443.75	0.0	364.89	
113.73	35.73	0.0	73.73	
378.73	0.0	0.0	75.60	
0.0	0.0	1880.76	1541.97	
657.47	497.47	269.73	1584.70	
828.11	0.0	707.62	1598.22	
0.0	0.0	0.0	1547.85	
357.73	0.0	184.08	337.85	
4851.71	0.0	0.0	3629.74	
TOTALS:	14167.61	1179.85	4700.29	13184.89

TOTALS:

16167.41

1179.45

4700.29

13184.89

TOTAL INVESTMENT: 39172.64

ECHELON: EQUIPMENT	SHIPS	PLSF	DEPDT	CENTERS	TOTAL
1	3.4/0.0/0.0	3.4/1.1/3.0	1.6/0.0/1.6	1.8/1.5/0.0	10.2/3.6/1.6
2	4.0/0.0/3.0	0.0/1.1/0.0	1.1/0.0/1.1	1.9/1.1/0.0	12.8/3.4/1.1
3	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
4	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
5	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
6	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
7	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
8	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
9	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
10	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
11	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
12	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
13	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
14	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
15	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
16	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
17	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
18	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
19	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
20	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
21	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
22	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
23	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
24	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
25	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
26	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
27	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
28	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
29	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
30	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
31	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
32	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
33	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
34	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
35	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
36	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
37	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
38	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
39	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
40	4.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0	0.0/0.0/0.0
41	4.0/0.0/0.0</				

TOTAL

1.9/0.6/0.6
1.8/ 3.3/ 3.6

18.5 / 2.6 / 9.5

10.4/ 9.4/ 7.4

4.1 / 2.5 / 1.4

573.8

GRAND TOTAL: 55.6/ 8.8/ 22.3

2 ENG USE ACTIVITIES WERE SIMULATED IN A MISSION OF DURATION 1000.
10 SIMULATED MISSIONS WERE RUN

THE FOLLOWING STATISTICS REPRESENT AVERAGES PER MISSION, PER FNC USE ACTIVITY

- ## 1. SYSTEM RELIABILITY (PROB CF SUCCESSFUL MISSION)

- 0.0

- ## 2. SYSTEM AVAILABILITY (PROB SYSTEM OPERATIONAL AT AN ARBITRARY TIME)

= 0.4587

APPENDIX F

METEOR PROGRAM LISTING

The program listing which follows, includes portions of the TIGER simulation and the complete multi-echelon supply program listing. Only the TIGER main program, and those subprograms changed as a result of METEOR, are presented. The major changes to TIGER are as follows when the multi-echelon supply option is in effect:

- a) Deletion of the TIGER logistics system and associated input parameters in subroutines TTE and PACK respectively.
- b) Call statement to subroutine MULTE in TIGER subroutine TTE.
- c) Call statement to subroutine MSTAT (supply system statistical summary) in TIGER main program.
- d) Additional read statements for supply system parameters in TIGER main program.
- e) Computation of equipment related performance measures in TIGER main program and subroutine RUN.


```

C ** BUNKER STOPS
18 READ (5,19) JCC,(RUNC(I),I=1,19)
19 FORMAT(14,19A4)
    WRITE(6,22) JCC
    DO 12 I=1,JCC
20 WRITE(6,30) (RUNC(I),I=1,19)
30 FORMAT(14H1,30X,19A4//)
    WRITE(6,40)
    WRITE(6,50)
    WRITE(6,55)
40 FORMAT(1X,50H *****+TIGER *****+
50 FORMAT(1X,50H++ NAVSEC 6112 LUETJEN+MANDEL+VAIL+ALLEY+BROWN ++ )
55 FORMAT(1X,50H++NPS IBM/360 VERSION LT. J. LEATHER THESIS 9/80++ )
56 FORMAT(1X,48H++AS AMENDED BY LCDR. T. A. BUNKER THESIS 3/83++ )
C ** BAPRIN=0 ACDS
    BUNKER = 0
    MULTC = 0
C ** BUNKER = STOPS
    DO 70 I=1,MAXNEC
60 COUNTB(I)=0.0
    TYCCOON(I)=0.0
    KEQU(I)=0
70 ETIME(I)=100000.
    IFF=0
    IFR=0
    UP4=0.0 ACDS
    BUNKER = 0
    DO 71 I=1,30
71 UP4SS(I)=0.0
    BUNKER = 0
    T3SUM=0.0
    SUMX=0.0
    SUMX2=0.0
    DO 80 I=1,100
80 T1MA(I)=0.0
    DO 90 I=1,3
    DO 90 J=1,MAXTYP
90 IUSEC(I,J)=0
    T12(I)=0.0
    UP2(I)=0.0
    IAUP1(I)=0
    IAUP2(I)=0
    REDAG(I)=0.0
    INMI(I)=0

```

MUL00970
MUL00980
MUL00990
MUL01000
MUL01010
MUL01020
MUL01030
MUL01040
MUL01050
MUL01060
MUL01070
MUL01080
MUL01090
MUL01100
MUL01110
MUL01120
MUL01130
MUL01140
MUL01150
MUL01160
MUL01170
MUL01180
MUL01190
MUL01200
MUL01210
MUL01220
MUL01230
MUL01240
MUL01250
MUL01260
MUL01270
MUL01280
MUL01290
MUL01300
MUL01310
MUL01320
MUL01330
MUL01340
MUL01350
MUL01360
MUL01370
MUL01380
MUL01390
MUL01400
MUL01410
MUL01420
MUL01430
MUL01440

```

100 INOABT(I)=0
    IAU=0
    XTCUM=0
    BUNKER ADDS
C ** DO 101 I=1,3C
C 101 XCUMSS(I)=0,Q
    BUNKER STOPS
    IF (JC-1) 11C, 11Q, 14Q
110 READ (5, 120) NMAX, NOPT, PL, XK, ISEED, NPH
120 FORMAT (2I4, 2F4.0, 2I4)
130 FORMAT (1X2I6, 2XF4.2, 2XF5.2, 2XI6, 2XI4)
140 CONTINUE
160 WRITE (6, 170) ISEED
170 FORMAT (//1X15HRANDOM SEED IS ,I4)
    IF (NMAX-MAXRUN) 190, 190, 180
180 NMAX=1000
    NOPT=1000
190 DO 200 I=1, NMAX
200 XTABT(I)=10000.
    WRITE (6, 130) NMAX, NOPT, PL, XK, ISEED, NPH
    IF (MAXNPH-NPH) 1260, 210, 210
210 INUM=10
220 FORMAT (//1X, 5HJCC= ,4I10)
230 DO 250 I=1, 151, 10
    READ (5, 240) XXT(I), {XXT(I+J), J=1, 5}
    IF (XXT(I)) 260, 260, 250
240 CONTINUE
250 WRITE (6, 270)
260 FORMAT (1H1, 10X40PHASE SEQUENCE TYPE DURATION CUM TIME)
    IK=1
    IK2=2*IK-1
    IK3=3*IK-1
    IXXT=XXT(IK3)
    TIMA(I)=XXT(IK2)
    BUNKER ADDS
C ** TPM = TIMA(I)
C 280 BUNKER STOPS
    WRITE (6, 28C) IK, IXXT, XXT(IK2), TIMA(IK)
    FORMAT (19XI4, 2XI4, 2XF8.2, 2XF8.2)
    DO 300 IK=2, 100
    IK2=2*IK
    IK3=3*IK-1
    IF (XXT(IK2)) 29C, 31C, 290
290 TIMA(IK)=TIMA(IK-1)+XXT(IK2)
    IXXT=XXT(IK3)
    WRITE (6, 28C) IK, IXXT, XXT(IK2), TIMA(IK)
C ** BUNKER ADDS

```

MULC1450
 MULC1460
 MULC1470
 MULC1480
 MULC1490
 MULC1500
 MULC1510
 MULC1520
 MULC1530
 MULC1540
 MULC1550
 MULC1560
 MULC1570
 MULC1580
 MULC1590
 MULC1600
 MULC1610
 MULC1620
 MULC1630
 MULC1640
 MULC1650
 MULC1660
 MULC1670
 MULC1680
 MULC1690
 MULC1700
 MULC1710
 MULC1720
 MULC1730
 MULC1740
 MULC1750
 MULC1760
 MULC1770
 MULC1780
 MULC1790
 MULC1800
 MULC1810
 MULC1820
 MULC1830
 MULC1840
 MULC1850
 MULC1860
 MULC1870
 MULC1880
 MULC1890
 MULC1900
 MULC1910
 MULC1920

```

C  **  TPM = TMA(IX)
C 300  BUNKER STOPS
C 310  CONTINUE
C 320  IF (JC-1) 320,32C,33C
C      CALL PACK
C 330  CONTINUE
      JRR=1
      RELPY=1.0
      UP3=0.0
      TT3=0.0
      REOAC2=0.0
      DO 340 I=1,MAXSS
C 340  ISW(I)=1
      ICRI=0
      DNT2=0.0
      BUNKER ADDS
      DO 345 I=1,30
C 345  DTSS2(I)=0.0
      ITSS(I)=0
      BUNKER STOPS
C 350  STPHAS=0
      TI=0.0
C
C      RDT IS RUNNING DCWNTIME
C
      RDT=0.0
      IF (KS(8)) 380,380,360
C 360  KAB=NUM+1
      WRITE (6,370) KAB
      FORMAT (IX,16)START OF MISSION,15,2CH*****
C 370  KKK=0
C 380  I=1
C 390  BUNKER ADDS
      MFLAG = 0
C 400  BUNKER STOPS
      LL=XT(I)
C 410  IF (LL) 450,450,410
      ENDPHA=STPHAS+XT(I+1)
      I=I+2
      CALL RUN
      IX=NUM+1
      IF (XTABT(IX)) 420,42C,440
C 420  WRITE (6,430)
C 430  FORMAT (IX,4)THE ABORT TIME IS ZERC,CHECK THE INPUT DATA.)
      GO TO 1200
  
```

```

440 STPHAS=ENDPTA
    GO TO 400
C
450 NUM=NUM+1
    IF (IFFEOP) 460,460,480
460 IFF=IFF+1
    IF (IT3) 470,480,470
470 CONTINUE
    T3SUM=T3SUM+T3
    T3=0.C
480 XTCUM=XTCUM+XCUM
    BUNKER ADDS
    DO 485 I=1,NRSHPS
    IF (ITEMSS(I).EQ.0) XCUMSS(I)=XCUMSS(I)+1
485 UP4SS(I)=UP4SS(I)+ENDPTA-DTSS2(I)
    BUNKER STOPS
    UP4=UP4+ENDPHA-DNT2
    IF (XTABT(NUM)-100000.) 500,490,500
490 X=ENDPHA
    GO TO 510
500 X=XTABT(NUM)
510 X2=X*#2
    SUMX=SUMX+X
    SUMX2=SUMX2+X2
    IF (ISW(N)) 530,530,520
520 IAUP=IAUP+1
530 IF (NUM-INUM) 330,540,540
540 INUM=INUM+10
550 WRITE (6,2017) NUM
    FORMAT (1X16H) GRAND TOTAL OF 16,24H MISSIONS HAVE BEEN RUN.)
560 XNUM=NUM
570 XPCAP=XTCUM/XNUM
580 WRITE (6,600) XPCAP
590 FORMAT (1X24H) THE RELIABILITY IS ,F8.4)
600 XPLCL=XPCAP-XK*SCRT(XFCAP*(1.-XPCAP)/XNUM)
610 IF (XPLCL) 620,630,630
620 XPLCL=0.
630 WRITE (6,640) XPLCL
640 FORMAT (1X24H) THE LOWER CONF LIMIT IS ,F8.4)
650 WRITE (6,650) PL
660 FORMAT (1X24H) THE SPEC REQUIREMENT IS ,F8.4)
66C WRITE (6,66C) RED2
    FORMAT (1X17H) THE REACINESS IS ,7XF8.4)
    AVA=UP4/T3
    WRITE (6,67C) AVA
670 FORMAT (1X28H) THE AVERAGE AVAILABILITY IS ,F8.4)
MULC1930
MULC1940
MULC1950
MULC1960
MULC1970
MULC1980
MULC1990
MULC2000
MULC2010
MULC2020
MULC2030
MULC2040
MULC2050
MULC2060
MULC2070
MULC2080
MULC2090
MULC2100
MULC2110
MULC2120
MULC2130
MULC2140
MULC2150
MULC2160
MULC2170
MULC2180
MULC2190
MULC2200
MULC2210
MULC2220
MULC2230
MULC2240
MULC2250
MULC2260
MULC2270
MULC2280
MULC2290
MULC2300
MULC2310
MULC2320
MULC2330
MULC2340
MULC2350
MULC2360
MULC2370
MULC2380
MULC2390
MULC2400

```

MULC2410
MULC2420
MULC2430
MULC2440
MULC2450
MULC2460
MULC2470
MULC2480
MULC2490
MULC2500
MULC2510
MULC2520
MULC2530
MULC2540
MULC2550
MULC2560
MULC2570
MULC2580
MULC2590
MULC2600
MULC2610
MULC2620
MULC2630
MULC2640
MULC2650
MULC2660
MULC2670
MULC2680
MULC2690
MULC2700
MULC2710
MULC2720
MULC2730
MULC2740
MULC2750
MULC2760
MULC2770
MULC2780
MULC2790
MULC2800
MULC2810
MULC2820
MULC2830
MULC2840
MULC2850
MULC2860
MULC2870
MULC2880

```

XIAUP=IAUP
AVAINS=XIAUP/XNUM
WRITE (6,80) AVAINS
FORMAT (1X28F10.4)
XDOWN=XNUM-XTCUM
IF (XDOWN) 650,650,700
XMTBA=2.0*SUMX
XLCCLA=0.434*SUMX
VAR=(0.5*SUMX)**2
GO TO 710
XMTBA=SUMX/XDOWN
VAR=(SUMX2/XNUM)-(SUMX/XNUM)**2
CORR=(SUMX*(1/XDOWN-1/XNUM))**2
VAR=VAR+CORR
XLCCLA=XMTBA-(1.28*SQRT(VAR))
710 WRITE (6,720) XMTBA
720 FORMAT (1X41F10.4)
730 WRITE (6,730) XLCCLA
740 WRITE (6,740) VAR
750 WRITE (6,750,760)
760 WRITE (6,760)
770 WRITE (6,770,780)
780 WRITE (6,780)
790 WRITE (6,790)
800 WRITE (6,800)
810 WRITE (6,810)
820 WRITE (6,820)
830 WRITE (6,830)
840 WRITE (6,840)
850 WRITE (6,850)
860 WRITE (6,860)
870 WRITE (6,870)
880 WRITE (6,880)
890 WRITE (6,890)
900 WRITE (6,900)
910 WRITE (6,910)

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```

920 IF (NMAX-NUM) 93C,930,960
930 WRITE (6,1940)
940 FORMAT (1X52F-SIM COMPLETE-PREDEFINED MAX NUMBER MISSIONS WERE RUN)
950 IF (XPLCL-PL) 89C,990,990
960 IF (XPLCL-PL) 85C,970,970
970 WRITE (6,1980)
980 FORMAT (2X22F-SIMULATION COMPLETE - )
990 IF (PL-EQ.10CC) GO TO 1010
1000 WRITE (6,10CC)
1010 FORMAT (1X33HWEAPON SYSTEM MEETS REQUIREMENTS.)
1020 CONTINUE
1030 IF (JC-1) 1020,1020,1230
1040 READ (5,1030) SPRS,APPL,GMMA,DMNO
1050 FORMAT (14A4)
1060 BUNKER ADDS
1070 IF (IOPTM-EC.1) GO TO 1190
1080 IF (IOPTM-EC.BLNK) GO TO 1190
1090 IF (SPRS-EQ.BLNK) GO TO 1190
1100 IF (SPRS-EQ.BLNK) GO TO 1190
1110 BUNKER STOPS
1120 BUNKER=0
1130 IDIFF=0
1140 TAFM=0.0
1150 TACMMH=0.0
1160 WRITE (6,1060)
1170 FORMAT (1H1,4X53HEQUIP FAILURES AND CORRECTIVE MAINTENANCE (CM) SUM
1180 MARY/8X7HEQUIP, NO TYPE NO: TOTAL EQUIP, AVG NO FAILURES A
2VG. CM MANHCURS/32X8HFAILURES,7X11HPER MISSION,5X11HPER MISSION/)
00 1090
1090 IF (XMYTR(IEQU(1))-EQ.9999.) GO TO 1090
1100 IF (KEQU(1)) 1090,1090,1070
1110 AFM=KEQU(1)/XNUM
1120 IEQ=IABS(IEQU(1))
1130 ACMMH=AFM+ABS(XMYTR(IEQ))
1140 WRITE (6,1080) I,IEC,KEQU(1),AFM,ACMMH
1150 FORMAT (110X14,6X14,6X10.3,6XF10.3)
1160 IDIFF=IDIFF+KEQU(1)
1170 TAFM=TAFM+AFM
1180 TACMMH=TACMMH+ACMMH
1190 CONTINUE
1200 IF (6,11CC) IDIFF,TAFM,TACMMH
1210 WRITE (6,11CC) IDIFF,TAFM,TACMMH
1220 FORMAT (31X10H-----,6X10H-----,6X10H-----/31X10,6X
1230 F10.3,6XF10.3)
1240 CONTINUE
1250 WRITE (6,1120)
1260 FORMAT (1H1,3X41FAVERAGE NUMBER OF SPARES USED PER MISSION)
1270 WRITE (6,1130)
1280 FORMAT (74X6FSPARES,7X4HSHIP,16X6HTENDER,16X4HBASE)
1290 WRITE (6,1140)
1300 FORMAT (8X4HTYPE,4X3(5HSTOCK,3X4HUSED,10X))

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MLL02890
MUL02900
MUL02910
MUL02920
MUL02930
MUL02940
MUL02950
MUL02960
MUL02970
MUL02980
MUL02990
MUL03000
MUL03010
MUL03020
MUL03030
MUL03040
MUL03050
MUL03060
MUL03070
MUL03080
MUL03090
MUL03100
MUL03110
MUL03120
MUL03130
MUL03140
MUL03150
MUL03160
MUL03170
MUL03180
MUL03190
MUL03200
MUL03210
MUL03220
MUL03230
MUL03240
MUL03250
MUL03260
MUL03270
MUL03280
MUL03290
MUL03300
MUL03310
MUL03320
MUL03330
MUL03340
MUL03350
MUL03360

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1014 FORMAT('0',5X,'THE FOLLOWING STATISTICS REPRESENT AVERAGES PER MIS
XSION) PER END USE ACTIVITY')
1015 FORMAT('0',5X,'1. SYSTEM RELIABILITY (PROB OF SUCCESSFUL MISSION)
X,')
1016 FORMAT('0',15X,'= ',F6.4)
1017 FORMAT('0',15X,'2. SYSTEM AVAILABILITY (PROB SYSTEM OPERATIONAL AT
X AN ARBITRARY TIME,')
C ** BUNKER STOPS
1260 STOP
END
C
C
C
SUBROUTINE RUN
COMMON /MAX/PAXNEQ,MAXTYP,MAXIB,MAXSTD
COMMON /ALPHA/DNT2,ENDPHA,ICRI,IFF,IFR,INUM,IOPT,JBB,KEQ,KKK,KZZ
1,KK1,KSL,LL,LLAST,NEQ,NPH,NTYPE,NUM,REDAD1(100),RELP,RED2
2,RELPH,RELPH1,STPHAS,TP,TP1,XCUM,TP3,UP3,IFFEOP,TP3,TIME,ISUM
COMMON /BETA/NRO(6,300),IB(6,300,8),NLINE(6)
COMMON /EXTRA/ KS(20),ISW(31)
COMMON /N/IECU(500),KEQU(500),ETIME(1000),XMTBF(200),XMTTR(200)
COMMON /NPH/ NSS(6),IFLAG(6),TITLE(6,31),SSTIME(6,31,2),ISS(6,31)
COMMON /SEQ/ INOABT(100),INMI(100),IAUP1(100),IT2(100),UP2(100)
1,IAUP2(100)
COMMON /EXP/ EX(2,200),ISPARE(3,200),IUSED(3,200),IUSED(3,200)
COMMON /GAMPA/ XMTBA,VAR,RELGA(100),TMA(100),XT(200),ITT,ISEED
COMMON /TABCRT/ XTABT(1000),RDT
COMMON /CELTA/ KKK2
COMMON /XXX/ XXX
COMMON /VDC/ VCC(50,6),IUI(200),VMTTR(200,6),TAD2
COMMON /STAN/ IST(60,10,6)
COMMON /RUNAP/ ITEMP2,DELT,ISSA(31),ISSC
COMMON /MULTI/ MAXC, MULTC, MELAG, IOPM, IIRC, IOPTP1
COMMON /NS/ NUMSS(30),NRSHPS,ITOTEQ,KSSSEQ(500),NRWCS
COMMON /ESTAT/ UP4SS(30),DTSS1(30),DTSS2(30),XCUMSS(30),RELSS(30),
1,AVASS(30),ITEMSS(30)
COMMON /D/ SSADT
TDEOP=0.0
TP=STPHAS
KAA=NUM+1
XKAA=KAA
NX=NSS(LL)
N=NX+1
ITEMP2=0
IF (KKK) 40,10,40

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MULC4330
MULC4340
MULC4350
MULC4360
MULC4370
MULC4380
MULC4390
MULC4400
MULC4410
MULC4420
MULC4430
MULC4440
MULC4450
MULC4460
MULC4470
MULC4480
MULC4490
MULC4500
MULC4510
MULC4520
MULC4530
MULC4540
MULC4550
MULC4560
MULC4570
MULC4580
MULC4590
MULC4600
MULC4610
MULC4620
MULC4630
MULC4640
MULC4650
MULC4660
MULC4670
MULC4680
MULC4690
MULC4700
MULC4710
MULC4720
MULC4730
MULC4740
MULC4750
MULC4760
MULC4770
MULC4780
MULC4790
MULC4800

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10  DO 20 I=1,3
    DO 20 J=1,NTYPE
    IUSED(I,J)=0
    CONTINUE
20  DO 30 I=1,NEQ
    ETIME(I)=100000.
    CONTINUE
30  DO 120 ILB=1,NEQ
    KEQ=ILB
    IF(ETIME(KEQ)+100001.001)55,120,55
55  IF(ETIME(KEQ)+99999.)60,60,120
60  IF (IFLAG(LL)) 120,70,120
    C
70  ETIME(KEQ)=STPHAS
    IABC=IABS(IEQU(KEQ))
    IF (XMTTR(IABC)) 80,80,100
80  XXX=VMTTR(IABC,LL)
    IF (XXX-9995.) 120,90,120
90  ETIME(KEQ)=-99999.
    GO TO 120
100 XXX=XMTTR(IABC)
110 CALL 77E
120 CONTINUE
    C
DO 140 ILB=1,NEQ
KEQ=ILB
IEQU(KEQ)=IABS(IEQU(KEQ))
IF(ETIME(KEQ)-100000.) 130,140,130
130 IEQU(KEQ)=-IABS(IEQU(KEQ))
140 CONTINUE
150 CONTINUE
    C
KKK2=KKK
K=NLINE(LL)
DO 250 I=1,K
    DO 250 J=1,K
    KEQ=IABS(IEQU(LL,I,J))
    IF (KEQ-MAXNEQ) 151,151,250
151 IF(ETIME(KEQ)+100001.001)160,250,160
155 IF(ETIME(KEQ)-100000.) 160,250,160
160 IEQU(KEQ)=IABS(IEQU(KEQ))
    IABC=IEQU(KEQ)
    IF (XMTTR(IABC)) 170,170,180
170 IF (VMTTR(IABC,LL)-99999.) 180,190,180
180 CONTINUE
    IF (IFLAG(LL)-1) 210,190,210
190 IF (ETIME(KEQ)) 200,210,210

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```

200 ETIME(KEQ)=ETIME(KEQ)-(ENDPHA-STPHAS)
210 IF (ETIME(KEQ)-100000.) 220,240,220
220 IF (ABS(ETIME(KEQ))-STPHAS) 240,230,230
230 IF (STPHAS)-STPHAS
240 ETIME(KEQ)=STPHAS
    IABC=IABS(IECU(KEQ))
    XXX=XMTTR(IABC)
    CALL TTE
    CONTINUE
250 KKK2=1
C
DO 330 ILB=1,NEQ
KEQ=ILB
IF (ETIME(KEQ)+1000001.001) 255,330,255
255 IF (IECU(KEQ)) 260,260,230
260 IECU(KEQ)=IABS(IECU(KEQ))
    IABC=IECU(KEQ)
    IF (XMTTR(IABC)) 270,270,280
    IF (YMTTR(IABC,LL)-9999.) 280,290,280
270 CONTINUE
280 IF (IFLAG(LL)-1) 310,290,310
290 IF (ETIME(KEQ)) 300,320,320
300 ETIME(KEQ)=ETIME(KEQ)-(ENDPHA-STPHAS)
    GO TO 330
331 IECU(KEQ)=-IABS(IECU(KEQ))
330 CONTINUE
C
CALL STATUS
CALL STNDBY
C
CALL STATUS
IF (ISW(N)) 350,350,340
340 IAUPI(JBB)=IAUPI(JBB)+1
350 XIAUPI=IAUPI(JBB)
    XAVI=XIAUPI/XKAA
C
TIME=STPHAS
DNT1=C.O
C ** BUNKER ADDS
DO 351 I=1,30
DTSSI(I)=0.C
351 BUNKER STOPS
C ** DO 360 KSS=1,N

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```

MUL C4810
MUL C4820
MUL C4830
MUL C4840
MUL C4850
MUL C4860
MUL C4870
MUL C4880
MUL C4890
MUL C4900
MUL C4910
MUL C4920
MUL C4930
MUL C4940
MUL C4950
MUL C4960
MUL C4970
MUL C4980
MUL C4990
MUL C5000
MUL C5010
MUL C5020
MUL C5030
MUL C5040
MUL C5050
MUL C5060
MUL C5070
MUL C5080
MUL C5090
MUL C5100
MUL C5110
MUL C5120
MUL C5130
MUL C5140
MUL C5150
MUL C5160
MUL C5170
MUL C5180
MUL C5190
MUL C5200
MUL C5210
MUL C5220
MUL C5230
MUL C5240
MUL C5250
MUL C5260
MUL C5270
MUL C5280

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MUL052900
MUL053000
MUL053100
MUL053200
MUL053300
MUL053400
MUL053500
MUL053600
MUL053700
MUL053800
MUL053900
MUL054000
MUL054100
MUL054200
MUL054300
MUL054400
MUL054500
MUL054600
MUL054700
MUL054800
MUL054900
MUL055000
MUL055100
MUL055200
MUL055300
MUL055400
MUL055500
MUL055600
MUL055700
MUL055800
MUL055900
MUL056000
MUL056100
MUL056200
MUL056300
MUL056400
MUL056500
MUL056600
MUL056700
MUL056800
MUL056900
MUL057000
MUL057100
MUL057200
MUL057300
MUL057400
MUL057500

```

C 360 S$TIME(LL,KSS,1)=0.0
370 TP=TIME
380 CALL STNDBY 390,440,390
390 IF (KS(6)) 390,440,390
400 WRITE(6,430) TP
410 DO 410 J=1,NEQ
420 IF (ETIME(J)-100000.) 400,410,400
430 IEQ=IABS(IECU(J))
440 WRITE(6,420) J,IEQ,ETIME(J)
450 CONTINUE
460 FORMAT (1X15,1X15,5XF22.4)
470 FORMAT (1X12.4)
480 CALL EYES(ETIME(KEQ))
490 IF (KS(5)) 450,470,450
500 WRITE(6,460) KEQ,ETIME(KEQ),KAA
510 FORMAT (10X5HEQUIP,15,F12.4,5X7HMISSION,110)
520 DELT=TIME-TF
530 CALL STATUS
540 DO 540 KSS=1,NX
550 IF (SW(KSS)) 490,500
560 S$TIME(LL,KSS,1)=S$TIME(LL,KSS,1)+DELT
570 GO TO 510
580 CONTINUE
590 IF (SW(N)) 520,520,520
600 S$TIME(LL,N,1)=S$TIME(LL,N,1)+DELT
610 T3=T3+DELT
620 IF (TIME-ENCPHA) 522,522,521
630 T3=T3+ENDPHA-TP-DELT
640 RDT=RCT+DELT
650 GO TO 550
660 T3=0.0
670 RDT=0.0
680 IF (S$TIME(LL,N,1)) 1140,550,540
690 T1=S$TIME(LL,N,1)
700 S$TIME(LL,N,1)=0.0
710 CONTINUE
720 IF (S$TIME(LL,N,1)) 570,560,570
730 IF (T1) 620,620,580
740 IF (T1) 620,610,620
750 IF (T1) 620,610,620
760 IF (T1) 620,610,620
770 IF (T1) 620,610,620
780 IF (T1) 620,610,620
790 IF (T1) 620,610,620
800 IF (T1) 620,610,620
810 IF (T1) 620,610,620
820 IF (T1) 620,610,620
830 IF (T1) 620,610,620
840 IF (T1) 620,610,620
850 IF (T1) 620,610,620
860 IF (T1) 620,610,620
870 IF (T1) 620,610,620
880 IF (T1) 620,610,620
890 IF (T1) 620,610,620
900 IF (T1) 620,610,620
910 IF (T1) 620,610,620
920 IF (T1) 620,610,620
930 IF (T1) 620,610,620
940 IF (T1) 620,610,620
950 IF (T1) 620,610,620
960 IF (T1) 620,610,620
970 IF (T1) 620,610,620
980 IF (T1) 620,610,620
990 IF (T1) 620,610,620
1000 IF (T1) 620,610,620

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MUL 05770
MUL 05780
MUL 05790
MUL 05800
MUL 05810
MUL 05820
MUL 05830
MUL 05840
MUL 05850
MUL 05860
MUL 05870
MUL 05880
MUL 05890
MUL 05900
MUL 05910
MUL 05920
MUL 05930
MUL 05940
MUL 05950
MUL 05960
MUL 05970
MUL 05980
MUL 05990
MUL 06000
MUL 06010
MUL 06020
MUL 06030
MUL 06040
MUL 06050
MUL 06060
MUL 06070
MUL 06080
MUL 06090
MUL 06100
MUL 06110
MUL 06120
MUL 06130
MUL 06140
MUL 06150
MUL 06160
MUL 06170
MUL 06180
MUL 06190
MUL 06200
MUL 06210
MUL 06220
MUL 06230
MUL 06240

```

61C  T1=SSTIME(LL,N,1)
620  CONTINUE
C    BUNKER ADDS
    DD 028 I=1,NRSHPS
    DIFFY=SSTIME(LL,I,1)-SSADT
622  IF(DIFFY)628,628,622
624  IF(DIFFY-ENDPHA)624,628,628
628  ITEMS(I)=1
    CONTINUE
C    BUNKER STOPS
    IF(ICRI) 640,640,660
C
640  ISSC=1
    ISSA(1)=N
    IF(RCT-TAD2)645,645,930
645  ICRI=0
    IF(SSTIME(LL,N,1)-SSTIME(LL,N,2)) 650,650,960
650  ICRI=0
    ISSC=0
    KSS=1,NX
    IF(SSTIME(LL,KSS,1)-SSTIME(LL,KSS,2))655,655,652
652  ISSC=ISSC+1
    ISSA(ISSC)=KSS
655  CONTINUE
660  IF(ISSC)660,660,962
    CONTINUE
C
    IF (TIME-ENDPHA) 670,670,1140
    IF (ISNIN) 680,680,730
670  CALL APPLF(KEQ), 810, 810, 740
680  IF (ETIMES(IEQU(KEQ))) 810, 810, 740
730  IABC=IABS(IEQU(KEQ))
740  IF (IFLAG(LL,I)-1) 750, 760, 750
750  CALL LRNC(ISEED,RN,1,16807,0)
760  IF (LRN-REPOL) 770, 770, 800
    ETIME(KEQ)=-99999.
    GO TO 830
770  IF (XMTTR(IABC)) 780, 780, 790
780  XXX=VMTTR(IABC,LL)
790  IF (XXX-9999.) 820, 760, 820
    XXX=XMTTR(IABC)
    GO TO 820
800  ETIME(KEQ)=-100001.001
    GO TO 830
810  IARC=IABS(IEQU(KEQ))
820  XXX=XMTTR(IARC)
    IF (IEQU(KEQ)) 811, 821, 821

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```

C      811 IEQU(KEQ)=1ABS(IEQU(KEC))
C      ETIME(KEQ)=100000.
C      GO TO 830
C      821 BUNKER ADDS
C      ** INDIC=0
C      830 IF (ETIME(KEQ)) 840,831,870
C      ** BUNKER ADDS
C      NOTE: LABEL 830 CHANGED FROM 840,1150,870
C      831 GO TO 1140
C      ** BUNKER STOPS
C      840 KEQU(KEQ)=KEQU(KEQ)+1
C      ** BUNKER ADDS
C      DO 842 I=1,NRSHPS
C      841 IF (ISW(I)) 841,842
C      842 CONTINUE
C      ** BUNKER STOPS
C      849 IF (ISW(N)) 850,85C,370
C      850 ONTI=ONTI+DELT
C      860 REDAD1(J88)=REDAD1(J88)+DELT
C      GO TO 370
C      870 CONTINUE
C      BUNKER ADDS
C      DO 872 I=1,NRSHPS
C      871 IF (ISW(I)) 871,871,873
C      873 OTSSI(I)=OTSSI(I) + DELT
C      CONTINUE
C      ** BUNKER STOPS
C      879 IF (ISW(N)) 880,880,370
C      880 ONTI=ONTI+DELT
C      890 REDAD1(J88)=REDAD1(J88)+DELT
C      900 TOTCHN=TIME-SSTIME(LL,A,1)
C      ITEMP=SSTIME(LL,A,1) 910
C      918 WRITE(6,920) LL,DOWN,ITEMP,KAA
C      920 FORMAT (13H DURING PHASE,16,20HSYSTEM WENT DOWN AT ,F14.4,13H DOWN
C      1 TIME IS 370
C      930 ICRI=5

```

```

940 TABORT=TIME-(RDI-TAD2)
950 IF (XTABT(KAA)-100000.) 645,645,660,95C,660
C ** ITEMP2=1
C ** BUNKER ADDS
C ** IF (IOPTM STOP) GO TO 555
C ** BUNKER STOP
WRITE(6,1010)LL,JBB,KAA,TABORT,TITLE(LL,N)
955 WRITE(6,1011)TAD2
CONTINUE
960 GO TO 1020
ICRI=4 964
GO TO 964
962 ICRI=2
964 TABORT=TIME-(SSTIME(LL,ISSA(1),1)-SSTIME(LL,ISSA(1),2))
970 IF (TABORT-ENDPHA) 99C,980,980
980 IF (ICRI-2) 65C,585,65C
985 ICRI=0
GO TO 660
C
990 IF (XTABT(KAA)-100000.) 660,1000,660
1000 ITEMP2=1
C ** BUNKER ADDS
C ** IF (IOPTM STOP) GO TO 1006
C ** BUNKER STOP
DO 1005 I=1,ISSC
WRITE(6,1006)LL,JBB,KAA,TABORT,TITLE(LL,ISSA(I))
1005 CONTINUE
1006 WRITE(6,1008)SSTIME(LL,ISSA(I),2)
1009 FORMAT(1X9HIN PHASE,12,1X3HSEQ,13,4X7HMISSION,16,4X15HABORTED AT
1008 TIME,F10.4,1X10H BECAUSE,1A4)
1010 FORMAT(1X34H EXCEEDED PHASE,ALLCWBLE,DCWNTIME,2XF10.3,5H HRS.)
1010 FORMAT(1X9HIN PHASE,12,1X3HSEQ,13,4X7HMISSION,16,4X15HABORTED AT
1011 TIME,F10.4,1X10H BECAUSE,1A4)
1011 FORMAT(1X36H EXCEEDED PHASE,ALLOWABLE,DOWNTIME,2XF10.3,5H HRS.)
1020 XTABT(KAA)=TABORT
1040 IF (XTABT(KAA)-1590,1590,1040)
1040 DO 1040 I=1,NEQ
IF (ETIME(I)) 1050,1110,1110
1050 IF (KES(I)) 1080,1110,1080
1080 IF (KES(2)) 1090,1110,1090
1090 WRITE(6,1100)ETIME(I)
1100 FORMAT(1X7HSEQUIPMENT,15,24H DOWN IT WILL CCME UP AT,F16.4)
1110 CONTINUE
1120 CALL APPLE
ITEMP2=0

```

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MUL06730
MUL06740
MUL06750
MUL06760
MUL06770
MUL06780
MUL06790
MUL06800
MUL06810
MUL06820
MUL06830
MUL06840
MUL06850
MUL06860
MUL06870
MUL06880
MUL06890
MUL06900
MUL06910
MUL06920
MUL06930
MUL06940
MUL06950
MUL06960
MUL06970
MUL06980
MUL06990
MUL07000
MUL07010
MUL07020
MUL07030
MUL07040
MUL07050
MUL07060
MUL07070
MUL07080
MUL07090
MUL07100
MUL07110
MUL07120
MUL07130
MUL07140
MUL07150
MUL07160
MUL07170
MUL07180
MUL07190
MUL07200

```

```

1130 GO TO 660
C 1140 CONTINUE
  IF FEOP=ISW(A)
C ** BUNKER ADDS
  DO 1148 I=1,NRSHPS
  IF (ICRIC(I)) 1142,1141,1141
  IF (ISW(NOPHA)-1) 1142,1142,1148
1141 TDEOP=INOPHA-1
1142 DTSS1(I)=DTSS1(I)+TDEOP
  CONTINUE
1148 IF (INCR) 1150,1149,1149
  IF (ISW(N)) 1160,1160,1270
C ** BUNKER STOPS
1149 CONTINUE
1150 TDEOP=ENDPHA-TP
1160 CONTINUE
1170 IF (KS13) 1210,1210,1180
  IF (TDEOP) 1190,1210,1190
1180 WRITE(6) 12001,LL,TDECP,KAA
1190 FORMAT(1X27HSYSTEM DOWN AT END OF PHASE,16,13H FOR DURATION,110.4)
1200 CONTINUE
1210 CONTINUE
  DNT1=DNT1+TDEOP
  RDT=RLT+TDECP-DELT
  DELT=APPLE
  CALL APPLE
  CONTINUE
1270 BUNKER ADDS
C ** DO 1288 I=1,NRSHPS
  DTSS2(I)=DTSS2(I)+DTSS1(I)
C ** BUNKER STOPS
1280 IF (ICRI) 1280,1290,1280
  REDAD1(JBB)=REDAD1(JBB)+TDEOP
1290 DNT2=DNT2+DNT1
1300 IF (KS(6)) 1310,1330,1310
1310 IF (KS(6)) 1325,1330,1325
1325 WRITE(6) 1320,LL,KAA,DNT2
1330 FORMAT(1X5HPHASE,15,1X29HTOTAL SYS DOWNTIME IN MISSION,15,1X3HWAS
  F12.4,4H HRS)
  CONTINUE
C 1340 IF (ICRI) 1350,1350,1340
  IF (ITEMP) 1360,1360,1350
1350 XCUM=1-ITEMP
  INOABT(JBB)=INOABT(JBB)+1-ITEMP
  INMI(JBB)=INMI(JBB)+1
  CONTINUE
1360

```

```

MUL072210
MUL072230
MUL072240
MUL072250
MUL072260
MUL072270
MUL072280
MUL072290
MUL072300
MUL072310
MUL072320
MUL072330
MUL072340
MUL072350
MUL072360
MUL072370
MUL072380
MUL072390
MUL072400
MUL072410
MUL072420
MUL072430
MUL072440
MUL072450
MUL072460
MUL072470
MUL072480
MUL072490
MUL072500
MUL072510
MUL072520
MUL072530
MUL072540
MUL072550
MUL072560
MUL072570
MUL072580
MUL072590
MUL072600
MUL072610
MUL072620
MUL072630
MUL072640
MUL072650
MUL072660
MUL072670
MUL072680

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```

1370 XND=INCABT(JBB)
      TNMI=INMI(JBB)
      IF (TNMI) 1380,1380,1370
1380 RELY=XNO/TNMI
1390 GO TO 1390
      RELPY=C.O
      RELPY=RELPY*RELY
      TT1=ENDPHA-STPHAS
      TT2(JBB)=TT2(JBB)+TT1
      UP1=TT1-ONT1
      UP2(JBB)=UP2(JBB)+UP1
      IF (ISW(N)) 1410,141C,1400
1400 IAU2(JBB)=IAU2(JBB)+1
141C XIAUPP=IAUP2(JBB)
      XAV=XIAUPP/XKAA
      IF (KAA-INUM) 1570,1420,1570
1420 WRITE (6,142C) XAV
1430 FORMAT (147X20HINSTANT AVAILABILITY,5X2X4H IS ,F6.4)
1440 WRITE (6,144C) LL,JBB,RELY,LL,RELPY
1450 FORMAT (9X17HRELIABILITY PHASE,I3,IH,,I3,5H, IS ,F6.4,3X25HRELIABI
      LITY UP TO PHASE ,I2,4H IS ,F6.4)
C
      RELGA(JBB)=RELPY
      AENDT1=0.0
      AENDT2=0.0
      DO 1520 I=1,KAA
      IF (XTABT(I))-100000. 1470,1520,1520
1460 IF (XTABT(I))-TIMA(JBB) 1480,1520,1520
1470 IF (XTABT(I))-TIMA(JBB)-XTABT(I)
1480 AENDT2=AENDT2+TIMA(JBB)-XTABT(I)
      JBB1=JBB-1
      IF (JBB1) 1500,150C,1490
149C IF (TIMA(JBB1)-XTABT(I)) 1500,1500,1510
1500 AENDT1=AENDT1+TIMA(JBB1)-XTABT(I)
      GO TO 1520
151C AENDT1=AENDT1+TIMA(JBB)-TIMA(JBB1)
1520 CONTINUE
      TT3=TT3+TT2(JBB)
      UP3=UP3+UP2(JBB)
      REOAC2=REOAC2+REOAC1(JBB)
      REO1=(UP2(JBB1)-AENDT1+REOAC1(JBB))/TT2(JBB)
      REO2=(UP3-AENDT2+REOAC2)/TT3
      WRITE (6,154C) REO1,REO2
1530 FORMAT (9X16HREADINESS
1540 ,9X4H IS ,F6.4,3X25HREADINESS
      ,9X4H IS ,F6.4,3X25HREADINESS)
      AVA1=UP2(JBB)/TT2(JBB)
      AVA2=UP3/TT3
      WRITE (6,155C) AVA1,AVA2
1550 FORMAT (9X23H AVERAGE AVAILABILITY ,2X4H IS ,F6.4,3X25H AVERAGE AV

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```

55 IF(XM1) 36,36,56
36 WRITE(6,60) REPC1,IAC2,XM,XM1
60 FORMAT(1X,4F10.2)
GO TO (70,90,100,120,130),KOPT

```

C

```

70 KS(1)=1
KS(4)=0
80 KS(3)=0
KS(2)=0
KS(5)=1
KS(6)=0
KS(7)=0
KS(8)=0
KS(9)=0
KS(10)=0
GO TO 130
90 KS(11)=0
KS(16)=0
KS(10)=0
100 KS(17)=1
KS(11)=1
KS(6)=1
KS(12)=1
KS(2)=1
KS(3)=1
KS(4)=1
KS(5)=1
KS(7)=1
KS(8)=1
KS(9)=1
GO TO 130
120 KS(1)=0
KS(4)=0
GO TO 80

```

C

```

130 NEQ=0
DO 140 I=1,MAXNEC
ETIME(I)=100000.
140 LEQU(I)=0
CONJ=NUE
DO 150 J=1,6
XMTBF(I)=9.8
XMTTR(I,J)=8.0

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MUL C8650
MUL C8660
MUL C8670
MUL C8680
MUL C8690
MUL C8700
MUL C8710
MUL C8720
MUL C8730
MUL C8740
MUL C8750
MUL C8760
MUL C8770
MUL C8780
MUL C8790
MUL C8800
MUL C8810
MUL C8820
MUL C8830
MUL C8840
MUL C8850
MUL C8860
MUL C8870
MUL C8880
MUL C8890
MUL C8900
MUL C8910
MUL C8920
MUL C8930
MUL C8940
MUL C8950
MUL C8960
MUL C8970
MUL C8980
MUL C8990
MUL C9000
MUL C9010
MUL C9020
MUL C9030
MUL C9040
MUL C9050
MUL C9060
MUL C9070
MUL C9080
MUL C9090
MUL C9100
MUL C9110
MUL C9120

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150 XMTR(I)=0.C
155 CONTINUE
160 WRITE (6,170)
170 FORMAT (//I1H TYPE NAME,18X4HMTBF,5X4HMTTR,7X2HDC,8X4HADT1,4X4HADT
180 READ (5,150) I,(CUM(J),J=1,4),X,Y,L,V,W,IDUM
190 FORMAT (14,4A4,F8.0,4F4.0,14)
200 IF (I-MAXTYP) 22C,220,210
210 WRITE (6,44C)
220 GO TO 1000
230 DO 230 J=1,4
230 F(I,J)=DUM(J)
240 IF (IUI(I)) 240,250,240
250 IF (IUI(I)) IUI(I)=IDUM
260 IF (IUI(I)) IUI(I)=IDUM
270 IF (IUI(I)) IUI(I)=IDUM
280 IF (IUI(I)) IUI(I)=IDUM
290 IF (KS(I)) 310,31C,290
300 WRITE (6,300) I,(F(I,J),J=1,4),X,Y,U,V,W
310 IF (IUI(I)) 380,380,320
320 IF (KS(I)) 340,340,320
330 IF (KS(I)) 340,340,320
340 IF (KS(I)) 340,340,320
350 IF (VDC(IU,ILL)) 360,360,350
360 IF (VDC(IU,ILL)) 360,360,350
370 IF (VDC(IU,ILL)) 360,360,350
380 IF (KS(I)) 410,410,390
390 IF (KS(I)) 410,410,390
400 IF (KS(I)) 410,410,390
410 IF (KS(I)) 410,410,390
420 IF (KS(I)) 410,410,390
430 IF (KS(I)) 410,410,390
433 IF (KS(I)) 410,410,390
435 IF (KS(I)) 410,410,390
440 IF (KS(I)) 410,410,390
450 IF (KS(I)) 410,410,390
460 IF (KS(I)) 410,410,390
470 IF (KS(I)) 410,410,390

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MULC9130
MULC9140
MULC9150
MULC9160
MULC9170
MULC9180
MULC9190
MULC9200
MULC9210
MULC9220
MULC9230
MULC9240
MULC9250
MULC9260
MULC9270
MULC9280
MULC9290
MULC9300
MULC9310
MULC9320
MULC9330
MULC9340
MULC9350
MULC9360
MULC9370
MULC9380
MULC9390
MULC9400
MULC9410
MULC9420
MULC9430
MULC9440
MULC9450
MULC9460
MULC9470
MULC9480
MULC9490
MULC9500
MULC9510
MULC9520
MULC9530
MULC9540
MULC9550
MULC9560
MULC9570
MULC9580
MULC9590
MULC9600

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MUL09610
 MUL09620
 MUL09630
 MUL09640
 MUL09650
 MUL09660
 MUL09670
 MUL09680
 MUL09690
 MUL09700
 MUL09710
 MUL09720
 MUL09730
 MUL09740
 MUL09750
 MUL09760
 MUL09770
 MUL09780
 MUL09790
 MUL09800
 MUL09810
 MUL09820
 MUL09830
 MUL09840
 MUL09850
 MUL09860
 MUL09870
 MUL09880
 MUL09890
 MUL09900
 MUL09910
 MUL09920
 MUL09930
 MUL09940
 MUL09950
 MUL09960
 MUL09970
 MUL09980
 MUL09990
 MUL10000
 MUL10010
 MUL10020
 MUL10030
 MUL10040
 MUL10050
 MUL10060
 MUL10070
 MUL10080

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684 IF(IUALIM-IELANK)650,720,690
690 WRITE(6,700)
700 FORMAT(1X4,FALL EQUIPMENT TYPES HAVE UNLIMITED SPARES)
710 DO 710 I=1,NTYPE
720 DO 710 J=1,3
730 ISPAARE(J,I)=90000
740 GO TO 760
750 C I=1,NTYPE
760 READ(5,101) (ISPAARE(J,I),J=1,3)
770 BILL=FLOAT(1,1)*SX
780 IF(IINT(BILL)-BILL) 727,725,727
790 ISPAARE(1,1)=BILL
800 GO TO 728
810 ISPAARE(1,1)=INT(BILL)+1
820 CONTINUE
830 IF (KS(1,1) 740,740,730
840 WRITE(6,750) (ISPAARE(J,I),J=1,3),SX
850 CONTINUE
860 FORMAT(5X,14,2X,3110,13X,F6.2)
870
880 WRITE(6,770) NPH
890 FORMAT(1H1,2X28HTHE MISSION WILL BE RUN WITH,14,7H PHASE ,27HTYPE
900 IS IN VARIABLE SEQUENCE.)
910
920 DO 777 I=1,6
930 DO 776 J=1,10
940 DO 775 K=1,60
950 ISTB(K,J,I)=0
960 CONTINUE
970 CONTINUE
980 DO 990 K=1,NPH
990 READ(5,780) X10,LL,NSS(K)+1,SSTIME(K,NSS(K)+1,2)
1000 ISYS(K)=ISS(K,NSS(K)+1)
1010 FORMAT(1A4,314,F8.0)
1020 NX=NX+1
1030 IF (KS(1,1) 820,820,790
1040 WRITE(6,810) X10,LL,NSS(K),ISS(K,N),SSTIME(K,N,2)
1050 FORMAT(1XA4,314,F10.2)
1060 DO 820 TITLE(K,N)=X10
1070
1080 DO 840 IK=1,NX
1090 READ(5,780) X10,LL,NSS(K),ISS(K,IK),SSTIME(K,IK,2)
1100 IF (KS(1,1) 840,840,830
1110 WRITE(6,800) TITLE(K,IK),LL,MM,ISS(K,IK),SSTIME(K,IK,2)
1120 CONTINUE

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MUL10090
MUL10100
MUL10110
MUL10120
MUL10130
MUL10140
MUL10150
MUL10160
MUL10170
MUL10180
MUL10190
MUL10200
MUL10210
MUL10220
MUL10230
MUL10240
MUL10250
MUL10260
MUL10270
MUL10280
MUL10290
MUL10300
MUL10310
MUL10320
MUL10330
MUL10340
MUL10350
MUL10360
MUL10370
MUL10380
MUL10390
MUL10400
MUL10410
MUL10420
MUL10430
MUL10440
MUL10450
MUL10460
MUL10470
MUL10480
MUL10490
MUL10500
MUL10510
MUL10520
MUL10530
MUL10540
MUL10550
MUL10560

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MUL10570
MUL10580
MUL10590
MUL10600
MUL10610
MUL10620
MUL10630
MUL10640
MUL10650
MUL10660
MUL10670
MUL10680
MUL10690
MUL10700
MUL10710
MUL10720
MUL10730
MUL10740
MUL10750
MUL10760
MUL10770
MUL10780
MUL10790
MUL10800
MUL10810
MUL10820
MUL10830
MUL10840
MUL10850
MUL10860
MUL10870
MUL10880
MUL10890
MUL10900
MUL10910
MUL10920
MUL10930
MUL10940
MUL10950
MUL10960
MUL10970
MUL10980
MUL10990
MUL11000
MUL11010
MUL11020
MUL11030
MUL11040

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C  **  BUNKER ADDS
      IF (IOPM.NE.1) GO TO 846
      DO 845 I=1, ITOSEC, 18
      READ(5,847) (NSSEC(I+J-1), J=1, 18)
      CONTINUE
      FORMAT(18I4)
C  **  BUNKER STOPS
      DO 850 JA=1, MAXIB
      DO 850 JB=1, 8
      IB(K, JA, JB)=C
      CONTINUE
      IOR=0
      I=0
      I=I+1
      READ(5,10) (IVAL(J), J=1, 10), IRULE
      IF (IVAL(1).EQ.0) GC TO 990
      IF (IRULE.NE.0) GO TO 930
C
      IF (I.LE.MAXIB) GC TO 880
      WRITE(6,870) MAXIB
      FORMAT(1H1, 10X, 29H# CF GROUP CARDS GREATER THAN, I4)
      STOP
      NRD(K, I)=IVAL(1)
C
      DO 890 J=1, 8
      IB(K, I, J)=IVAL(J+1)
      CONTINUE
      I=IBNUM(K, I, 1)-500)=I
      NLINE(K)=I
      IF (KS(1)) 86C, 86C, 910
      IF (KS(1)) 86C, 86C, 910
      WRITE(6,920) NRD(K, I), (IB(K, I, J), J=1, 8)
      FORMAT(1X, 13, 8I4)
      GO TO 860
      CONTINUE
      I=I-1
      IOR=ICR+1
C
      IF (IOR.LE.MAXSTC) GO TO 950
      WRITE(6,940) MAXSTC
      FORMAT(1H1, 10X, 36H# OF OPERATE PULE CARDS GREATER THAN, I4)
      STOP
      CONTINUE
      DO 960 J=1, 10
      I=IB(IOR, J, K)=IVAL(J)
      CONTINUE
      IF (KS(1)) 86C, 86C, 970
      WRITE(6,980) (ISTB(IOR, J, K), J=1, 10)

```

```

98G  FORMAT(30X,1G14)
    GO TO 860
99C  CONTINUE
1000 CONTINUE
    RETURN
    END
CCC
SUBROUTINE EVENT
COMMON /ALPHA/CNT2, ENDPHA, ICRI, IFF, IFR, INUM, IQPT, JBB, KEQ, KKK, KZZ
1, KK1, KSL, LL, LLAST, NEC, NPH, NTYPE, NUM, REDAD2, REDAD1, RELP, RED2
2, RELPY, REPOL, STPHAS, TP, T1, XCUM, T13, UP3, IFFEOP, T3, TIME, T3SUM
COMMON /N/IECU(500), KEQU(500), ETIME(1000), XMTBF(200), XMTTR(200)
COMMON /MULTI/MAXC, MULTC, MFLAG, IQPTM, IRC, IQPTPI
R=ABS(ETIME(1))
KEQ=1
DO 20 I=2,NEC
RR=ABS(ETIME(I))
IF (R-RR) 20,20,10
10 R=RR
20 KEQ=I
CONTINUE
RETURN
END
CCC
SUBROUTINE TIE
COMMON /ALPHA/CNT2, ENDPHA, ICRI, IFF, IFR, INUM, IQPT, JBB, KEQ, KKK, KZZ
1, KK1, KSL, LL, LLAST, NEC, NPH, NTYPE, NUM, REDAD2, REDAD1, RELP, RED2
2, RELPY, REPOL, STPHAS, TP, T1, XCUM, T13, UP3, IFFEOP, T3, TIME, T3SUM
COMMON /N/IECU(500), KEQU(500), ETIME(1000), XMTBF(200), XMTTR(200)
COMMON /EXTRA/ KSI(20), ISW(31)
COMMON /NPH/ NSS(6), FLAG(6), TITLE(6,31), SSTEME(6,31), ISS(6,31)
COMMON /TYP/ EX(2,200), ISPAE(3,200), IUSED(3,200), IUSED(3,200)
COMMON /DELTA/ KKK2
COMMON /XXX/XXX
COMMON /VDC/VDC(5C,6), IUI(200), VMTTR(200,6), IAD2
COMMON /GAMMA/XMTBA, VAR, RELGA(100), TIME(100), XXT(200), ITT, ISEED
COMMON /MULTI/MAXC, MULTC, MFLAG, IQPTM, IRC, IQPTPI
COMMON /NS/NUMSS(30), NRSHPS, ITOTEQ, NSSEQ(500), NRWCS
** BUNKER ADDS
ADT = 0.
** BUNKER ADDS

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MUL11050
MUL11060
MUL11070
MUL11080
MUL11090
MUL11100
MUL11110
MUL11120
MUL11130
MUL11140
MUL11150
MUL11160
MUL11170
MUL11180
MUL11190
MUL11200
MUL11210
MUL11220
MUL11230
MUL11240
MUL11250
MUL11260
MUL11270
MUL11280
MUL11290
MUL11300
MUL11310
MUL11320
MUL11330
MUL11340
MUL11350
MUL11360
MUL11370
MUL11380
MUL11390
MUL11400
MUL11410
MUL11420
MUL11430
MUL11440
MUL11450
MUL11460
MUL11470
MUL11480
MUL11490
MUL11500
MUL11510
MUL11520

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MUL 11530
MUL 11540
MUL 11550
MUL 11560
MUL 11570
MUL 11580
MUL 11590
MUL 11600
MUL 11610
MUL 11620
MUL 11630
MUL 11640
MUL 11650
MUL 11660
MUL 11670
MUL 11680
MUL 11690
MUL 11700
MUL 11710
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MUL 11730
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MUL 11760
MUL 11770
MUL 11780
MUL 11790
MUL 11800
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MUL 11820
MUL 11830
MUL 11840
MUL 11850
MUL 11860
MUL 11870
MUL 11880
MUL 11890
MUL 11900
MUL 11910
MUL 11920
MUL 11930
MUL 11940
MUL 11950
MUL 11960
MUL 11970
MUL 11980
MUL 11990
MUL 12000

```

10 K=REQ
20 J=IAB$ (IEQU(K))
C 20 IF (ETIME(K)-100000.) 30,120,30
C 30 IF (BUNKER ADDS
C 30 IF (ETIME(K)) 120,120,35
C 35 IF (IOPM EQ 0) 60,120,40
C 35 CALL MULT$ (REQ,ETIME(K),J,NTYPE,NUM, ACT)
C 40 IF (ABS(XXX)-9999.) 41,120,41
C 41 DO 60 I=1,2
C 50 IF (IUSED(I,J)-IUSED(I,J)+1
C 50 IF (IUSED(I,J)-IUSED(I,J)+1
C 60 GO TO 120
C 60 CONTINUE
C 70 IF (I$PARE(2,J)-IUSED(2,J)) 70,70,110
C 80 IF (ETIME(K)-500000.) 80,120,80
C 90 IF (KS(12)) 340,340,50
C 100 IF (KS(12)) 340,340,50
C 110 IF (KS(12)) 340,340,50
C 110 IF (KS(12)) 340,340,50
C 110 IF (KS(12)) 340,340,50
C 120 XXX=ABS(XXX)
C 130 IF (KKK2) 140,130,140
C 140 IF (I=0)
C 150 IF (ETIME(K)-100000.) 160,150,160
C 160 IF (ETIME(K)) 170,170,180
C 170 IF (X=1)
C 180 IF (X=-1)
C 190 CALL LRND(I SEED,RN,1,16807,0)
C 200 IF (IOPM EQ 1) GO TO 220
C 200 IF (IOPM EQ 2) 200,210,210
C 200 ADT=0
C 200 GO TO 220

```

```

210 III=I-I
220 ADT=EX(I,II,J)
230 IF (ETIME(K)) 230,230,330
240 K1=ABS(IEQU(K))
250 IF (IUI(K1)) 330,330,240
260 IU=IUI(K1)
270 ST=0.0
280 SR=I.0
290 RN3=RN
300 DO 310 I=JBB,100
310 T=XX(I,2*I)
320 IF (ST) 320,250
330 T=TIMA(I)+ETIME(K)
340 IF (T) 270,310,300
350 GO TO 310
360 LLL=XX(I,2*I-1)
370 XM=VDC(IU,LLL)
380 IF (XM) 280,320,280
390 R=EXP(-T/XM)
400 SR=SR+R
410 IF (SR-RN) 320,320,290
420 ST=ST+R
430 RN3=RN/SR
440 CONTINUE
450 ETIME(K)=ST-(XM*ALG(RN3))+ABS(ETIME(K))+ADT
460 GO TO 340
470 ETIME(K1)=X*(-XX*ALG(RN)+ABS(ETIME(K))+ADT)
480 IF (IFLAG(1)-1) 370,350
490 IF (ETIME(K)+500000.) 360,370,260
500 ETIME(K)=100000.
510 CONTINUE
520 RETURN
530 END

```

CCCCCCC

```

SUBROUTINE STNDBY
COMMON /ALPHA/CNT2,ENCPHA,ICR1,IFF,IFR,INUM,IQPT,JBB,KEQ,KKK,KZZ
1,KK1,KSA,LL,LLLAST,NEC,NPH,NTYFF,NUM,REDAD2,REDAD1,100,REL P,RED2
2,KK1,KSA,REPOL,STPHAS,TP,T1,XCUM,T3,UP3,IFFEOP,T3,TIME,T3SUM
COMMON /N/IECU(500),KEQU(500),ETIME(1000),XMTBF(200),XMTTR(200)

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MUL12010
MUL12020
MUL12030
MUL12040
MUL12050
MUL12060
MUL12070
MUL12080
MUL12090
MUL12100
MUL12110
MUL12120
MUL12130
MUL12140
MUL12150
MUL12160
MUL12170
MUL12180
MUL12190
MUL12200
MUL12210
MUL12220
MUL12230
MUL12240
MUL12250
MUL12260
MUL12270
MUL12280
MUL12290
MUL12300
MUL12310
MUL12320
MUL12330
MUL12340
MUL12350
MUL12360
MUL12370
MUL12380
MUL12390
MUL12400
MUL12410
MUL12420
MUL12430
MUL12440
MUL12450
MUL12460
MUL12470
MUL12480

```

      PRBSUM=PRBSUM+DUM*(EX90DD**K)/KFACT
      IF (PRBSUM-XAVAIL) 40,50,50
50   ISPARE(1,1)=K
      GO TO 90
60   IF (4.*EX90DC-CUT) 80,80,70
70   ISPARE(1,1)=1
      GO TO 50
80   ISPARE(1,1)=C
90   CONTINUE
      DO 100 I=1,NTYPE
      DO 100 J=1,3
100  ISPARE(J,1)=0
      CONTINUE
      RETURN
      END

```

C

CCCCCCCCCCCCCCCCCCCC C

```

***** SUBROUTINE MULTIE *****
** SUBROUTINE MULTIE. SIMULATES A MULTI-ECHELON SUPPLY NETWORK
** WITH VARIABLE RESUPPLY CHANNELS. IT RECORDS AND MONITORS ALL
** SUPPLY ACTIONS RESULTING FROM AN EQUIPMENT FAILURE IN THE
** TRIGGER. SIMULATION. IT PROVIDES THE TYPE, SUBROUTINE AND
** RESPONSE TIME WHICH IS RETURNED TO THE. MULTIE, WILL ALSO
** ADDECT TO THE EQUIPMENT'S TIME-TO-REPAIR. SUMMARIES UPON COMPLE-
** OUTPUT VARIOUS DATA AND INFORMATION FOR FURTHER DETAILS).
** TION OF ALL MISSIONS (SEE DOCUMENTATION FOR FURTHER DETAILS).
*****

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SUBROUTINE MULTIE(KEQ,CTIME,EQTP,NTY,NUM, SRT)
COMMON/STAT/XD(200,4),XT(4),XG,SUMD(200,4),SUMXD(200,4)
COMMON/ISTAT/NSHIP(200,4,2),NNN(200,4,3),NRA,NRRf,
1  INRF(200,4,2),NSHIP(1,4,1),IXD(200,4),IXT(4),IXG
COMMON/MAX/MAXNEC,MAXTYP,MAXBIB,MAXSTD
COMMON/MULTI/MAXCL,MULTC,MFLAG,IOPTM,IRC,IOPTPI
COMMON/MP/CRAR,ALFA1,ALFA2,SSRf,ECCST(200),OSTSR(6),OSTM(11),
1  OST(2,1,1)
COMMON/NS/NUMSS(30),NRSHPS,ITOTEC,NSSEQ(500),NRWCS
COMMON/COAST,DESTN,DTOT,DUEH,CUES,ECH,EQTP,OQICP,REQN,SHIPR,
1  SHPR,SHLOC,SSN,TC,RORD,RP,ENUSE

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MUL15370
MUL15380
MUL15390
MUL15400
MUL15410
MUL15420
MUL15430
MUL15440
MUL15450
MUL15460
MUL15470
MUL15480
MUL15490
MUL15500
MUL15510
MUL15520
MUL15530
MUL15540
MUL15550
MUL15560
MUL15570
MUL15580
MUL15590
MUL15600
MUL15610
MUL15620
MUL15630
MUL15640
MUL15650
MUL15660
MUL15670
MUL15680
MUL15690
MUL15700
MUL15710
MUL15720
MUL15730
MUL15740
MUL15750
MUL15760
MUL15770
MUL15780
MUL15790
MUL15800
MUL15810
MUL15820
MUL15830
MUL15840

132

```

C ** ESTABLISH A DUE-IN AT REPAIR FACILITY.
C
C   DTIME = CSTR(SHLOC) + CTIME
C   CALL ESQUE(SSN,EQTP,DTIME,1,DUEA,DUEE,DUEQ,DUEI)
C   NRRT = NRRT + 1
C   GO TO 15
C
C ** CARCASS LOSS DUE TO ATTRITION, REDUCE ICP INV POSITION.
C
C   12 IP(38,EQTP) = IP(38,EQTP) - 1
C   IS = ISHIP-869
C   IF(IOP11.EQ.0) GO TO 14
C   WRITE(6,60)EQTP,IS
C   600 FORMAT(10,5X,REPAIRABLE, EQ NR,14, WAS NOT RECEIVED BY REPAIR F
C   14 FACILITY FROM SHIP NR,13, DUE TO ATTRITION.)
C   15 CONTINUE
C
C ** IF SUFFICIENT CARCASSES ARE AVAILABLE AT REPAIR FACILITIES,
C ** INDUCT ERQ AND DISTRIBUTE TO STOCK POINTS AS APPROPRIATE.
C
C   NEED = -1
C   DO 22 I=1,37
C   CHECK REPAIR ACTIVITIES FOR CARCASSES DUE IN.
C   CALL CHKCU(I,EQTP,CTIME,DUEA,DUEE,DUEQ,DUEI, DUES)
C   ONFND(I,EQTP) = CNFND(I,EQTP) + DUES
C   L=1
C   ST = 0.0
C   IF(ONFND(I,EQTP) .LT. ERQ(EQTP)) GO TO 22
C   SSN = 34
C   IF(I.EQ.37)SSN = 33
C   IF(HILIM(34,EQTP).EQ.0 .AND. 1.EQ.36) GO TO 22
C   IF(HILIM(33,EQTP).EQ.0 .AND. 1.EQ.37) SSN = 35
C   IF(SSN.EC.35 .AND. HILIM(35,EQTP).EQ.0) GO TO 22
C   IF(SSN.EC.35) GO TO 1601
C   IF(I.EQ.37) GO TO 16
C   ROPD = ERQ(EQTP)
C   NRPF(EQTP,3,1) = NRPF(EQTP,3,1) + 1
C   NRPF(EQTP,3,2) = NRPF(EQTP,3,2) + RORD
C   NRPF(EQTP,1,2) = NRPF(EQTP,1,2) + RORD
C   CALL LGAMA(IX2,A,SSN,EQTP,17)
C   IF(1.EQ.26 .OR. SSN.EQ.35) GO TO 17
C   EQREC = HILIM(NEED,ERQ(EQTP))
C   RORD = HINO(NEED,ERQ(EQTP))
C   NRPF(EQTP,2,1) = NRPF(EQTP,2,1) + 1
C   ST = OST(1,9,3)
C   17 CONTINUE
C
C   1601
C
C   16
C
C   17

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MUL16330
MUL16340
MUL16350
MUL16360
MUL16370
MUL16380
MUL16390
MUL16400
MUL16410
MUL16420
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MUL16440
MUL16450
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MUL16470
MUL16480
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MUL16500
MUL16510
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MUL16590
MUL16600
MUL16610
MUL16620
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MUL16680
MUL16690
MUL16700
MUL16710
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MUL16730
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MUL16780
MUL16790
MUL16800

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90MUL17290
 91MUL17300
 92MUL17310
 93MUL17320
 94MUL17330
 95MUL17340
 96MUL17350
 97MUL17360
 98MUL17370
 99MUL17380
 00MUL17390
 01MUL17400
 02MUL17410
 03MUL17420
 04MUL17430
 05MUL17440
 06MUL17450
 07MUL17460
 08MUL17470
 09MUL17480
 10MUL17490
 11MUL17500
 12MUL17510
 13MUL17520
 14MUL17530
 15MUL17540
 16MUL17550
 17MUL17560
 18MUL17570
 19MUL17580
 20MUL17590
 21MUL17600
 22MUL17610
 23MUL17620
 24MUL17630
 25MUL17640
 26MUL17650
 27MUL17660
 28MUL17670
 29MUL17680
 30MUL17690
 31MUL17700
 32MUL17710
 33MUL17720
 34MUL17730
 35MUL17740
 36MUL17750
 37MUL17760

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MUL17790
MUL17800
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MUL18020
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MUL18100
MUL18110
MUL18120
MUL18130
MUL18140
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MUL18160
MUL18170
MUL18180
MUL18190
MUL18200
MUL18210
MUL18220
MUL18230
MUL18240

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105      CALL CHKDU(SSN,EQTP,CTIME,CUEN,DUEA,DUEE,DUEQ,DUET, DUES)
      ONHND(SSN,EQTP) = CNHND(SSN,EQTP) + DUES
      DELOH(ECH+1) = DELCH(ECH+1) + DUES
110      CONTINUE
      ANN(EQTP,ECH+1,1) = ANN(EQTP,ECH+1,1) + 1
      ISSUE = MINO(ONHND(SSN,EQTP),CRDQT(1))
      IF(ISSUE.EC.0) GC TC 127
      CNHND(SSN,EQTP) = ONHND(SSN,EQTP) - ISSUE
      DELOH(ECH+1) = DELCH(ECH+1) - ISSUE

      ** IP IS DECREMENTED FOR REPAIRABLES ONLY IF ATTRITION OCCURS.
C      C
      IF(SSN.EQ.31.CR.SSN.EQ.32) GC TO 112
      IF(RPAIR(EQTP).EC.0) IP(38,EQTP)=IP(38,EQTP) - 1ISSUE
      GO TO 113
112      IP(SSN,EQTP) = IP(SSN,EQTP) - 1ISSUE
113      CONTINUE

      ** DETERMINE SHIPPER AND SHIPMENT DESTINATION.
C      C
      SHIPR = SSN - 24
      DESTN = SHLCC
      IF(ORACT(1).GT.30) DESTN = ORACT(1) - 24
      NSHIP(SHIPR,DESTN) = NSHIP(SHIPR,DESTN) + 1

      ** IF END USE REQUIREMENT, ESTABLISH SRT.
C      C
      IF(RESO(1).EQ.2) GC TO 115
      SRT = QST(COAST,DESTN,ECH)
      IF(DESTN.LE.6) SRT = SRT + MSD
      IASRT = SSN
      CALL SWITCH(SRT,ORACT(1),EQTP,CUEN,DUEA,DUEE,DUEQ,DUET)
      GO TO 120
115      CONTINUE

      ** IF REQUISITION IS FOR STOCK, ESTAB DUE-IN AT ORDERING ACTIVITY.
C      C
      DTIME = CST(CCAST,DESTN,ECH) + CTIME + SRT
      IF(DESTN.LE.6) CTIME = DTIME + MSD
      CALL ESQUE(ORACT(1),EQTP,DTIME,ISSUE,DUEN,DUEA,DUEE,DUEQ,
1          DUET)
      DTCT = DTCT + 1
      IOUEJ(1,CTOT) = ORACT(1)
      IOUEJ(2,CTOT) = INT(DTIME)
      IOUEJ(3,CTOT) = SSN
120      CONTINUE

      ** IF REQUISITION PARTIALLY FILLED, SEND REMAINING REQUIRMENT TO
C      C

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```

C ** NEXT ECHELON.
C IF(ORDQT(1) .LE. ISSUE) GO TO 122
C   ORCQT(1) = ORCQT(1) - ISSUE
C   GO TO 13C
122 CONTINUE
C   REQN = REQN - 1
C
C ** IF REQUISITION FILLED, REMOVE FROM THE REQUISITION QUEUE.
C ** IF NONE REMAIN IN QUEUE, GO BACK TO MLSF OR ON TO ICP AS
C ** APPROPRIATE. IF REQUISITIONS REMAIN IN QUEUE, ATTEMPT TO
C ** FILL AT THIS ECHELON.
C
C   IF(REQN .EQ. 0) GO TO 130
C   DO 125 I = 1, REQN
C     ORACT(I) = ORACT(I+1)
C     RESCN(I) = RESCN(I+1)
C     ORCQT(I) = ORCQT(I+1)
C   CONTINUE
C   GO TO 110
125
C
C ** IF NOT AVAILABLE FROM MLSF, ADD MLSF SCREENING DELAY TO SHIPMENT.
C
127 IF(HILIM(SSN,EQTYP) .EQ. 0) GO TO 128
C   NNN(EQTYP,ECH+1,2) = NNN(EQTYP,ECH+1,2) + 1
C   GO TO 125
128 NNN(ECTYP,ECH+1,2) = NNN(EQTYP,ECH+1,3) + 1
129 IF(SSN .EQ. 31 .OR. SSN .EQ. 32) MSD = MSD + 1
130 IF(SSN .EQ. 31 .OR. SSN .EQ. 32) GO TO 310
C   GO TO 400
C
C ** LABELS 200-210 REFER TO WEST COAST DEPT.
C
200 CONTINUE
C   ECH = 2
C   SSN = 33
C   IF(COAST .EQ. 1) GO TO 210
C     SSN = 34
C     ECH = 3
210 CONTINUE
C   GO TO 105
C
C ** LABELS 300-320 REFER TO MLSF.
C
300 CONTINUE
C   ECH = 1

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MUL18730
MUL18740
MUL18750
MUL18760
MUL18770
MUL18780
MUL18790
MUL18800
MUL18810
MUL18820
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MUL18840
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MUL18860
MUL18870
MUL18880
MUL18890
MUL18900
MUL18910
MUL18920
MUL18930
MUL18940
MUL18950
MUL18960
MUL18970
MUL18980
MUL18990
MUL19000
MUL19010
MUL19020
MUL19030
MUL19040
MUL19050
MUL19060
MUL19070
MUL19080
MUL19090
MUL19100
MUL19110
MUL19120
MUL19130
MUL19140
MUL19150
MUL19160
MUL19170
MUL19180
MUL19190
MUL19200

```

SSN = 31
IF(COAST.EC. 2) SSN = 32
GO TO 105

C ** IF IP AT REORDER POINT, SEND REQUISITION TO NEXT ECHELON.
C
C 310 CONTINUE
C IF(HILIM(SSN,EQTP) .EQ. 0) GO TO 320
C IF(IP(SSN,EQTP) .GT. REORD(SSN,EQTP)) GO TO 320
C   REACT = RECN + 1
C   REASON(RECN) = 3
C   ORDCT(RECN) = HILIM(SSN,EQTP) - IP(SSN,EQTP)
C   IP(SSN,EQTP) = IP(SSN,EQTP) + ORDCT(RECN)
C 320 CONTINUE
C ** IF REQUISITIONS IN QUEUE, GO TO NEXT ECHELON:
C ** ELSE RETURN TO TIGER.
C IF(RECN.GT. 0) GO TO 200
C GO TO 495

C ** LABELS 400-495 REFER TO ICP
C 400 CONTINUE
C ** LABEL 404-425 WILL REDISTRIBUTE ASSETS BETWEEN STOCK PCINTS FOR
C ** MLSF AND ST-IP REQUISITIONS.
C 404 CONTINUE
C IF(RECN.EQ. 0) GO TO 450
C IF(ORACT(1) .GT. 32) GO TO 450
C IF(SSN.NE. 33) GO TO 406
C IF(ONHND(35,EQTP) .GE. 1) GO TO 4C8
C IF(ONHND(34,EQTP) .GE. 1) GO TO 4C9
C ** NONE AVAILABLE FOR REDISTRIBUTION, INDUCT CR PROCURE AS
C ** APPROPRIATE (LABEL 460).
C GO TO 460
C 406 IF(SSN.EQ. 34) GO TO 407
C IF(ONHND(34,EQTP) .GE. 1) GO TO 4C9
C GO TO 460
C 407 IF(ONHND(35,EQTP) .GE. 1) GO TO 408
C GO TO 460
C 408 IA = 35

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MUL19210
MUL19220
MUL19230
MUL19240
MUL19250
MUL19260
MUL19270
MUL19280
MUL19290
MUL19300
MUL19310
MUL19320
MUL19330
MUL19340
MUL19350
MUL19360
MUL19370
MUL19380
MUL19390
MUL19400
MUL19410
MUL19420
MUL19430
MUL19440
MUL19450
MUL19460
MUL19470
MUL19480
MUL19490
MUL19500
MUL19510
MUL19520
MUL19530
MUL19540
MUL19550
MUL19560
MUL19570
MUL19580
MUL19590
MUL19600
MUL19610
MUL19620
MUL19630
MUL19640
MUL19650
MUL19660
MUL19670
MUL19680

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COAST = 1
ECH = 3
GO TO 410
409 IA = 34
COAST = 2
ECH = 3

C C
C ** LABELS 410-425 REFER TO REDISTRIBUTION ISSUE PROCESS.

410 ISSUE = MINO(ONHND(IA,EQTP),ORDQT(1))
ONHND(IA,EQTP)=CNHND(IA,EQTP) - ISSUE
DELOH(ECH+1) = DELOH(ECH+1) - ISSUE
IF(RPAIR(EQTP) .EQ. 0) IP(38,EQTP)=IP(38,EQTP) - ISSUE
DESTN = SHLCC
IF(ORACT(1) .GT. 30) DESTN = ORACT(1) - 24
SHIPR = IA - 24
NSHIP(SHIPR,DESTN) = ASHIP(SHIPR,DESTN) + 1
IF(RESN(1) .EQ. 2) GO TO 412
SRT = OST(COAST,DESTN,ECH)
IF(CESTN .LE. 6) SRT = SRT + MSD
IASRT = IA
CALL SWITCH(SRT,ORACT(1),EQTP,DUEN,DUEA,DUEE,DUEQ,DUET)
GO TO 414

412 CONTINUE
DTIME = OST(COAST,DESTN,ECH) + CTIME + SRT
IF(DESTN .LE. 6) DTIME = DTIME + MSD
CALL ESQUE(CRACT(1),EQTP,DTIME,ISSLE,DUEN,DUEA,DUEE,DUEQ,DUET)
DTOT = DTOT + 1
IDUEJ(1,DTOT) = CRACT(1)
IDUEJ(2,DTOT) = INT(DTIME)
IDUEJ(3,DTOT) = IA
CONTINUE
414 IF(ORCCCT(1) .LE. ISSUE) GO TO 420
IF(ORCCCT(1) = ORDQT(1) - ISSUE
GO TO 425
420 CONTINUE
RECQ = REQN - 1

C C
C ** IF NC REQUISITIONS IN QUEUE, CHECK ICP INVENTORY POSITION.

IF(REQN .EQ. 0) GC TO 450
DO 422 I=1,REQN
GRACN(I)=ORACT(I+1)
RESN(I)=RESN(I+1)
ORDCT(I)=ORDQT(I+1)
422 CONTINUE
425 CONTINUE
C

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```

** ** THERE IS ANOTHER REQUISITION IN QUEUE. IF FROM SHIP/MLSF
** ** DETERMINE IF REDISTRIBUTION IS POSSIBLE.
      GO TO 404
** ** LABELS 450-455 ESTABLISH REQUISITIONS FOR DEPOT AND CENTERS
** ** IF ICP (SYSTEM) IP AT REORDER POINTS THE ORDER QUANTITY IS
** ** DIVIDED AND SENT TO THE STOCK POINTS BASED ON THEIR STOCK
** ** DEFICIENCIES.
450 CONTINUE
   IF (HILIM(38,EQTY) - EC. 0) GO TO 455
   IF (IP(38,EQTY) .LE. REORD(38,EQTY)) GO TO 451
   GO TO 495
451 OQICP = HILIM(38,EQTY) - IP(38,EQTY)
   IP(38,EQTY) = IP(38,EQTY) + OQICP
   DO 452 I=1,3
   OQREQ(I) = HILIM(32+I,EQTY) - ONHND(32+I,EQTY)
   ORDER(I) = 0
   IF (HILIM(32+I,EQTY) .EQ. 0) OQREQ(I) = -9999
452 CONTINUE
453 ITEMQ = 1
   ITEMQ = OQREQ(1)
   DO 454 I=2,3
   IF (OQREQ(I) .LE. ITEMQ) GO TO 454
   ITEMQ = OQREQ(I)
454 CONTINUE
   CRDER({ITEMA}) = ORDER({ITEMA}) + 1
   OQREQ({ITEMA}) = OQREQ({ITEMA}) - 1
   CQICP = CQICP - 1
   IF (OQICP .GT. 0) GO TO 453
   DO 455 I=1,3
   IF (CQICP(I) .EQ. 0) GO TO 455
   RECN = RECN + 1
   ORACT (RECN) = 1 + 32
   REASON (RECN) = 2
   ORCQI (RECN) = ORDER(I)
455 CONTINUE
** ** LABELS 460-482 DETERMINE REPAIR INDUCTION REQUIREMENTS FOR
** ** SHIP/MLSF REQUISITIONS AND SYSTEM ATTRITION REPLACEMENTS.
460 CONTINUE
   IF (RPAIR (EQTY) .EQ. C) GO TO 490
   RP = 37
   COAST = 1
   N = CRACT(1)

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MUL2017C
MUL20180
MUL20190
MUL20200
MUL20210
MUL20220
MUL20230
MUL20240
MUL20250
MUL20260
MUL20270
MUL20280
MUL20290
MUL20300
MUL20310
MUL20320
MUL20330
MUL20340
MUL20350
MUL20360
MUL20370
MUL20380
MUL20390
MUL20400
MUL20410
MUL20420
MUL20430
MUL20440
MUL20450
MUL20460
MUL20470
MUL20480
MUL20490
MUL20500
MUL20510
MUL20520
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MUL20560
MUL20570
MUL20580
MUL20590
MUL20600
MUL20610
MUL20620
MUL20630
MUL20640

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IF(N.LE.15 .CR. N.EQ.31 .OR. N.EQ.32 .OR. N.EQ.35) GO TO 465
  RP = 36
  COAST = 2
  465 CONTINUE
  461 ISSUE = MINC(ONHND(RP,EQTP),OROQT(1))
  IF(ISSUE.EQ.0) GO TO 470
  CNHND(RP,EQTP) = ONHND(RP,EQTP) - ISSUE
  DESTN = SHLCC
  IF(ORACT(1).GT.30) DESTN = ORACT(1) - 24
  SHIPR = RP - 24
  NSHIP(SHIPR,DESTN) = NSHIP(SHIPR,DESTN) + 1
  TO = LEVEL(DESTN)
  NRF(EQTP,TC,1) = NRF(EQTP,TO,1) + 1
  NRF(EQTP,TC,2) = NRF(EQTP,TO,2) + 1
  CALL LGAMMA(1,3,A,1,ISSUE,1,0,ALPHA)
  DO 463 I = 1,1
  463 I = 1,1
  RTIME = RTIME + RTIME * A(1)
  IF(RESO(1).EQ.2) GO TO 462
  IF(SRT = RTIME + OST(COAST,DESTN,4)
  IF(DESTN.LE.6) SRT = SRT + MSC
  CALL SWITCH(SRT,ORACT(1),EQTP,DUEN,DUEA,DUEE,DUEQ,DUET)
  CALL PRICR(OST,EQTP,DESTN,SRT,ASHIP,SHPR,DUEN,DUEA,DUEE,DUEQ,DUET)
  DUEQ = EQTP
  IF(SHPR.EQ.38) GO TO 464
  IASRT = SHPR
  NSHIP(SHIPR,DESTN) = NSHIP(SHIPR,DESTN) - 1
  NSHIP(SHIPR,SHPR-24) = NSHIP(SHIPR,SHPR-24) + 1
  GO TO 464
  462 CONTINUE
  RTIME = RTIME + CTIME + OST(COAST,DESTN,4)
  IF(DESTN.LE.6) CTIME = CTIME + MSD
  CALL ESQUE(ORACT(1),EQTP,DTIME,1,DUEN,DUEA,DUEE,DUEQ,DUET)
  DTCT = DTOT + 1
  IQUEJ(1,DTOT) = ORACT(1)
  IQUEJ(2,DTOT) = INT(DTIME)
  IQUEJ(3,DTOT) = RP
  463 CONTINUE
  464 IF(ORDCT(1).LE.ISSUE) GO TO 480
  470 CONTINUE
  C
  C
  C
  ** IF PARTIAL CRDR FILLED OR CARCASSES UNAVAILABLE FROM NEAREST
  ** REPAIR FACILITY, ATTEMPT TO FILL AT THE OTHER.
  IF(RP.EQ.36) GO TO 472
  RP = 36
  COAST = 2
  IF(ONHND(RP,EQTP).GE.1) GO TO 461

```

```

472 CONTINUE
    RP = 37
    COAST = 1
    IF (CNHND(RP, EQTYP) .GE. 1) GO TO 461
    GO TO 490
480 CONTINUE
    REQN = REQN - 1
** IF NC REQUISITIONS IN QUEUE, DETERMINE IF SYSTEM IP AT REORDER PT
C C C
    IF (RECN .EQ. 0) GO TO 450
    DO 482 I = 1, REQN
        ORACT(I) = CRACT(I+1)
        RESON(I) = RESCN(I+1)
        ORCQT(I) = CRDQT(I+1)
    CONTINUE
482 CONTINUE
    GO TO 460
** LABELS 490-495 DETERMINE END USE AND SYSTEM REQUIREMENTS FOR
** PROCUREMENT FROM MANUFACTURER.
C C C
490 CONTINUE
    ISSUE = CRDQT(1)
    IF (RPAIR(EQTYP) .EQ. 1 .AND. ORACT(1) .LE. 30) IP(38, EQTYP) = ORCQT(1)
X
    COAST = 2
    N = ORACT(1)
    IF (N .LE. 15) OR. N.EQ. 31 .OR. N.EQ. 23 .OR. N.EQ. 35) COAST = 1
    DESTN = SHLCC
    IF (ORACT(1) .GT. 30) DESTN = ORACT(1) - 24
    NSHIP(14, DESTN) = NSHIP(14, DESTN) + 1
    TO = LEVEL(CRACT(1))
    NMFR(EQTYP, TC, 1) = NMFR(EQTYP, TC, 2) + 1
    NMFR(EQTYP, TC, 2) = NMFR(EQTYP, TC, 2) + 1
    CALL LGAMA(IX4, A1, 1, 1, 0, ALFA2)
    IF (RESCN(1) .EQ. 2) GO TO 492
    IF (SRT = PLT + OSTN(DESTN))
        IF (DESTN .LE. 6) SRT = SRT + MSC
        IF (SRT = 38)
            CALL SWITCH(SRT, ORACT(1), EQTYP, DUEN, DUEA, DUEE, DUEQ, DUEI)
            CALL PRICR(OST, EQTYP, DESTN, SRT, NSHIP, SHPR, DUEN, DUEA, DUEE, DUEQ,
            DUEI)
            IF (SHPR .EQ. 38) GO TO 494
            IASRT = SHPR
            NSHIP(14, DESTN) = NSHIP(14, DESTN) - 1
            NSHIP(14, SHPR-24) = NSHIP(14, SHPR-24) + 1
1

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MUL20650
MUL20660
MUL20670
MUL20680
MUL20690
MUL20700
MUL20710
MUL20720
MUL20730
MUL20740
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MUL20760
MUL20770
MUL20780
MUL20790
MUL20800
MUL20810
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MUL20830
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MUL20870
MUL20880
MUL20890
MUL20900
MUL20910
MUL20920
MUL20930
MUL20940
MUL20950
MUL20960
MUL20970
MUL20980
MUL20990
MUL21000
MUL21010
MUL21020
MUL21030
MUL21040
MUL21050
MUL21060
MUL21070
MUL21080
MUL21090
MUL21100
MUL21110
MUL21120

```

492 CONTINUE = PLT + CTIME + OSTH(DESTN)
      IF(DESTN LE 6) CTIME = DTIME + MSD
      CALL ESQUEL(ORACT(1),EQTP,DTIME,ISSUE,DUEA,DUEE,DUEQ,DUEI)
      OTCT = DTCT + 1
      IDUEJ(1,CTOT) = ORACT(1)
      IDUEJ(2,CTOT) = INT(DTIME)
      IDUEJ(3,CTOT) = 38
494 CONTINUE REQN = REQN - 1
      IF(REQN LE 0) GO TO 450
      DO 494 I=1,REQN
        ORACT(I+1) = ORACT(I)
        ORCQT(I+1) = ORCQT(I)
        RESCN(I+1) = RESCN(I)
4941 CONTINUE
      GO TO 460
495 CONTINUE
C ** CALCULATE CHANGES IN ON-HAND INVENTORY LEVELS AT ALL ECHELONS
C ** TO DETERMINE AVERAGE INVENTORY DOLLAR VALUE.
      DELTIM=CTIME-OTIME
      DO 496 I=1,NTY
        DO 496 J=1,NJTY
          SUMD(J,I) = SUMXD(J,I)*DELTIM + SUMD(J,I)
496 DO 496 I=1,NTY
          SUMD(EQTP,I) = .5*DELTIM*FLCAT(DELOH(I)) + SUMD(EQTP,I)
          SUMXD(EQTP,I) = SUMXD(EQTP,I) + DELOH(I)
4961 CONTINUE
C ** SUMMARY OF ACTION TAKEN
      IF(IOPTP1.EQ.0) GO TO 499
      ICTIME = INT(CTIME)
      NUM1 = NUM + 1
      ENUSE = ISHIP - 869
      IF(OTIME GT 0.0) GO TO 4965
      WRITE(6,655)NUM1
4965 WRITE(6,688)EQTP,ENUSE,ICTIME
      WRITE(6,680)EQTP,ENUSE,ICTIME
      WRITE(6,681)IASRT,SRT
      IF(OTCT.EQ.0) GO TO 498
      WRITE(6,684)
      WRITE(6,685)
      DO 497 I=1,CTOT

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MUL211130
MUL211140
MUL211150
MUL211160
MUL211170
MUL211180
MUL211190
MUL211200
MUL211210
MUL211220
MUL211230
MUL211240
MUL211250
MUL211260
MUL211270
MUL211280
MUL211290
MUL211300
MUL211310
MUL211320
MUL211330
MUL211340
MUL211350
MUL211360
MUL211370
MUL211380
MUL211390
MUL211400
MUL211410
MUL211420
MUL211430
MUL211440
MUL211450
MUL211460
MUL211470
MUL211480
MUL211490
MUL211500
MUL211510
MUL211520
MUL211530
MUL211540
MUL211550
MUL211560
MUL211570
MUL211580
MUL211590
MUL211600

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497 CONTINUE
498 GO TO 499
499 WRITE(6,691)
499 CTIME = CTIME
RETURN
680 FORMAT('0',5X,'FAILURE OF EQUIPMENT TYPE',I3,' ON SHIP',I3,' AT TIME',I5,1X,
681 'ME',I5,1X,' RESULTED IN THE FOLLOWING SUPPLY ACTIONS:')
683 FORMAT('0',5X,'END USE REQUIREMENT FILLED BY SSN',I3,'',4X,'SUPPLY R
684 XESPONSE TIME IS:',F7.0)
685 FORMAT('0',5X,'STOCK WERE GENERATED AS FOLLOWS:')
685 FORMAT('0',5X,'REQUISITIONOR(SSN)',5X,'DUE-IN AT TIME',5X,'ISSUED
686 XFROM(SSN):',I4,20X,I5,16X,I2)
688 FORMAT('0',5X,'MISSION: ',I4,1X,1X,1X)
695 FORMAT('0',5X,'NO CRODERS FOR STOCK RESULTED FROM THIS ISSUE.')
691 END

CCCCCCCCCCCCCCCC

*****
** THIS SUBROUTINE UPDATES AN ACTIVITIES DUE-IN-FOR-STOCK VEC-
** TOR. DUE-IN'S ARE FILED CHRONOLOGICALLY IN THE VECTOR (QUEUE). **
*****
SUBROUTINE FSDUE(ACT,EQTYP,DTIME,QTYD,DUEIN,DUEA,DUEE,DUEQ,DUET)
COMMON/MULTI/MAXC,MULTI,MELAG,IOP1
INTEGER K,QTYD,KM1,ACT,EQTYP,DUEIN
INTEGER DUEA(MAXC),DUEE(MAXD),DUEQ(MAXD)
REAL DUET(MAXD),CTIME
K = DUEN + 1
IF((K+1).GE. MAXD) GO TO 25
** THIS LOOP FINDS PROPER PLACE IN QUEUE AND MOVES OTHERS ACCORDINLY
DO 20 I=1,K
IF(CTIME .GE. DUET(I)) GO TO 20

```

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MUL21610
MUL21620
MUL21630
MUL21640
MUL21650
MUL21660
MUL21670
MUL21680
MUL21690
MUL21700
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MUL21720
MUL21730
MUL21740
MUL21750
MUL21760
MUL21770
MUL21780
MUL21790
MUL21800
MUL21810
MUL21820
MUL21830
MUL21840
MUL21850
MUL21860
MUL21870
MUL21880
MUL21890
MUL21900
MUL21910
MUL21920
MUL21930
MUL21940
MUL21950
MUL21960
MUL21970
MUL21980
MUL21990
MUL22000
MUL22010
MUL22020
MUL22030
MUL22040
MUL22050
MUL22060
MUL22070
MUL22080

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```

KMI=K-1 .EC. 0) GO TO 16
IF (KMI .EQ. 0) GO TO 16
DO 15 J=1,KMI
  DUEA(K+1-J) = DUEA(K-J)
  DUEQ(K+1-J) = DUEQ(K-J)
  DUEE(K+1-J) = DUEE(K-J)
  CONTINUE
  DUEA(I) = DTIME
  DUEQ(I) = ACT
  DUEE(I) = EQTYP
  GO TO 21
20 CONTINUE
21 DUEA = K
22 GO TO 30
23 CONTINUE
24 GO TO 30
25 WRITE(6,100)ACT
100 FORMAT(10X,1)
600 1. HAS EXCEEDED MAX ALLOWABLE.
2 WILL NOT BE RECORDED FOR THIS ACTIVITY UNTIL SPACE IS AVAILABLE.
STOP
30 CONTINUE
END

*****
** THIS SUBROUTINE DETERMINES IF ANY DUE-IN'S HAVE ARRIVED AT
** OR BEFORE CURRENT TIME. IF SO, IT ELIMINATES THOSE DUE-IN'S
** FROM THE QUEUE AND CALCULATES THE QUANTITY RECEIVED.
**
*****
SUBROUTINE CHKDU(SSN,ECTYP,CTIME,DUEA,DUEE,DUEQ,DUEJ,DUES)
COMMON/MULTI/MAXC,MULTIC,MFLAG,IOPTR,IRC,IOPTR1
INTEGER DUES,SSN,EQTYP,DUEA
REAL DUEA(MAXD),DUEE(MAXD),DUEQ(MAXD),CTIME

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MUL22090
MUL22100
MUL22110
MUL22120
MUL22130
MUL22140
MUL22150
MUL22160
MUL22170
MUL22180
MUL22190
MUL22200
MUL22210
MUL22220
MUL22230
MUL22240
MUL22250
MUL22260
MUL22270
MUL22280
MUL22290
MUL22300
MUL22310
MUL22320
MUL22330
MUL22340
MUL22350
MUL22360
MUL22370
MUL22380
MUL22390
MUL22400
MUL22410
MUL22420
MUL22430
MUL22440
MUL22450
MUL22460
MUL22470
MUL22480
MUL22490
MUL22500
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MUL22550
MUL22560

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MUL225570
MUL225580
MUL225590
MUL226610
MUL226620
MUL226630
MUL226640
MUL226650
MUL226670
MUL226680
MUL226690
MUL227700
MUL227710
MUL227720
MUL227730
MUL227740
MUL227750
MUL227760
MUL227770
MUL227780
MUL227790
MUL228800
MUL228810
MUL228820
MUL228830
MUL228840
MUL228850
MUL228860
MUL228870
MUL228880
MUL228890
MUL229900
MUL229910
MUL229920
MUL229930
MUL229940
MUL229950
MUL229960
MUL229970
MUL229980
MUL229990
MUL230000
MUL230010
MUL230020
MUL230030
MUL230040

```

C      DUES=C
CC     K=0
CC
**    CALCULATE TOTAL DUES
10    K = K+1
      IF(DUEA(K) .GT. CTIME) GO TO 2C
      IF(DUEA(K) .NE. SSN) GC TO 10
      IF(DUEE(K) .NE. EQTYP) GO TO 10
      DUES = DUEE(K) + DUES
      KR = KUEN+1
**    ADJUST CUE-IN VECTOR AS NECESSARY.
      DC 15 I = K,KR
          DUEC(I) = DUEC(I+1)
          DUEE(I) = DUEE(I+1)
          DUEA(I) = DUEA(I+1)
          DUEN = DUEN - 1
15    CONTINUE
      GO TO 10
20    CONTINUE
      RETURN
      END

```

SUBROUTINE PRIOR(COST,EQTYP,DESTN,SRT,NSHIP,SHPR,DUEN,DUEA,DUEE,

```

C      1  DUEQ,DUEI)
C      COMMON/MULTI/MAXC,MULTC,MELAG,IOTM,IRC,IOTPI
C      INTEGER SHPR,ECH,COAST,DESTN,ECTYP,NSHIP,DUEN,DNUM
C      REAL MIN,T,CST(2,14,3),SRT,DTIME,SRT1,CTIME,DUEI(MAXD)
C      SHPR=C
C      SRT1=SRT
C      MIN=9999
C      IF(DUEA .EQ. 0) GO TO 51
C      DO 10 J=1,DUEN
C      IF(DUEI(J) .GE. SRT) GO TO 11
C      IF(DUEE(J) .NE. ECTYP) GO TO 10
C      IF(DUEA(J).GT.35 .CR. DUEA(J).LT.33) GO TO 10
C      ECH=3
C      IF(DUEA(J) .EC. 33) ECH = 2
C      IF(COAST = 1
C      IF(DUEA(J) .EC. 34) COAST = 2
C      IF(DUEI(J) + OST(COAST,DESTN,ECH)
C      IF(T .GE. MIN) GO TO 10
C      SHPR=DUEA(J)
C      MIN = T
C      DNUM = J
C      10 CONTINUE
C      11 IF(SHPR .EQ. 0 .OR. MIN .GE. SRT) GO TO 50
C      SHPR = SHPR - 24
C      NSHIP(SHPR1,DESTN) = NSHIP(SHPR1,DESTN) + 1
C      SRT=MIN
C      DUEQ(CNUM) = DUEQ(DNUM) - 1
C      ** IF THE DUE-IN QUANTITY WAS ONE, ELIMINATE THE DUE-IN FROM QUEUE.
C      IF(DUEQ(DNUM) .NE. 0) GO TO 20
C      DO 12 I=CNUM,DUEN
C      DUEA(I) = DUEA(I+1)
C      DUEE(I) = DUEE(I+1)
C      DUEQ(I) = DUEQ(I+1)
C      DUEI(I) = DUEI(I+1)
C      12 CONTINUE
C      DUEN = DUEN - 1
C      20 CONTINUE
C      ** INSERT NEW DUE-IN IN SHIPPER'S DUE-IN QUEUE.
C      DTIME=SRT1-CST(COAST,DESTN,ECH) + CTIME

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MUL23050
 MUL23060
 MUL23070
 MUL23080
 MUL23090
 MUL23100
 MUL23110
 MUL23120
 MUL23130
 MUL23140
 MUL23150
 MUL23160
 MUL23170
 MUL23180
 MUL23190
 MUL23200
 MUL23210
 MUL23220
 MUL23230
 MUL23240
 MUL23250
 MUL23260
 MUL23270
 MUL23280
 MUL23290
 MUL23300
 MUL23310
 MUL23320
 MUL23330
 MUL23340
 MUL23350
 MUL23360
 MUL23370
 MUL23380
 MUL23390
 MUL23400
 MUL23410
 MUL23420
 MUL23430
 MUL23440
 MUL23450
 MUL23460
 MUL23470
 MUL23480
 MUL23490
 MUL23500
 MUL23510
 MUL23520

```

CALL ESDUE(SHPR,EQTYP,CTIME,1,CUEN,DUEA,DUEE,DUEQ,DUET)
GO TO 51
CONTINUE
SHPR = 38
50 CONTINUE
51 RETURN
END

```

```

*****
** WHEN A SUPPLY RESPONSE TIME IS ESTABLISHED FOR AN END-USER,
** SUBROUTINE SWITCH WILL CHECK THE ENC-USERS DUE-IN FILE TO
** TO ASCERTAIN IF ANY EQUIPMENTS OF THIS TYPE ARE DUE IN FOR
** STOCK AT A TIME PRIOR TO THE SRT. IF SO THE EARLIEST SUCH
** STOCK DUE WILL BE SWITCHED TO SATISFY THE END USE REQUIRE-
** MENT WHILE THE INCOMING SRT WILL BE DIVERTED TO STOCK.
**
*****

```

```

SUBROUTINE SWITCH(SRT,ACT,EQTYP,DUEN,DUEA,DUEE,DUEQ,DUET)
COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTR,IRC,IOTPI
INTEGER DUEN,DNUM
REAL SRT,SRT1,DUET(MAXD)

```

```

SRT1 = SRT
IFLAG = 0
IF(DUEN.EQ.0) GO TO 50
DO 10 J=1,DUEN
  IF(CUE(J).GE.SRT) GO TO 11
  IF(DUEA(J).NE.ACT.OR.DUEE(J).NE.EQTP) GO TO 10
  DNUM = J
  SRT1 = DUET(J)
  IFLAG = 1
  GO TO 11
10 CONTINUE
11 IF(IFLAG.EQ.0) GC TC 50

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MUL23530
MUL23540
MUL23550
MUL23560
MUL23570
MUL23580
MUL23590
MUL23600
MUL23610
MUL23620
MUL23630
MUL23640
MUL23650
MUL23660
MUL23670
MUL23680
MUL23690
MUL23700
MUL23710
MUL23720
MUL23730
MUL23740
MUL23750
MUL23760
MUL23770
MUL23780
MUL23790
MUL23800
MUL23810
MUL23820
MUL23830
MUL23840
MUL23850
MUL23860
MUL23870
MUL23880
MUL23890
MUL23900
MUL23910
MUL23920
MUL23930
MUL23940
MUL23950
MUL23960
MUL23970
MUL23980
MUL23990
MUL24000

```

      QUEQ(DNUM) = DUEQ(DNUM) - 1
      IF(QUEQ(DNUM).NE.0) GO TO 20
      DO 12 I = DNUM, DUEQ
        DUEA(I) = DUEA(I+1)
        DUEE(I) = DUEE(I+1)
        DUEC(I) = DUEC(I+1)
        DUEI(I) = DUEI(I+1)
      CONTINUE
      DUEQ = DUEQ - 1
      CONTINUE
      OTIME = SRTI
      CALL ESDUE(ACT,ECTYP,CTIME,1,DUEQ,DUEE,DUEQ,DUEI)
      CONTINUE
      RETURN
      END
12
20
50

```

```

*****
** SUBROUTINE 'MPACK' READS AND INITIALIZES INPUT VARIABLES FOR:
** THE 'MULTIE' SUBROUTINE. THE INITIAL DOLLAR VALUE INVESTED
** IN INVENTORY IS CALCULATED FOR ALL ECHELONS. ADDITIONALLY,
** AT THE START OF EACH MISSION IT RESETS APPROPRIATE VARI-
** ABLES TO THEIR INITIAL CONDITIONS.
**
*****

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```

SUBROUTINE MPACK(ERQ,HILIM,IP,ONHNC,MPLT,MRT,MSDT,REORD,
1 RPAIR,OTIME,DUEA,DUEE,DUEQ,DUEI,DUEQ,DUEE,DUEQ,DUEI)
COMMON/MULTI/MAXLC,MULTC,MFLAG,IQPTM,IRC,IQPTP1
COMMON/STAT/XD(200,4),XT(4),XG,SUMD(200,4),SUMXD(200,4)
COMMON/ISTAT/NIST,NMFR(200,4,2),NNN(200,4,3),NRA,NRR1,
1 NRF(200,4,2),NSHIP(14,14),IXD(200,4),IXI(4),IXG
COMMON/MP/CAAR,ALFAI,ALFA2,SSRT,ECCS(200),CSTR(6),OSTM(11),
1 CST(2,11,4)
COMMON/NS/NUPSS(30),NRSHPS,ITOTEQ,NSSEQ(500),NRWCS
INTEGER DUEQ
INTEGER DUEE
INTEGER DUEA(MAXC),DUEE(MAXD),CUEQ(MAXD),IP(38,200),ERQ(200),
1 HILIM(38,200),ONFNC(38,200),RECRD(38,200),RPAIR(200),NSSS(30),
1 REAL CUEI(MAXD),MPLT(200),MRT(200),MSDT

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MUL244010
MUL244020
MUL244030
MUL244040
MUL244050
MUL244060
MUL244070
MUL244080
MUL244090
MUL244100
MUL244110
MUL244120
MUL244130
MUL244140
MUL244150
MUL244160
MUL244170
MUL244180
MUL244190
MUL244200
MUL244210
MUL244220
MUL244230
MUL244240
MUL244250
MUL244260
MUL244270
MUL244280
MUL244290
MUL244300
MUL244310
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MUL244370
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MUL244390
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MUL 24490
MUL 244500
MUL 244510
MUL 244520
MUL 244530
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MUL 244580
MUL 244590
MUL 244600
MUL 244610
MUL 244620
MUL 244630
MUL 244640
MUL 244650
MUL 244660
MUL 244670
MUL 244680
MUL 244690
MUL 244700
MUL 244710
MUL 244720
MUL 244730
MUL 244740
MUL 244750
MUL 244760
MUL 244770
MUL 244780
MUL 244790
MUL 244800
MUL 244810
MUL 244820
MUL 244830
MUL 244840
MUL 244850
MUL 244860
MUL 244870
MUL 244880
MUL 244890
MUL 244900
MUL 244910
MUL 244920
MUL 244930
MUL 244940
MUL 244950
MUL 244960

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C C C
DATA ERQ/200*0/,FILIM/7600*0/,REORC/7600*0/,OSTM/11*0.0/,
1OSTSR/6*0.0/,OST/88*0.0/

MFLAG = 1
IF(MULTC = 1) NE 0) GO TO 50
READ(5,502)PI,CRAR,MSDT,SSRT,ALFA1,ALFA2
DO 20 J=1,NTY
  IF(RPA(5,504)RPAIR(J),MPLT(J),ECOST(J))
  IF(EQ. 1) READ(5,506)MRT(J),ERQ(J)
  GO TO 20
  IF(RPA(5,508)HILIM(NUMSS(1)-869,J),HILIM(1,J),I=31,38)
  READ(5,508)RECRD(NUMSS(1)-869,J),RECRD(1,J),I=31,38)
  IF(NRSHPS=2,NEQ:PS) GC TO 20
  DO 10 K=2,NRSHPS
    NMS1 = NUMSS(K)-869
    NMS1 = NUMSS(1)-869
    HILIM(NMS1,J)
    REORC(NMS,J) = REORC(NMS1,J)
  10 CONTINUE
  20 GO TO 25
  25 DO 30 I=1,NRSHPS
    NMS = NUMSS(I)-869
    READ(5,512)FILIM(1,J),J=1,NTY}
    33 DO 35 I=31,38
      READ(5,512)HILIM(1,J),J=1,NTY}
    35 CONTINUE
    40 READ(5,516)OSTSR(I),I=1,6)
    READ(5,516)OSTM(I),I=1,11)
    DO 46 I=1,22
      46 READ(5,516)OST(I,J,K),J=1,11)
      WRITE(6,600)ARSHFS
      WRITE(6,602)ARSHFS
      WRITE(6,604)NTY
      WRITE(6,606)
      WRITE(6,608)
      WRITE(6,610)
      DO 100 I=1,NTY
        100 WRITE(6,612)I,RPAIR(I),MPLT(I),ECOST(I),ERQ(I)
        WRITE(6,626)
        WRITE(6,627)
        WRITE(6,627)
        DO 101 I=1,NRSHPS
          101 NS3(I) = NUMSS(I) - 869

```

```

1011 CONTINUE
NRS = NRSHPS
IF(NRSHPS.GT. 15) NRS = 15
I1 = 1
WRITE(6,628)(NSSS(I),I=11,NRS)
DO I=1,NRS
  I1 = I
  WRITE(6,629) I1,NTY
  DO I=1,NTY
    WRITE(6,630) I, (HILIM(NUMSS(J)-869,I),J=11,NRS)
    WRITE(6,632)(REORD(NUMSS(J)-869,I),J=11,NRS)
  CONTINUE
IF(NRSHPS.LE.15 .OR. 11.EQ.16) GO TO 104
I1 = 16
NRS = NRSHPS
GO TO 101
104 WRITE(6,634)
  WRITE(6,635)
  DO I=1,NRS
    I1 = I
    WRITE(6,636) I, (HILIM(J,I),J=31,38)
    WRITE(6,638)(REORD(J,I),J=31,38)
  CONTINUE
  WRITE(6,614)
  WRITE(6,616)
  WRITE(6,618)(I,I=1,14)
  DO I=1,14
    WRITE(6,620)I,OSTSR(I)
  DO I=1,14
    WRITE(6,622)I,OSTSR(I)
  IA = 1
  IB = 1
  IC = 1
  DO K=1,4
    IF(K.EQ.1 .OR. K.EC.2) GO TO 118
    IB = 1
    WRITE(6,624)IC,(OST(IA,J,K),J=1,11)
    IC = IC + 1
    IF(K.EC.2) GO TO 120
    WRITE(6,624)IC,(OST(IB,J,K),J=1,11)
    IC = IC + 1
  CONTINUE
  WRITE(6,624)IC,(CSTM(I),I=1,11)
C
  IXT(1) = 0
  DO I=1,NTY
    IXL(1,I) = 0
    DO J=1,3C
      IXD(I,I) = HILIM(J,I) + IXD(I,1)

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1001 CONTINUE IXD(1,1) = IXD(1,1) + IXT(1)
1002 CONTINUE IXG = IXT(1)
      ITEM = 28
      DO 1004 I=2,4
        ITEM = ITEM + 2
        IF(I, EQ, 4) ITEM = ITEM - 1
        IXT(I) = 0
      DO 1003 J=1,NTY
        XD(J,I) = HILIM(ITEM+1,J) + IXD(J,I)
        IF(I, NE, 3) IXD(J,I) = HILIM(ITEM+2,J) + IXD(J,I)
        IXT(I) = IXD(J,I) + IXT(I)
      CONTINUE
1003 IXG = IXT(1) + IXG
1004 CONTINUE XG = 0.0
      DO 1114 I=1,4
        XT(I) = 0.0
        DO 1113 J=1,NTY
          XD(J,I) = FLOAT(IXD(J,I))*ECOST(J)
          XT(I) = XD(J,I) + XT(I)
          SUMC(J,I) = 0.0
          SUMXD(J,I) = 0.0
        CONTINUE
        XG = XT(I) + XG
      CONTINUE
      NRRT = 0
      NRAT = 0
      NIST = 0
      DO 1125 K=1,3
        DO 1125 J=1,4
          DO 1125 I=1,NTY
            IF(K, EQ, 3) GO TO 1120
            NMFR(I,J,K) = 0
            NMF(I,J,K) = 0
            NNN(I,J,K) = 0
          CONTINUE
        DO 1130 I=1,14
          DO 1130 J=1,14
            NSHIP(I,J) = 0
          CONTINUE
        DO 50 CTIME = 0.0
          DO 51 I=1,4
            DO 51 J=1,NTY
              SUMXC(J,I) = FLOAT(IXD(J,I))
            DO 55 I=1,MAXD

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**
** SUBROUTINE 'MSTAT' CCMPLES AND PRINTS END-OF-RUN STATISTICS
** FOR THE MULTI-ECHOLON SUPPLY NETWORK.
**
**
**
SUBROUTINE MSTAT(IITMSN,NTY,TPM,IOPT)
COMMON/STAT/XD(200,4),XT(4),XG,SUMC(200,4),SUMXD(200,4)
COMMON/ISTAT/NSHIP(200,4,2),NNK(200,4,3),NRA,NRRF,
1NRFF(200,4,2),NSHIP(14,14),IXD(200,4),IXT(4),IXG
COMMON/MP/CRAR,ALFA1,ALFA2,SSRT,ECCST(200),OSTM(11),
1OST(2,11,4)
COMMON/MULTI/MAXC,MULTC,MELAG,IOPTM,IRC,IOPTPI
INTEGER NNFL(4,2),NMFE(200,2),NMFT(2),NRFL(4,2),
1NRFT(2),NNNL(4,3),NNNE(200,3),NNNT(3),IEQ(200)
REAL ANMFE(200,2),ANMFL(4,2),ANMFT(2),ANRFE(200,2),ANRFL(4,2),
1ANRFT(2),ANNK(200,4,3),ANNNE(200,3),ANNNL(4,3),ANSHIP(14,14),
2AADV(200,4),AADV(4),ANNNT(3),SUMDM(200,4),CSUMDM(200,4)

** COMPUTE CROSS SUMS AND TOTALS
DO 10 K=1,3,NTY
  IF(K,NTY) EQ 3) GC TO 4
  NMFE(I,K) = 0
  NRFE(I,K) = 0
  NNNL(I,K) = 0
  DC 6 J=1,4
  IF(K,NTY) EQ 3) GO TO 5
  NMFE(I,K) = NMFE(I,K) + NMFE(I,K)
  NRFE(I,K) = NRFE(I,K) + NRFE(I,K)
  NNNL(I,K) = NNNL(I,K) + NNNL(I,K)
  CC CONTINUE
CONTINUE
DO 30 K=1,3 GO TO 12
  IF(K,NTY) EQ 3) GO TO 12
  NMFT(K) = 0
  NRFT(K) = 0
  NNNT(K) = 0
  DO 25 J=1,4

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14      IF(K.EQ.3) GC TO 14
        NMFL(J,K) = 0
        NRFL(J,K) = 0
        NNNL(J,K) = 0
        DO 20 I = 1,NTY
          IF(K.EQ.3) GO TO 16
          NMFL(J,K) = NMFL(I,J,K) + NMFL(J,K)
          NRFL(J,K) = NRFL(I,J,K) + NRFL(J,K)
          NNNL(J,K) = NNNL(I,J,K) + NNNL(J,K)
          CONTINUE
        GO TO 22
        NMFL(J,K) = NMFL(J,K) + NMFL(K)
        NRFL(J,K) = NRFL(J,K) + NRFL(K)
        NNNL(J,K) = NNNL(J,K) + NNNL(K)
        CONTINUE
23      CONTINUE
30      NSPT = 0
        DO 60 I=7,14
          DO 55 J = 1,11
            NSPT = NSPT + ASHIP(I,J)
          CONTINUE
55      CONTINUE
60      ** COMPUTE AVERAGES PER MISSION.
        TMSN=FLCAT(I,TMSN)
        WRITE(6,700C)TMSN
        FORMAT(10,5X,'CTAL NR OF MISSIONS IS: ',F5.0)
7000     DO 110 K= 1,3
          DO 100 I=1,NTY
            IF(K.EQ.3) GC TO 90
            ANMFE(I,K) = (FLOAT(NMFE(I,K)))/TMSN
            ANRFE(I,K) = (FLOAT(NRFE(I,K)))/TMSN
            ANNNE(I,K) = (FLOAT(NNNE(I,K)))/TMSN
          CONTINUE
          J=1,4
          DO 105 J=1,4
            IF(K.EQ.3) GC TO 102
            ANMFL(J,K) = (FLOAT(NMFL(J,K)))/TMSN
            ANRFL(J,K) = (FLOAT(NRFL(J,K)))/TMSN
            DO 103 L=1,NTY
              ANN(L,J,K) = (FLCAT(NNN(L,J,K)))/TMSN
            CONTINUE
            ANNNL(J,K) = (FLOAT(NNNL(J,K)))/TMSN
          CONTINUE
          IF(K.EQ.3) GO TO 107
          ANPFT(K) = (FLOAT(NMFT(K)))/TMSN
          ANRFT(K) = (FLOAT(NRFT(K)))/TMSN
105

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107 ANANT(K) = (FLOAT(ANANT(K)))/TMSN
110 CONTINUE
    ANRRT = (FLCAT(NRRT))/TMSN
    ANRST = (FLCAT(NRST))/TMSN
    ANRA = (FLCAT(NRA))/TMSN
    ANSPT = (FLCAT(NSPT))/TMSN
    DO 115 I=7,14
        DO 113 J=1,11
            ANSHIP(I,J) = (FLOAT(NSHIP(I,J)))/TMSN
        CONTINUE
    CONTINUE
    DO 120 J=1,4
        DO 122 I=1,NTY
            SUMDM(I,J) = SUMD(I,J)/TMSN
            CSUMCM(I,J) = SUMDM(I,J)*ECCST(I)
            AADV(I,J) = CSUMDM(I,J)/TPM
        CONTINUE
    CONTINUE
    AAGTV = 0.0
    DO 128 I=1,4
        AATDV(I) = 0.0
        DO 124 J=1,NTY
            AATCV(I) = AADV(J,I) + AATCV(I)
        CONTINUE
        AAGTV = AATDV(I) + AAGTV
    CONTINUE
    DO 130 I=1,NTY
        IEQ(I) = 1
    CONTINUE
    ** WRITE OUTPUT SUMMARIES.
    WRITE(6,600) ITMSN
    WRITE(6,603)
    WRITE(6,688)
    IF(IQPT.EQ.2) GO TO 200
    WRITE(6,606)
    WRITE(6,610) (ANMFL(I,1),I=1,4)
    WRITE(6,612) (ANMFL(I,2),I=1,4)
    IF(IQPT.EQ.1) GO TO 205
    WRITE(6,614)
    DO 202 I=1,NTY,11
        DO 204 J=1,10
            WRITE(6,616) (IEC(J),J=1,110)
            WRITE(6,620) (ANMFE(J,1),J=1,110)
            WRITE(6,622) (ANMFE(J,2),J=1,110)
        CONTINUE
    CONTINUE

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202 CONTINUE
205 WRITE(6,688)
    IF(100.EQ.0) 2) GO TO 208
    WRITE(6,686)
    WRITE(6,626)
    WRITE(6,628)
    IF(100.EQ.0) 1) GO TO 212
    DO 210 I=1,NTY,11
        WRITE(6,616) (IEQ(J),J=1,110)
        WRITE(6,632) (ANRFE(J,1),J=1,110)
        WRITE(6,634) (ANRFE(J,2),J=1,110)
    CONTINUE
212 WRITE(6,636) ANRT
    WRITE(6,638) ANRA
    WRITE(6,640)
    WRITE(6,642)
    WRITE(6,644)
    WRITE(6,646)
    WRITE(6,648)
    WRITE(6,650)
    WRITE(6,652)
    WRITE(6,654)
    WRITE(6,656)
    WRITE(6,658)
    WRITE(6,660)
    WRITE(6,662)
    WRITE(6,664)
    WRITE(6,666)
    WRITE(6,668)
    IF(100.EQ.0) 1) GO TO 220
    DO 214 I=1,NTY
        WRITE(6,674) IEQ(I), (XD(I,J),J=1,4)
    CONTINUE
220 WRITE(6,676) (XT(I),I=1,4)
    WRITE(6,678) XG
    WRITE(6,680)
    IF(100.EQ.0) 1) GO TO 224
    WRITE(6,672)

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DO 224 I=1,NTY
  WRITE(6,674) IEQ(I), (AADV(I,J), J=1,4)
  CONTINUE
  WRITE(6,676) (AATDV(J), J=1,4)
  WRITE(6,678) (AAGV
  WRITE(6,680)
  WRITE(6,682)
  WRITE(6,683)
  IF(IOPT.EQ. 1) GO TO 230
  WRITE(6,672)
  DO 230 I=1,NTY
    WRITE(6,684) IEQ(I), ((ANN(I,J,K), K=1,3), J=1,4), (ANNE(I,K), K=1,3)
    CONTINUE
    WRITE(6,685) ((ANNL(I,K), K=1,3), I=1,4)
    WRITE(6,686) (ANNNT(K), K=1,3)
    WRITE(6,688)
    RETURN
  230
600 FORMAT(1,2CX,'DATA SUMMARY: MULTI-ECHELON SUPPLY SYSTEM')
602 FORMAT(0,5X,14,'SIMULATED MISSILES HAVE BEEN RUN. THE FOLLOWING')
603 FORMAT(6X,'SUMMARY STATISTICS ARE BASED ON AVERAGE NUMBERS PER MISS')
604 X
604 FORMAT(1,0,5X,1,'PROCUREMENT COSTS')
606 FORMAT(1,0,5X,1,'ECHELON SUMMARY')
608 X
608 FORMAT(1,0,5X,1,'SHIPPED FROM MFR TO:',7X,'SHIPS',7X,'MLSF',7X,
  610 'DEPT',7X,'SUPPLY CENTERS',7X,3(8X,F4.1),12X,F4.1)
612 FORMAT(1,0,5X,1,'ITEMS PROCURED',5X,3(8X,F4.1),12X,F4.1)
614 FORMAT(1,0,5X,1,'EQUIPMENT',5X,3(8X,F4.1),12X,F4.1)
616 FORMAT(1,0,5X,1,'EQUIPMENT',5X,3(8X,F4.1),12X,F4.1)
620 FORMAT(1,0,5X,1,'ITEMS PROCURED',5X,3(8X,F4.1),12X,F4.1)
622 FORMAT(1,0,5X,1,'ITEMS PROCURED',5X,3(8X,F4.1),12X,F4.1)
624 FORMAT(1,0,5X,1,'ITEMS PROCURED',5X,3(8X,F4.1),12X,F4.1)
626 X
626 FORMAT(1,0,5X,1,'SHIPPED FR REPAIR FACILITIES TO:',4X,'SHIPS',4X,
  628 'MLSF',4X,'DEPT',4X,'SUPPLY CENTERS',7X,3(8X,F4.1),12X,F4.1)
630 FORMAT(1,0,5X,1,'ITEMS PROCURED',5X,3(8X,F4.1),12X,F4.1)
632 FORMAT(1,0,5X,1,'ITEMS PROCURED',5X,3(8X,F4.1),12X,F4.1)
634 FORMAT(1,0,5X,1,'ITEMS PROCURED',5X,3(8X,F4.1),12X,F4.1)
636 X
636 FORMAT(1,0,5X,1,'ITEMS RETURNED BY SHIPS TO REPAIR FACILITIES:',
  638 'MLSF',4X,'DEPT',4X,'SUPPLY CENTERS',7X,3(8X,F4.1),12X,F4.1)
640 X
640 FORMAT(1,0,5X,1,'REPAIRABLE CARCASSES LOST DUE TO ATTRITION:',
  642 'MLSF',4X,'DEPT',4X,'SUPPLY CENTERS',7X,3(8X,F4.1),12X,F4.1)
644 X
644 FORMAT(1,0,5X,1,'TRANSPORTATION COSTS (NR. SHIPMENTS)',
  646 'MLSF',4X,'DEPT',4X,'SUPPLY CENTERS',7X,3(8X,F4.1),12X,F4.1)
648 X
648 FORMAT(1,0,5X,1,'DESTINATION ACTIVITY',
  650 'MLSF',4X,'DEPT',4X,'SUPPLY CENTERS',7X,3(8X,F4.1),12X,F4.1)
652 X
652 FORMAT(1,0,5X,1,'DESIGNATIONS 1-6 REFER TO SHIP LOCATIONS',
  654 'MLSF',4X,'DEPT',4X,'SUPPLY CENTERS',7X,3(8X,F4.1),12X,F4.1)

```


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